

# CHEMICAL AND RADIOPHARMACEUTICAL SCIENCES UNIT

## MISSION

CRSU is a multi- and inter-disciplinary unit designed to promote and provide a focus for networks aiming to develop research and expertise in the synthesis and characterization of inactive and radioactive compounds, and characterization of cultural, geological and biogenic materials, and hydrological resources. Its activities focus on Radiopharmaceutical and Health Sciences, Nuclear Sciences and Techniques, Catalysis, Materials Science, Environmental and Earth Sciences, and Cultural Heritage applications.

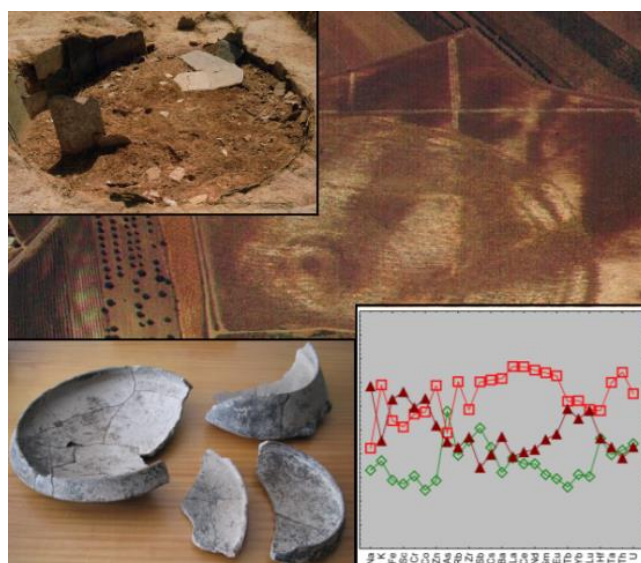
## OBJECTIVES

- Nuclear methods for the characterization, provenancing, production technologies, absolute dating by TL-OSL of cultural heritage.
- Geochemistry, mineralogy, spatial variation of dose rate and absolute dating of different geological/geomorphological contexts.
- Elemental and Isotopic Analysis and Radiocarbon Dating- applications in the fields of Environmental Geochemistry, Isotope Hydrology, Oceanography and Archaeometry.
- *f*-Element chemistry studies at fundamental and applied levels in the areas of nuclear science, catalysis and new materials, comprising work in coordination and organometallic chemistry, catalytic applications of inorganic compounds, functional hybrid materials, gas-phase chemistry/mass spectrometry and molecular energetics.
- Basic/oriented research and technology transfer on specific halogen- and metal-based nuclear tools for SPECT and PET Molecular Imaging and Targeted Radiotherapy. Molecular or nano-radioactive tools bearing peptide or non-peptide molecules are synthesized, structurally characterized and pre-clinically evaluated *in vitro* and *in vivo*. The mechanism of action and interaction with biomarkers is studied using molecular and cellular biology techniques.
- Exploration of ternary intermetallics phase diagrams based on *f*- and *d*- elements and studies of exotic ground state properties such as strongly correlated electron behavior, superconductivity and magnetism.
- Development of multifunctional molecular Materials by combination of magnetic and electroactive centers, comprising switchable magnetic conductors, transition metal bisdithiolene complexes for magnetic and conducting networks and single molecule magnets based on *f*-elements.

## ACHIEVEMENTS

### Nuclear Methods Applied to Cultural Heritage

Compositional data of ceramics from Perdigões point to a regional origin with a spread of resources in the Chalcolithic funerary pottery - necropolis used by distant communities, and a consistent occupation of the site with the resource to the same type of raw materials from Neolithic to Chalcolithic (Fig. 1).



**Fig. 1:** Perdigões archaeological site (Reguengos de Monsaraz, Portugal).

## Archaeometallurgy



**Fig. 2:** Middle Bronze Age dagger (Montinhos 6).

Study of grave goods from hypogea and cists produced new evidence on the role of metal (copper, bronze and silver) during the Middle Bronze Age and on the introduction of the first bronzes in southern Portugal. Lead isotope ratios determinations on bronzes and lead artefacts were used to investigate their provenance (Fig. 2).

## Spatial Variation of Dose Rate in Superficial Environments

Soil and sediment were collected from contrasting lithological settings from locations across north-central Portugal. Detailed in situ measurements and area surveys by gamma spectrometry were done (Fig. 3).



**Fig. 3:** Soil sampling and field gamma spectrometry in Central Portugal.

## Environmental Changes Along the Portuguese Coastal Area by Organic and Inorganic Geochemistry and Dating

Sources of sedimentary organic matter in the Guadiana estuary were related to C3 vascular plants and/or fossil carbon. A recent increase in marine OM in the lower estuary was associated to Alqueva dam.

Marine radiocarbon reservoir effect ( $\Delta R$ ) in southern Iberian Atlantic coast was found to depend upon oceanographic conditions; a Bond event at 0.8 ka cal BP and a drastic change during the V Millennium cal BP were identified in Barlavento and Andalusian coastal areas.

## Isotope Hydrology

Conceptual models establishing relationships between mineral water and local infiltration of rainwater in the Melgaço-Messagães and Caldas da Rainha systems. At Melgaço system the  $\delta^{13}\text{C}$  on  $\text{CO}_2$  in the groundwater indicates methane origin from the upper mantle.

Evaluation of the origin of salinization in coastal aquifers- Algarve and Lower Sado basins, and Santiago Island (Cape Verde) (Fig. 4).  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  contents point to recent (Algarve) and ancient seawater (Sado) trapped in sediments.



**Fig. 4:** Santiago Island: groundwater - a natural resource (sustainability and management).

## Organometallic Chemistry and Catalysis of the *f*-elements

Rare examples of  $\text{CO}_2$  activation by molecular thorium(IV) and uranium(IV) alkyl compounds were obtained, and new bimetallic copper or nickel and thorium or uranium oxides were shown to be active in the oxidation or conversion of methane to C2 hydrocarbons, using nitrous oxide as oxidant (Fig. 5).

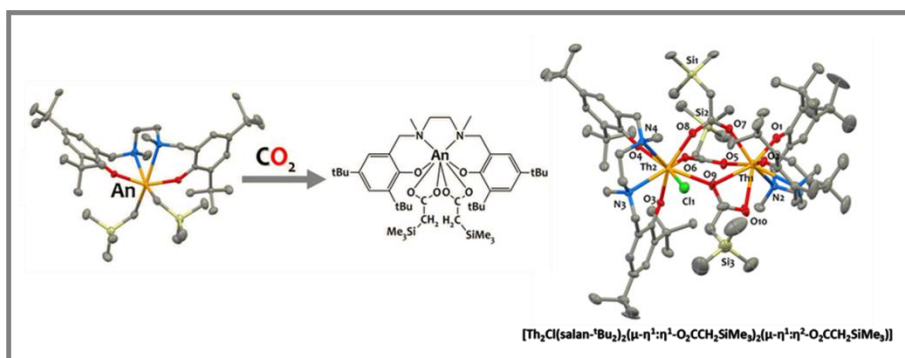


Fig. 5: Activation of CO<sub>2</sub> by thorium and uranium alkyl complexes.

## Radiopharmaceutical Research

A nanoplatform bearing bifunctional chelators and mannose units has been synthesized and labeled with <sup>99m</sup>Tc. The pre-clinical evaluation of this compound has shown its suitability for sentinel lymph node detection (SLND) (Fig. 6).

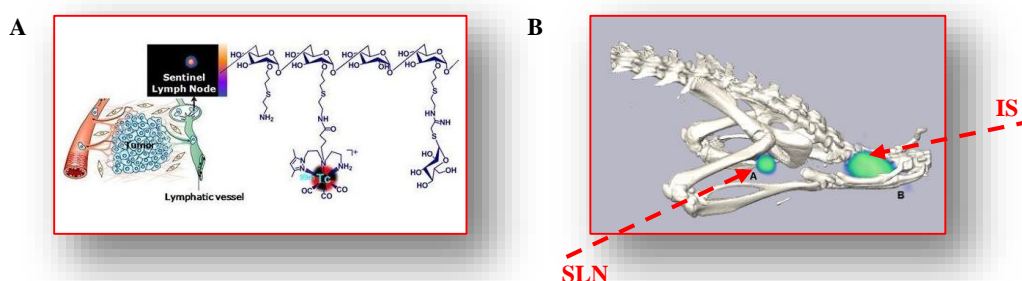


Fig. 6: For SLND: A) Structure of the <sup>99m</sup>Tc-nanocompound; B) SPECT/CT Imaging after injection of the radioprobe (IS, injection site; SLN, sentinel lymph node).

Following our previous work on radiopeptides for melanoma detection (MD), we have also shown, at the pre-clinical level, how the substitution pattern of a bifunctional chelator affects the pharmacokinetic profile of the peptide, without compromising *in vitro* and *in vivo* targeting properties (Fig. 7).

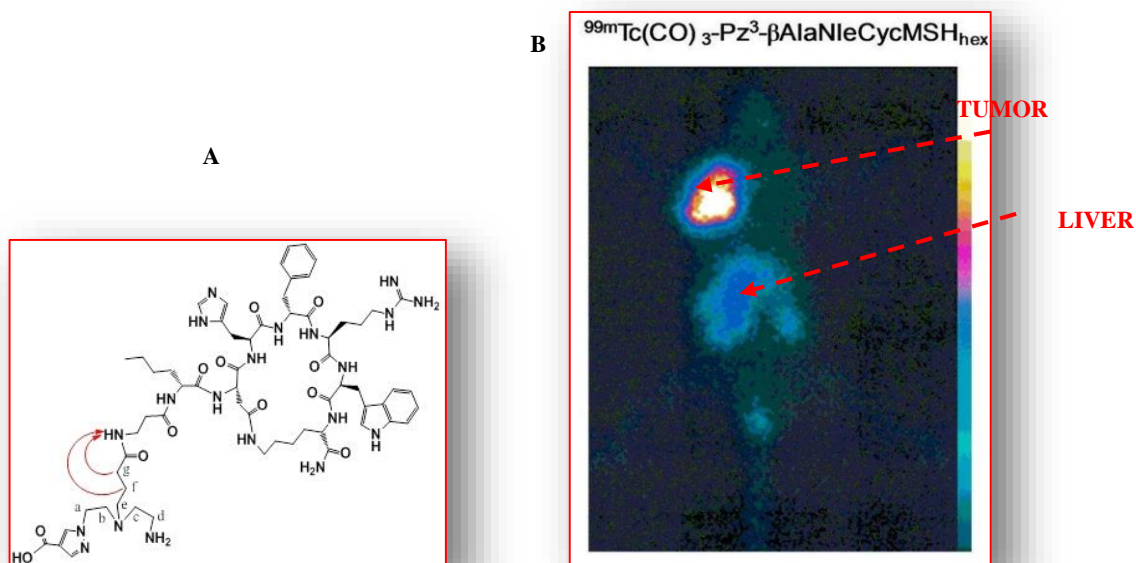
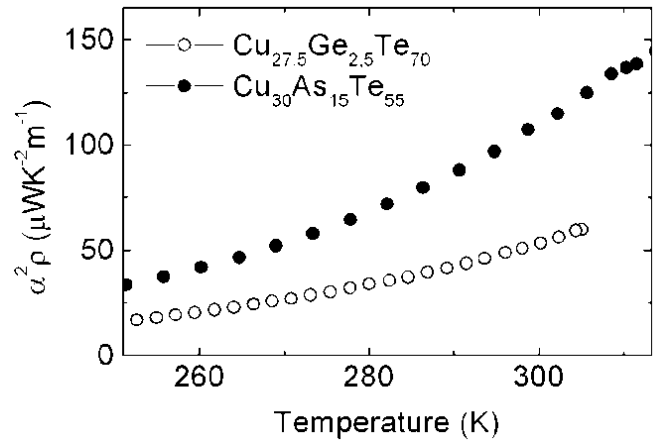


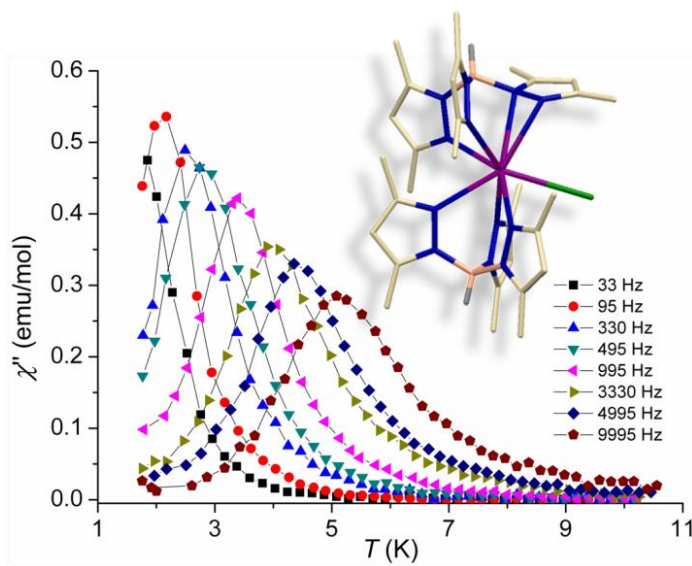
Fig. 7: For MD A) Structure of the Pz<sup>3</sup>-βAlaNleCycMSH<sub>hex</sub>; B) Planar scintigraphic images of B16F1 murine melanoma-bearing mice after injection of the radiotracer.

## New Thermoelectric Materials

Identification, synthesis and characterization of semiconducting chalcogenide glasses as new thermoelectric materials with high ZT, namely  $\text{Cu}_x\text{As}_y\text{Te}_z$  ones showing power factors as high as  $110 \mu\text{WK}^{-2}\text{m}^{-1}$  at room temperature.



## f-Element Centers for Single Molecule Magnetic Behaviour from Lanthanides to Uranium



Identification of a new series of lanthanide one-dimensional coordination polymers with single molecule magnetic (SMM) behavior and enlargement of the still rare family of mononuclear U(III) compounds with SMM behavior, enabling the establishment of key correlations between the f-element coordination and magnetic relaxation properties.

## Groups – R&D Activities

### Radiopharmaceutical Sciences Group

#### TEAM

Name	Category	R&D
Isabel Rego dos Santos	Principal Researcher with habilitation	100%
António Manuel Rocha Paulo	Principal Researcher	100%
João Domingos Galamba Correia	Principal Researcher	100%
Maria de Lurdes Barreira Patricio Gano	Auxiliary Researcher	100%
Fernanda Marujo Marques	Auxiliary Researcher	100%
Paula Dolores Galhofas Raposinho	Auxiliary Researcher	100%
Maria Cristina das Neves Oliveira	Auxiliary Researcher	100%
Maria Paula Campello	Auxiliary Researcher	100%
Célia Maria da Cruz Fernandes	Auxiliary Researcher	100%
Filipa Fernandes Mendes	Auxiliary Researcher ( <i>Ciência 2007</i> )	100%
Goreti J. R. Morais	Auxiliary Researcher ( <i>Ciência 2008</i> )	100%
Amadeu Rodrigues	Assistant Technician	90% RSG + 10% UCQR
Elisabete Correia	Assistant Technician	100%
Sofia Gama	Post-doctoral Researcher	100%
Elisa Palma	Post-doctoral Researcher	100%
Carolina Moura	PhD Student	20%
Maurício Morais	PhD Student	100%
Francisco Silva	PhD Student	100%
Susana Cunha	PhD student	100%
M. Angeles Medrano	PhD student at Madrid (stay 5 months)	50%
Jacqueline Herrera	PhD student at Madrid (stay 1 month)	10%
Leonor de Sá Nogueira Côrte-Real	MSc Student	100%
Filipa Gonçalves.	MSc Student	80%
Marta O. Antunes,	MSc Student	50%
Patrícia Mendes	MSc Student	90%
Nuno Martins	MSc Student	35%
Inês Rodrigues	MSc Student + Research Grant (BI)	80%
Vera Ferreira	MSc Student	30%
Isabel Rodrigues	MSc Student	30%
Leticia Quental	MSc Student	30%
Rafael Gomes	MSc Student	10%
Ana Rita Palma	MSc Student	50%
Fernando Toscano	MSc Student	40%
Patrique Nunes	Research Grant (BI)	25%
Carina Neto	Research Grant (BI)	60%
Filipe Vultos	Research Grant (BI)	100%
Sofia Monteiro	Research Grant (BI)	100%
Joana Castro	Undergraduate Student	10%
Ana Teresa Pinto	Undergraduate Student	40%
Ana Bárbara Pereira	Undergraduate Student	25%
Janete Almeida	Undergraduate Student	25%

#### OBJECTIVES

Cancer and neurodegenerative disorders are major life threatening diseases and a developing number of these pathologies are diagnosed every year in developed countries. To overcome such problem intense research in biomedical sciences takes place worldwide to implement sensitive *imaging modalities for an early diagnosis and targeted specific therapies*. In this field the nuclear techniques have enormous advantages due to their high intrinsic sensitivity and unlimited depth penetration. The main goal of the Radiopharmaceutical Sciences Group (RSG) is to contribute for this area by carrying on basic/ oriented research and technology transfer *on specific halogen- and metal-based nuclear tools for SPECT and PET Molecular Imaging and Targeted Radiotherapy based on beta- and Auger electron - emitters*. To perform this research using the facilities implemented and maintained by the RSG as well the expertise of the multidisciplinary team in organic and

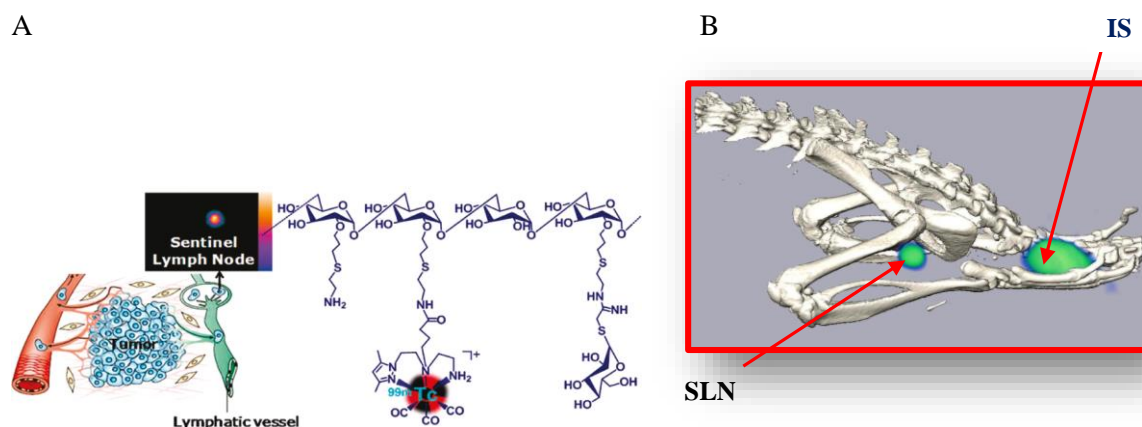
inorganic chemistry, bioconjugation, radiochemistry, animal and cell studies and molecular biology. To use our facilities and know-how to provide education and training at different levels, to act as a key partner in national and international projects and to provide expertise to National and International Centres and Universities, Science Foundations, Scientific and Technical Committees and Agencies.

## MAIN ACHIEVEMENTS

Aiming at the design of innovative nuclear tools for an early diagnosis of cancer and neurological diseases as well as for targeted radiotherapy, we have studied several molecular and nano-specific metal- and halogen-based compounds targeted at biomarkers related to: melanoma, breast and prostate cancer, bone metastasis, sentinel lymph node and beta-amyloid (A $\beta$ ) plaques.

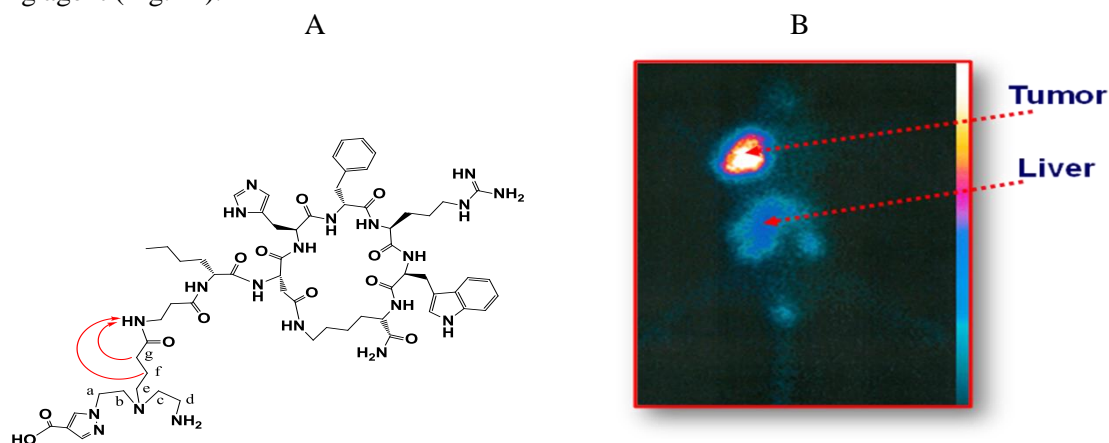
From all the radiotracers synthesized and pre-clinically evaluated, we must refer a nano-specific multifunctional complex for sentinel lymph node detection (SLND) and a specific molecular compound for melanoma detection (MD).

For **SLND** a dextran-based platform bearing bifunctional chelators and mannose units has been synthesized, as well as the corresponding  $^{99m}\text{Tc}$  radiotracers which were characterized by comparing their HPLC chromatograms with the ones obtained for the corresponding Re surrogates characterized both at the chemical and physical level (Fig.1A). One of these radiotracers, with positive potential zeta (+ 7.1 mV, pH 7.4) and hydrodynamic diameter in the range 8.4–8.7 nm has provided a clear delineation of the SLN without significant washout to other regions (Fig. 1B).



**Fig. 1:** SLND: A) Structure of the  $^{99m}\text{Tc}$ -nanocompound; B) SPECT/CT Imaging after injection of the radiotracer (IS, injection site; SLN, sentinel lymph node)

Following our previous work on radiopeptides for **MD**, we have also shown, at the pre-clinical level, how the substitution pattern of the bifunctional chelator affects the pharmacokinetic profile of the  $^{99m}\text{Tc}(\text{CO})_3$ -labeled lactam bridge-cyclized  $\alpha$ -melanocyte stimulating hormone derivative -  $\beta\text{AlaNleCycMSH}_{\text{hex}}$ , without compromising its *in vitro* and *in vivo* targeting properties. The good tumor uptake and favorable tumor-to-non-target-organs ratios of one of these compounds (Fig. 2 A) highlights its potential usefulness as a melanoma imaging agent (Fig.2B).



**Fig. 2:** MD A) Structure of the  $\text{Pz}^3$ - $\beta\text{AlaNleCycMSH}_{\text{hex}}$ ; B) Planar scintigraphic images of B16F1 murine melanoma-bearing mice after injection of the radiotracer.

We have also contributed for a better understanding of the *in vivo* behavior of neuropeptide Kyotorphin derivatives and small domain antibodies, which are being developed as analgesics and as biopharmaceuticals for therapeutic applications, respectively.

### Financial Support:

A scientist *Ciência 2007* of the RSG was selected at the National Level as **FCT Researcher** and will stay in the Group.

**Two new projects** coordinated by RSG/IST/CTN were funded by FCT:

- Project in research lines of excellence (EXCL/QEQ-MED/0233/2012) entitled *Molecular and Nano Tools for Cancer Theranostics*. This project aims to consolidate our research on radiopharmaceutical sciences and to extend the scope of the research currently underway.
- Exploratory research project (EXPL/BIM-MEC/0115/2012) entitled *A Molecular Imaging Approach to Cystic Fibrosis*. This type of project is based on an idea/concept considered as having great originality and/or innovative potential.

### Education and Training:

- **High School/University Visits:** The group has been visited by 564 students from High School and 25 from Universities
- **Graduation:** i) Radiopharmacy in Nuclear Medicine Course, ESTeSL.
- **Post-graduation:** i) Coordination and Teaching of the Master Course Biomedical Inorganic Chemistry: Diagnostic and Therapeutical Applications; ii) Coordination and teaching of Radiopharmaceutical Chemistry in the Master Course Pharmaceutical and Therapeutic Chemistry/FFUL; iii) Teaching of Chemical Systems and Reactivity in the 2<sup>nd</sup> Cycle of Chemistry, FCUL; iv) Teaching at the Master in Pharmaceutical Sciences, Lusófona University; v) Teaching at the Master Course in Nuclear Medicine, ESTeSL; vi) Radiopharmacy in the Integrated Master of Pharmaceutical Sciences, FFUL.
- **Young scientists:** Several young scientists got MSc or PhD degrees in the group, playing a major role in our projects.

### Expertise Provided:

Public Nuclear Medicine Centers, Nuclear Medicine Champalimaud Foundation, INFARMED, IAEA, National and International Science Foundations (Portuguese, Canadian, USA, South Africa, Argentina, Uruguay and Chile) International Conferences and International Journals.

### Publications:

International Journals: 27; Patents Pending: 2; Proceedings:1; Invited Lectures: 14; Posters: 30; PhD thesis: 2; MSc thesis: 6; Participation in Juries: 28; Participation in Scientific and Technical Committees: 14; Organization Scientific Meetings: 2.

### RELEVANT PAPERS

- G. R. Morais, I. Santos, A. Paulo, Organometallic complexes for SPECT imaging and/or radionuclide therapy, *Organometallics*, 31, 5693-5714 (2012) DOI: 10.1021/om300501d.
- G. R. Morais, A. Paulo, I. Santos, A synthetic overview of radiolabeled compounds for  $\beta$ -amyloid targeting, *Eur. J. Org. Chem.*, 1279–1293 (2012) DOI: 10.1002/ejoc.201101449.
- S. Gama, F.Mendes, T. Esteves, F. Marques, A. Matos, J. Rino, J. Coimbra, M. Ravera, E. Gabano, I. Santos, A. Paulo, Synthesis and biological studies of pyrazolyl-diamine Pt(II) complexes containing polyaromatic DNA-binding groups, *ChemBioChem*. 13, 2352-2362 (2012) DOI:
- D. Can, B. Spingler, P. Schmutz, F. Mendes, P. Raposinho, C. Fernandes, F. Carta, A. Innocenti, I. Santos, C. Supuran, R. Alberto, [(Cp-R)M(CO)<sub>3</sub>] (M = Re or <sup>99m</sup>Tc) Sulphonamide Conjugates for Selective Targeting of Human Carbonic Anhydrase IX, *Angewandte Chemie*, 51, 3354–3357 (2012) DOI: 10.1002/anie.201107333
- I. Pirmettis, Y. Arano, T. Tsotakos, K. Okada, A. Yamaguchi, T. Uehara, M. Morais, J. D. G. Correia, I. Santos, M. Martins, S. Pereira, C. Triantis, P. Kyprianidou, M. Pelecanou, M. Papadopoulos, New

$^{99m}\text{Tc}(\text{CO})_3$ -mannosylated dextran bearing S-derivatized cysteine chelator for sentinel lymph node detection, Molecular Pharmaceutics, 9, 1681-1692 (2012) DOI: 10.1021/mp300015s.

## FUNDS

Project/Service	Reference	Timeframe	2012
Nitric oxide synthase targeting with Re(I)/ $^{99m}\text{Tc}$ (I)-complexes containing L-Arg derivatives: a structure-activity study.	PTDC/QUI/QUI/121752/2010 Leading Institution: IST/ID. Coord: J.D.G.Correia	2012-2015	17.100,00 €
Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for Targeted Radiotherapy of Tumors.	PTDC/QUI-QUI/111891/2009 Leading Institution: IST/ITN. Coord: L. Gano	2011-2014	12.765,72 €
Synthesis, Characterization and Biological Assessment of Multi-Functional Bone-Seeking Agents.	PTDC/QUI-QUI/115712/2009 Leading Institution: IST/ITN. Coord: I. Santos	2011-2014	13.066,44 €
Targeting telomerase inhibition with new anti-tumoral Cu(II) complexes.	PTDC/QUI/QUI/114139/2009 Leading Institution: IST/ITN. Coord: S. Gama/A. Paulo	2011-2014	9.030,00 €
Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation.	PTDC/QUI/QUI/102049/2008 Leading Institution: IST/ITN. Coord: A. Paulo	2010-2013	27.917,75 €
Chemical, Radiochemical and Biological Studies of Pyrazolyl-Alkylamine Pt(II) Complexes: Application on the Development of Novel Anti-Cancer Drugs.	PTDC/QUI/66813/2006 Leading Institution: IST/ITN. Coord: A. Paulo	2009-2012	38.336,70 €
Preclinical evaluation of ruthenium potential drugs for cancer therapy.	PTDC/QUI-QUI/118077/2010. Leading Institution:-FCUL IST/ID Coord: F. Marques	2012-2015	7.149,80 €
Albumin binding-domain fusions to improve protein pharmacokinetics.	PTDC/SAU-FAR/115846/2009 Leading Institution:FFUL IST/ITN Coord: JDG Correia	2011-2014	0,00 €
Complexos de Ruténio para aplicação anti-tumoral.	PTDC/QUI-QUI/101187/2008 Leading Institution:FCUL IST/ITN Coord: F. Marques	2011-2013	1300,86 €
Radioligandos para o Receptor Estrogénico - Potencial Clínico em Imagem e Terapia de Tumores da Mama.	Fundação Calouste Gulbenkian:Project 96476/2009 Leading Institution: CIMAGO ITN Coord: C. Melo	2009-2012	5254,00 €
Radiolabeling and biological assessment of therapeutic antibodies.	TECHNOPHAGE /IST-ITN Service Agreement	2012	3528,00 €
<b>Total</b>			<b>135. 449,55 €</b>

## INTERNATIONALIZATION

- **Bilateral Project Portugal/Spain-E-23/12:** Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies, 2012-13.
- **COST ACTION CM 1105:** Functional metal complexes that bind to biomolecules, 2012-.
- **COST ACTION TD1004:** Theragnostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery, 2012-
- **COST ACTION TD1007:** Bimodal PET-MRI molecular imaging technologies and applications for in vivo monitoring of disease and biological processes, 2012- .



# SOLID STATE GROUP

## TEAM

Name	Category	R&D
Manuel Leite de Almeida	Senior Researcher	100%
João Carlos Waerenborgh	Principal Researcher	100%
António Pereira Gonçalves	Principal Researcher	100%
Vasco da Gama	Principal Researcher	100%
Elsa Branco Lopes	Auxiliary Researcher	100%
Isabel Cordeiro Santos	Auxiliary Researcher	100%
Laura Pereira	Auxiliary Researcher	100%
Dulce Belo	Auxiliary Researcher (contract)	100%
Sandra Rabaça	Auxiliary Researcher (contract)	100%
Yuriy Verbovitsky	Post-Doc Grantee	100%
Penka Girginova	Post-Doc Grantee	100%
Ekaterina Tshipis	Post-Doc Grantee	100%
Maria Augusta Antunes	Post-Doc Grantee	50%
Sandra Dias	Post-Doc Grantee	100%, until 30 October
Mónica Afonso	Post-Doc Grantee	100%, until 30 June
Ana Neves	PhD Grantee	100%
Ana Cerdeira	PhD Grantee	100%
Sandrina Oliveira	PhD Grantee	100%
Margarida Henriques	PhD Grantee	100%
Bruno Vieira	PhD Grantee	100%
Rafaela Silva	Grantee	100%
Joana Coutinho	Grantee	100%
Timóteo Mendes	Grantee	100% until 31 July

## OBJECTIVES

Basic research activities in **Intermetallic** systems focused on the following topics:

- Ternary Phase Diagrams based on f- and d- elements:
- Superconductivity and magnetism in TiNiSi-type structure compounds:
- Magnetic and strongly correlated electron behavior.
- New Thermoelectric Materials

Basic research activities in **Molecular Materials** aiming at further development of multifunctional molecular materials, especially by the combination of magnetic and electroactive centers and the study of novel electronic states, addressing the following topics:

- **Switchable magnetic conductors** made by combination of spin-crossover complexes with electroactive counterions.
- **Neutral transition metal bisdithiolene complexes** for single component molecular metals, based on highly extended or substituted ligands and their processing by solution techniques.
- Thio-azo ligands and azo-substituted TTF donors for **hetero-bimetallic magnetic networks and conducting magnetic materials** based on novel tectons.
- **Single Molecule Magnetic (SMM) Behavior** in mononuclear U(III) Complexes and Ln coordination polymers.

Exploration of the **Mossbauer spectroscopy laboratory** pursuing activities supporting external collaborations in different topics in materials science and geochemistry.

Exploration of the **Low Temperature and High Magnetic Field facilities**, which include several magnetometers and the 18 T magnet with  $^3\text{He}$  insert, maintained available to the external scientific community on a scientific collaboration basis.

Pursuing research activities under contracts on the following FCT projects:

- **PTDC/CTM/102766/2008: *New Thermoelectric Systems.***
- **PTDC/FIS/102270/2008: *Nanostructured magnetic nitrides.***

- **PTDC/CTM-CER/114561/2009:** *Novel methodological approaches to analyze ion transport. mechanism in complex crystal lattices and to forecast performance-determining parameters of the oxide materials.*
- **PTDC/FIS/102284/2008:** *Study and development of new molecular magnets.*
- **PTDC/CTM/101033/2008:** *High Curie temperature dilute magnetic oxide semiconductors for application in spintronics – SEMISPIN.*
- **PTDC/QUI-QUI/101788/2008:** *Electrocrystallisation of Charge Transfer salts, from crystallogenesis to devices – CRISLALOGEN.*
- **PTDC/FIS/113500/2009:** *Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds;  $\alpha$ -(Per) $_2$ [M(mnt) $_2$ ] – PRESSMAG.*
- **CERN/FP/123588/2011:** *New Targets for particle accelerators.*
- **PICS bilateral Action FCT-CNRS,** with University of Rennes 1, France, *Electronic and magnetic properties of Strongly Correlated Electron Systems (SCES): molecular materials and uranium intermetallics.*
- **FCT/ASCR Scientific Cooperation Program,** with Charles University, Czech Republic, *Emergent phenomena in intermetallic compounds with f elements and their hydrides.*

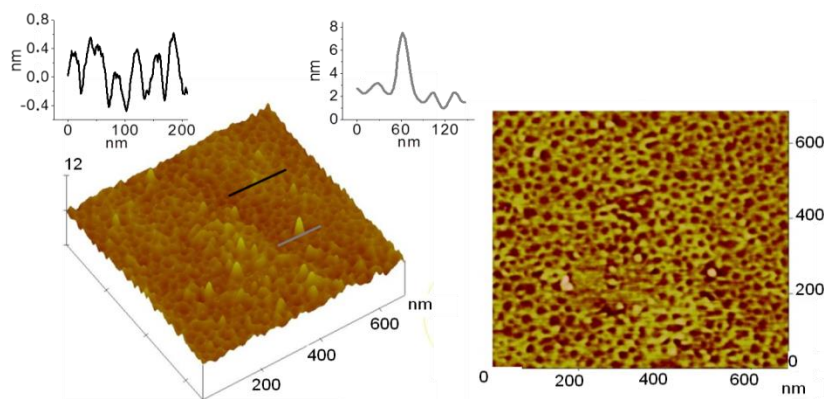
## MAIN ACHIEVEMENTS

### Two-chain (conducting and magnetic) compounds (Per) $_2$ [M(mnt) $_2$ ]

The electrocrystallisation of charge transfer salts based on perylene and transition metal bis-maleonitriledithiolate anions [M(mnt) $_2$ ] (M=Au, Cu, Ni, Pd, Pt, Co, Fe),  $\alpha$ -(Per) $_2$ [M(mnt) $_2$ ], has remained during many years a challenge limiting many studies in these unique two-chain systems.

Systematic studies aiming at the optimization of the electrocrystallisation conditions by where made providing quality crystal for detailed physical studies, including  $^1\text{H}$  and  $^{195}\text{Pt}$  NMR investigations of the low temperature Peierls and spin-Peierls transitions under high magnetic field in the Pf compound and allowing for the first time the growth of (Per) $_2$ [Pd(mnt) $_2$ ] crystals by electrocrystallisation.

The early stages of the electrocrystallisation of these compounds on different substrates were investigated by a combination of several techniques including AFM enabling to understand the determinant factors for nucleation and crystal growth.

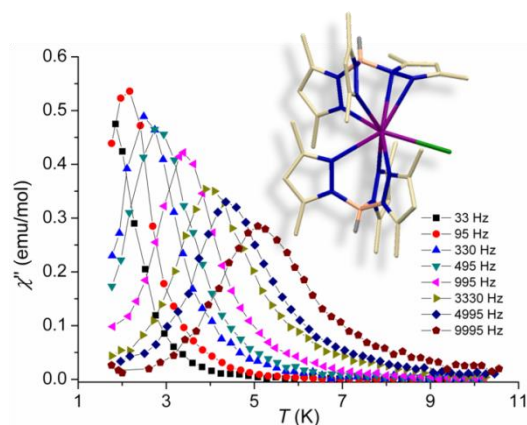


**Fig.:** AFM images of a gold surface in  $1 \times 10^{-3}$  M  $(n\text{Bu}_4)[\text{Au}(\text{mnt})_2]$  and perylene / dichloromethane after applying a  $0.05 \mu\text{A}/\text{cm}^2$  current density during: 1 s a) topography; b) phase images.

### f-Element centers for single molecule magnetic behaviour; from lanthanides to uranium

The f-element complexes which as discrete molecules can display single molecule magnetic (SMM) behavior became recently a hot topic in molecular magnetism and their study is expected to enlighten the origin of the low temperature magnetic relaxation mechanisms and improve the design of new compounds with higher relaxation barriers.

Our efforts were centered in the magnetic characterization of a series of lanthanide one-dimensional coordination polymers



based on picolinic and glutaric acids,  $\text{Ln}(\text{glu})(\text{pic})(\text{H}_2\text{O})_2$ ,  $\text{Ln}=\text{Gd}$ ,  $\text{Tb}$ , and  $\text{Dy}$  and in several mononuclear  $\text{U}(\text{III})$  compounds based on the  $\text{Tp}^{\text{Me}_2}$  ligand such as  $[\text{U}(\text{Tp}^{\text{Me}_2})_2\text{I}]$ .

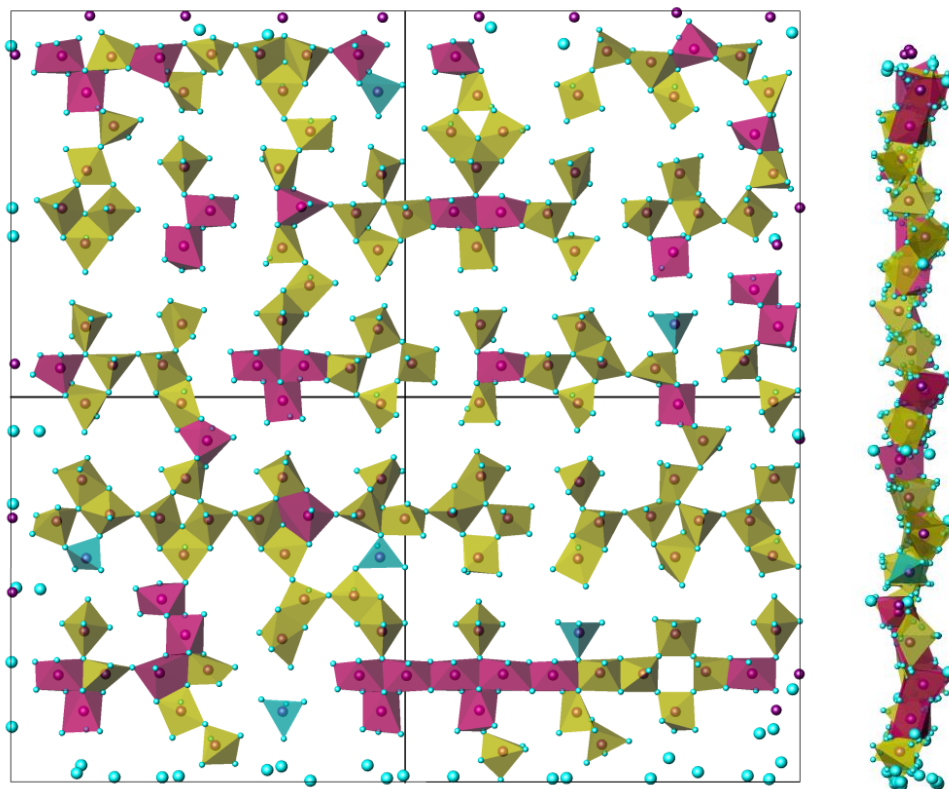
All these compounds clearly present at low temperatures slow relaxation of magnetization. In the  $\text{Ln}(\text{glu})(\text{pic})(\text{H}_2\text{O})_2$  compounds, in spite of the double chain ladder structure, these effects are due to single ions, as in the  $\text{U}$  compounds which are still rare examples of actinide complexes with SMM behavior, enabling already to establish some important structure-magnetic properties correlations.

### **Ion conducting oxide materials; Novel methodologies to analyze ion transport mechanism in complex crystal lattices and to forecast performance-determining parameters.**

Ionic conducting materials based on perovskite-derived structures attract significant attention for energy-related electrochemical technologies, such as electrodes of solid oxide fuel cells or ceramic membranes for conversion of natural gas and biogas.

$\text{La}_2\text{MRuO}_6$  double perovskites were investigated by XPS. Charge transfer was found to occur between the 4d and lower 3d energy levels of the  $\text{M}$  transition metals leading to mixed ion pairs,  $\text{Ru}^{(4-\delta)+}-\text{Ru}^{4+} \leftrightarrow \text{Co}^{2+}-\text{Co}^{3+}$  and  $\text{Ru}^{4+}-\text{Ru}^{(4+\delta)+} \leftrightarrow \text{Ni}^+-\text{Ni}^{2+}$  for  $\text{M}=\text{Co}$  and  $\text{Ni}$ , respectively.

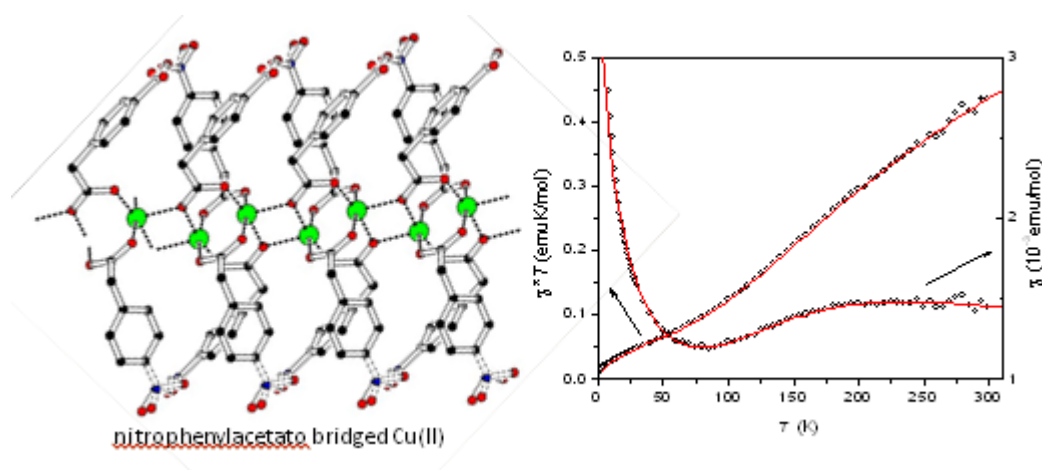
Oxidation of  $\text{Fe}$ -containing  $\text{YBaCo}_4\text{O}_{7+\delta}$ -based phases, promising as oxygen storage materials, was found to lead to penta rather than hexa-coordination of  $\text{Co}^{3+}$ .



### **Study and development of new molecular magnets**

In the scope of this project the search of molecular magnets based on  $\text{Cu}(\text{II})$  nitrophenylacetate and oxo-centered  $\text{Fe}(\text{III})$  carboxylate complexes was pursued with significant structural and magnetic characterization progresses.

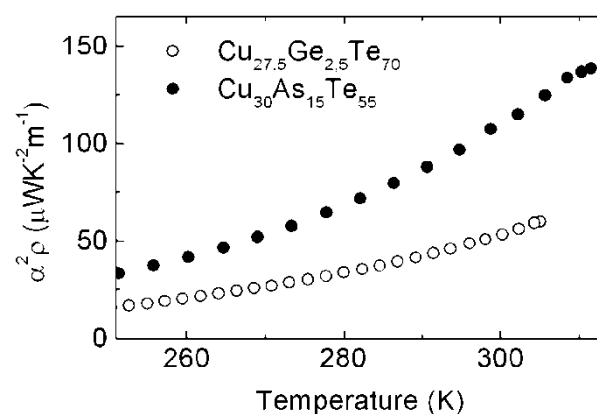
- Alternate chains are formed in  $\text{Cu}(\text{II})$  compounds. One of the bridging paths between the metal centers is made by four carboxylic groups, in a paddle-wheel configuration. A strong antiferromagnetic behavior was revealed in *Catena*-(bis( $\mu_3$ -4-nitrophenylacetato- $\text{O},\text{O},\text{O}'$ )-(bis( $\mu_2$ -4-nitrophenylacetato- $\text{O},\text{O}'$ )-copper(II) with a coupling constant of  $-302\text{ cm}^{-1}$ , in close agreement with studies based on broken-symmetry unrestricted density functional theory.
- Oxo-bridged tri-nuclear  $\text{Fe}(\text{III})$  complexes mimic different metalloprotein centers.  $\text{Fe}$  cations in ( $\mu_3$ -Oxo)-hexakis( $\mu_2$ -cyanoacetato)-triaqua-tri  $\text{Fe}(\text{III})$  nitrate penta-hydrate, were found to be in a  $S=5/2$  state. The antiferromagnetic exchange interactions compel the system to a total spin ground state  $S=1/2$ .



## New Thermoelectric materials

Aiming at the identification, synthesis and characterization of new thermoelectric materials with high ZT our attention has been focused on semiconducting glasses, and several potential chalcogenide glasses were investigated. The  $\text{Cu}_x\text{As}_y\text{Te}_z$  ones show interesting properties at room temperature, with power factors as high as  $110 \mu\text{WK}^{-2}\text{m}^{-1}$ . However, their glass transition temperatures and stabilities are low when compared with traditional bulk materials. The addition of Se in the CuAsTe family was found to stabilize the glass, while not significantly disturbing the thermoelectric properties.

New strategies to improve the thermoelectric properties of  $\text{CePd}_3$  were developed. Nanostructured  $\text{CePd}_{3+x}$  ( $-0.5 \leq x \leq 0.3$ ) samples were prepared by splat cooling and their electrical transport properties were studied. Good thermoelectric properties were observed for compositions close to  $\text{CePd}_{2.7}$ .



## RELEVANT PAPERS

- “Single-Ion Magnet behaviour in  $[\text{U}(\text{Tp}^{\text{Me}_2})_2\text{I}]$ ”, J. T. Coutinho, M. A. Antunes, L.C.J. Pereira, J. Marçalo, M. Mazzanti, H. Bolvin, M. Almeida, *Dalton Transactions*, **41**(44), 13568–13571 (2012).
- “Studies on the Electrochemical Growth of  $(\text{Per})_2[\text{Au}(\text{mnt})_2]$ ”, M. L. Afonso, R. A. L. Silva, M. Matos, A. S. Viana, M. F. Montemor, M. Almeida, *Langmuir*, **28**, 4883–4888 (2012).
- “Polycarbonate films metalized with a single component molecular conductor suited to strain and stress sensing applications”, E. Laukhina, V. Lebedev, V. Laukhin, A. P. del Pino, E. B. Lopes, A. I. S. Neves, D. Belo, M. Almeida, J. Veciana, C. Rovira, *Organic Electronics*, **13**, 894–898 (2012).
- “Magnetization, Mössbauer and isothermal dilatometric behavior of oxidized  $\text{YBa}(\text{Co},\text{Fe})_4\text{O}_{7+\delta}$ ”, J. C. Waerenborgh, E. V. Tsipis, L. C. J. Pereira, M. Avdeev, E. N. Naumovich, V. V. Kharton, *Dalton Trans.* **41**, 667–678 (2012).
- “Semiconducting Glasses: A New Class of Thermoelectric Materials?”, A. P. Gonçalves, E. B. Lopes, G. Delaizir, J. B. Vaney, B. Lenoir, A. Piarristeguy, A. Pradel, J. Monnier, P. Ochin, C. Godart, *J. Solid State Chem.* **193**, 26–30 (2012).

## FUNDS

Project/Service	Reference	Timeframe	2012
MOLMAG - <i>Study and development of new molecular magnets</i>	PTDC/CTM/102284/2008	01-07-2009; 30-06-2012	--
SEMISPIN - <i>High Curie temperature dilute magnetic oxide semiconductors for application in spintronics</i>	PTDC/CTM/101033/2008	01-01-2010; 31-12-2012	4.817,17 €
SisTermo - <i>New Thermoelectric Systems</i>	PTDC/CTM/102766/2008	01-02-2009; 31-07-2013	19.046,89 €
CRISLALOGEN - <i>Electrocrystallisation of Charge Transfer salts, from crystallogenes to devices</i>	PTDC/QUI- QUI/101788/2008	01-02-2010; 31-01-2013	70.005,45 €
PRESSMAG - <i>Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds; <math>\alpha</math>-(Per)<sub>2</sub>[M(mnt)<sub>2</sub>]</i>	PTDC/FIS/113500/2009	01-05-2011; 31-11-2013	12.386,91 €
Ion Transport - <i>Novel methodological approaches to analyze ion transport mechanism in complex crystal lattices and to forecast performance-determining parameters of the oxide materials.</i>	PTDC/CTM- CER/114561/2009	01-01-2011; 31-12-2013	--
PICS - <i>Electronic and magnetic properties of Strongly Correlated Electron Systems (SCES): molecular materials and uranium intermetallics</i>	Acordo CNRS/FCT: PICS	01-01-2011; 31-12-2013	4.000,00 €
New Targets	CERN/FP/123588/2011	01-01-2012; 31-12-2012	2.250,00 €
<b>Total</b>			<b>112.506,42 €</b>

## INTERNATIONALIZATION

- **PICS** bilateral Action FCT-CNRS, with University of Rennes 1, France, *Electronic and magnetic properties of Strongly Correlated Electron Systems (SCES): molecular materials and uranium intermetallics.*
- **FCT/ASCR** Scientific Cooperation Program, with Charles University, Czech Republic, *Emergent phenomena in intermetallic compounds with f elements and their hydrides.*

# Inorganic and Organometallic Chemistry Group

## TEAM

Name	Category	R&D
Joaquim Marçalo	Principal Researcher	100%
João Paulo Leal	Auxiliary Researcher with habilitation	100%
Joaquim B. Branco	Auxiliary Researcher	100%
José Manuel Carretas	Auxiliary Researcher	100%
Teresa Almeida-Gasche	Auxiliary Researcher	100%
Cláudia C. L. Pereira	Auxiliary Researcher ( <i>Ciência 2007</i> )	100%
Leonor Maria	Auxiliary Researcher ( <i>Ciência 2008</i> )	100%
Adelaide Cruz	Graduated Technician	100%
Bernardo Monteiro	Post-doc (FCT grant)	100% (Jan-Jul)
Ana F. Lucena	PhD student (FCT grant)	100%
Ana C. Ferreira	PhD student (FCT grant)	100%
Pedro G. Rosado	Research student (FCT project grant)	100% (Jan-Jul)
Elsa Mora	Research student (FCT project grant)	100% (Jan-Feb)
Vânia Sousa	Research technician (FCT grant; UCQR)	100%
Maria Augusta Antunes	Post-doc (FCT grant; ES-UCQR)	50%
Rita Melo	PhD student (FCT grant; TRPP-UFA)	20%
Joana M. Vitorino	PhD student (FCT grant; CQB-FCUL)	30%
Célia Lourenço	Research student (FCT project grant; CQE-IST)	80%

## OBJECTIVES

The research activities of the Inorganic and Organometallic Chemistry Group are centred on the study of several aspects of *f*-element chemistry, at a fundamental level and directed to applications in nuclear science, catalysis and new materials:

**Coordination and organometallic chemistry of the lanthanides and actinides:** Creation of new coordination environments for the *f*-elements (Ln, Th, U) that can lead to unusual chemical, structural and magnetic properties of the compounds, and to potential applications in organic synthesis, catalysis and as new materials.

**Catalytic applications of inorganic compounds of the *f*-block elements:** Study of the *f*-elements (Ln, Th, U) as catalysts or catalyst precursors in heterogeneous phase, development of new methods of preparation of nanostructured materials to use in catalytic applications, and contribution to a solution for relevant environmental problems, e.g. activation of methane and carbon dioxide, and elimination of gaseous pollutants and urban waste.

**Functional hybrid materials with *f*-elements:** Synthesis of new materials containing *f*-elements (Ln, Th, U), namely Metal-Organic Frameworks (MOFs), Layered Lanthanide Hydroxides (LLHs) and ionic liquids (ILs), and examination of their structural, photophysical, photochemical and magnetic properties.

**Gas-phase chemistry/mass spectrometry of lanthanides and actinides:** Gas-phase chemistry studies of the *f*-elements (Ln, Th, Pa, U, Np, Pu, Am, Cm), performed by LDI-FTICR/MS and ESI-QIT/MS, for the identification of new species with relevance in nuclear science and investigation of their physicochemical properties.

**Molecular energetics of organic, inorganic and organometallic compounds:** Collection of energetics data of organic and inorganic compounds, investigation of correlations between energetics and molecular structure, using calorimetry, thermal analysis and MS as experimental techniques, and development of databases and models for prediction of thermodynamic properties.

## MAIN ACHIEVEMENTS

**Coordination and organometallic chemistry of the lanthanides and actinides:**

Reactions of the complexes  $[\text{An}^{\text{IV}}(\text{salan-}^t\text{Bu}_2)(\text{CH}_2\text{SiMe}_3)_2]$  (An=Th, U) with  $\text{CO}_2$  showed that it inserts rapidly into the An-C bonds with formation of carboxylate ligands; a rare example of a Th- $\text{CO}_2$  insertion complex was identified by XRD (*Fig. 1*).

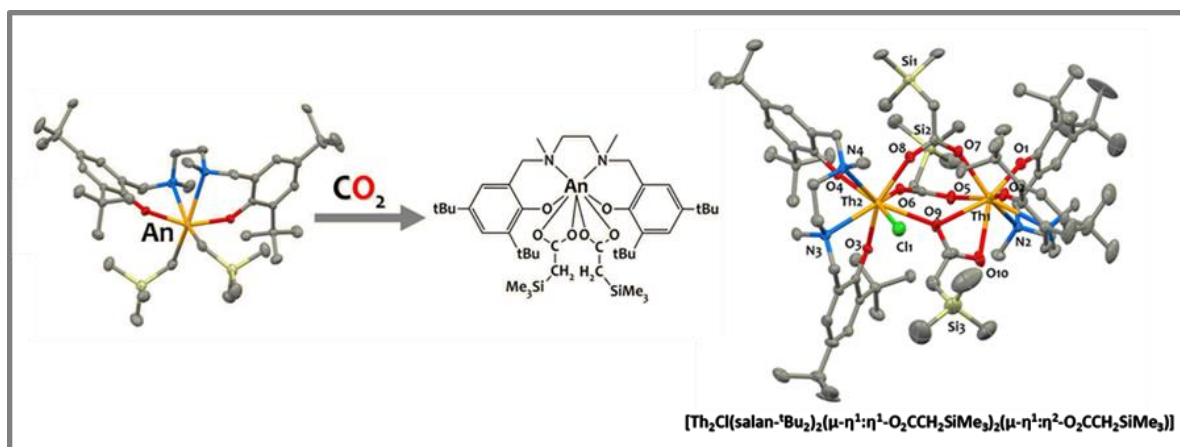


Fig. 1. Reactions of An(IV)-alkyl complexes with CO<sub>2</sub>.

The reactivity of the new complexes [M{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}Cl] (M=Y, Sm), with LiCH<sub>2</sub>SiMe<sub>3</sub>, and [U{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}I], with redox-active substrates (azides, azobenzene, I<sub>2</sub>, TIBPh<sub>4</sub>), was investigated.

{(Ar<sup>R2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}<sup>2-</sup> (R=Me, t-Bu) ligands, as well as the {Tp<sup>tBu,Me</sup>}<sup>-</sup> ligand, were used to stabilize complexes of Sm(II) and Yb(II) and examine the coordination of isonitriles.

The reactivity of the complex [U<sup>III</sup>(({Me<sub>2</sub>SiNPh}<sub>3</sub>-tacn)] was investigated, namely reactions with S<sub>8</sub>, S=PPh<sub>3</sub>, CO<sub>2</sub>, CS<sub>2</sub> and O<sub>2</sub>.

New U(III) complexes with the {Tp<sup>Me2</sup>}<sup>-</sup> ligand were identified, structurally characterized and their behavior as single-molecule magnets examined.

[Collab. CEA-Grenoble, CQE/IST, Solid State Group/UCQR.]

### Catalytic applications of inorganic compounds of the *f*-block elements:

For the first time, bimetallic Cu-Th, Ni-Th and Ni-U oxides were tested for the conversion of CH<sub>4</sub> with N<sub>2</sub>O as oxidant. At isoconversion, the production of C<sub>2</sub> hydrocarbons was high over the U catalyst, but the formation of CO<sub>2</sub> and CO prevailed over the Th-based catalysts (Fig. 2).

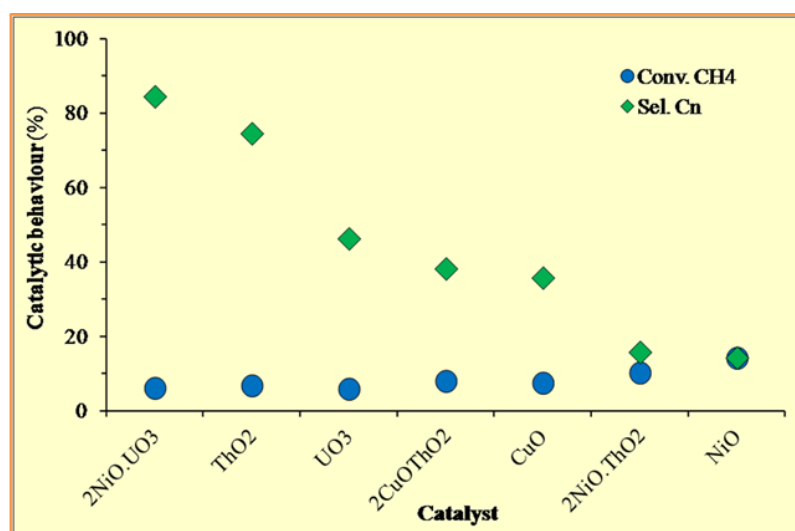


Fig. 2. Conversion of CH<sub>4</sub> using N<sub>2</sub>O as oxidant over Th and U pure metal oxides and bimetallic oxides at 700 °C.

New Ni/*f*-block element (Ln, Th, U) bimetallic oxide nanocatalysts were obtained using a sol-gel method and characterized by SEM, TEM and XRD. They were highly active and selective towards syngas production in the partial oxidation of CH<sub>4</sub> at low temperatures, and presented remarkable long term stability and an unusual low deposition of carbon. [Collab. CQFM/IST, ISQ.]

### Functional hybrid materials with *f*-elements:

New ILs of general formula  $[\text{Ln}(\text{NTA})_4][\text{PC}_{32}\text{H}_{68}]$  ( $\text{Ln}=\text{Eu}, \text{Gd}, \text{Tb}, \text{Dy}$ ;  $\text{NTA}=\text{naphthoyltrifluoroacetate}$ ), were synthesized and characterized. The luminescence of the Eu-IL was studied in detail (Fig. 3).

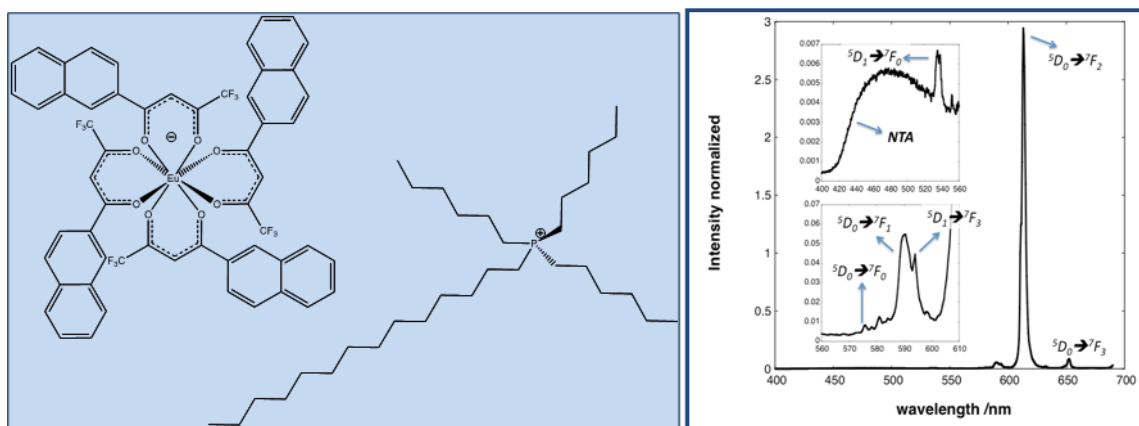


Fig. 3.  $[\text{P}_{6,6,6,14}][\text{Eu}(\text{NTA})_4]$  ionic liquid and its emission spectrum at  $71^\circ\text{C}$  ( $\lambda_{\text{exc}}=360 \text{ nm}$ ).

The study of LLHs and their intercalation products continued. The magnetic properties of Dy-LLHs were examined and the luminescence of mixed Eu/Gd-LLHs investigated.

The synthesis and characterization of new MOFs of Th, U and U/Eu, using phosphonate ligands, were performed and their luminescence and catalytic properties examined.

[Collab. Photochemistry Group/FCT-UNL, CICECO/U. Aveiro, Solid State Group/UCQR.]

### Gas-phase chemistry/mass spectrometry of lanthanides and actinides:

ESI-QIT/MS was used to explore the chemistry of elementary actinide species, namely hydration and oxidation of uranyl, neptunyl and plutonyl (Fig. 4), and oxo exchange in uranyl and plutonyl.

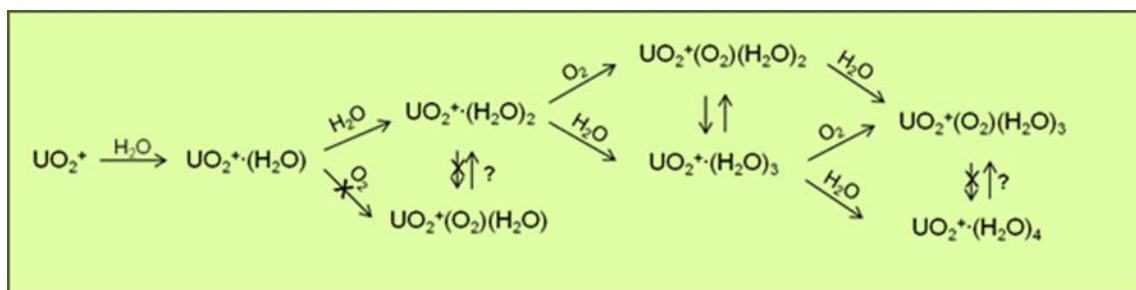


Fig. 4. Gas-phase reactions of  $\text{U}^{\text{V}}\text{O}_2^+$  with  $\text{H}_2\text{O}$  and  $\text{O}_2$ .

ESI-QIT/MS and LDI-FTICR/MS were used to perform gas-phase coordination chemistry studies of An(III) and Ln(III) species ( $\text{MX}_2^+$ ,  $\text{MX}_4^-$ ;  $\text{X}=\text{Cl}, \text{NO}_3$ ;  $\text{An}=\text{Am}, \text{Cm}$ ;  $\text{Ln}=\text{La-Lu}$ ) with N- and O-donor organic molecules.

The interactions of Th(IV), U(V/VI), Np(V) and Pu(IV/V/VI) ions with amino-acids (gly, his, cys, asp) were examined using ESI-QIT/MS.

[Collab. LBNL, CEA-Marcoule, U. Calabria, U. Paul Sabatier-Toulouse III.]

### Molecular energetics of organic, inorganic and organometallic compounds:

The enthalpies of formation of several new diol compounds of alkaline-earth metals, Si and Ln were determined, including a mixed Si/Ln compound with unexpected properties.

The density and viscosity of several ILs and their solutions were measured at various temperatures and enthalpies of formation were also determined.

The ThermoInfo databases ([www.therminfo.com](http://www.therminfo.com)) were improved in structure and number of compounds. New models for prediction of thermodynamic properties were implemented. [Collab. CQB-FCUL.]



## Other activities of the Group members:

- Studies of low temperature gas discharges for the activation of CH<sub>4</sub> and CO<sub>2</sub> (collab. with Nuclear Methods and Instrumentation Group/UFA).
- Gas-phase chemistry studies of *d*-transition metals (collab. with CQE-IST).
- Studies of the degradation of bio-recalcitrant compounds (collab. with Radiation Technologies Group/UFA).
- Studies of hybrid materials for biomedical applications (collab. with Condensed Matter Physics Group/UFA and U. Aveiro).
- Chemistry for Education activities at the Chemistry and Biochemistry Department of FCUL.

The Group members were co-authors in: 12 publications in ISI journals (plus 3 in press or accepted), 2 publications in conference proceedings, 27 communications in conferences, 5 other publications, 1 PT patent.

A new FCT project, led by the Group, was approved in 2012: “CO<sub>2</sub> mitigation and production of methanol by reforming of CH<sub>4</sub>” - PTDC/AAG-TEC/3324/2012. Members of the Group are also in the teams of 3 new FCT projects approved in 2012: “Increasing the energy efficiency of plasma conversion of methane” - PTDC/FIS-PLA/2135/2012 (Leader UFA); “Application of ionizing radiation for a sustainable environment” - RECI/AAG-TEC/0400/2012 (Leader UFA); “From drug design to new materials: structural approach in emergent fields” - RECI/QEQ-QIN/0189/2012 (Leader CQE-IST).

## RELEVANT PAPERS

- E. Mora, L. Maria, B. Biswas, C. Camp, I.C. Santos, J. Pécaut, A. Cruz, J.M. Carretas, J. Marçalo, M. Mazzanti, Diamine bis(phenolate) as supporting ligands in organoactinide(IV) chemistry. Synthesis, structural characterization, and reactivity of stable dialkyl derivatives, *Organometallics*, Publication Date (Web): December 18, 2012, doi: 10.1021/om3010806.
- J.B. Branco, A.C. Ferreira, A.M. Botelho do Rego, A.M. Ferraria, T. Almeida-Gasche, Conversion of methane over bimetallic copper and nickel actinide oxides (Th, U) using nitrous oxide as oxidant, *ACS Catalysis*, 2, 2482–2489 (2012), doi: 10.1021/cs300530h.
- D. Rios, M.C. Michelini, A.F. Lucena, J. Marçalo, T.H. Bray, J.K. Gibson, Gas-phase uranyl, neptunyl, and plutonyl: hydration and oxidation studied by experiment and theory, *Inorganic Chemistry*, 51, 6603–6614 (2012), doi: 10.1021/ic3001625.
- D. Rios, M.C. Michelini, A.F. Lucena, J. Marçalo, J.K. Gibson, On the origins of faster oxo exchange for uranyl(V) versus plutonyl(V), *Journal of the American Chemical Society*, 134, 15488–15496 (2012), doi: 10.1021/ja305800q.
- R.C. Santos, J.P. Leal, A review on prediction methods for molar enthalpies of vaporization of hydrocarbons - The ELBA method as the best answer, *Journal of Physical and Chemical Reference Data*, 41, 043101 (2012), doi: 10.1063/1.4754596.

## FUNDS

Project/Service	Reference	Timeframe	2012
Chiral metalla-diaminocarbene precatalysts for asymmetric catalytic reactions obtained by the metal-mediated approach	PTDC/QUI-QUI/109846/2009	01.04.2011-31.03.2014	3.600,50 €
Energetics of metal polyalkoxides	PTDC/QUI/65507/2006	01.01.2009-31.12.2012	21.283,20 €
Gas-phase thermochemistry of 4d and 5d transition metal oxides: a study by FTICR-MS	PTDC/QUI-QUI/108977/2008	01.01.2010-31.12.2012	1.677,43 €
Exploring the chemical differences between trivalent lanthanides and actinides by mass spectrometry techniques	ACTINET-I3/FP7-III-232631/JRP17	01.07.2010-30.06.2012	2.210,00 €
EUFEN: European f-Element Network	COST Action CM1006	19.04.2011-18.04.2015	2.500,00 €
<b>Total</b>			<b>31.271,13 €</b>

# Environmental and Analytical Chemistry Group

## TEAM

Name	Category	R&D
Maria de Fátima Araújo	Principal Researcher	100%
A.M. Monge Soares	Principal Researcher	100%
Paula M. M. Carreira Paquete	Auxiliary Researcher	100%
J.M. De La Rosa*	Auxiliary Researcher ( <i>Ciência</i> )	100%
Pedro M.F. Valério	Graduated Technician (PhD)	100%
Dina Nunes	Graduated Technician	100%
António Amaro	Laboratory Technician	100%
M. Manuela Correia	Laboratory Technician	100%
Elin Figueiredo	Post-doc, FCT grant	50%
M. João Furtado	PhD student, FCT grant	50%
José Manuel M. Martins	PhD student, FCT grant	100%
Filipa Pereira	PhD student, FCT grant	50%
Filipa Lopes	Project grant	50%
Susana Sousa Gomes	Project grant	100%
Paulo Portela	Project grant	100%

\**Ciência* contract, finished on March 31<sup>st</sup>

## OBJECTIVES

Activities in the Environmental and Analytical Chemistry Group combine fundamental and methodological research to develop and apply Elemental and Isotopic Analysis methodologies in the fields of Environmental Geochemistry, Oceanography, Isotope Hydrology and Archaeometry.

### Environmental Geochemistry

Geochemistry (e.g. elemental, isotopic) and radiocarbon dating in estuaries along the Portuguese coast (Minho, Tagus, Mira, Neiva, Alcabrichel and Bensafirim) aiming to establish the evolution model over the last millennia, as well as to identify palaeoenvironmental changes, climatic events, and evaluate effects of human activities.

### Oceanography

The marine radiocarbon reservoir effect ( $\Delta R$ ) in Iberian Atlantic coastal area: assessment of the variability of oceanographic conditions using  $\Delta R$  as a proxy. Also its use in palaeoenvironmental and palaeoclimatic reconstructions.

### Isotope Hydrology

Determination of isotopic composition:  $^2\text{H}/^1\text{H}$ ,  $^{13}\text{C}/^{12}\text{C}$ ,  $^{15}\text{N}/^{14}\text{N}$  and  $^{18}\text{O}/^{16}\text{O}$ , tritium and radiocarbon dating in water and carbonate samples (from water systems and carbonates), aiming to construct/identify groundwater circulation models and residence time for protection, sustainability and proper management of groundwater and surface water resources.

### Archaeometry – Provenance, metal composition and manufacturing techniques

- Studies on the elemental and microstructural characterization of archaeological metallic artefacts and other materials related to metallurgical activities from various archaeological sites of the Portuguese territory, to investigate the metallurgical evolution from Chalcolithic till Late Bronze Age and Orientalizing period.
- Composition and microstructures of imperial Cu-based Chinese coins from the Macau Scientific and Cultural Centre to establish the evolution on their production 300 BC till AD 1854.
- Study on the Portuguese silversmiths' artefacts from the XV till XVII centuries aiming to establish composition patterns, technological production and provenance.

## MAIN ACHIEVEMENTS

### Environmental geochemistry

Geochemical (elemental, isotopic) and dating approaches were applied in the study of sedimentary sequences evolution patterns to evaluate (paleo)environmental changes, along the Portuguese coastal area. Enhanced anthropogenic elemental contents (Cu, Zn, As and Pb), could be related to specific effects of Human occupation and industrialization. Enrichments on the lithogenic elements (Ti, Zr, K, Rb) were associated with stronger terrestrial sources (flood periods), whereas high Ca, Sr, Cl and Br indicate a dominant marine contribution. Besides, the sources of organic matter (OM) investigated by elemental (C, N) and stable isotope analysis ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ ) on the radiocarbon dated sequences showed complex mixtures with different marine and continental contributions related to the alternation of dry and flood periods and identified the evolution of fluvial and marine influences as well as responses to climatic events and the impact of land use changes in the estuarine environmental conditions over the last millennia.

Sources of sedimentary OM in the Guadiana estuary have been related to C3 vascular plants and/or fossil carbon. Soot-black carbon constituted a significant portion of the estuarine OM which is selectively preserved in sediments. A recent increase in marine OM in the lower estuary was associated to Alqueva dam.



### Oceanography

Research on the variability of the marine radiocarbon reservoir effect ( $\Delta R$ ) in southern Iberian Atlantic coast has shown the existence of different  $\Delta R$  values corresponding to different oceanographic conditions, namely those prevailing off the Barlavento (windward), the Sotavento (leeward), and the Andalusian coast. The results show that the  $\Delta R$  weighted mean values for the three regions are distinct in accordance with the different prevailing oceanographic conditions. Besides, a Bond event at 0.8 ka cal BP and a drastic change of the oceanographic conditions during the V Millennium cal BP were identified in Barlavento and Andalusian coastal areas.



### Isotope Hydrology

An important part of the work developed on groundwater resources were linked to mineral waters, particularly in Melgaço-Messagães and Caldas da Rainha systems, and aimed to develop and characterize conceptual models establishing relationships between mineral water and local infiltration of rainwater. Besides, the study of the isotopic variations in groundwater systems has been also essential in the identification and quantification of the origin of salinization being an additional tool in hydrogeochemical investigations, which in some cases are not able to clarify these issues (origin of salts). Three case studies in coastal aquifers have been part of our research (in Algarve sedimentary basin, in the Lower Tagus - Lower Sado Sedimentary Basin and in Santiago volcanic island Island (Cape Verde)). Previous sampling campaigns constituted the working

base to present scientific work to the community, having as main goals the protection and management of water resources.

Following the joint actions IST/ITN with the IAEA - WMO, systematic determination of the isotopic composition of precipitation was continued.



### Archaeometry

Archaeometallurgical research was pursued by the characterization of metallic artefacts and production remains from Chalcolithic till Early Iron Age, recovered at different regions all over the Portuguese territory. The investigation of Chalcolithic arsenical coppers from Estremadura indicate that the potential for obtaining a harder material was not recognized by the ancient metallurgists and the selection of the alloy was possibly made based on colour. The study of grave goods from hypogea and cists produced new evidences on the role of metal (copper, bronze and silver) during the Middle Bronze Age, as well as on the introduction of the first bronzes in southern Portugal. Research on the early bronze metallurgy based on Bujões/Barcelos axe types from diverse sites and metallurgical remains from NE territory shows binary bronze or unalloyed copper. The later presents an occasional presence of low Pb content. Experiments were carried out on lead isotope ratios determinations of bronzes and lead artefacts to investigate their provenance; also neutron radiography and tomography were used to study internal structural heterogeneities related to specific manufacturing techniques.



### Other

The EAC group was highly engaged in education and training of MSc and PhD students in collaboration with different Universities. Technical services, including elemental and isotopic analysis and radiocarbon dating were carried out for Public and Private Institutions.

## RELEVANT PAPERS

- J.M. De la Rosa, M.F. Araújo, J.A. González-Pérez, F.J. González-Vila, A.M. Soares, J.M. Martins, E. Leorri, R. Corbett, F. Fatela. Organic matter sources for tidal marsh sediment over the past two millennia in the Minho River estuary (NW Iberian Peninsula), *Organic Geochemistry*, 53 (2012) 16-24.
- J.M. Marques, P.M. Carreira, F. Goff, H.G.M. Eggenkamp, M. Antunes da Silva. Input of  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios and Sr geochemical signatures to update knowledge on thermal and mineral waters flow paths in fractured rocks (N-Portugal), *Applied Geochemistry*, 27 (2012) 1471-1481.
- J.M.M. Martins, A. Mederos Martín, P.J.C. Portela, A.M.M. Soares Improving the  $^{14}\text{C}$  Dating of Marine Shells from the Canary Islands for Constructing More Reliable and Accurate Chronologies, *Radiocarbon*, 54(3-4) (2012) 943-952.
- P. Valério, R.J.C. Silva, M.F. Araújo, A.M.M. Soares, L. Barros. A multianalytical approach to study the Phoenician bronze technology in the Iberian Peninsula—A view from Quinta do Almaraz, *Materials Characterization*, 67 (2012) 74–82.
- V. Martins, R.C.L.Figueira, E.J. França, P.A.L. Ferreira, P. Martins, J.F. Santos, J.A. Dias, L.L.M. Laut, A.M.M. Soares, E.F. Silva, F. Rocha (2012) Sedimentary processes on the NW Iberian Continental Shelf since the Little Ice Age, *Estuarine, Coastal and Shelf Science*, 102-103, 48-59.

## FUNDS

Project/Service	Reference	Timeframe	2012
Early Metallurgy in the Portuguese Territory (EARLYMETAL). Leading Institution IST/ITN, Coordinator: M.F. Araújo	PTDC/HIS-ARQ/110442/2008	1 April 2010 – 30 Sept 2013	70.763,26 €
Recent evolution of Portuguese W coast estuaries: high resolution studies from marshes geological record (WesTLog). Leading Institution FCUL; IST/ITN Coordinator: M.F. Araújo	PTDC/CTE-GIX/105370/2008	1 January 2010 – 30 June 2013	9.664,64 €
Fluvio-marine interactions over the last 5000 yrs (FMI 5000). Leading Institution IGOT-UL; IST/ITN Coordinator: A.M.M. Soares	PTDC/CTE-GIX/104035/2008	1 February 2010; 31 January 2013	---
The Ocean Reservoir Effect in the Transition Area of the West-Iberian Coastal Upwelling (Aveiro/Mouth of the Minho River; Cape Santa Maria/Mouth of the Guadiana River). Leading Institution IST/ITN, Coordinator: A.M.M. Soares	PTDC/MAR/68942/2006	2008-2011	77.104,20 €
Microecology and Littoral Dynamics: definition of multi-proxies applicable to Quaternary paleogeographical and paleoclimatic reconstruction (MicroDyn). Leading Institution FCUL; IST/ITN Coordinator: M.F. Araújo	POCTI/CTA/45185/2002	2005-2008	3.850,38 €
Determination of the biobased content of fuel used in Setúbal paper mill.	PORTUCEL SOPORCEL Group		2.400,00 €
Radiocarbon dating	Associação de Defesa do Património Histórico e Arqueológico de Aljezur		1.125,00 €
Radiocarbon dating; $^{13}\text{C}$ and $^{15}\text{N}$ content samples	FCSH/ Universidade Nova de Lisboa		1.375,00 €
Radiocarbon dating	FCSH/ Universidade Nova de Lisboa		1.250,00 €
Isotope composition of water samples ( $^2\text{H}$ and $^{18}\text{O}$ )	FCUL - Centro de Geologia, Universidade de Aveiro		4.398,00 €
PhD's fees Elin Figueiredo & M. João Furtado	DCR/ Universidade Nova de Lisboa		1.925,00 €
<b>Total</b>			<b>173.855,48€</b>

# Applied Geochemistry & Luminescence on Cultural Heritage Group

## TEAM

Name	Category	R&D
Maria Isabel Garrido Prudêncio	Principal Researcher with habilitation	100%
Maria Isabel Marques Dias	Invited Auxiliary Researcher	100%
Christopher Ian Burbidge	Auxiliary Researcher (Contract)	100%
Rosa Maria Salgueiro Marques	Graduated Technician (MSc)	100%
Guilherme de Jesus de Oliveira Cardoso	Graduated Technician (MSc)	100%
Luís Manuel Ferreira Belot Fernandes	Graduated Technician	100%
Dulce da Conceição Brejo Russo Franco	Technician (Assistant)	100%
Maria José Ferreira Trindade	Post-Doc, FCT grant	100%
Ana Luisa Sebastião Rodrigues	PhD, FCT grant	100%
João Davide Neto Franco	BIC, FCT grant (MSc)	100%
Telma da Piedade Silva	BIC, FCT grant (MSc)	100%

## OBJECTIVES

The mission of the GeoLuC research group is to perform research mainly in applied physics, chemistry, geochemistry and mineralogy, focussing on nuclear and luminescence techniques and knowledge in earth sciences, environment and cultural heritage (CH), including the interaction of humans with the environment.

The principal objectives for 2012 include:

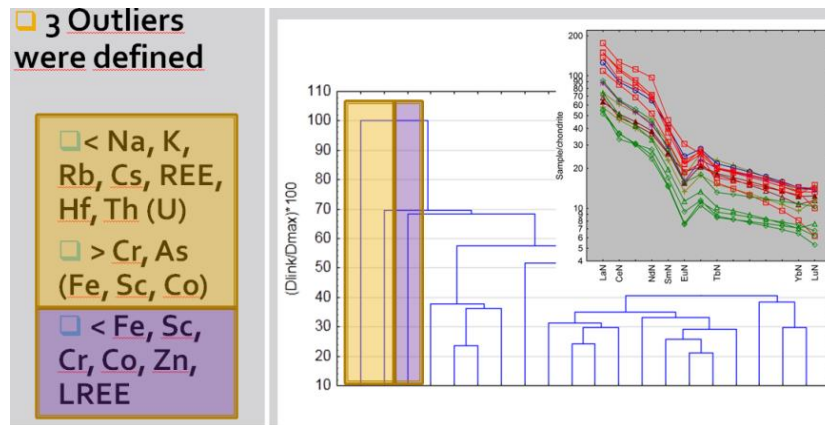
- Nuclear methods development and optimization for the characterization, dating and preservation of cultural and natural heritage, and geoenvironments – from field work with in situ measurements, sampling, laboratorial procedures, and data analysis: INAA and TL-OSL.
- Characterization for provenance and production technologies determination, and absolute dating of CH objects, particularly pre-historic and historic ceramics, and glazed tiles.
- Neutron tomography and ionizing radiation studies – contribution for the establishment of conservation techniques and biological inactivation in ancient glazed tiles.
- Geochemistry, mineralogy, environmental dosimetry and absolute dating by luminescence of soils and sediments in surficial environments – differentiation of geogenic and anthropogenic origins.
- Luminescence-dosimetric processes in quartz.
- Spatial variation of dose rate in superficial environments.
- Contribution to the construction of the Geochemical Atlas of Cape Verde (according to the IGCP 259 - “International Geochemical Mapping”) – Santiago, Fogo and Brava islands.

The education and training courses and the organization of international conferences was also a major goal.

## MAIN ACHIEVEMENTS

### *Nuclear methods and cultural heritage characterization*

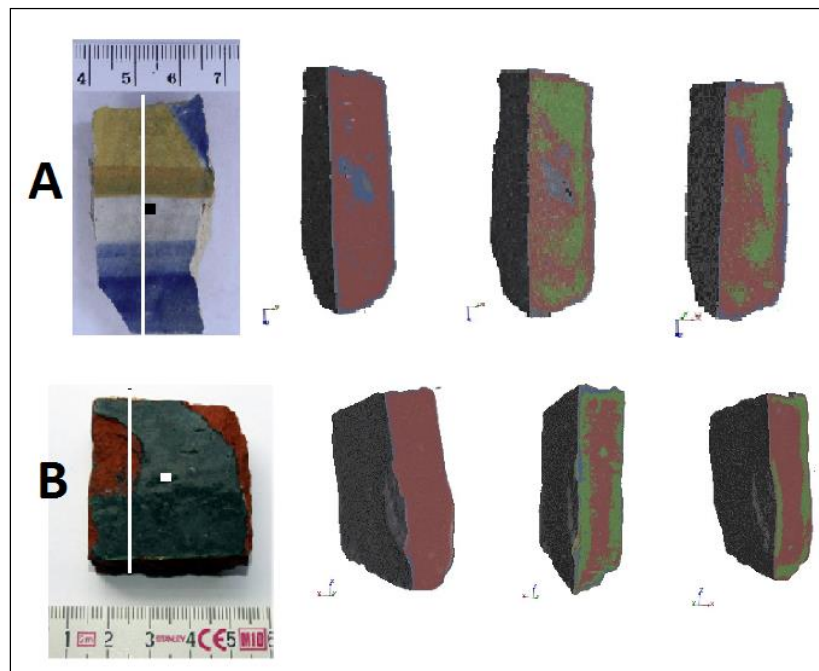
Chemical and mineralogical composition of CH and raw materials from several archaeological sites were performed. The establishment of provenances and production technologies on Neolithic and Chalcolithic contexts from Perdigões was achieved (PTDC/CS-ANT/104333/2008). Compositional results of ceramics and clays point mostly toward a regional origin, with a spread of resources in the Chalcolithic funerary pottery (Fig.1). The results agree with the hypothesis of the necropolis of Perdigões be used by distant communities, and of a consistent occupation of the site with the resource to the same type of raw materials from Neolithic to Chalcolithic (Dias et al, 2012).



**Fig. 1:** Geochemistry/multivariate statistical analyses applied to provenance of ancient ceramics from Perdigões site.

### *Nuclear methods for the optimization of conservation strategies of cultural heritage*

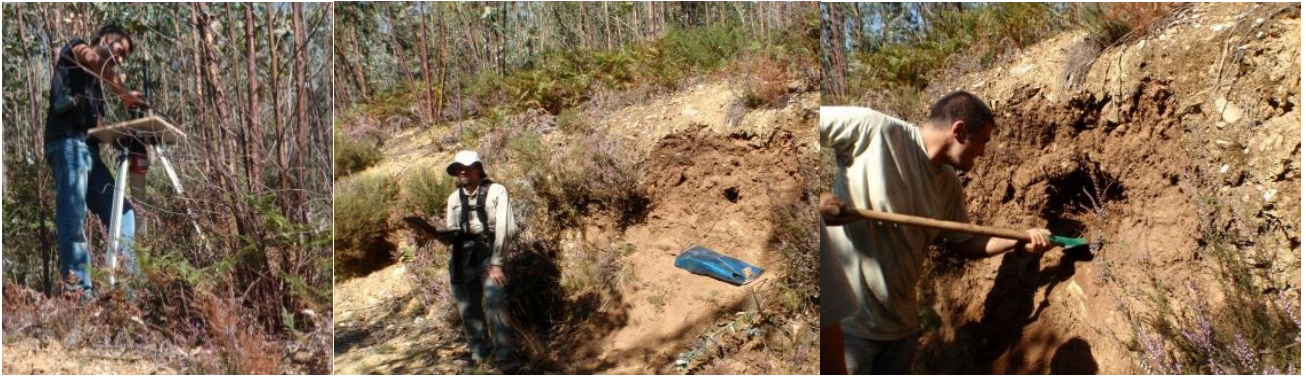
The neutron tomography (NT) setup of RPI was applied to visualize the inner structure of ancient Portuguese glazed tiles undergoing conservation treatments in the National Tile Museum (PTDC/HIS-HEC/101756/2008). The first article on the subject was published on an ISI journal (Prudêncio et al, 2012). The results obtained show that: NT is a useful tool for visualization of the inner structure of ancient glazed tiles, and to assess penetration depth of consolidant and its distribution inside the tile (Fig. 2).



**Fig. 2:** NT images of glazed tiles: from left to right: before treatment, after the impregnation of resin using brushing, and immersion (red-ceramic body; blue-voids; green- resin).

### *Nuclear methods - spatial variation of dose rate in superficial environments*

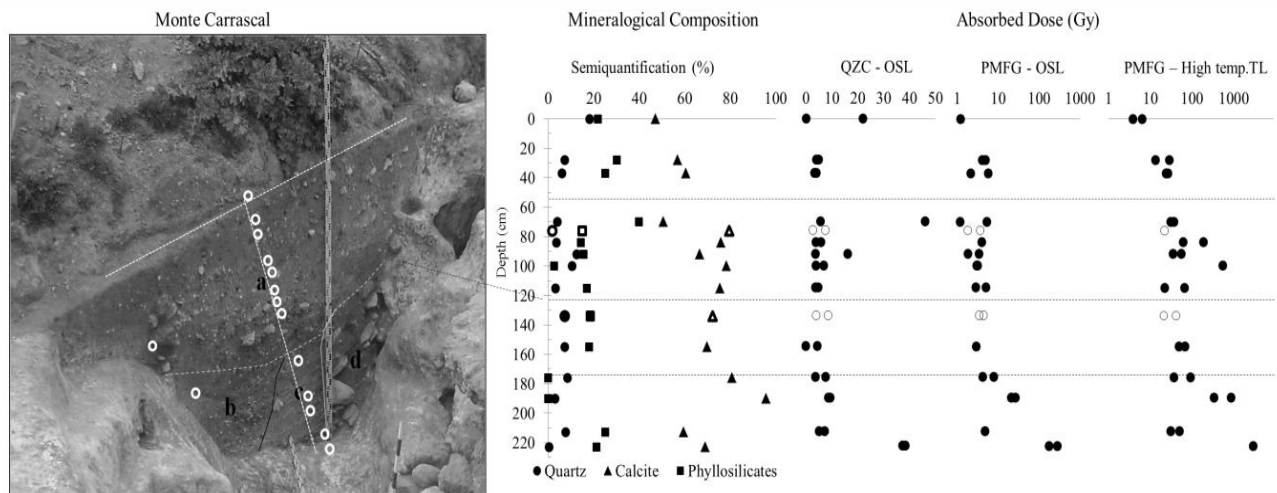
In the frame of the VADOSE project (PTDC/AAC-AMB/121375/2010), work consisted of fieldwork, sample preparation, initial studies in radiation transport modelling, and calibration of in situ dosimeters (Burbidge, 2012). Seven ca. 100 kg soil and sediment samples were collected from contrasting lithological settings, in 1 week based at UA, from six locations across north-central Portugal. Sampling was combined with detailed in situ measurements and area surveys by gamma spectrometry (Fig. 3), including the first application in this context of a novel backpack system developed by the group of the project consultant. This project is helping to develop gamma spectrometry of non-neutron-activated materials in the GeoLuC group.



**Fig. 3:** Soil sampling and field gamma spectrometry ( $4\pi$ ,  $2\pi$ , and backpack survey) at the Macida-Éolica site, Central Portugal (Schist).

### *Nuclear methods applied to human-paleoenvironments interactions*

Nuclear techniques, geochemistry, mineralogy and dating (optical stimulated luminescence and thermoluminescence) have been applied to geological and archaeological materials and contexts around Alqueva dam (FCT Doctoral Fellowship SFRH/BD/62396/2009); application of nuclear techniques on elemental characterization of naturally occurring radioactive materials (NORM); contribution for the knowledge of the environmental variability and human-environment interactions to reconstruct human impacts on ecosystems over the past 7000 years (Fig. 4).



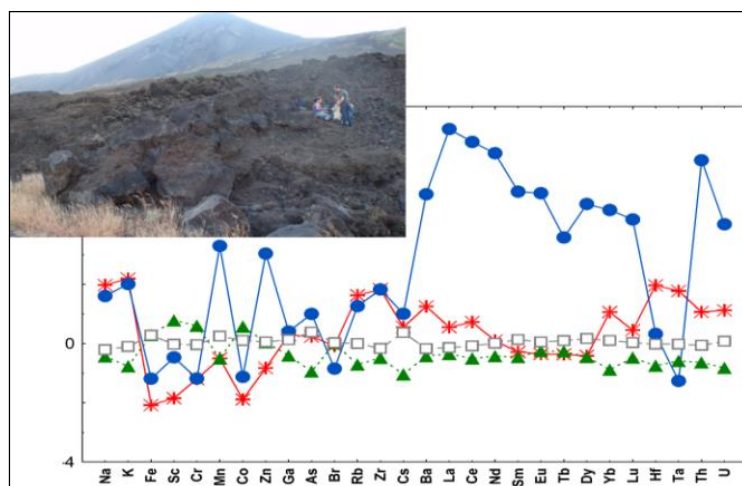
**Fig. 4:** Monte Carrascal: Sampled profile, semiquantification and estimated absorbed dose (Rodrigues et al., submitted).

### *Nuclear methods for Environmental analysis and Geochemical Mapping*

Chemical characterization of volcanic soils was made by INAA contributing to the establishment of a geochemical atlas of the Santiago and Fogo islands, in collaboration with Univ. of Aveiro. Sampling was made according to the recommendations of the IGCP 259 (“International Geochemical Mapping”). Rare earth elements patterns clearly differentiate soils with contrasting parent materials, particularly carbonatites-related soils, associated with higher actinides contents (Marques et al, 2012) (Fig. 5). Iron speciation was done for topsoils and weathering profiles in different environments of Fogo.

The geochemical and mineralogical data obtained in a constructed passive system (from an abandoned mine, Jales, Portugal) showed the role of different solid materials in the retention of metals and arsenic, observed during the start-up period of the treatment plant (collaboration with Univ. Minho; Valente et al., 2012).





**Fig. 5:** Soil sampling and chemical differentiation of topsoils from diverse environments of Cape Verde.

### ***L.A.I.S. 2012 Conference***

The first international conference focussed on the luminescence dating research community to be held in Portugal, and the second Luminescence in Archaeology International Symposium (LAIS 2012), was hosted by the GeoLuC group at IST/ITN from the 5<sup>th</sup>-7<sup>th</sup> September 2012. The participants, from Asia, Africa, North and South America, and Europe, represented a ca. 30% increase on the first meeting and contributes to the establishment of a new fully international conference series in which CTN and Lisbon will be remembered positively (Fig. 6).



**Fig. 6:** LAIS 2012 Conference photo.

### **RELEVANT PAPERS**

- C.I. Burbidge. Facets of Luminescence for Dating. *Spectroscopy Letters* 45, 118–126 (2012). <http://dx.doi.org/10.1080/00387010.2011.610657>.
- M.I. Dias, M.I. Prudêncio, M.J. Trindade, A.C. Valera. Towards a Temporality Approach in Perdigões, Portugal: Chemical and Mineralogical Composition of Neolithic and Chalcolithic Pottery and Raw Materials. *Revista De La Sociedad Española De Mineralogía*. Macla, nº 16, Junio'12, 28-30 (2012). [http://www.ehu.es/sem/macla\\_pdf/macla16/Macla16\\_028.pdf](http://www.ehu.es/sem/macla_pdf/macla16/Macla16_028.pdf)
- M.I. Prudêncio, M.A., Stanojev Pereira, J.G. Marques, M.I. Dias, L. Esteves, C.I. Burbidge, M.J. Trindade, M.A. Albuquerque, Neutron tomography for the assessment of consolidant impregnation efficiency in portuguese glazed tiles (16th and 18th centuries). *Journal of Archaeological Science*, 39: 964-969 (2012), <http://dx.doi.org/10.1016/j.jas.2011.11.010>.

- R. Marques, M.I. Prudêncio, F. Rocha, M.M.M.S. Cabral Pinto, M.V.G. Silva, E. Ferreira Da Silva, E., REE and other trace and major elements in the topsoil layer of Santiago island, Cape Verde. *Journal of African Earth Sciences*, 64, 20–33 (2012), TOP 25 HOTTEST ARTICLE: Earth and Planetary Sciences - January to March 2012, doi:10.1016/j.jafrearsci.2011.11.011.
- T.M. Valente, M. Antunes, M.A. Sequeira Braga, M.I. Prudêncio, R. Marques, J. Pamplona, Mineralogical attenuation for metallic remediation in a passive system for mine water treatment. *Environmental Earth Sciences*, 66, Issue 1: 39-54 (2012), doi: 10.1007/s12665-011-1205-7.

## FUNDS

Project/Service	Reference	Timeframe	2012
The Della Robbia sculptures in Portugal: History, Art and Laboratory – ROBBIANA.	PTDC/HIS-HEC/116742/2010	05-03-2012 to 04-03-2015	5.200,00 €
RUPSCIENCE - Analysis of the operational chains, archaeometry and chronology of Rock Art Paintings. An approach to materials technology of Portugal, Spain and Colombia's contexts.	PTDC/HIS-ARQ/101299/2008	01-06-2010 to 31-05-2013	0,00 €
Diagnosis, decontamination and conservation of cultural heritage: neutrons and ionizing radiation in artwork (RADIART).	PTDC/HIS-HEC/101756/2008	01-01-2010 to 30-06-2013	23.509,44 €
Spatial Variation of Dose Rate in Soils and Sediments – VADOSE.	PTDC/AAC-AMB/121375/2010	01-01-2012 to 31-12-2014	29.926,80 €
Death management in Recent Prehistory: funerary practices in Perdigoes enclosure (FUNPERD).	PTDC/CS-ANT/104333/2008	01-06-2010 to 31-05-2013	0,00 €
Chemical analysis of Neolithic ceramics and clays from archaeological sites of the Estremenho limestone massif and the western Algarve region, by neutron activation analyses. Universidade do Algarve - Centro de Ciências do Mar.		01-10-2011 to 31-01-2012	3.444,00 €
<b>Total</b>			<b>62.114,24 €</b>

## INTERNATIONALIZATION

- IAEA “Regional Training Course on Radiation Technology for Cultural Heritage Preservation” in the frame of the International Atomic Energy Agency TC Project RER/0/034 - Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts. Course Director: M. Isabel Prudêncio, IST, CTN, Nov. 4-9 (2012).
- Convénio Portugal (FCT) / Itália (CNR) 2011-2012.
- Collaborations with University of Huelva, Spain for environmental studies.
- Collaborations with University of Seville, Spain for cultural heritage studies.
- Collaborations with University of Coruña, Spain for environmental and cultural heritage studies.
- Collaborations with SUERC, Scotland, UK for environmental dosimetry.
- Collaboration with USGS - “Reference Materials” for certification testing.
- Members of Scientific Committees of international conferences.
- Members, Working Group Secretary, participation in international intercomparison exercises: European Radiation Dosimetry Group (EURADOS).

# Researchers – Scientific Activities

(ordered by category and name)

**NAME: Manuel José Duarte Leite de Almeida**

**CATEGORY:** Senior Researcher

**ID NUMBER:** 2144

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Conselho Directivo do ITN	10%
2	Comissão Científica da IST/ITN	5%
3	Electrocrystallisation of Charge Transfer salts; from crystallogenesi to electronic devices, projecto PTDC/QUI-QUI/101788/2008, <i>CRYSTALOGEN</i> .	30%
4	Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds; $\alpha$ -(Per) <sub>2</sub> [M(mnt) <sub>2</sub> ], projecto PTDCI/FIS/113500/2009, <i>PRESSMAG</i> .	25%
5	“Electronic and magnetic properties of Strongly Correlated Electron Systems (SCES): molecular materials and uranium intermetallics”, programa PICS de colaboração bilateral Franco-Portuguesa da FCT com o CNRS - Universidade de Rennes.	5%
6	Magnetic properties of <i>f</i> -electron molecules. Lantanide and Uranium III and IV complexes with Soft Donor Ligands.	10%
7	Thiophenic TTF type donors, corresponding bisdithiolenes and their derivatives.	5%
8	TTF type donors and bisdithiolenes complexes with N Coordinating groups for Molecular Materials	5%
9	Management of the Solid State Group	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	President of Directive board of ITN until its integration at IST in 29 Feb. 2012. Collaboration with following management team in the transition period until full extinction of ITN as an independent Institution.
2	Coordination of scientific advisory activities for both the Comissão Instaladora IST/ITN and for the IST President. Collaboration with IST Scientific Council.
3	Charge transfer salts based on perylene and transition metal bis-maleonitrile-dithiolate [M(mnt) <sub>2</sub> ] (M=Au, Cu, Ni, Pd, Pt, Co, Fe) may present different stoichiometries and polymorphs. The $\alpha$ -(Per) <sub>2</sub> [M(mnt) <sub>2</sub> ] phases are of special interest due to unique properties derived from the coexistence in the same solid of two types of chains: conducting chains of partially oxidised perylene molecules (Per) <sup>1/2+</sup> and chains of monoanionic complexes [M(mnt) <sub>2</sub> ] <sup>-</sup> that depend on the metal can be either diamagnetic or paramagnetic. The electrocrystallisation technique of these systems was optimized and the conditions allowing for the first time the growth of (Per) <sub>2</sub> [Pd(mnt) <sub>2</sub> ] crystals were found being limited by close proximity of the oxidation potentials of the perylene donor and [Pd(mnt) <sub>2</sub> ] <sup>-</sup> anion. Depending on the specific conditions different morphologies can be obtained, being mainly of the $\beta$ -polymorph with electrical and magnetic properties comparable to the Cu, Ni and Pt previously described. The early stages of the electrocrystallisation of these compounds with emphasis on M=Au were studied by combination of different techniques including high resolution AFM. The electrocrystallisation of these systems and related charge transfer salts on a variety of substrates including microelectrodes was also developed.
4	Activities concerned the characterisation of different $\alpha$ -(Per) <sub>2</sub> [M(mnt) <sub>2</sub> ] systems at low temperatures and high magnetic field and pressure, with special emphasis on the M=Pt compound.  <sup>1</sup> H and <sup>195</sup> Pt NMR were used to probe the spin 1/2 anion chain in the quasi-one-dimensional conductor Per <sub>2</sub> [Pt(mnt) <sub>2</sub> ], which exhibits nearly simultaneous charge density wave (CDW) and spin-Peierls (SP) transitions at low temperatures (T <sub>c</sub> ~ 8 K). Below T <sub>c</sub> the [Pt(mnt) <sub>2</sub> ] <sup>-</sup> chain forms a spin-singlet state that was evident in <sup>1</sup> H NMR spectra and spin relaxation (1/T <sub>1</sub> ) rates;

	<p>however minority unpaired Pt spins remaining in the SP ground state. With increasing magnetic field, the SP and CDW order parameters were found to decrease in unison, indicating they are coupled up to a critical field <math>B_c \sim 20</math> T. Above <math>B_c</math>, the spin singlet evolves into a spin-polarized configuration. The <math>^{195}\text{Pt}</math> NMR signals vanish as either <math>T_c</math> or <math>B_c</math> are approached from within the SP ground state, suggesting the hyperfine field of the Pt nucleus is significantly stronger than at the proton sites. Simulations yield a consistent picture of the angular, temperature, and magnetic field-dependent spectral features.</p> <p>This activity leads to 3 publications and 2 oral presentations.</p>
5	<p>Coordination of joint collaborative activities with Univ. Rennes under the general topic of common interest "Electronic and magnetic properties of Strongly Correlated Electron Systems (SCES): molecular materials and uranium intermetallics". Organisation of a joint workshop in Rennes with emphasis on molecular systems <i>Workshop on Molecular Materials with Strong Electronic Correlations</i> where 5 oral contributions were presented.</p> <p>The activities besides molecular materials research detailed in other topics included also research on intermetallics aiming at the understanding of the magnetic and strongly correlated electron behavior of intermetallic compounds containing <i>f</i>-elements (in particular the role of <i>5f</i>-electrons), leading in 2012 to the following results:</p> <p>Characterization of the low temperature physical properties of UFeGe samples, which indicated that the structural distortion of the orthorhombic phase is due to the increase on the density of states at the Fermi level.</p> <p>Magnetic characterization of the low temperature physical properties of large single crystals of <math>\text{U}_2\text{Fe}_3\text{Ge}</math> grown by the Czochralski method were an abnormally small magnetic anisotropy was observed.</p> <p>Crystal structure and magnetic properties investigation of other uranium ternary systems, namely <math>\text{UFe}_3\text{B}_2</math> were a ferromagnetic behavior in the 2-300K temperature range was observed.</p>
6	<p>The preparation and characterization of a series of lanthanide-containing one-dimensional coordination polymers based on picolinic and glutaric acids, <math>\text{Ln}(\text{glu})(\text{pic})(\text{H}_2\text{O})_2</math>, <math>\text{Ln}=\text{Gd}</math>, <math>\text{Tb}</math>, and <math>\text{Dy}</math> and some mononuclear uranium(III) compounds based on the <math>\text{Tp}^{\text{Me}_2}</math> ligand such as <math>[\text{U}(\text{Tp}^{\text{Me}_2})_2\text{I}]</math>, was performed. All these compounds present at low temperatures slow relaxation of magnetization, the so called single ion magnet behavior, presently a hot topic. In the <math>\text{Ln}(\text{glu})(\text{pic})(\text{H}_2\text{O})_2</math> compounds, in spite of the double chain ladder structure, these effects are due to single ions, as in the uranium compounds, which are still rare examples of actinide complexes with SMM behavior, however already enabling the establishment of important structure-magnetic properties correlations. The identification of mononuclear lanthanide compounds with clear single ion magnet behavior showed that many of the previously claimed single chain magnet behavior with <i>f</i>-elements is due essentially to single ion effects.</p> <p>The single-crystal X-ray diffraction analysis of the uranium complexes revealed interesting and unexpected results. In addition to the previously reported structure for <math>[\text{U}(\text{Tp}^{\text{Me}_2})_2\text{I}]</math>, in which one of the pyrazolyl rings coordinates side-on to the uranium, we found out another structure incorporating solvent molecules that presents undistorted pyrazol rings, and a third one which is the ionic compound <math>[\text{U}(\text{Tp}^{\text{Me}_2})_2\text{I}]</math>.</p>
7	<p>The synthesis of several TTF type donors and of the corresponding bisdithiolene metal complexes with variable extent and bearing N-coordinating groups was intensively explored in order to access the possibility of these units to incorporate transition metals in electroactive conducting systems or build heterobimetallic networks. The molecular and crystal structure of many of these new units was determined by single crystal x-ray diffraction and their redox behavior was characterized by Cyclic Voltammetry studies, an essential step necessary to establish the stability range of these units and their subsequent incorporation in salts.</p> <p>The coordination ability of several transition metal bisdithiolene complexes based on small ligands containing N atoms, such as <math>[\text{M}(\text{cbdt})_2]^{2-}</math>, <math>[\text{M}(\text{dcbdt})_2]^{2-}</math> and <math>[\text{M}(\text{dcdmp})_2]^{2-}</math> with <math>\text{M} = \text{Fe}</math>, <math>\text{Cu}</math>, towards other metals, in order to obtain bimetallic networks was explored, and they were successfully combined with <math>[\text{M}(\text{cyclam})]^{2+}</math> (<math>\text{M}=\text{Ni}</math>, <math>\text{Cu}</math>) cations. The obtained bimetallic complexes were fully characterised by a variety of techniques.</p> <p>This work was partially developed in collaboration with a group from Université de Rennes 1,</p>

	France and involved the PhD project of Ana Cláudia Cerdeira and research training of the M.Sc. Sandrina Oliveira, leading to three research papers and four oral presentations.
8	<p>Preparation and characterization of <math>\alpha</math>-DT-TTF (alpha-dithiophene tetrathiafulvalene), the missing element in the family of simple thiophenic-TTF donors. This donor was used as an active material in a field-effect transistor with moderate mobility and its ability to provide conducting charge transfer salts was already demonstrated by <math>\text{PF}_6^-</math> salts which were characterised.</p> <p>A new series of compounds based on the <math>[\text{Ni}(\alpha\text{-tpdt})_2]^-</math> anion and crown-ethers cations, was studied, enabling a detailed comparison of the physical properties and a clear establishment of the relationships between the crystal structure and the physical properties in this type of solids, enlightening the role of the sulphur atom position on the solid state mediating electronic and magnetic interactions.</p> <p>The first members of a new family of transition metal complexes based on the methyl substituted 2,3-thiophene-dithiolate, which are more soluble than the related unsubstituted complexes, have been obtained and characterised, opening the way of its use as the base components of electronic devices by solution processing techniques.</p> <p>These activities gave rise to 4 research papers, in peer review journals and to three oral presentations. They included the research training of the M.Sc. Rafaela Silva and the supervision of a PhD Thesis in materials chemistry by Ana Neves, at IST.</p>
9	The management of the Solid State Group included the general coordination of research activities in the group, maintenance of infrastructures, the preparation of research proposals and grants submissions.

## PAPERS

- S.I. G. Dias, S. Rabaça, I. C. Santos, L. C. J. Pereira, R. T. Henriques, M. Almeida, Bisdithiolene complexes based on an extended ligand with TTF and pyridine moieties *Inorg. Chem. Comm.*, **15**, 102-105 (2012). <http://dx.doi.org/10.1016/j.inoche.2011.10.001>.
- M.L. Afonso, R. A. L. Silva, M. Matos, E. B. Lopes, J. T. Coutinho, L. C. J. Pereira, R. T. Henriques, M. Almeida, Growth of (Perylene)<sub>2</sub> [Pd(mnt)<sub>2</sub>] crystals, *J. Crystal Growth*, **340**, 56-60 (2012). [10.1016/j.jcrysgro.2011.11.083](http://dx.doi.org/10.1016/j.jcrysgro.2011.11.083).
- R.A. L. Silva, M. L. Afonso, I. C. Santos, D. Belo, R. R. Freitas, E. B. Lopes, J. T. Coutinho, L. C. J. Pereira, R. T. Henriques, M. Almeida, C. Rovira, (DT-TTF)<sub>2</sub>[Pd(mnt)<sub>2</sub>]: An unusual ionic salt, *Phys. Status Solidi C*, **9**, No. 5, 1134–1136 (2012). <http://dx.doi.org/10.1002/pssc.201100631>.
- M. L. Afonso, R. A. Silva, L. C. J. Pereira, J. T. Coutinho, R. R. Freitas, E. B. Lopes, M. Matos, R. T. Henriques, A. Viana, M. Almeida, Electrocrystallisation of (Per)<sub>2</sub> [Pd(mnt)<sub>2</sub>], *Phys. Status Solidi C* **9**, No. 5, 1131–1133 (2012). <http://dx.doi.org/10.1002/pssc.201100632>.
- D. Belo, A. I. S. Neves, L. C. J. Pereira, M. Almeida, Magnetic properties of [K(18-crown-6)] [Ni( $\alpha$ -tpdt)<sub>2</sub>], *Physica Status Solidi C*, **9**, No.5, 1199–1201 (2012). <http://dx.doi.org/10.1002/pssc.201100637>.
- M. L. Afonso, R. A. L. Silva, M. Matos, R. T. Henriques, M. Almeida, “Electrocrystallisation of (Perylene)<sub>2</sub> [M(mnt)<sub>2</sub>] salts”, *Physica Status Solidi C*, **9**, No.5, 1123-1126 (2012), <http://dx.doi.org/10.1002/pssc.201100699>.
- S. Rabaca, A. Cerdeira, S. Oliveira, I. C. Santos, R. T. Henriques, L. C. J. Pereira, J. T. Coutinho, M. Almeida; Neutral gold and nickel bis[1-(pyridin-4-yl)-ethylene-1,2-dithiolene] complexes: Synthesis, structure and physical properties; *Polyhedron*, **39**, 91–98 (2012). <http://dx.doi.org/10.1016/j.poly.2012.03.024>.
- A.C. Cerdeira, M. L. Afonso, I. C. Santos, L. C. J. Pereira, J. T. Coutinho, S. Rabaça, D. Simão, R. T. Henriques, M. Almeida; Synthesis, Structure and Physical Properties of Transition Metal bis 4-cyanobenzene-1,2-dithiolate Complexes [M(cbdt)<sub>2</sub>]<sup>z-</sup> (M = Zn, Co, Cu, Au, Ni, Pd, z = 0, 1, 2); *Polyhedron* **44**, 228–237 (2012). <http://dx.doi.org/10.1016/j.poly.2012.07.010>.
- J.T. Coutinho, M. A. Antunes, L.C.J. Pereira, J. Marçalo, M. Mazzanti, H. Bolvin, M. Almeida, Single-Ion Magnet behaviour in [U(Tp<sup>Me2</sup>)<sub>2</sub>I], *Dalton Transactions*, **41**(44), 13568–13571 (2012).

<http://dx.doi.org/10.1039/C2DT31421E>.

- A. Casaca, E. B. Lopes, A. P. Gonçalves, M. Almeida, Electrical transport properties of CuS single crystals, *J. Phys. Condens. Matter*, **24**, 015701 (2012). <http://dx.doi.org/10.1088/0953-8984/24/1/015701>
- M.L. Afonso, R. A. L. Silva, M. Matos, A. S. Viana, M. F. Montemor, M Almeida, “Studies on the Electrochemical Growth of (Per)<sub>2</sub>[Au(mnt)<sub>2</sub>]”, *Langmuir*, **28**, 4883-4888 (2012), DOI: 10.1021/la204713s
- Neves, E. B. Lopes, M. Almeida, D. Belo, New copper thiophenedithiolenes for single component molecular metals, *Physica Status Solidi C*, **9**, 1137-1139 (2012). <http://dx.doi.org/10.1002/pssc.201100635>.
- E. Laukhina, V. Lebedev, V. Laukhin, A. P. del Pino, E. B. Lopes, A. I. S. Neves, D. Belo, M. Almeida, J. Veciana, C. Rovira, Polycarbonate films metalized with a single component molecular conductor suited to strain and stress sensing applications, *Organic Electronics* **13**, 894-898 (2012). <http://dx.doi.org/10.1016/j.orgel.2012.01.031>.
- D. Espa, L. Marchiò, L. Pilia, M. L. Mercuri, F. Artizzu, A. Serpe, D. Simão, M. Almeida, M. Pizzotti, P. Deplano, “Structure and Second-Order NLO Properties of a Square-Planar Pt(II) Mixed Ligand Dithiolene Complex based on Dithione/benzodithiolato Ligands”, *Dalton Transactions*, **41**, 3485-3493 (2012), <http://dx.doi.org/10.1039/c2dt11956k>.
- E.L. Green, L. Lumata, J. S. Brooks, P. Kuhns, A. Reyes, S. E. Brown, M. Almeida, “<sup>1</sup>H and <sup>195</sup>Pt NMR study of the parallel two-chain compound Perylene<sub>2</sub>[Pt(mnt)<sub>2</sub>]” *Crystals*, **2**, 1116-1135; (2012), DOI:10.3390/cryst2031116.
- García-Simón, M. Garcia-Borràs, L. Gómez, I. Garcia-Bosch, S. Osuna, M. Swart, J. M. Luis, C. Rovira, M. Almeida, I. Imaz, D. Maspocho, M. Costas, and X. Ribas, “Self assembled tetragonal prismatic molecular cage highly selective for anionic  $\pi$ -guests”, *Chemistry an Europea Journal*, em publicação DOI: 10.1002/chem.201203376.
- R.A. L. Silva, A. I. S. Neves, M. L. Afonso, I. C. Santos E. B. Lopes, F. del Pozo, R. Pfattner, M. Mas-Torrent, C. Rovira, M. Almeida, D. Belo,  $\alpha$ -DT-TTF; a detailed study of an electronic donor and its derivatives, accepted for publication in *European Journal of Inorganic Chemistry*, <http://dx.doi.org/10.1002.ejic.201201362>.
- R.A. L. Silva, A. I. S. Neves, J. T. Coutinho, L. C. J. Pereira, I. C. Santos, E. B. Lopes, C. Rovira, D. Belo, M. Almeida, (a-DT-TTF)<sub>2</sub> [Au(mnt)<sub>2</sub>]; a weakly disordered organic spin-ladder, submitted to *Advanced Functional Materials*.

## COMMUNICATIONS

- *Slow magnetic relaxation in f-element compounds; from lanthanide double chain magnets to uranium single-ion magnets*, M.A. Antunes, P. Girginova, J. T. Coutinho, L.C.J. Pereira, I.C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), Invited oral.
- *Low-temperature properties of orthorhombic UFeGe*, A.P. Gonçalves, M.S. Henriques, L.C.J. Pereira, M. Almeida, L. Havela, J.C. Waerenborgh, E.B. Lopes, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), poster.
- *Single-Molecule-Magnet behaviour in [U(Tp<sup>Me2</sup>)<sub>2</sub>]I*, J. T. Coutinho, M. A. Antunes, L. C. J. Pereira, I. C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), poster.
- *“f-elements Centers for Single Molecule Magnets; from Lanthanides to Uranium”* M. Almeida, ChemFORUM 2012 Winter Edition, IST, 29 February 2012, Invited Seminar.
- *Uranium(III) Tris(pyrazolyl)borate Complexes as Single-Ion Magnets*, M. A. Antunes, J. Coutinho, L. C. J. Pereira, I. C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, *European f-element Chemistry, EUFEN1, Cost Action CM1006, Univ. Rovira I Vergili, Tarragona, Spain, April 2-4 (2012)*, poster.
- *Magnetic Properties of a Dysprosium Layered Lanthanide Hydroxide and its intercalation for 2,6-naphthalenedicarboxylate*, C. C. L. Pereira, L. C. J. Pereira, B. Monteiro, Ho M. Dung, J. Marçalo, M. Almeida, *European f-element Chemistry, EUFEN1, Cost Action CM1006, Univ. Rovira I Vergili,*

Tarragona, Spain, April 2-4 (2012), poster.

- *f-Element centers for single molecule magnetic behaviour; from lanthanides to uranium*, M. A. Antunes, P. I. Girginova, J. T. Coutinho, L. C. J. Pereira, I. C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, 62<sup>nd</sup> Fujihara Seminar, *Frontier and Perspectives in molecule-based quantum magnets*, Koyo Grand Hotel, Sendai, Japan, May 7-10 (2012), invited talk.
- *Development of new neutral bisdithiolene transition metal complexes for conducting and magnetic materials*”, M. Almeida, 11 May 2012, Invited Seminar at Nihon University, Tokyo, Japan.
- *Electrocrystallisation of two chain, conducting and magnetic, systems (Perylene)<sub>2</sub>[M(mnt)<sub>2</sub>]*, M. L. Afonso, R. A. L. Silva, M. Matos, R. T. Henriques, A. S. Viana, M. F. Montemor, M. Almeida, 62<sup>nd</sup> Fujihara Seminar, *Frontier and Perspectives in molecule-based quantum magnets*, Koyo Grand Hotel, Sendai, Japan, May 7-10 (2012), poster presentation and seminar at Nihon University, Tokyo, Japan 11 May (2012).
- *Bisdithiolene Complexes Based on Extended TTF-Derivatives Bearing Pyridine Rings*, S.I.G. Dias, J.T. Coutinho, A.I.S. Neves, L.C.J. Pereira, I.C. Santos, S. Rabaça, J.D. Wallis, M. Almeida, *ICCC40, 40<sup>th</sup> International Conference on Coordination Chemistry*, Valencia, Spain, September 9-13(2012), oral.
- *Lanthanide Ladder Type Coordination Polymers with Single Ion Magnet Behaviour*, P.I. Girginova, L.C.J. Pereira, J.T. Coutinho, I.C. Santos, M. Almeida, *ICCC40, 40<sup>th</sup> International Conference on Coordination Chemistry*, Valencia, Spain, September 9-13 (2012), poster.
- *Bisdithiolene Complexes Containing N-coordinating Groups; Towards New Coordination Structures*, A.C. Cerdeira, S. Rabaça, D. Belo, I.C. Santos. L.C.J. Pereira, J.T. Coutinho, R.T. Henriques, D. Simão, O. Jeannin, M. Fourmigué, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations*, Institut des Sciences Chimiques de Rennes, Rennes, France, October 23-24 (2012), oral.
- *New bisditholene complexes based on substituted thiophenic ligands for magnetic and conducting materials*, A. I. S. Neves, I. C. Santos, J. T. Coutinho, L. C. J. Pereira, E. B. Lopes, R. T. Henriques, H. Alves, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations*, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, October 23-24 (2012), oral.
- *Strong and Weak Disorder Effects in Molecular Spin Ladders*. R. A. L. Silva, D. Belo, E. B. Lopes, J. T. Coutinho, L. C. J. Pereira, C. Rovira, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations*, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, October 23-24 (2012), Invited talk.
- *α-DT-TTF ; a new electronic donor*, R. A. L. Silva, A. I. S. Neves, M. L. Afonso, I. C. Santos, E. B. Lopes, M. Mas-Torrent, C. Rovira, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations*, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, 23<sup>th</sup> -24<sup>th</sup> October (2012), oral presentation.
- *New TTF Derivatives with Cyano Coordination Groups*, S. Oliveira, S. Rabaça, I. C. Santos. D. Simão, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations*, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24(2012), Oral presentation.
- *Extended Bisdithiolene Complexes with Benzocycano and Pyrazine Units, for Molecular Materials*, S. Rabaça, S. Oliveira, I. C. Santos. D. Simão, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations*, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24 (2012), Oral presentation.

## EDUCATION

- Co-Supervisor, PhD Thesis, *Complexos de Metais de Transição Baseados em Ligandos Ditiolatos Tiofênicos para Compostos Condutores e Magnéticos*, by A. S. Neves, PhD Program in Chemistry at IST.
- Co-Supervisor, PhD Thesis, *Redes heterometálicas e novas arquiteturas supramoleculares baseadas em complexos de metais de transição com ligandos dito-azo*, by A. C. Cerdeira, PhD Program in Chemistry at IST.
- Supervisor, PhD Thesis, *Novas unidades estruturais para condutores e magnetos moleculares: sais de tetratiafulvaleno contendo grupos coordenantes de metais de transição* Sandrina de Oliveira Simões, programa de Doutoramento em Química no IST.

- Supervisor, PhD Thesis, *Thiophenic-TTF derivatives and Thiophenic-bisdithiolenes complexes for magnetic and conducting materials*, by Rafaela Antunes Leão da Silva, PhD Program in Chemistry at IST, bolsa FCT (SFRH/BD/86131/2012).

## PROJECTS

### Running

- “*Electrocrystallisation of Charge Transfer salts; from crystallogenesis to electronic devices*”, PTDC/QUI-QUI/101788/2008, CRYSTALOGEN, Coordinator.
- “*Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds;  $\square$ -(Per)<sub>2</sub>[M(mnt)<sub>2</sub>]*”, PTDCI/FIS /113500/2009, PRESSMAG, Coordinator.
- “*Electronic and magnetic properties of Strongly Correlated Electron Systems (SCES): molecular materials and uranium intermetallics*”, programa PICS de colaboração bilateral Franco-Portuguesa da FCT, com o CNRS da Universidade de Rennes, 2011-2013. Coordinator.

### Submitted

- “*Crystal and Molecular Engineering of multifunctional materials with unconventional electrical and magnetic properties*”: Proposta FCT EXCL/QEQ-SUP/0184/2012, Very Good, not recommended for funding.
- PhD grant in Chemistry, *Thiophenic-TTF derivatives and Thiophenic-bisdithiolenes complexes for magnetic and conducting materials*, for Rafaela Antunes Leão da Silva, at IST. FCT grant (SFRH/BD/86131/2012), starting Jan. 2013.

## CONFERENCE ORGANIZATION / COMMITTEES

- Member Organization Committee of *Workshop on Molecular Materials with Strong Electronic Correlations*, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, October 23-24 (2012).
- Member do *International Advisory Committee da 10th International Symposium on Crystalline Organic Metals Superconductors and Ferromagnets (ISCOM 2013)* that will take place in Montreal, Québec, Canada, from July 14 to July 19 2013.
- Member of the international evaluation pannel of research projects for the Italian Ministry of Science and Universities "Ministero dell'Università e della Ricerca Scientifica e Tecnologica".
- Member of the *International Advisory Board do European Journal of Inorganic Chemistry*.

## NAME: Isabel da Graça Rego dos Santos

**CATEGORY:** Principal Researcher with habilitation

**ID NUMBER:** 25348

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Coordination of the Radiopharmaceutical Sciences Group	35%
2	Coordination of the project “ <i>Synthesis, characterization and biological assessment of multi-functional bone-seeking agents</i> ” PTDC/QUI-QUI/115712/2009. Collaboration: IMM/FML	25%
3	Coordination of the project “ <i>Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies</i> ” (Portugal/Spain- E 23/12) and COST ACTION CM1105. Collaboration: Universidade Autónoma de Madrid/ Rijksuniversiteit Groningen.	5%
4	Coordination of the IAEA CRP project “ <i>Bimodal dextran-based probes for Sentinel Lymph Node Detection by SPECT and Optical Imaging</i> ”. Collaboration with IAEA to provide new methodologies to developing countries participating in the CRP.	10%
5	Team Member of the project “ <i>Radiolabeled Benzazole Derivatives for In Vivo</i> ”	10%



	Imaging of Amyloid Aggregation” (PTDC/QUI/QUI/102049/2008) Collaboration; IMM/FML, ICNAS/UC	
6	Scientific Coordination of the Projects Involving Peptide-Based Metal Complexes.	5%
7	Education/Teaching Activities	5%
8	Councils, Commissions and Consultancy Activities	5%
Total		100%

## WORK SUMMARY

N°	Work Summary and Main Achievements
1	<p>Coordination of the Radiopharmaceutical Sciences Team and Respective Programs:</p> <ul style="list-style-type: none"> <li>- Scientific Strategy of the Group and Definition of New Programs/Projects in Collaboration with Senior Researchers;</li> <li>- Management of the Global Budget Available and Coordination of the Scientific and Technical Activities Supporting Research and Services.</li> <li>- Promotion of Scientific Interaction and/or Services with National/International Institutions/Universities.</li> <li>- Promotion of Education and Training;</li> </ul>
2	<p>The main goal of the project “<i>Synthesis, characterization and biological assessment of multi-functional bone-seeking agents</i>” is the design and synthesis of multifunctional metal complexes for the simultaneous delivery of radiation, bisphosphonates and chemotherapy to bone metastatic lesions, using novel and well-defined multifunctional chemical/radiochemical approaches.</p> <p>Main results:</p> <ul style="list-style-type: none"> <li>- Synthesis and biological evaluation (in cells and healthy animals) of several compounds bearing a bisphosphonate unit and a radionuclide (Re/Tc).</li> <li>- Using different chemical strategies, the best performing complexes have been structurally modified to conjugate a cytotoxic agent, without compromising their bone uptake.</li> </ul> <p>I have coordinated and supervised the research work of Célia Fernandes, Patrícia Mendes (Master student) and Sofia Monteiro (BI) as well as the interaction with the partner Institution.</p>
3	<p>The main goal of the project “<i>Target-specific and Heterobimetallic Pt Complexes: Synthesis, Characterization and Mechanistic Studies</i>” is the design, synthesis and biological evaluation of target-specific Pt and Pt/Tc complexes. Such approach intends to overcome the side effects of the conventional Pt complexes and by using bimetallic complexes (Pt/Tc) intend to use molecular imaging to modulate pharmacokinetics.</p> <p>Main Results:</p> <ul style="list-style-type: none"> <li>- Synthesis/characterization of new target-specific Pt(II) and Pt(IV) complexes bearing a RGD peptide.</li> <li>- Synthesis/characterization of a heterobimetallic Pt/Re complex.</li> <li>- Synthesis/characterization of a protected bifunctional chelator bearing Pt(II) and a donor atom set suitable to <sup>99m</sup>Tc-tricarbonyl.</li> <li>- Mechanistic studies of the Pt complexes: interaction with Zn finger proteins models, with DNA and cytotoxic activity.</li> </ul> <p>I have coordinated this multidisciplinary project: Meetings with the Spanish Coordinator, coordination of the work performed by the two Spanish PhD students and by the PhD student Maurício Morais which has also been involved in the project as well as F. Mendes and A. Paulo.</p>
4	<p>The main goal of the project “<i>Bimodal dextran-based probes for Sentinel Lymph Node Detection by SPECT and Optical Imaging</i>” is the design/synthesis and characterization of <sup>99m</sup>Tc-complexes for accurate SLND, a key issue for tumor staging, evaluation of the extension of surgery, and establishment of the most adequate therapy.</p> <p>Main Results:</p> <ul style="list-style-type: none"> <li>- Introduction of the first <sup>99m</sup>Tc(CO)<sub>3</sub>-mannosylated nano-compounds with superior biological features for SLN Detection.</li> <li>- Animal SPECT/CT imaging confirmed the biodistribution data: The nanocompounds are retained in the first lymph node allowing its clear visualization.</li> <li>- Profiting from the superior SLN-targeting properties of this compound, novel mannose-</li> </ul>

	<p>containing dextran derivatives with both radioactive (<math>^{99m}\text{Tc}(\text{CO})_3</math>) and fluorescent units have been prepared, to be evaluated <i>in vivo</i> as a multimodal probe (SPECT and Optical imaging).</p> <p>I have coordinated the scientific activities of this project and delineated the synthetic strategy to be followed by Maurício Morais (PhD student) which has performed the work, in collaboration with J.D.G.Correia. I have also coordinated the interaction with partners (IAEA, UAveiro, countries involved in the IAEA CRP)</p>
5	<p>The main goal of the project entitled “<i>Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation</i>” is the design of radiolabeled amyloid-avid probes for the early diagnosis of neurodegenerative diseases by Positron Emission Tomography (PET) or Single Photon Emission Computed Tomography (SPECT).</p> <p>Main results:  <i>PET imaging</i> - new radiofluorinated styryl-benzazole derivatives have been synthesized and pre-clinically evaluated (biodistribution studies in male Wistar rats and in the triple-transgenic mouse line (3 x Tg-AD) and metabolic and autoradiographic studies). The tested compounds cross the blood-brain barrier (BBB) but display a rather slow brain washout. Structural modifications of these compounds are under way to improve biodata.  <i>SPECT imaging</i> - a new (S,N,O)-tridentate ligand of the cysteamine type functionalized with a benzothiazole group for amyloid binding has been synthesized and characterized. This new ligand has been successfully used to obtain the correspondent Re(I) tricarbonyl complex, which will be applied as surrogate of the <math>^{99m}\text{Tc}(\text{I})</math> congener and used to measure <i>in vitro</i> the binding affinity towards A<math>\beta</math>(1-42) aggregates.  As team member, I have participated in scientific discussions and strategies to be followed.</p>
6	<p>The main goal of the project “<i>Peptide-Based Metal Complexes</i>” is the design, synthesis and biological evaluation of peptide – based complexes (Tc, Ga, In) potentially interesting for cancer detection, namely melanoma and breast cancer.</p> <p>Main Results:</p> <ul style="list-style-type: none"> <li>- Conjugation of different pyrazolyl-diamine chelators to a melanocortin derivative and labeling with <math>^{99m}\text{Tc}</math>: Synthesis, chemical/radiochemical characterization and biological studies. One of these complexes presented excellent characteristics for molecular imaging of melanoma. In this work has been involved the PhD student Maurício Morais, P. Raposinho, J.D.G.Correia.</li> <li>- Synthesis of NPY-derivatives conjugated to a pyrazolyl-diamine or to DOTA and labeling with <math>^{99m}\text{Tc}</math> and <math>^{67/68}\text{Ga}</math>, respectively. <i>In vitro/in vivo</i> studies to evaluate the effect of the structural parameters on the biological behavior of the complexes. In this work have been involved two MSc students (Marta Antunes and Isabel Rodrigues), C. Fernandes, P. Raposinho.</li> <li>- Synthesis of CXCR4 analogues as well as the corresponding metal(Re)cyclized derivatives. This work has been performed by PhD student Maurício Morais, J.D.G Correia.</li> </ul> <p>I have coordinated the scientific activities of this project and synthetic strategy to be followed.</p>
7	Education/Teaching Activities: Coordination of a Master Course, Coordination and Teaching of Disciplines, Supervision or Co-Supervision of Students and Participation in Juries.
8	Councils, Commissions and Consultancy Activities

## PUBLICATIONS

- S. Gama, F. Mendes, T. Esteves, F. Marques, A. Matos, J. Rino, J. Coimbra, M. Ravera, E. Gabano, I. Santos, A. Paulo, Synthesis and biological studies of pyrazolyl-diamine PtII complexes containing polyaromatic DNA-binding groups, *ChemBioChem* 13, 2352 – 2362 (2012), doi: 10.1002/cbic.201200472.
- G. R. Morais, I. C. Santos, I. Santos, A. Paulo, X-ray diffraction structures of regioisomers of N-methylated benzimidazole compounds with interest for the design of amyloid-avid probes, *J. Chem. Crystallogr.*, 42, 1052–1059 (2012), doi: 10.1007/s10870-012-0358-x.
- G. R. Morais, I. Santos, A. Paulo, Organometallic complexes for SPECT imaging and/or radionuclide therapy, *Organometallics*, 31, 5693-5714 (2012), doi: 10.1021/om300501d.

- C. Moura, L. Gano, F. Mendes, P. D. Raposinho, A. M. Abrantes, M. F. Botelho, I. Santos, A. Paulo, <sup>99m</sup>Tc(I)/Re(I) tricarbonyl complexes for *in vivo* targeting of melanotic melanoma: Synthesis and biological evaluation, *Eur. J. Med. Chem.*, 50, 350-360 (2012), doi: 10.1016/j.ejmech.2012.02.014.
- C. Moura, L. Gano, I. C. Santos, A. Paulo, I. Santos, <sup>99m</sup>Tc(I) scorpionate complexes for brain imaging: synthesis, characterization and biological evaluation, *Current radiopharmaceuticals*, 5, 150-157 (2012), doi: 10.2174/1874471011205020150.
- G. R. Morais, A. Paulo, I. Santos, A synthetic overview of radiolabeled compounds for  $\beta$ -amyloid targeting, *Eur. J. Org. Chem.*, 1279–1293 (2012, doi : 10.1002/ejoc.201101449. (cover picture)
- F. Mendes, L. Gano, C. Fernandes, A. Paulo, I. Santos, Studies of the myocardial uptake and excretion mechanisms of a novel Tc-99m heart perfusion agent, *Nucl. Med. Biol.*, 39, 207-213 (2012), doi: 10.1016/j.nucmedbio.2011.08.007.
- B. L. Oliveira, I. S. Moreira, P. A. Fernandes, M. J. Ramos, I. Santos, J. D. G. Correia, Insights into the structural determinants for selective inhibition of nitric oxide synthase isoforms, *Journal of Molecular Modeling* (2012), doi: 10.1007/s00894-012-1677-8.
- M. Morais, P. D. Raposinho, M. C. Oliveira, D. Pantoja-Uceda, M. A. Jimenez, I. Santos, J. D. G. Correia, NMR Structural Analysis of MC1R-Targeted Rhenium(I) Metallopeptides and Biological Evaluation of <sup>99m</sup>Tc(I) Congeners, *Organometallics*, 31, 5929-5939 (2012), doi: 10.1021/om300502n.
- I. Pirmettis, Y. Arano, T. Tsotakos, K. Okada, A. Yamaguchi, T. Uehara, M. Morais, J. D. G. Correia, I. Santos, M. Martins, S. Pereira, C. Triantis, P. Kyprianidou, M. Pelecanou, M. Papadopoulos, New <sup>99m</sup>Tc(CO)<sub>3</sub>-mannosylated dextran bearing S-derivatized cysteine chelator for sentinel lymph node detection, *Molecular Pharmaceutics*, 9, 1681-1692 (2012), doi: 10.1021/mp300015s.
- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Yasuda, T. Thiemann, T. Kniess, I. Santos, Novel 7 $\alpha$ -alkoxy-17 $\alpha$ -(4'-halophenylethynyl)estradiols as potential SPECT/PET imaging agents for estrogen receptor expressing tumors:synthesis and binding affinity evaluation, *Steroids*, 77, 1123-1132 (2012) doi:10.1016/j.steroids.2012.05.004.
- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Thiemann, I. Santos, Novel estradiol based complexes of Tc-99m, *Journal of Inorganic Biochemistry*, 111, 1-9 (2012), doi:10.1016/j.jinorgbio.2012.03.001
- M. Kuchar, M. C. Oliveira, L. Gano, I. Santos, T. Kniess, Radioiodinated sunitinib as a potential radiotracer for imaging angiogenesis-radiosynthesis and first radiopharmacological evaluation of 5-[<sup>125</sup>I]iodo-sunitinib, *Bioorganic & Medicinal Chemistry Letters*, 22, 2850-2855 (2012), doi:10.1016/j.bmcl.2012.02.068.
- M.C. Oliveira, C. Neto, L. Gano, F. Marques, I. Santos, T. Thiemann, A.C. Santos, F. Botelho, C.F. Oliveira, Estrogen receptor ligands for targeting breast tumors: a brief outlook on radioiodination strategies, *Current Radiopharmaceuticals* 5, 124-141 (2012), doi:10.2174/1874471011205020124.
- C. Neto, C. Fernandes, M.C. Oliveira, L. Gano, F. Mendes, T. Kniess, I. Santos, Radiohalogenated 4-anilinoquinazoline-based EGFR-TK inhibitors as potential cancer imaging agents, *Nuclear Medicine & Biology*, 39, 247–260 (2012), doi:10.1016/j.nucmedbio.2011.09.001.
- T. S. Morais, T. J. L. Silva, F. Marques, M. P. Robalo, F. Avecilla, P. J. A. Madeira, P. J.G. Mendes, I. Santos, M. H. Garcia, Synthesis of organometallic ruthenium(II) complexes with strong activity against several human cancer cell lines, *Journal of Inorganic Biochemistry* 114, 65–74 (2012).
- A. I. Tomaz, T. Jakusch, T. S. Morais, F. Marques, R. F.M. Almeida, F. Mendes, E. A. Enyedy, I. Santos, J. C. Pessoa, T. Kiss, M. H. Garcia, [RuII( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)(bipy)(PPh<sub>3</sub>)]<sup>+</sup>, a promising large spectrum antitumor agent : cytotoxic activity and interaction with human serum albumin, *J Inorg Biochem.* 117, 261-269 (2012).
- D. Can, B. Spingler, P. Schmutz, F. Mendes, P. Raposinho, C. Fernandes, F. Carta, A. Innocenti, I. Santos, C. Supuran, R. Alberto, [(Cp-R)M(CO)<sub>3</sub>] (M = Re or <sup>99m</sup>Tc) Sulphonamide Conjugates for Selective Targeting of Human Carbonic Anhydrase IX, *Angewandte Chemie*, 51, 3354–3357 (2012), doi: 10.1002/anie.201107333

- M. Serratrice, F. Edafe, F. Mendes, R. Scopelliti, S.M. Zakeeruddin, M. Graetzel, I. Santos, M.A. Cinellu, A. Casini A, Cytotoxic gold compounds: synthesis, biological characterization and investigation of their inhibition properties of the zinc finger protein PARP-1, *Dalton Transactions*, 41, 3287-3293 (2012), doi: 10.1039/c2dt11913g.
- M. Morais, P. D. Raposinho, M. C. Oliveira, J. D. G. Correia, I. Santos, Evaluation of novel  $^{99m}\text{Tc}(\text{I})$ -labeled homobivalent alpha-melanocyte-stimulating hormone analogs for melanocortin-1 receptor targeting, *Journal of Biological Inorganic Chemistry*, 17, 491-505 (2012), doi: 10.1007/s00775-011-0871-y.
- Can, Daniel; N'Dongo, Harmel W. Peindy; Spingler, Bernhard; Schmutz, Paul; Raposinho, Paula; Santos, Isabel; Alberto, Roger, The  $[(\text{Cp})\text{M}(\text{CO})_3]$  ( $\text{M}=\text{Re}$ ,  $^{99m}\text{Tc}$ ) Building Block for Imaging Agents and Bioinorganic Probes: Perspectives and Limitations, *Chemistry & Biodiversity*, 2012, 9, 1849-1866.

## COMMUNICATIONS

- Coordination Chemistry and Target-Specific Delivery of Radioactivity, Isabel Santos, *CiCbiomaGUNE, San Sebastian, Espanha, December 2012*, Invited Talk.
- Molecular Imaging Using Nuclear Probes: Design and Preclinical Evaluation, Isabel Santos, *Curso de Bioquímica Inorgânica, DQB, FCUL, 15 March de 2012*, Invited Talk.
- Organometallic Chemistry of Re and Tc Fuelled by Medical Applications, Isabel Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, September 2012*, Invited Talk.
- Metal-Based Complexes for Targeted Molecular Imaging and/or Therapy, Isabel Santos, *Whole Action Meeting of the COST Action CM1105, Granada, Spain, Sep,17, 2012*, Oral..
- $^{99m}\text{Tc}/\text{Re}$ -tricarbonyl complexes containing pendant acetamidine moieties for iNOS targeting, B. L. Oliveira, N. R. Martins, I. F. Rodrigues, A. Ponces, C. Cordeiro, P.A. Fernandes, M. J. Ramos, I. Santos, J. D. G. Correia, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, Sep 2-7 (2012)*, Poster.
- *Design, characterization and evaluation of cyclized  $\alpha$ -MSH Derivatives for MC1R Targeting*, M. Morais, P. D. Raposinho, M. C. Oliveira, M. A. Jiménez, D. Pantoja-Uceda, J. D. G. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, Sep 2-7 (2012)*, Poster.
- *BP-containing  $\text{M}(\text{CO})_3$ -complexes ( $\text{M} = ^{99m}\text{Tc}/\text{Re}$ ) as multi-functional bone-seeking agents*, S. Monteiro, P. Mendes, C. Fernandes, L. Gano, E. Palma, J. D. G. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, Sep 2-7 (2012)*, Poster.
- *Peptide-Based Radioactive Probes for SPECT-Imaging of Melanoma*, J. D. G. Correia, M. Morais, I. Santos, P. D. Raposinho, *Pharmacokinetics, Toxicology and Targeting — Groningen Research Institute of Pharmacy, University of Groningen, the Netherlands, Sep 6 (2012)*, Invited Talk.
- *MC1R-targeting properties of  $^{99m}\text{Tc}(\text{I})$ -labeled cyclic  $\alpha$ -MSH analogs with thioether or amine bridge*, J. D. G. Correia, M. Morais, P. D. Raposinho, M. C. Oliveira, I. Santos, M. A. Jiménez, D. Pantoja-Uceda, *XIII Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Radiometallated neuropeptide Y analogs for breast cancer imaging*, C. Fernandes, P. Antunes, P. D. Raposinho, I. Rodrigues, I. Santos, *XIII Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Modulation of the Pharmacokinetic Properties of  $^{99m}\text{Tc}(\text{CO})_3$ - $\beta$ Ala-MTII*, M. Morais, B. L. Oliveira, J. D. G. Correia, M. C. Oliveira, I. Santos, P. D. Raposinho, *XIII Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Radiofluorinated benzazole derivatives for in vivo imaging of amyloid aggregation*, G. Ribeiro Morais, L. Gano, T. Kniess, R. Bergman, A. Abrunhosa, C. Pereira, C. Oliveira, I. Santos, A. Paulo, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, Portugal, July 18-20 (2012)*, Poster.
- *Rhenium(I) and Technetium- $^{99m}\text{Tc}$  tricarbonyl complexes with hybrid scorpionates: chemical studies and biological evaluation*, A. Paulo, C. Moura, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, September 2-7 (2012)*, Poster.

- *Influence of polar substituents on the biodistribution and metabolic stability of pyrazolyldiamine  $^{99m}\text{Tc}(I)$  organometallic complexes*, A. R. Palma, C. Fernandes, L. Gano, A. Paulo, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, September 2-7 (2012)*, Poster.
- *Pyrazolyl-diamine Pt(II) complexes bearing DNA-intercalating moieties: Synthesis, characterization and in vitro evaluation*, S. Gama, T. Esteves, F. Mendes, F. Marques, I. Santos, J. Coimbra, A. Matos, M. Ravera, E. Gabano, A. Paulo, *ISMEC2012, Lisbon, Portugal, June 18-22 (2012)*, Poster.
- *Bidentate and tridentate pyrazolyl-containing Pt(II) complexes: synthesis, characterization and in vitro evaluation*, E. Gabano, S. Gama, T. Esteves, F. Mendes, F. Marques, I. Santos, J. Coimbra, M. Ravera, A. Paulo, D. Osella, *XII Workshop on Pharmaco-Bio-Metallics (Biomet 12), Padova, Italy, October (2012)*. Poster
- *Peptide-based Probes for Amyloid and Cancer Imaging*, A. Paulo, G. Morais, I. Santos, WG3 meeting – COST TD1004, London, England, 29th November (2012), Invited Talk.
- *Multifunctional Gold Nanoparticles for Theranostic Applications*, F. Silva, A. Zambre, L. Gano, A. Paulo, R. Kannan, I. Santos, COST action TD1004 meeting, London, England, Oct 29-30(2012), Poster.
- *Compounds for visualization of amyloid aggregates in Alzheimer's patients*, G. Ribeiro Morais, A. Paulo, I. Santos, *Department of Chemistry, University of Évora, Évora, May 9<sup>th</sup> (2012)*, Invited Talk
- *Fluorescent and radionuclide labeling of a synthetic neuroactive glycoside*, N. R. Martins, I. F. Rodrigues, I. Garcia-Álvarez, G. Corrales, G. Ribeiro Morais, I. Santos, E. Doncel-Pérez, A. Fernández-Mayorales, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 July (2012)*, P91
- *Metabolic oligosaccharide engineering: synthesis of N-acetyl-D-mannosamine analogs and their evaluation as substrates of the sialic acid aldolase*, I. F. Rodrigues, N. R. Martins, I. Garcia-Álvarez, G. Ribeiro Morais, I. Santos, E. Doncel-Pérez, I. Oroz-Guinea, E. Garcia-Junceda, A. Fernández-Mayorales, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 (2012)*, P115.
- *Synthesis and preclinical evaluation of  $^{67}\text{Ga}$ -/ $^{111}\text{In}$ -estradiol based complexes for tumour imaging*, S. Cunha, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *16<sup>th</sup> European Symposium on Radiopharmacy and Radiopharmaceuticals, ESRR'12, Nantes, France, April 26-29 April (2012)*, poster.
- *Estradiol based indium complexes towards the estrogen receptor*, F. Vultos, S. Cunha, C. Fernandes, L. Gano, I. Santos, *XXIII International Symposia on Metal Complexes – ISMEC, Lisbon, June 18-22 (2012)*, poster.
- *Synthesis and characterization of novel DOTA – Estradiol derivatives targeting the Estrogen Receptor*, S. M. Cunha, F. J. Vultos, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, Sep 2-7 (2012)*, poster.
- *Novel  $^{111}\text{In}$ -estradiol based complexes: preclinical evaluation for oestrogen positive tumour targeting*, S. Cunha, F. Vultos, C. Fernandes, M.C. Oliveira, M. F. Botelho, I. Santos; L. Gano, *25<sup>th</sup> EANM Congress, Milan, Italy, Oct 27-31 (2012)*, poster.

## EDUCATION / THESES SUPERVISION

### Supervision

- Sofia Monteiro, BI Project PTDC/QUI-QUI/115712/2009.
- M. Sc. Thesis, *Fluorescent and radionuclide labeling of a synthetic neuroactive glycoside*, by Nuno R. Martins, Faculdade de Ciências, Universidade de Lisboa, 6th July 2012
- M. Sc. Thesis, *Metabolic Engineering Applied to Neural Stem Cells*, by Inês Rodrigues, Faculdade de Ciências, Universidade de Lisboa, 6th July 2012

### Co-Supervision

- PhD Thesis, *Re and  $^{99m}\text{Tc}$  organometallic complexes for targeting nitric oxide synthase*, by Bruno Luís Jesus Pinto de Oliveira, Faculdade de Ciências, Universidade de Lisboa, 27 June 2012.

- PhD Thesis, Target-specific detection of melanoma and sentinel lymph node with  $^{99m}\text{Tc}(\text{CO})_3$ -containing probes, by Maurício Morais, Faculdade de Ciências, Universidade de Lisboa, Thesis in preparation.
- M.Sc. Thesis, *Synthesis, characterization and biological assessment of multi-functional bone-seeking agents*, by Patrícia Raquel Henriques Serra Mendes, Faculdade de Ciências, Universidade de Lisboa, 2012.
- Jacqueline Herrera Núñez (1 mês) and Maria Angeles Medrano Chacón (5 meses) under the Integrated Action Portugal-Spain.

## Teaching

- Invited Professor at FCUL (0%)
- Teaching of the Discipline “Chemical Systems and Reactivity”, in Master Courses: Biomedical Inorganic Chemistry and 2<sup>nd</sup> Cycle of Chemistry.
- Coordination of the Master Course Biomedical Inorganic Chemistry: Diagnostic and Therapeutical Applications.
- Invited Seminar in the Inorganic Biochemistry Course, DQB, FCUL
- Coordination and Teaching of the Discipline Radiopharmaceutical Chemistry, Master Course on Pharmaceutical and Therapeutic Chemistry, Faculty of Pharmacy, University of Lisbon.

## JURY PARTICIPATION

### MSc

- **Biomedical Inorganic Chemistry, Síntese, caracterização e avaliação biológica de compostos multifuncionais osteotrópicos**, Licenciada Patrícia Raquel Henriques Serra Mendes, *Faculdade de Ciências, Universidade de Lisboa*, 2012.
- *Biomedical Inorganic Chemistry*, Avaliação in silico da tioredoxina redutase como alvo para a terapia anti-tumoral, Licenciada em Ciências Farmacêuticas Ana Sofia Cardoso Capacho, *Faculdade de Ciências, Universidade de Lisboa*, 2012.
- *Biomedical Inorganic Chemistry*, Síntese de novos compostos organometálicos de Ferro(II): Estudos das suas potencialidades como agentes anticancerígenos, Licenciada Ana Cristina Teixeira Martins Gonçalves, *Faculdade de Ciências, Universidade de Lisboa*, 2012.
- *Biomedical Inorganic Chemistry*, Complexos de ruténio como potenciais agentes terapêuticos: estudos dos mecanismos de captação celular e modulação de enzimas metabólicos, Licenciada Leonor Sá Nogueira Corte-Real, *Faculdade de Ciências, Universidade de Lisboa*, 2012.
- Chemistry, Saúde e Nutrição, Metabolic Oligosaccharide Engineering Applied to Neural Stem Cells”, Licenciada Inês Alexandra Figueiredo Rodrigues, *Faculdade de Ciências, Universidade de Lisboa*, 2012
- Chemistry, Saúde e Nutrição, Fluorescent and radionuclide labeling of a synthetic neuroactive glycoside, Licenciado Nuno Miguel Rodrigues Martins, Faculdade Ciências, Universidade Lisboa, 2012.

### PhD

- Chemistry, MSc Carolina Maria Candeias de Moura, entitled *Complexos Organometálicos de Tc(I)/Re(I) para Imagiologia Molecular de Tecidos Neoplásicos*, Faculdade de Ciências, Universidade de Lisboa, 2012.
- Chemistry, MSc Bruno Luís Jesus Pinto de Oliveira, entitled *Re and  $^{99m}\text{Tc}$  Organometallic Complexes for Targeting Nitric Oxide Synthase*, Faculdade de Ciências, Universidade de Lisboa, 2012.

## PROJECTS

- Scientific Coordination of the project “*Synthesis, characterization and biological assessment of multi-functional bone-seeking agents*” PTDC/QUI-QUI/115712/2009.
- Scientific Coordination of the project *Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies*” (Acções Integradas Luso-Espanholas/2012).

- National Representative and Participant in **COST Action CM1105**: *Functional metal complexes that bind to biomolecules*.
- Management Committee substitute member and participant in **COST Action TD1004**: *Theranostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery*.
- Coordination of the Peptide –Based projects (*Melanocortin, NPY and CXCR4*) in the Group
- *Molecular and Nano Tools for Cancer Theranostics*, EXCL/QEQ-MED/0233/2012, **Leading Institution**: IST-ID, Lisbon, Portugal; **Principal Researcher**: I. Santos/IST/CTN; **Position of Referees**: Outstanding, Deserves funding; **FCT**: Recommended for funding.
- Metal-based Multimodal Probes for Breast Cancer Imaging Targeting Y1-NPY Receptors: Synthesis, Characterization and Pre-clinical Evaluation FCT-ANR/QEQ-MED/0117/2012, **Leading Institution**: IST-ID, Lisbon, Portugal; **Principal Researcher**: I. Santos/IST/CTN; **Referees**: This is a strong proposal, worthy of funding; **FCT**: Not Recommended for funding.

## CONTRACTS

- Coordination of the Service Agreement Provided to TECHNOPHAGE (IST/ITN/TECHNOPHAGE), 3 month, 2012, 3528,00 euros.

## CONFERENCE ORGANIZATION

- Honour Committee of the *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 July, 2012*.
- Member of the Scientific Committee of the *XXV International Conference on Organometallic Chemistry, (ICOMC 2012), Lisbon, Portugal, Sep 2-7, 2012*.

## COMMITTEES

- Member of the Scientific Council of the Instituto de Ciências Nucleares Aplicadas à Saúde (ICNAS)
- Member of the Scholarships & Fellowships Selection Committee for Chemistry of the Natural Sciences and Engineering Research Council of Canada (NSERC) Ottawa, Canada.
- Member of the Scholarships & Fellowships Selection Committee for Chemistry of the Fundação para a Ciência e Tecnologia (FCT), Lisbon, Portugal.
- Member of the Centro de Ivestigação em Meio-Ambiente, Genética e Oncobiologia (CIMAGO)
- Projects External Evaluator of the Agência Nacional de Promocion Científica, Tecnologia y de Innovacion, Ministerio de Education, Ciencia y de Innovation, Buenos Aires, Argentina.
- Projects External Evaluator of the Program of Technological Development, Ministry of Education and Culture, Uruguay.
- Projects External Evaluator of the American Chemical Society - Petroleum Research Fund.
- Projects External Evaluator of the National Research Foundation of South Africa.
- Projects External Evaluator of the Comissão Nacional de Investigação Científica e Tecnológica, Chile.
- Projects External Evaluator of the Czech Science Foundation, Czech Republic.
- Member of the Selection Committee of the “International Symposium in Radiopharmaceutical Sciences.
- Independent External Evaluator of the University of Missouri, School of Medicine, USA
- Member of the Working Group Involved on the Cyclotron Facility Project.
- Reviewer of Manuscripts Submitted to Scientific Journals (J. Am. Chem. Society, Molecular Pharmaceutics, Inorganic Chemistry, Bioconjugate Chemistry, J. Inorg. Biochemistry, J. Biological Inorg. Chem., J. Labelled Compounds Radiopharmaceuticals, Inorg Chim Acta, Eur. J. Nucl. Med and Molecular Imaging, Applied radiation and Isotopes).

## COLLABORATIONS

- Maria de Los Angeles Medrano, PhD student, Universidad Autónoma de Madrid, Spain, 31 Jan- 30 June, Acções Integradas Luso-Espanholas E-23/12
- Jacqueline Herrera, PhD student, Universidad Autónoma de Madrid, Spain, 1-30 November, Acções Integradas Luso-Espanholas E-23/12
- Prof. Adoracion Quiroga, Universidad Autónoma de Madrid, Spain 20-22 February and 28-29 June – discussion of results and overall strategies-Acções Integradas Luso-Espanholas E-23/12
- Prof. Angela Casini, Research Institute Pharmacy, University of Groningen, Netherlands, 20-22 February and 18-22 June – discussion of results and work on mechanism of action of metal complexes - COST Action CM1105, EU.
- Prof. Roger Alberto, Zurich University, Switzerland- COST Action CM1105 - In vitro and in vivo biological evaluation of metal complexes.
- Torsten Kniess, PET-center, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany – Training on cyclotron-produced  $^{18}\text{F}$ .
- Antero Abrunhosa, ICNAS, Coimbra – Production of  $^{18}\text{F}$ .
- Alfonso Fernández-Mayorales, Bioorganic Chemistry Group, “Instituto de Química Orgánica General” (IQOG), Madrid, Spain - Synthesis of biologically active compounds for labeling with  $^{18}\text{F}$ .
- Dr. Sergio Pereira, CICECO, Universidade de Aveiro – Physical characterization of biologically active nanocompounds..
- Dr. Michel Picquet, Institut de Chimie Moléculaire de l'Université de Bourgogne (ICMUB), CNRS Equipe "Architecture, Réactivité, Electrochimie et Catalyse Organométallique" (ARECO), DIJON - Synthesis and biological evaluation of radioactive heteronuclear lanthanide ruthenium complexes.
- Dr. Olga Iranzo, ITQB/ UNL/Portugal and CNRS/France- Peptide Synthesis.
- Mauro Ravera (Dipartimento di Scienze e Innovazione Tecnologica, Università del Piemonte Orientale “Amedeo Avogadro”, Alessandria, Italy) - Synthesis, characterization and biological evaluation of Pt compounds.
- Tiago Outeiro (Cell and Molecular Neuroscience Unit, Instituto de Medicina Molecular): In vitro evaluation of the interaction of fluorinated compounds with amyloid aggregates.
- Kattesh Katti (Department of Radiology from the University of Missouri): gold nanoparticles.
- Prof. Maria Helena Garcia, DQB, FCUL, Portugal - Preclinical evaluation of ruthenium potential drugs for cancer therapy.
- Prof. M. Castanho, IMM, FMUL, Portugal - Synthesis of 125-I- KTP-derivative (IbKTP-NH<sub>2</sub>) and biological evaluation evaluate their ability to cross the BBB.
- Prof. Luis Costa, Clinical and Translational Oncology Research Unit , IMM, FML, Portugal – Evaluation of bisphosphonates/Re/citotoxic complexes in animal models with induced bone metastasis.

---

**NAME: Maria Isabel Garrido Prudêncio**

**CATEGORY:** Principal Researcher with habilitation

**ID NUMBER:** 5349

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Coordinator of Chemical and Radiopharmaceutical Research Unit (CRSU)	15%
2	Coordinator of the research group “Applied Geochemistry & Luminescence on Cultural Heritage” (GeoLuC)	10%
3	Responsible of the gamma spectrometry laboratories – neutron activation analysis and	10%



	naturally occurring radioactive materials.	
4	Services – compositional characterization of cultural objects.	5%
5	Project: "Diagnosis, decontamination and conservation of cultural heritage: neutrons and ionizing radiation in artwork (RADIART)" (PTDC/HIS-HEC/101756/2008)	10%
6	Project: Technical Cooperation Project - IAEA TC Project RER/0/034 "Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts" (2012-2013).	5%
7	Project: RUPSCIENCE - Analysis of the operational chains, archaeometry and chronology of Rock Art Paintings. An approach to materials technology of Portugal, Spain and Colombia's contexts. (PTDC/HIS-ARQ/101299/2008)	5%
8	Project: FUNPERD - Death management in Recent Prehistory: funerary practices in Perdigoes enclosure (PTDC/CS-ANT/104333/2008)	5%
9	Project: ROBBIANA - The Della Robbia sculptures in Portugal: History, Art and Laboratory (PTDC/HIS-HEC/116742/2010)	5%
10	Project: Spatial Variation of Dose Rate in Soils and Sediments – VADOSE (PTDC/AAC-AMB/121375/2010)	5%
11	Bilateral Cooperation: Processos Luminescentes-Dosimetricos no Quartzo. italia128584682220330. Convénio Portugal (FCT) / Itália (CNR) 2011-2012.	5%
12	Project: SIMPLE Dark Matter project; Coordinator: T.A. Girard (CFNUL)	5%
13	Supervision of post-docs and PhD	10%
14	Course Director: IAEA "Regional Training Course on Radiation Technology for Cultural Heritage Preservation" in the frame of the International Atomic Energy Agency TC Project RER/0/034 - Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts. IST, CTN, 4-9 November 2012.	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	Coordination of the combined activities of CRSU including the general management of expenses, and renewal and maintenance of equipment; elaboration of the 2011 report and the work plan for 2012; contribution for the establishment of procedure system for the attribution of gases expenses.
2	Coordination of the activities of GeoLuC research group, including the general management of human resources and laboratories, renewal and maintenance of equipment, elaboration of the 2011 report and the work plan for 2012. The promotion activities and the publications of the research group result on the expertise recognition of the international scientific community through the invitation for research collaboration at several levels, participation in research projects, conferences organization and scientific committees. Also several invitations were received for peer review of manuscripts on earth sciences, environment and health, and cultural heritage, particularly geochemistry (particularly REE) of the earth surface, environmental studies using inorganic and organic indicators, applied geochemistry and chronology, cultural heritage characterization and conservation, among other domains.
3	Coordination of the activities of the gamma spectrometry laboratories for instrumental neutron activation analysis (INAA) using the RPI as neutron source, and naturally occurring radioactive materials (NORM). Promotion of collaborative activities with the United States Geological Survey (USGS) in the frame of the project "Reference Materials Project". As a result of the promotion of the INAA laboratory, editors of several international journals asked for peer review of manuscripts concerning nuclear methods and applications.
4	Chemical analysis of ancient ceramics and raw materials of Algarve region, by using neutron activation analysis (one report).
5	Project: "Diagnosis, decontamination and conservation of cultural heritage: neutrons and ionizing radiation in artwork (RADIART)" (PTDC/HIS-HEC/101756/2008) – coordination of the technical-scientific management structure, and responsible for the IST/ITN team. Synchronization of the teams of the participant institutions was done according with the main methodological approaches developed in each task of the project. As main results obtained during 2012, the first article on the application of neutron tomography of cultural assets using the RPI setup was published in a Web of Science journal; three articles were submitted for publication (one is already online:

	<a href="http://downloads.hindawi.com/journals/jmat/aip/972018.pdf">http://downloads.hindawi.com/journals/jmat/aip/972018.pdf</a> ) and four presentations were done in international conferences.
6	Project: Portuguese nuclear scientist nominated, designated Responsible Person from Counterpart Institute (IST) Technical Cooperation Project - IAEA TC Project RER/0/034. The main activities were: promotion of nuclear techniques on Cultural Heritage (mobile and immobile) in Portugal, elaboration of the report with the main activities in 2011/2012, contribution for the establishment of recommended values for IAEA standards by XRF and PIXE. The main results were the organization of an international course and the increase of collaboration with archaeological museums and conservators.
7	Member of the project: RUPSCIENCE - (PTDC/HIS-ARQ/101299/2008) – coordination of the neutron activation analysis of different types of materials and participation in the integration studies of the results obtained by different methodologies of materials/contextes.
8	Member of the project: FUNPERD - (PTDC/CS-ANT/104333/2008) – coordination of the neutron activation analysis of different types of materials and participation in the integration studies of the results obtained by different methodologies of materials/contextes. One article was published and presentations were made in international conferences.
9	Member of the project: ROBBIANA - (PTDC/HIS-HEC/116742/2010) – coordination of the neutron activation analysis of different types of materials and participation in the integration studies of the results obtained by different methodologies of materials/contextes.
10	Member of the project: VADOSE (PTDC/AAC-AMB/121375/2010) – participation in the field work – geological contexts/sampling; coordination of the neutron activation analysis of geological materials.
11	Member of the “Convénio” Portugal (FCT)/Itália (CNR) 2011-2012, italia128584682220330 - Participation in the field work – geological contexts/sampling; coordination of the neutron activation analysis of geological materials.
12	Project: SIMPLE Dark Matter project; Coordinator: T.A. Girard (CFNUL) Belonging to the Core Team of the project, I was the responsible Researcher on the precise and accurate determination of the uranium and thorium concentrations by instrumental neutron activation analysis (INAA) in different materials involved in the experiments such as glass, wood, etc. (one publication) <a href="https://sites.google.com/site/dm2011simple/general-research">https://sites.google.com/site/dm2011simple/general-research</a>
13	Supervision of post-docs and PhD on nuclear techniques/geochemistry/geomaterials – establishment of natural backgrounds of different environments (Portuguese territory and Cape Verde islands); differentiation of geogenic and anthropogenic origins; application of nuclear techniques on elemental characterization and naturally occurring radioactive materials (NORM). Besides one published article, three manuscripts were submitted for publication (one is already online: <a href="http://www.geologica-acta.com/pdf/vol1102a22.pdf">http://www.geologica-acta.com/pdf/vol1102a22.pdf</a> ).
14	IAEA “Regional Training Course on Radiation Technology for Cultural Heritage Preservation” – Course director of the IAEA “Regional Training Course on Radiation Technology for Cultural Heritage Preservation” with the IAEA support – program elaboration - invited lectures, local lecturers/experimental supervisors. Theoretical and Experimental Themes: (I) Inactivation of microorganisms/ higienisation/ preservation (determination of Dmin) on tiles and cellulosic samples; (II) Impact of ionizing in materials measurement of mechanical properties and color (determination Dmax) on tiles and cellulosic samples; (III) – Routine dosimetry with amber Perspex; and (IV) Retrospective evaluation of absorbed dose within objects using stimulated luminescence.

## PUBLICATIONS

### Papers

- M. Felizardo, T.A. Girard, T. Morlat, A.C. Fernandes, A.R. Ramos, J.G. Marques, A. Kling, J. Puibasset, M. Auguste, D. Boyer, A. Cavallou, J. Poupenny, C. Sudre, H.S. Miley, R.F. Payne, F.P. Carvalho, M.I. Prudêncio, A. Gouveia, R. Marques, Final analysis and results of the phase II simple dark matter search, *Physical Review Letters*, 108, 201302, 5 pp, (2012), doi: 10.1103/PhysRevLett.108.201302
- M.I. Dias, M.I. Prudêncio, M.J., Trindade, A.C., Valera, Towards a Temporality Approach in Perdigões, Portugal: Chemical and Mineralogical Composition of Neolithic and Chalcolithic Pottery and Raw

Materials. Revista De La Sociedad Española De Mineralogía. *Macla*, nº 16, Junio'12, 28-30 (2012), [http://www.ehu.es/sem/macla\\_pdf/macla16/Macla16\\_028.pdf](http://www.ehu.es/sem/macla_pdf/macla16/Macla16_028.pdf)

- Francisco Ruiz, María Luz González-Regalado, Emilio Galán, María Isabel González, María Isabel Prudencio, María Isabel Dias, Manuel Abad, Antonio Toscano, José Prenda, Edith Xio Mara García (2012). Benthic foraminifera as bioindicators of anthropogenic impacts in two north African lagoons: a comparison with ostracod assemblages. *Revista Mexicana de Ciencias Geológicas*, 29, nº 3, 527-533 (2012), [http://satori.geociencias.unam.mx/29-3/\(01\)Ruiz.pdf](http://satori.geociencias.unam.mx/29-3/(01)Ruiz.pdf)
- M.I. Prudêncio, M.I., Trace element geochemistry and mineralogy for solving problems in provenance and production technologies of pre-historic ceramics. *Seminarios SEM 9*, 29-40 (2012), ISSN 1698-5478, [http://sociedadmineralogia.es/cd\\_semsea2012/Seminarios.SEM.v9web.pdf](http://sociedadmineralogia.es/cd_semsea2012/Seminarios.SEM.v9web.pdf)
- T.M. Valente, M. Antunes, M.A. Sequeira Braga, M.I. Prudêncio, R. Marques, J. Pamplona, Mineralogical attenuation for metallic remediation in a passive system for mine water treatment. *Environmental Earth Sciences*, 66, Issue 1: 39-54 (2012), doi:10.1007/s12665-011-1205-7
- M.I. Prudêncio, M.A., Stanojev Pereira, J.G. Marques, M.I. Dias, L. Esteves, C.I. Burbidge, M.J. Trindade, M.A. Albuquerque, Neutron tomography for the assessment of consolidant impregnation efficiency in portuguese glazed tiles (16th and 18th centuries). *Journal of Archaeological Science*, 39: 964-969 (2012), <http://dx.doi.org/10.1016/j.jas.2011.11.010>
- R. Marques, M.I. Prudêncio, F. Rocha, M.M.M.S. Cabral Pinto, M.V.G. Silva, E. Ferreira Da Silva, E., REE and other trace and major elements in the topsoil layer of Santiago island, Cape Verde. *Journal of African Earth Sciences*, 64, 20–33 (2012), TOP 25 HOTTEST ARTICLE: Earth and Planetary Sciences - January to March 2012, doi:10.1016/j.jafrearsci.2011.11.011
- M.I. Prudêncio, M.I., Dias, M.J., Trindade, M.A. Sequeira Braga, Rare earth elements as tracers for provenancing ancient ceramics. *Estudos do Quaternário*, vol. 8, 6-12 (2012).
- M.I. Prudêncio. Aplicação de técnicas nucleares no Património Cultural Português. *País Positivo*, Sol, 21 de December de 2012.

### Proceedings of International Conferences

- Susana Varela Flor, Catarina Figueiredo, Célia Pilão, José Meco, M. Isabel Marques Dias, M. Isabel Prudêncio; Maria José Trindade; Pedro Flor, Vítor Serrão (2012). The adaptation of the main floor of the Palace Melo e Abreu (18th century) to an infirmary of the old asylum of mendicity: history and tile panels compositional characterization. *Proceedings of the International Cong. Azulejar*, Aveiro, Portugal, 37 - ArtAz\_c10\_SFlor (2012).
- M. Isabel Dias, M. José Trindade, Leonel Ribeiro, M. Isabel Prudêncio, M. Teresa Bispo, Laura Trindade, Pedro Flor, Susana Varela Flor, Fernando T. Rocha (2012). Geochemical patterns and firing technology research on ceramic glazed tiles from the 17th – 20th centuries (Lisbon region, Portugal). *Proceedings of the International Cong. Azulejar*, Aveiro, Portugal, 60 - ArtAz\_c10\_MDias (2012).
- Silva, T., Cabo Verde, S., Cardoso, G., Fernandes, A. C., Trindade, M.J., Burbidge, C. I., Dias, M. I., Bothelho, M. L., Prudêncio, M.I. Perfis de contaminação e inactivação microbiana em azulejos. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 253-260. (2012).
- Stanojev Pereira, M.A., Prudêncio, M.I., Marques, J.G., Figueiredo, M.O., Dias, M.I., Silva, T.P., Esteves, L., Burbidge, C.I., Trindade, M.J., Marques, R, Alberquerque. M.B. Tomografia de neutrões aplicada a azulejos do século XVI e XVII – visualização para caracterização, diagnóstico e optimização de técnicas de conservação. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 261-266. (2012).

### Book Chapters

- M.I. Prudêncio, Ceramic in Ancient Societies: A Role for Nuclear Methods of Analysis. In: Encyclopedia of Chemistry Research, Vol. II, chapter 25. Series: Chemistry Research and Applications and Chemical Engineering Methods and Technology, Editors: Gerald R. Newmann and Andrew P. Albertis, ISBN: 978-1-61470-104-0, Nova Science Publishers, Inc., 641-671 (2012). (Hardcover)
- F. Ruiz, M. L. González-Regalado, J. M. Muñoz, M. Abad, M. I. Prudêncio, M. I. Dias, M. I. Carretero, M. Pozo And A. Toscano, Pollution Sources and Fluxes in the South-western Spanish Littoral. In: Metal

Contamination: Sources, Detection and Environmental Impact. Chapter 5. Editor: Shao Hong-Bo, ISBN: 978-1-61942-111-0, Nova Science Publishers, Inc., 95-106 (2012). (Hardcover)

- ebook:  
[https://www.novapublishers.com/catalog/product\\_info.php?products\\_id=26343&osCsid=fd5b0c2bedb9d1cb1991865fd94e0c38](https://www.novapublishers.com/catalog/product_info.php?products_id=26343&osCsid=fd5b0c2bedb9d1cb1991865fd94e0c38)
- ebook: [https://www.novapublishers.com/catalog/product\\_info.php?products\\_id=30209](https://www.novapublishers.com/catalog/product_info.php?products_id=30209)

## COMMUNICATIONS

### Invited

- *Trace element geochemistry and mineralogy for solving problems in provenance and production technologies of pre-historic ceramics*, M.I. Prudêncio, *International Seminar on "Archaeometry And Cultural Heritage: The Contribution of Mineralogy*, University of Bilbao, Spain, 27 June (2012), Invited Lecture

### Oral

- *Iron speciation in volcanic soils from fogo island (Cape Verde)*, R. Marques, J.C. Waerenborgh, M.I. Prudêncio, F. Rocha, E. Ferreira da Silva. *9th ISEG - International Symposium on Environmental Geochemistry, Aveiro, Portugal, Book of Abstracts: 154, 15-22 July 2011*. Oral
- *Environmental effects on glazed ceramics: green stains in 18th century blue-and-white Portuguese tile glaze*, T.P. Silva, M.O., Figueiredo, A. Barreiros, M.I. Prudêncio, *37th Inter. Symp. Environmental Analytical Chemistry, Antwerp/Belgium, 22-25 May, 2012*. Book of Abstracts, p. 92, Oral.
- *The adaptation of the main floor of the Palace Melo e Abreu (18th century) to an infirmary of the old asylum of mendicity: history and tile panels compositional characterization*. S. Varela Flor, C. Figueiredo, C. Pilão, J. Meco, M.I. Dias, M.I. Prudêncio, M.J. Trindade; P. Flor, V. Serrão, *International Congress Azulejar, Aveiro, Portugal, 10-12 October 2012*. Oral
- *Geochemical patterns and firing technology research on ceramic glazed tiles from the 17th – 20th centuries (Lisbon region, Portugal)*, M.I. Dias, M.J. Trindade, L. Ribeiro, M.I. Prudêncio, M.T. Bispo, L. Trindade, P. Flor, S. Varela Flor, F. Rocha, *International Congress Azulejar, Aveiro, Portugal, 10-12 October 2012*. Oral
- *OSL dating at Perdigões enclosure complex (Reguengos de Monserraz, Portugal)*, C.I. Burbidge, G. Cardoso, M.I. Dias, M.I. Prudêncio, A. Valera, J. Márquez Romero, D. Franco, R. Marques. *2nd Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 7, Lisbon, Portugal, September 5-7 (2012)*, Oral.
- *Heated flint from Gruta de Oliveira (Portugal): comparison of TL-dating results with radiocarbon and U-series dating*, D. Richter, D., D.E. Angellucci, C.I., Burbidge, M.I., Dias, M.A.I., Gouveia, M.I., Prudêncio, J. Zilhão. *2nd Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 35, Lisbon, Portugal, September 5-7 (2012)*, Oral.
- *Luminescence and mineralogy of profiling samples from negative archaeological features*. A.L. Rodrigues, C.I. Burbidge, M.I. Dias, F. Rocha, A., Valera, M.I. Prudêncio, *2nd Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 36, Lisbon, Portugal, September 5-7 (2012)*, Oral.

### Poster

- *Geochemistry and mineralogy in a paleosol and in a present-day topsoil developed on pyroclasts, Fogo Island (Cape Verde)*, R. Marques, M.I. Prudêncio, F. Rocha, E. Ferreira Da Silva, C. Burbidge, M.I. Dias, D. Franco, *XI Congresso de Geoquímica de Países de Língua Portuguesa, Luanda, Angola, November 2012*, Poster.
- *Quinta do Torel glazed tile panel: a first compositional approach of the ceramic body (Lisbon, Portugal)*, M.I. Prudêncio, S. Flor, L. Ribeiro, M. I. Dias, M.J. Trindade, M.T. Bispo, L. Trindade, P. Flor, *International Congress Azulejar, Aveiro, Portugal 10-12 October 2012*, Poster.
- *Distribution of natural radionuclides (K, Th and U) in an aplite dyke from the Beira uraniferous province (Fornos de Algodres, Portugal)*, M.J. Trindade, M.I. Prudêncio, C.I. Burbidge, M.I. Dias, R. Marques, G.

Cardoso, F. Rocha. *2<sup>nd</sup> Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 43, Lisbon, Portugal, 5-7 September 2012, Poster.*

- *Geochemistry and field radiometric measurements of naturally occurring radionuclides in several lithologies of Fornos de Algodres area.* M.J. Trindade, M.I. Prudêncio, M.I. Dias, C.I. Burbidge, G. Cardoso, R. Marques, F. Rocha. *2<sup>nd</sup> Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 44, Lisbon, Portugal, 5-7 September 2012, Poster.*
- *VADOSE - a new project to investigate spatial variation of dose rates in soils and sediments,* C.I. Burbidge, P.M. Teles, M.J. Trindade, M.J. Reis, M.I. Prudêncio, S. Andrejkovicova, D.C.W. Sanderson, F. Rocha, J.V. Cardoso, G. Carvalho, J. Abrantes, R. Marques, G.J.O. Cardoso, Y. Romanets, L. Santos, D. Franco, M.C. Sequeira, M.A. Gouveia, *2<sup>nd</sup> Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 9, Lisbon, Portugal 5-7 September 2012, Poster.*
- *Combination of IBA techniques to study art-historical objects using a microprobe,* V. Corregidor, C.P. Marques, R.C. Silva, P.A. Rodrigues, M. Vilarigues, T. Silva, S. Cabo Verde, M.L. Botelho, M.I. Prudêncio, S. Coentro, V.S.F. Muralha, E. Alves, L.C. Alves. *2<sup>nd</sup> Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 13, Lisbon, Portugal, 5-7 September 2012, Poster.*
- *Scintillators applied in neutron imaging techniques.* M.A. Stanojevic Pereira, J.G. Marques, M.I. Prudêncio, J.P. Santos, C. Burbidge. *2<sup>nd</sup> Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 41, Lisbon, Portugal, 5-7 September 2012, Poster.*
- *REE in topsoils and rocks from Santiago island (Cape Verde),* R. Marques R, M.I. Prudêncio, M. Cabral Pinto, F. Rocha, E. Ferreira da Silva, *9<sup>th</sup> International Symposium on Environmental Geochemistry, Aveiro, Portugal, 15-21 July 2012, Poster*
- *Geochemical and mineralogical characterization of fill materials from a negative archaeological structure, and relations with luminescence and dosimetric behavior.* A.L. Rodrigues, C.I. Burbidge, M.I. Dias, F. Rocha, D. Franco, M.I. Prudêncio, A.C. Valera, *9<sup>th</sup> International Symposium on Environmental Geochemistry, Book of Abstracts: 190, Aveiro, Portugal, 15– 21 July 2012, Poster.*
- *Radiogenic elements in soils from Fogo Island (Cape Verde),* R. Marques, C.I. Burbidge, M.I. Dias, M.I. Prudêncio, D. Franco, G. Cardoso, F. Rocha, E. Ferreira da Silva, *9<sup>th</sup> ISEG - International Symposium on Environmental Geochemistry, Book of Abstracts: 348-349, Aveiro, Portugal, 15-22 July 2012, Poster.*
- *Distribution of uranium and other trace elements in an aplite dyke from Fornos de Algodres area (northern central Portugal),* M.J. Trindade, M.I. Prudêncio, C.I. Burbidge, M.I. Dias, R. Marques, G. Cardoso, F. Rocha, *9<sup>th</sup> ISEG - International Symposium on Environmental Geochemistry, Book of Abstracts: 240, Aveiro, Portugal, 15-22 July 2012, Poster.*
- *Distribution of K, Th and U in aplite and dolerite veins, granite and schist from sobral pichorro area (Fornos de Algodres, Central Portugal),* M.J. Trindade, M.I. Prudêncio, M.I., Dias, C.I. Burbidge, G. Cardoso, R. Marques, F. Rocha, *9<sup>th</sup> ISEG - International Symposium on Environmental Geochemistry, Book of Abstracts: 213, Aveiro, Portugal, 15-22 July 2012, Poster.*
- *Chinese porcelain ordered for the portuguese market during the 16<sup>th</sup> century: study on the compositional differences by neutron activation analysis and indirect provenance issues,* M.I. Dias, M.I. Prudêncio, M.A. Matos, A.L. Rodrigues, *39<sup>th</sup> International Symposium on Archaeometry, ISA2012, Book of Abstracts: V31, p. 350, Leuven, Belgium, 28 May-1 June 2012, Poster.*
- *Chemical signatures of Coimbra and Lisbon early Portuguese faience productions (17<sup>th</sup> – 18<sup>th</sup> cent.).* M.I. Dias, M.I. Prudêncio, A. Pais, A.L. Rodrigues. *39<sup>th</sup> International Symposium on Archaeometry, ISA2012, Book of Abstracts: V32, p. 351, Leuven, Belgium, 28 May-1 June 2012, Poster.*
- *Portuguese glazed tiles (16<sup>th</sup>-18<sup>th</sup> centuries): INAA, XRD and luminescence for raw materials characterization and production technologies of the ceramic bodies, and chronology.* M.I. Prudêncio, M.I. Dias, C.I. Burbidge, L. Esteves, M.J. Trindade, R. Marques, G. Cardoso, D. Franco. *39<sup>th</sup> International Symposium on Archaeometry, ISA2012, Book of Abstracts: V80, p. 405, Leuven, Belgium, 28 May-1 June 2012, Poster.*

- *Análise composicional de materiais do Património Cultural e das Ciências da Terra*. M.I. Dias, M.I. Prudêncio, C.I. Burbidge, *Festa da arqueologia: ciências da arqueologia*. Museu Arqueológico do Carmo, Lisbon. 5-6 May (2012).
- *Datação por Luminescência*, C.I. Burbidge, M.I. Dias, M.I. Prudêncio, *Festa da Arqueologia: Ciências da Arqueologia*, Museu Arqueológico do Carmo, Lisbon. 5-6 May (2012), Poster.
- *Luminescence Techniques on Earth Sciences and Cultural Heritage*. G. Cardoso, C.I. Burbidge, M.I. Dias, M.I. Prudêncio, F. Rocha, *ADVANCEG 1, Erasmus Intensive Programme in Advanced*
- *Environmental Geology 1 (Mineral resources suitable for environmental application)*, Banská Štiavnica, Slovakia. 2–13 Jul, (2012), Poster

## **EDUCATION / THESES SUPERVISION**

- IAEA “Regional Training Course on Radiation Technology for Cultural Heritage Preservation” in the frame of the International Atomic Energy Agency TC Project RER/0/034 - Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts. Course Director: M. Isabel Prudêncio, IST, CTN, Nov. 4-9 (2012).
- R. Marques, “Rare earth elements and other trace elements in Cape Verde Island” (PhD, in course). Supervisores: Prof. Fernando Tavares Rocha of the University of Aveiro, and M.I. Prudêncio, IST.

## **PROJECTS**

- *Evaluation of the Degradation State of Ancient Portuguese Glazed Tiles Aiming the Establishment of Conservation Strategies* (CHAR2012-BRR-345) CHARISMA – Cultural Heritage Advance Research Infrastructures, FIXLAB PLATFORM B - BUDAPEST RESEARCH REACTOR. Coordinator: M.I. Prudêncio.
- Project "Diagnosis, decontamination and conservation of cultural heritage: neutrons and ionizing radiation in artwork (RADIART)" (PTDC/HIS-HEC/101756/2008) - 2010-2013, Leading Institution: IST/ITN; Coordinator: M.I. Prudêncio (25%).
- Project: DeepElectroMetal. FP7-NMP-2013-LARGE-7. NMP.2013.4.1-2 Breakthrough Solutions for Mineral Extraction and Processing in Extreme Environments. Coordinating person: Prof. Ludo Diels (VITO). Coordinating person at IST: M.I. Prudêncio. Proposed duration of the project: 42 months. Accepted for the second stage.

## **CONFERENCE ORGANIZATION / COMMITTEES**

- Member of the Scientific Committee of IST-ITN.
- Member of the Committee for the integration of ITN in IST.
- Member of the Directive Board of the “Sociedad de Arqueometría Aplicada al Patrimonio Cultural”.
- Member of the Organizing Committee of the *2nd Luminescence in Archaeology International Symposium*, LAIS’2012, Sacavém, Portugal, 5-7 September, 2012.
- Member of the Scientific Committee of the *International Congress AZULEJAR*, Aveiro, Portugal, 10-12 October, 2012.
- Member of the Scientific Committee of the *4rd International Meeting on Multivariate Analysis and Chemometry for Cultural Heritage and Environment*, CMA4CH 2012, Rome, Italy, 27-30 May 2012.

## **COLLABORATIONS**

Collaboration with several national and international scientists/Universities, namely:

- Prof. Fernando Rocha and Prof. Eduardo Ferreira da Silva - University of Aveiro: Member, GeoBioTec Research Team, UA; collaboration in georesources and environmental studies – contribution for the construction of the “Geochemical Atlas of Cape Verde islands”.
- Prof. Teresa Valente and Prof. M. Amália Sequeira Braga - University of Minho – geoenvironments, geological resources and tailings - environmental studies.

- Prof. Fernando Ruiz and Doctor Manuel Abad - University of Huelva – geoenvironments.
- Prof. Manuel Pozo - University of Madrid – geoenvironments.
- Prof. Aldona Beganskienė - 2012, Radiation Technology for Cultural Heritage Preservation. Vilniaus universitetas / Vilnius University, LT VILNIUS01, Universiteto 3, LT-01513 Vilnius, LITHUANIA, Assoc. Prof. Rimantas Vaitkus and Doutora M.I. Prudêncio (ERASMUS).
- Dr. Luis Rebêlo – LNEG- geochronology – absolute dating for the coastal reconstruction.

**NAME: António Manuel Rocha Paulo**

**CATEGORY:** Principal Researcher

**ID NUMBER:** 5355

**R&D ACTIVITIES**

Nº	Activity Description	R&D
1	Scientific coordination of the project “Chemical, Radiochemical and Biological Studies of Pyrazolyl-Alkylamine Pt(II) Complexes: Application on the Development of Novel Anti-Cancer Drugs” (PTDC/QUI/66813/2006)	20%
2	Scientific coordination of the project “Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation” (PTDC/QUI/QUI/102049/2008)	25%
3	Scientific Coordination of the project “Targeting telomerase inhibition with new anti-tumoral Cu(II) complexes” (PTDC/QUI-QUI/114139/2009)	15%
4	Collaboration on the scientific coordination of the bilateral project “Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies” (Acções Integradas Luso-Espanholas/2012)	5%
5	Supervision the PhD work of Carolina Moura (SFRH/BD/38469/2007) untitled “Organometallic Tc(I)/Re(I) complexes for Molecular Imaging of Neoplastic Tissues”	10%
6	Supervision of the PhD work of Francisco Silva (SFRH/BD/47308/2008) untitled “Targeted Nanoradiopharmaceuticals for Cancer Diagnosis and/or Therapy: Synthesis, Characterization and Biological Evaluation”	20%
7	Responsible by the NMR spectrometer of the UCQR	5%
Total		100

**WORK SUMMARY**

Nº	Work Summary and Main Achievements
1	<p>The main goal of this project was to obtain chemical and biological knowledge helpful to design Pt(II) complexes with improved therapeutic effectiveness and/or reduced toxic side effects in comparison with cisplatin.</p> <p>During 2012, the <i>in vitro</i> evaluation of new <math>[PtCl(pz^*NN)]^{n+}</math> complexes anchored by pyrazolyl-diamine (<math>pz^*NN</math>) ligands bearing anthracenyl or acridine orange DNA-binding groups has been completed. The study of their interaction with supercoiled DNA indicated that the anthracenyl-containing complex, <math>L^1Pt</math>, presents a covalent type of binding while the acridine orange counterpart, <math>L^2Pt</math>, shows a combination of intercalative and covalent binding modes. Unlike <math>L^2Pt</math>, <math>L^3Pt</math> showed a very high cytotoxic effect on ovarian carcinoma cell lines A2780 and A2780cisR that are sensitive and resistant to cisplatin, respectively. Both complexes were able to overcome significantly cisplatin cross-resistance. Cell uptake studies have shown that <math>L^2Pt</math> accumulates preferentially in the cytoplasm while <math>L^3Pt</math> reaches more easily the cell nucleus, as clearly visualized by time-lapse confocal imaging of live A2870 cells. Ultrastructural studies of A2870 cells exposed to <math>L^2Pt</math> and <math>L^3Pt</math> revealed that these complexes induce different alterations in cell morphology, pointing out for the involvement of different modes of action in cell death.</p>
2	<p>This multidisciplinary project involves teams from ITN/IST, ICNAS, IMM and its main objective is the design of radiolabeled amyloid-avid probes for the early diagnosis of neurodegenerative diseases by Positron Emission Tomography (PET) or Single Photon Emission</p>

	<p>Computed Tomography (SPECT).</p> <p>For PET imaging, the synthesis and pre-clinical evaluation of new radiofluorinated styryl-benzazole derivatives have been done. Such pre-clinical evaluation involved biodistribution studies in male Wistar rats and in the triple-transgenic mouse line (3 x Tg-AD), as well as metabolic and autoradiographic studies. The tested compounds can cross the blood-brain barrier (BBB) but displays a rather slow brain washout, most probably due to the occurrence of metabolization/defluorination <i>in vivo</i>. The radiosynthesis and biological evaluation of alternative benzimidazole derivatives is under way.</p> <p>For SPECT imaging, a new (S,N,O)-tridentate ligand of the cysteamine type functionalized with a benzothiazole group for amyloid binding has been synthesized and characterized. This new ligand has been successfully used to obtain the correspondent Re(I) tricarbonyl complex, which will be applied as surrogate of the <sup>99m</sup>Tc(I) congener and used to measure <i>in vitro</i> the binding affinity towards Aβ(1-42) aggregates. This part of the work has been performed by Patrique Nunes (Research Assistant (BI)) under my supervision.</p>
3	<p>The PI of this FCT-funded project is Sofia Gama, a Post-doctoral Researcher who is working under my supervision. Being a member of the research team, I collaborate in the scientific coordination of the project.</p> <p>The project intends to develop new effective chemotherapeutic drugs based on Cu(II) complexes that are expected to be incorporated into telomeric DNA causing irreversible damage and cancer cell cycle arrest. To achieve this goal we have focused on cationic Cu(II) complexes with N<sub>4</sub>-tetradentate ligands, combining a 9,10-phenantroline core with two pendant pirazolyl arms, and on mixed-ligand Cu(II) complexes with a N<sub>3</sub>-tetradentate ligand (terpyridine or bis(pyrazolyl)pyridine derivatives) and a N<sub>2</sub>-bidentate ligand (bipyridine derivative).</p> <p>During 2012, we have succeeded in the synthesis and characterization of the different types of N-donor ligands. The synthesis and characterization of the bidentate ligands has been performed by Inês Rodrigues (Research Assistant (BI)) under my supervision in collaboration with Sofia Gama; Sofia Gama has been involved in the synthesis of the tridentate ligands, while Elisa Palma (Post-doctoral Researcher) has performed the synthesis and characterization of the tetradentate ligands. Currently, we are studying the synthesis of Cu(II) complexes with the several N-donor ligands that have been already obtained.</p>
4	<p>This bilateral project, involving our Research Group and the Group of Prof. Adoración from Universidad Autónoma de Madrid, aims to introduce and evaluate non conventional target-specific Pt complexes and innovative heterobimetallic complexes. The cell-specific Pt complexes contain bioactive peptides, while the heterobimetallic complexes combine a radiometal with <i>trans</i>-Pt(II) cores.</p> <p>My contribution to this project has involved mainly the collaboration on the scientific coordination of the work related with heterobimetallic complexes. Within this topic, an heterobimetallic Pt/Re complex has been synthesized by conjugation of a pyridine-containing Pt(II) complex with a pyrazolyldiamine Re(I) tricarbonyl complex. The formation of the final Pt/Re heterobimetallic complex has been confirmed by ESI-MS but further studies are needed to optimize the purification of the complex and proceed with its characterization by multinuclear NMR (<sup>195</sup>Pt, <sup>1</sup>H, <sup>13</sup>C). To obtain the congener Pt/<sup>99m</sup>Tc heterobimetallic, the synthesis of a Pt(II) complex functionalized with a pyrazolyl-diamine chelator for further coordination of the <i>fac</i>-[<sup>99m</sup>Tc(CO)<sub>3</sub>]<sup>+</sup> core has been studied. The functionalization of the Pt(II) complex with the pyrazolyl-diamine chelating framework having BOC-protected terminal amine groups was successfully performed. However, the deprotection of these terminal amine groups still needs to be optimized.</p>
5	<p>The PhD work of Carolina Moura involved chemical, radiochemical and biological studies of Re(I)/<sup>99m</sup>Tc(I) tricarbonyl complexes functionalized with small molecules, benzamide derivatives or triphenylphosphonium salts, aiming at the design of radioactive probes for <i>in vivo</i> detection of neoplastic tissues. During 2012, the <i>in vitro</i> biological evaluation of <sup>99m</sup>Tc(I) tricarbonyl complexes containing triphenylphosphonium derivatives and stabilized by bifunctional chelators with (N,N,N), (N<sub>pz</sub>,N,O) and (S,N,O) donor atom sets has been accomplished. The best</p>



	<p>performing complex has shown a higher affinity towards tumor mitochondria than towards normal mitochondria, as well as a highest uptake in human tumor cells if compared with normal cells from human origin. Altogether, these results indicate that these TPP-containing <math>^{99m}\text{Tc}(\text{I})</math> tricarbonyl complexes are promising platforms to design radioactive metalloprobes targeted to the mitochondria for <i>in vivo</i> detection of tumor tissues.</p> <p>Carolina Moura successfully defended her PhD thesis at 28<sup>th</sup> February 2012.</p>
6	<p>Gold nanoparticles (AuNPs) have very attractive properties for medical application such as, biocompatibility, easy functionalization with molecular vectors and good biological half-life. The PhD work of Francisco Silva deals with the synthesis, characterization and biological evaluation of gold nanoparticles (AuNPs) labelled with metallic radioisotopes (<math>^{99m}\text{Tc}</math>, <math>^{67}\text{Ga}^{3+}/^{68}\text{Ga}^{3+}</math> or <math>^{111}\text{In}^{3+}</math>) aimed at the design of targeted nanoradiopharmaceuticals for early diagnosis of specific tumors by means of SPECT (<math>^{67}\text{Ga}/^{111}\text{In}</math>) or PET (<math>^{68}\text{Ga}</math>) imaging and/or for selective antitumor therapy with Auger emitters (<math>^{111}\text{In}</math>).</p> <p>During 2012, the most important achievements of this project have been the labelling with <math>^{99m}\text{Tc}</math> and <math>^{67}\text{Ga}</math> of small (3-5 nm) gold core AuNPs (BBN-AuNP-DTDTPA) stabilized with a polymerized coat of a DTPA derivated ligand (DTDTPA)<sup>1</sup>, and also incorporating bombesin (BBN) as a target specific vector. Cell uptake studies have been done for the <math>^{99m}\text{Tc}</math>- and <math>^{67}\text{Ga}</math>-labeled BBN-AuNP-DTDTPA using human prostate PC-3 cells, as well as biodistribution studies in a PC-3 tumor xenograft. In some cases, encouraging and significant tumor uptake values have been observed. Further biological studies are underway, namely blockade experiments with cold BBN, in order to confirm the specificity of tumor uptake.</p>
7	<p>The UCQR is equipped with a Unity Inova Varian 300 Mhz multinuclear spectrometer with pulsed field gradient (PFG) probes. This NMR machine is used by researchers of the Groups of Radiopharmaceuticals Sciences, Solid State and Inorganic and Organometallic Chemistry to the study the molecular structures in solution of organic, inorganic and organometallic compounds, based on a variety of multinuclear and/or 2D techniques. As responsible of the NMR spectrometer, I have assured that the use of the machine was available all along 2012. Whenever required, I've provided technical and scientific support to the users of the spectrometer, particularly in the case of young students and researchers.</p>

## PAPERS

- S. Gama, F. Mendes, T. Esteves, F. Marques, A. Matos, J. Rino, J. Coimbra, M. Ravera, E. Gabano, I. Santos, A. Paulo, Synthesis and biological studies of pyrazolyl-diamine PtII complexes containing polyaromatic DNA-binding groups, *ChemBioChem* 13, 2352 – 2362 (2012), doi: 10.1002/cbic.201200472.
- G. R. Morais, I. C. Santos, I. Santos, A. Paulo, X-ray diffraction structures of regioisomers of N-methylated benzimidazole compounds with interest for the design of amyloid-avid probes, *J. Chem. Crystallogr.*, 42, 1052–1059 (2012), doi: 10.1007/s10870-012-0358-x.
- G. R. Morais, I. Santos, A. Paulo, Organometallic complexes for SPECT imaging and/or radionuclide therapy, *Organometallics*, 31, 5693-5714 (2012), doi: 10.1021/om300501d.
- C. Moura, L. Gano, F. Mendes, P. D. Raposinho, A. M. Abrantes, M. F. Botelho, I. Santos, A. Paulo,  $^{99m}\text{Tc}(\text{I})/\text{Re}(\text{I})$  tricarbonyl complexes for *in vivo* targeting of melanotic melanoma: Synthesis and biological evaluation, *Eur. J. Med. Chem.*, 50, 350-360 (2012), doi: 10.1016/j.ejmech.2012.02.014.
- C. Moura, L. Gano, I. C. Santos, A. Paulo, I. Santos,  $^{99m}\text{Tc}(\text{I})$  scorpionate complexes for brain imaging: synthesis, characterization and biological evaluation, *Current radiopharmaceuticals*, 5, 150-157 (2012), doi: 10.2174/1874471011205020150.
- G. R. Morais, A. Paulo, I. Santos, A synthetic overview of radiolabeled compounds for  $\beta$ -amyloid targeting, *Eur. J. Org. Chem.*, 1279–1293 (2012, doi : 10.1002/ejoc.201101449.
- F. Mendes, L. Gano, C. Fernandes, A. Paulo, I. Santos, Studies of the myocardial uptake and excretion mechanisms of a novel Tc-99m heart perfusion agent, *Nucl. Med. Biol.*, 39, 207-213 (2012), doi: 10.1016/j.nucmedbio.2011.08.007.

## COMMUNICATIONS

- *Radiofluorinated benzazole derivatives for in vivo imaging of amyloid aggregation*, G. Ribeiro Morais, L. Gano, T. Kniess, R. Bergman, A. Abrunhosa, C. Pereira, C. Oliveira, I. Santos, A. Paulo, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, Portugal, July 18-20 (2012)*, Poster.
- *Rhenium(I) and Technetium-99m(I) tricarbonyl complexes with hybrid scorpionates: chemical studies and biological evaluation*, A. Paulo, C. Moura, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, September 2-7 (2012)*, Poster.
- *Influence of polar substituents on the biodistribution and metabolic stability of pyrazolyldiamine <sup>99m</sup>Tc(I) organometallic complexes*, A. R. Palma, C. Fernandes, L. Gano, A. Paulo, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, September 2-7 (2012)*, Poster.
- *Pyrazolyl-diamine Pt(II) complexes bearing DNA-intercalating moieties: Synthesis, characterization and in vitro evaluation*, S. Gama, T. Esteves, F. Mendes, F. Marques, I. Santos, J. Coimbra, A. Matos, M. Ravera, E. Gabano, A. Paulo, *ISMEC2012, Lisbon, Portugal, June 18-22 (2012)*, Poster.
- *Bidentate and tridentate pyrazolyl-containing Pt(II) complexes: synthesis, characterization and in vitro evaluation*, E. Gabano, S. Gama, T. Esteves, F. Mendes, F. Marques, I. Santos, J. Coimbra, M. Ravera, A. Paulo, D. Osella, *XII Workshop on Pharmaco-Bio-Metallics (Biomet 12), Padova, Italy, October (2012)*, Poster
- *Peptide-based Probes for Amyloid and Cancer Imaging*, A. Paulo, G. Morais, I. Santos, *WG3 meeting – COST TD1004, London, England, 29th November (2012)*, Invited Talk.
- *Multifunctional Gold Nanoparticles for Theranostic Applications*, F. Silva, A. Zambre, L. Gano, A. Paulo, R. Kannan, I. Santos, *COST action TD1004 meeting, London, England, Oct 29-30(2012)*, Poster.

## EDUCATION / THESES SUPERVISION

- Invited Coordinator Professor at ESTeSL, Disciplines: Radiopharmacy I (2<sup>nd</sup> year, 2<sup>nd</sup> Semester), Radiopharmacy II (3<sup>rd</sup> year, 1<sup>st</sup> Semester).
- A. Paulo, Invited Professor, Faculdade de Farmácia da Universidade de Lisboa, Master Course on Pharmaceutical and Therapeutic Chemistry: lectures on Fundamentals of Radioactivity, Production of Radionuclides and Basics Aspects of Coordination Chemistry, discipline Radiopharmaceutical Chemistry.
- Supervisor, PhD Thesis, *Complexos organometálicos de Tc(I)/Re(I) para Imagiologia Molecular de Tecidos Neoplásicos*, by Carolina Candeias de Moura, Faculdade de Ciências, Universidade de Lisboa, 28 November 2012.
- Member of the jury of the PhD thesis of Carolina Candeias de Moura, *Complexos organometálicos de Tc(I)/Re(I) para Imagiologia Molecular de Tecidos Neoplásicos*, Faculdade de Ciências, Universidade de Lisboa, 28 November 2012.
- Arguing Member of the jury of the Msc Thesis of Ana Cristina Teixeira Martins Gonçalves, *Síntese de novos compostos organometálicos de Fe(II): estudo das suas potencialidades como agentes anticancerígenos*, Faculdade de Ciências, Universidade de Lisboa, 3 October 2012.

## PROJECTS

- *Chemical, Radiochemical and Biological Studies of Pyrazolyl-Alkylamine Pt(II) Complexes: Application on the Development of Novel Anti-Cancer Drugs*, PTDC/QUI/66813/2006, Leading Institution: IST/ITN. IST/ITN Coordinator: A. Paulo (25%).
- *Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation*, PTDC/QUI/QUI/102049/2008, Leading Institution: IST/ITN. IST/ITN Coordinator: A. Paulo (25%).
- *Targeting telomerase inhibition with new anti-tumoral Cu(II) complexes*, PTDC/QUI-QUI/114139/2009,
- Leading Institution: IST/ITN. Member of the research team (15 %).
- *Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for Targeted Radiotherapy of Tumors*, PTDC/QUI-QUI/111891/2009, Leading Institution: IST/ITN. Member of the research team (5%).

- *Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies*” (Acções Integradas Luso-Espanholas/2012), member of the IST/ITN team.
- *COST Action TD1007 “Bimodal PET-MRI molecular imaging technologies and applications for in vivo monitoring of disease and biological processes”*, National MC substitute member.
- *COST Action CM1105: Functional metal complexes that bind to biomolecule*, participant.
- *COST Action TD1004 Theragnostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery*, participant.

## CONFERENCE ORGANIZATION / COMMITTEES

- President, *13th International Conference on Nuclear Microprobe Technological Applications (ICNMTA)*, Lisbon, Portugal, 22-27 July, 2012.

## COLLABORATIONS

- Mauro Ravera (Dipartimento di Scienze e Innovazione Tecnologica, Università del Piemonte Orientale “Amedeo Avogadro”, Alessandria, Italy): Synthesis, characterization and biological evaluation of Pt compounds.
- Antero Abrunhosa (Universidade Coimbra, ICNAS): Synthesis of radiofluorinated compounds.
- Tiago Outeiro (Cell and Molecular Neuroscience Unit, Instituto de Medicina Molecular): In vitro evaluation of the interaction of fluorinated compounds with amyloid aggregates.
- Raghuraman Kannan (Department of Radiology from the University of Missouri): collaboration in the supervision of the PhD work of Francisco Silva.
- João Costa Pessoa (IST/CQE): Collaboration in the supervision of the Post-doctoral researcher Elisa Palma.

## NAME: João Domingos Galamba Correia

**CATEGORY:** Principal Researcher

**ID NUMBER:** 05450

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Nitric oxide synthase targeting with Re(I)/ <sup>99m</sup> Tc(I)-complexes containing L-Arg derivatives: a structure-activity study – PTDC/QUI-QUI/121752/2010. <i>Coordinator</i> . In cooperation with Prof. Maria João Romão and Prof. Maria López Macedo (REQUIMTE/FCT-UNL), and Prof. Maria João Ramos (REQUIMTE/Depart. Chem. Biochem. FC-UP, Universidade do Porto).	35%
2	Peptide-based radiometal probes for CXCR4 targeting. <i>Coordinator</i> .	5%
3	ICTP and NTx peptides as markers of bone resorption – <i>IST/ITN coordinator</i> . In collaboration with Prof. Luís Costa and Dr <sup>a</sup> Sandra Casimiro from the unit of Clinical and Translational Oncology Research Unit of IMM, Faculty of Medicine, University of Lisbon.	5%
4	Albumin binding-domain fusion to improve protein pharmacokinetics – PTDC/SAU-FAR/115846/2009. <i>IST/ITN coordinator</i> . In collaboration with Prof. João Gonçalves (PI) from the Unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon.	15%
5	Synthesis, characterization and biological assessment of multi-functional bone-seeking agents – PTDC/QUI-QUI/115712/2009. <i>Team member</i> . In collaboration with Prof. Luis Costa and Dr <sup>a</sup> Sandra Casimiro from the Unit of Clinical and Translational Oncology Research Unit of IMM, Faculty of Medicine, University of Lisbon.	15%
6	Bimodal dextran-based probes for Sentinel Lymph Node Detection by SPECT and Optical Imaging – <i>Team member</i> . This project was partially supported by the IAEA.	5%

7	A molecular imaging approach to cystic fibrosis – <i>Team member</i> . In collaboration with Dr. Filipa Mendes (PI).	5%
8	Radiolabeling and biological assessment of therapeutic antibodies – Technophage. Services Agreement, celebrado entre o IST/ITN e a empresa TECHNOPHAGE, em 15 de March de 2012.	5%
9	Teaching activities.	5%
10	Management of Laboratory infrastructure – Solid Phase Peptide Synthesis Laboratory.	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	Aiming to probe Nitric Oxide Synthase (NOS) levels <i>in vivo</i> by SPECT-imaging we have introduced complexes containing N <sup>□</sup> -NO <sub>2</sub> -L-Arg and the core “ <sup>99m</sup> Tc(CO) <sub>3</sub> ” separated by 3- ( <b>Tc1</b> ) or 6-carbon linkers ( <b>Tc2</b> ). The complexes are stabilized by a pyrazoly-diamine bifunctional chelator. Enzymatic assays with purified iNOS have shown that the non-radioactive surrogates <b>Re1</b> and <b>Re2</b> are stronger inhibitors than the respective metal-free conjugates <b>L1</b> and <b>L2</b> , with <b>Re2</b> displaying an inhibitory potency that is comparable to that of N <sup>□</sup> -NO <sub>2</sub> -L-Arg. To get a better insight into the structural parameters responsible for this behavior we have studied the free conjugates and complexes by molecular docking and molecular dynamics simulations. The higher inhibitory activity of <b>Re2</b> is most likely related to the stronger electrostatic interactions between the “Re(CO) <sub>3</sub> ” core and Arg260 and Arg382 of the enzyme. Free energy perturbation calculations have shown that the resultant relative binding energies are in accordance with the experimental results. Indeed, there is an energetic penalty for the transformation of the Re complexes into the conjugates, which is higher for the pair <b>Re2/L2</b> . The experimental work of the project has been done by B. Oliveira (BI) under my supervision (PI of the project) and Dr. Filipa Mendes (biological evaluation).
2	Chemokines are a family of glycoproteins that mediate intracellular signaling pathways, involved in cell movement and activation through binding to a family of G-protein coupled receptors, differently expressed in various cell types. Besides their physiological role, the receptor/ligand pairs have been associated with autoimmune disorders, pulmonary diseases, transplant rejection, and cancer. The axis CXCR4/CXCL12 play a key role in fetal development, mobilization of haemopoietic stem cells, and trafficking of naïve lymphocytes. CXCR4 is overexpressed in more than 23 human cancers, being its expression low or absent in many normal tissues adjacent to the tumor. There is also evidence supporting the link between CXCR4/CXCL12 and metastization. Therefore, targeting of CXCR4 expression <i>in vivo</i> by Single-Photon Emission Computed Tomography or Positron Emission Tomography holds great potential for imaging the metastatic potential of tumors. No effective imaging methods to screen for CXCR4-positive patients and tumor types likely to respond to CXCR4 blockade have been reported yet. This situation prompted us to design <sup>99m</sup> Tc- and <sup>67</sup> Ga-based radiometallated peptides with high affinity/selectivity for CXCR4. The preliminary work already done, which comprised the synthesis and characterization of metal(Re)-cyclized peptides (T140 derivatives), was performed by the graduate student M. Morais under my supervision.
3	Under the framework of a cooperation project between the Radiopharmaceutical Sciences Group of IST/ITN and the unit of Clinical and Translational Oncology Research Unit of IMM (Prof. Luís Costa and Dr <sup>a</sup> Sandra Casimiro), Faculty of Medicine, University of Lisbon, we have started a preliminary bibliographic study which aims at answering the following question: “ <i>Type I Collagen Fragments ICTP and CTX: Metabolic Waste or cell mediators?</i> ”. For the sake of lack of space, the complete report on this topic (July 2012) is available upon request.
4	Small domain antibodies are a promising class of biopharmaceuticals with very high potential in therapeutic applications, however, due to their small size, are rapidly cleared from circulation. The unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon, proposed a bacterial albumin-binding domain (Zag) derived from <i>Streptococcus zooepidemicus</i> fused to an anti-TNF VHH small domain antibody as a strategy to improve the pharmacokinetic properties of therapeutic proteins. Profiting from the presence of hexahistidine tags in the proteins VHH and VHH fused with the ZAG albumin-binding domain, both antibodies were labeled with [ <sup>99m</sup> Tc(CO) <sub>3</sub> ] <sub>+</sub> and purified (> 95%). The radioactive VHH-based antibodies are stable towards transchelation reactions in the presence of histidine or cysteine, as well as in human serum for 24

	<p>hours. The biodistribution studies in healthy CD-1 mice indicated that the ZAG domain affected the pharmacokinetic profile of <math>^{99m}\text{Tc}(\text{I})\text{-PL-VHH}</math> with a remarkable 10-25 fold decrease of blood clearance. The first radiolabeling assays and the general coordination of the IST/ITN team (L. Gano – Biological studies, C. Fernandes – <math>^{99m}\text{Tc}</math>-labeling and M. C. Oliveira – <math>^{125}\text{I}</math>-labeling) is at my responsibility. M. Morais performed most of the radiolabeling assays, purification and stability studies under my direct supervision.</p>
5	<p>The main goal of the project entitled “<i>Synthesis, characterization and biological assessment of multi-functional bone-seeking agents</i>” is the assessment of the simultaneous delivery of radiation/bisphosphonates/chemotherapy to bone metastatic lesions, using novel and well-defined multifunctional chemical identities. By using a bifunctional chelating approach, the bone-uptake of the bisphosphonate (BP) is expected to be preserved, reducing toxicity exposure to extra-skeletal sites. A synergistic effect of such combination, in pain therapy and/or cancer progression, compared to the conventional sequential treatment, and an understanding of the underlying mechanisms is expected. Under the framework of this project we have successfully synthesized and characterized a set of novel organometallic compounds of the type <math>\text{fac-}[\text{M}(\text{CO})_3(\text{k}_3\text{-Pz-BP})]_+</math>, which contain a bisphosphonate unit (bone seeking agent), and the metal fragment <math>\text{fac-}[\text{M}(\text{CO})_3]</math> (<math>\text{M} = ^{99m}\text{Tc}, \text{Re}</math>). The biological evaluation (e.g. cytotoxicity, bone-targeting properties) of the complexes both in cell lines and animals (mice and rats) is currently underway. I have been participating in this project under the framework of Task 1, suggesting new synthetic pathways and discussing relevant results with the aim of accomplishing the goals of the project.</p>
6	<p>Sentinel lymph nodes (SLN) are the first lymph nodes to receive lymphatic flow as well as metastatic cells from the primary tumor sites. In cases of breast cancer or melanoma, SLN detection (SLND) is followed by excision and biopsy of the SLN to detect the presence of metastasis. Accurate SLND is a key issue for tumor staging, evaluation of the extension of surgery, and establishment of the most adequate therapy. Recent studies have shown that receptor-binding mannosylated nanocarriers provide selectivity for mannose receptors on lymph node macrophages. We have introduced the first class of <math>^{99m}\text{Tc}(\text{CO})_3</math>-mannosylated dextran derivatives with superior biological features for SLN detection. The SPECT/CT studies in mice confirmed that those radiolabeled polymeric nanoparticles are retained in the first lymph node allowing its clear visualization. Profiting from the superior SLN-targeting properties of such derivatives, we have synthesized novel mannose-containing dextran derivatives with both radioactive (<math>^{99m}\text{Tc}(\text{CO})_3</math>) and fluorescent units as selective probes for SPECT and Optical imaging of SLN. Full physicochemical characterization of such probes is currently underway. The experimental work of this project has been performed by the graduate student M. Morais, under my direct supervision. Dr. I. Santos is responsible for the overall coordination of this research project.</p>
7	<p>Cystic fibrosis (CF) is the most common lethal autosomic recessive disease among Caucasians. The gene responsible for the disease encodes the CF transmembrane conductance regulator (CFTR) protein, a polytopic integral membrane protein that functions as a cyclic AMP-activated chloride channel and regulator of other channels at the apical membrane of epithelial cells. The main goal of this project, which started in September 2012, is to develop radioactive probes for detect the expression of rescued trafficking mutants at the membrane of epithelial pulmonary cells. New radiolabelled molecules – <i>antibodies (Abs) and small organic inhibitors</i> – will be prepared and tested as molecular imaging radioprobes in human pulmonary immortalized and primary cell lines. We started with the optimization of the <math>^{99m}\text{Tc}</math>-labelling of the anti-CFTR Abs MA1-935 and ECL1. Furthermore, following the bifunctional approach, we have also prepared and characterized the conjugates CFTRinh-PzNN and Gpinh-5<sup>a</sup>-PzNN, which comprise small molecule drug inhibitors and a pyrazolyl-diamine-coordinating unit for labeling with <math>^{99m}\text{Tc}(\text{CO})_3</math>. The synthetic and characterization work, as well as the radiolabeling studies have been performed by the students V. Ferreira and B. Oliveira under my direct supervision. Dr. Filipa Mendes is the PI of this project, being responsible for its overall coordination.</p>
8	<p>Radiolabeling and biological assessment of therapeutic antibodies – Technophage-IMM. <i>Services Agreement, celebrado entre o IST/ITN e a empresa TECHNOPHAGE, em 15 de March de 2012.</i> Optimization and labelling of the three molecules provided by Technophage and evaluation of the <i>in vivo</i> stability of the molecules as well as their Biodistribution at different time points after i.v. injection in mice and rats. The radioalabeling work was done by B. Oliveira, and the Biodistribution studies were performed by L. Gano. I was in charge of the overall coordination of the project at the IST/ITN site.</p>

9	<ul style="list-style-type: none"> <li>- Invited Lecturer at the Groningen Research Institute of Pharmacy, University of Groningen, the Netherlands. <i>Radioactive Metal-Based Drugs for Imaging and Therapy</i>, within the Pharmaceutical Inorganic Chemistry course, 1<sup>st</sup> year Master in Pharmacy, Sep 6-7 (2012).</li> <li>- Invited Lecturer at the Faculdade de Farmácia da Universidade de Lisboa, <i>Master Course on Pharmaceutical and Therapeutic Chemistry 2011/2012</i>, Radiopharmaceutical Chemistry.</li> </ul>
10	<p>Management of Laboratory infrastructure – Solid Phase Peptide Synthesis Laboratory:</p> <ul style="list-style-type: none"> <li>- Responsible for the MW-assisted Solid Phase Peptide Synthesizer – CEM Liberty.</li> <li>- Training of the new users.</li> </ul>

## PAPERS

- B. L. Oliveira, I. S. Moreira, P. A. Fernandes, M. J. Ramos, I. Santos, J. D. G. Correia, Insights into the structural determinants for selective inhibition of nitric oxide synthase isoforms, *Journal of Molecular Modeling* (2012), doi: 10.1007/s00894-012-1677-8.
- M. Morais, P. D. Raposinho, M. C. Oliveira, D. Pantoja-Uceda, M. A. Jimenez, I. Santos, J. D. G. Correia, NMR Structural Analysis of MC1R-Targeted Rhenium(I) Metallopeptides and Biological Evaluation of <sup>99m</sup>Tc(I) Congeners, *Organometallics*, 31, 5929-5939 (2012), doi: 10.1021/om300502n.
- I. Pirmettis, Y. Arano, T. Tsotakos, K. Okada, A. Yamaguchi, T. Uehara, M. Morais, J. D. G. Correia, I. Santos, M. Martins, S. Pereira, C. Triantis, P. Kyprianidou, M. Pelecanou, M. Papadopoulos, New <sup>99m</sup>Tc(CO)<sub>3</sub>-mannosylated dextran bearing S-derivatized cysteine chelator for sentinel lymph node detection, *Molecular Pharmaceutics*, 9, 1681-1692 (2012), doi: 10.1021/mp300015s.
- M. Morais, P. D. Raposinho, M. C. Oliveira, J. D. G. Correia, I. Santos, Evaluation of novel <sup>99m</sup>Tc(I)-labeled homobivalent alpha-melanocyte-stimulating hormone analogs for melanocortin-1 receptor targeting, *Journal of Biological Inorganic Chemistry*, 17, 491-505 (2012), doi: 10.1007/s00775-011-0871-y.

## COMMUNICATIONS

- *Peptide-Based Radioactive Probes for SPECT-Imaging of Melanoma*, J. D. G. Correia, M. Morais, I. Santos, P. D. Raposinho, *Pharmacokinetics, Toxicology and Targeting – Groningen Research Institute of Pharmacy, University of Groningen, the Netherlands, Sep 6 (2012)*, Invited Talk.
- *MC1R-targeting properties of <sup>99m</sup>Tc(I)-labeled cyclic  $\alpha$ -MSH analogs with thioether or amine bridge*, J. D. G. Correia, M. Morais, P. D. Raposinho, M. C. Oliveira, I. Santos, M. A. Jiménez, D. Pantoja-Uceda, *XIII Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Modulation of the Pharmacokinetic Properties of <sup>99m</sup>Tc(CO)<sub>3</sub>- $\beta$ Ala-MTII*, M. Morais, B. L. Oliveira, J. D. G. Correia, M. C. Oliveira, I. Santos, P. D. Raposinho, *XIII Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Albumin-binding domain (Zag) from Streptococcus zooepidemicus increases half-life and affect blood clearance of anti-TNF VHH*, C. Cantante, S. Lourenço, M. Morais, L. Gano, C. Santos, C. Fontes, J. D. G. Correia, F. Silva, J. Gonçalves, *8<sup>th</sup> Annual PEGS 2012 - the Essential Protein Engineering Summit, Boston, MA, USA, Apr 30 - May 4 (2012)*, Poster.
- *<sup>99m</sup>Tc/Re-tricarbonyl complexes containing pendant acetamide moieties for iNOS targeting*, B. L. Oliveira, N. R. Martins, I. F. Rodrigues, A. Ponces, C. Cordeiro, P.A. Fernandes, M. J. Ramos, I. Santos, J. D. G. Correia, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, Sep 2-7 (2012)*, Poster.
- *Design, characterization and evaluation of cyclized  $\alpha$ -MSH Derivatives for MC1R Targeting*, M. Morais, P. D. Raposinho, M. C. Oliveira, M. A. Jiménez, D. Pantoja-Uceda, J. D. G. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, Sep 2-7 (2012)*, Poster.
- *BP-containing M(CO)<sub>3</sub>-complexes (M = <sup>99m</sup>Tc/Re) as multi-functional bone-seeking agents*, S. Monteiro, P. Mendes, C. Fernandes, L. Gano, E. Palma, J. D. G. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry, Lisbon, Portugal, Sep 2-7 (2012)*, Poster.
- *Albumin-binding domain from Streptococcus pyogenes protein H increases half-life and affect blood clearance of anti-TNF VHH*, C. Cantante, S. Lourenço, J. Leandro, M. Morais, L. Gano, C. Fontes, J. D. G. Correia, P. Leandro, F. Silva, J. Gonçalves, *PEGS Summit Europe 2012 – Protein and Antibody Engineering Summit, Vienna, Austria, Nov 6-8 (2012)*, Poster.

## EDUCATION / THESES SUPERVISION

- Supervisor, Ph.D Thesis, *Re and <sup>99m</sup>Tc organometallic complexes for targeting nitric oxide synthase*, by Bruno Luís Jesus Pinto de Oliveira, Faculdade de Ciências, Universidade de Lisboa, 27 June 2012.
- Supervisor, Ph.D Thesis, *Target-specific detection of melanoma and sentinel lymph node with <sup>99m</sup>Tc(CO)<sub>3</sub>-containing probes*, by Maurício Morais, Faculdade de Ciências, Universidade de Lisboa, Tese em preparação.
- Main Jury member (*arguente*): M. Sc. Thesis, *Síntese, caracterização e avaliação biológica de compostos multifuncionais*, by Patrícia Raquel Henriques Serra Mendes, Faculdade de Ciências, Universidade de Lisboa, 23 November 2012.
- Main Jury member (*arguente*): M. Sc. Thesis, *Compostos de dextrano-manose marcados com o <sup>67</sup>Ga para a deteção do gânglio sentinela*, by Filipa António Drumond Gonçalves, Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), 4 December 2012.
- Invited Lecturer at the Groningen Research Institute of Pharmacy, University of Groningen, the Netherlands. *Radioactive Metal-Based Drugs for Imaging and Therapy*, within the Pharmaceutical Inorganic Chemistry course, 1<sup>st</sup> year Master in Pharmacy, Sep 6-7 (2012).
- Invited Lecturer at the Faculdade de Farmácia da Universidade de Lisboa, *Master Course on Pharmaceutical and Therapeutic Chemistry 2011/2012*, Radiopharmaceutical Chemistry.

## PROJECTS

- **COST Action CM1004** (2011 – 2015) *Synthetic Probes for Chemical Proteomics and Elucidation of Biosynthetic Pathways*. Portuguese representative – Management committee.

### Principal Researcher

- *Nitric Oxide Synthase targeting with Re(I)/<sup>99m</sup>Tc(I)-complexes containing L-Arg derivatives: A structure-activity study*, PTDC/QUI-QUI/121752/2010. Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. IST/ITN Principal Researcher: J. D. G. Correia (35%).

### Team Member (15%)

- *Synthesis, Characterization and Biological Assessment of Multi-Functional Bone-Seeking Agents*, PTDC/QUI-QUI/115712/2009. Leading Institution: ITN, Sacavém, Portugal. IST/ITN Principal Researcher: I. Santos.
- *Albumin binding-domain fusions to improve protein pharmacokinetics*, PTDC/SAU-FAR/115846/2009. Leading Institution: Associação para o Desenvolvimento do Ensino e Investigação da Microbiologia (ADEIM), Faculdade de Farmácia, Universidade de Lisboa. Principal Researcher: João Manuel Braz Gonçalves.

### **Submitted in 2012**

#### Principal Researcher (35%)

- *Albumin-binding proteins as drug carriers*, PTDC/DTP-FTO/0189/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. IST/ITN Principal Researcher: J. D. G. Correia (35%). *Not recommended for funding*.

## CONTRACTS

- *Radiolabeling and biological assessment of therapeutic antibodies*, Services Agreement, celebrado entre o IST/ITN e a empresa TECHNOPHAGE, em 15 de March de 2012. - 3 months - April – June 2012.

## CONFERENCE ORGANIZATION / COMMITTEES

- Membro efectivo da Comissão de Avaliação de Medicamentos (CAM) do Ministério da Saúde – INFARMED. Avaliação de medicamentos.

## COLLABORATIONS

- Prof. Angela Casini, Groningen Research Institute of Pharmacy, University of Groningen, the Netherlands.
- Dr. Olga Iranzo, Instituto de Tecnologia Química e Biológica, UNL, Oeiras, Portugal.
- Prof. Adoración G. Quiroga, Departamento de Química Inorgánica, Facultad de Ciencias, Universidad Autónoma de Madrid, Spain.

---

## NAME: João Carlos Bentes Waerenborgh

**CATEGORY:** Principal Researcher

**ID NUMBER:** 21892

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Materials for solid oxide fuel cells and dense ceramic membranes	20%
2	Study and development of new molecule-based magnets and multifunctional materials	10%
3	Magnetic and strongly correlated electron behaviour in intermetallics	10%
4	Mössbauer effect applications in environmental science and technology	10%
5	Management of the Mössbauer Spectroscopy Facility of IST/ITN	30%
6	Supervision and training of graduate students	20%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>IST/ITN coordinator of project <i>Novel methodological approaches to analyze ion transport mechanism in complex crystal lattices and to forecast performance-determining parameters of the oxide materials (PTDC/CTM-CER/114561/2009)</i>.</p> <p>Materials based on iron-containing oxides with perovskite-derived structures attract significant attention for energy-related electrochemical technologies, such as electrodes of solid oxide fuel cells (SOFC) or ceramic membranes for conversion of natural gas and biogas.</p> <p>La<sub>2</sub>MRuO<sub>6</sub> double perovskites were investigated by XPS. Charge transfer was found to occur between the 4d and lower 3d energy levels of the M transition metals leading to mixed ion pairs, Ru<sup>(4-δ)+</sup>-Ru<sup>4+</sup> ↔ Co<sup>2+</sup>-Co<sup>3+</sup> and Ru<sup>4+</sup>-Ru<sup>(4+δ)+</sup> ↔ Ni<sup>+</sup>-Ni<sup>2+</sup> for M = Co and Ni, respectively.</p> <p>Dominant oxidation states of transition metals at low temperatures in brownmillerite-type Ca<sub>2</sub>Fe<sub>1.6</sub>M<sub>0.4</sub>O<sub>5±δ</sub> (M=Mn, Fe and Co) were found to be Mn<sup>4+</sup>, Fe<sup>3+</sup> and Co<sup>3+</sup>. Doping with cobalt leads to higher conductivity above 600 K and to lower thermal expansion. Although these effects are beneficial for membrane and electrode applications, the stability of the Co-substituted Ca<sub>2</sub>Fe<sub>2</sub>O<sub>5-δ</sub> towards reduction becomes lower. A similar influence on the phase stability is observed when iron is substituted with manganese, while the conductivity decreases indicating strong localization of Mn<sup>4+</sup> states.</p>
2	<p>Team member of the project <i>Study and development of new molecular magnets (PTDC/FIS/102284/2008)</i>. Leading Institution: Faculdade de Ciências e Tecnologia da Univ. Coimbra.</p> <p>- Oxo-bridged tri-nuclear Fe<sup>III</sup> complexes mimic different metalloprotein centers. Fe cations in (μ<sub>3</sub>-Oxo)-hexakis(μ<sub>2</sub>-cyanoacetato)-triqua-tri Fe<sup>III</sup> nitrate penta-hydrate were found to be in a S=5/2 state. The antiferromagnetic exchange interactions compel the system to a total spin ground state S=1/2.</p> <p>- Iron-sulfur cubanes able to cycle between two (or more) oxidation states constitute the electron-transfer components of several ferredoxins involved in biological redox processes. The study of complexes containing Fe<sub>4</sub>S<sub>4</sub>-cubane cores has been a central theme of bioinorganic chemistry. The spectroscopic study of the Mo<sub>3</sub>(FeCl)S<sub>4</sub>(dmpe)<sub>3</sub><sup>3-</sup> Mo<sub>3</sub>(FeCl)S<sub>4</sub>(dmpe)<sub>3</sub><sup>2-</sup> redox couple suggests that</p>



	<p>the cores are described as <math>[\text{Mo}_2^{\text{III}}\text{Mo}^{\text{IV}}\text{Fe}^{\text{II}}\text{S}_4]^{4+}</math> and <math>[\text{Mo}_2^{\text{III}}\text{Mo}^{\text{IV}}\text{Fe}^{\text{III}}\text{S}_4]^{5+}</math>, respectively, and the redox event is largely confined to the Fe site. The redox description of <math>\text{Mo}_3(\text{FeCl})\text{S}_4(\text{dmpe})_3\text{Cl}_3</math> (formally <math>[\text{Mo}_2^{\text{III}}\text{Mo}^{\text{IV}}\text{Fe}^{\text{II}}\text{S}_4]^{4+}</math>) has implications for its synthesis, as it is prepared from <math>[\text{Mo}_3\text{S}_4(\text{dmpe})_3\text{Cl}_3]^+</math> (formally <math>[\text{Mo}_3^{\text{IV}}\text{S}_4]^{4+}</math>) cluster via addition of <math>\text{FeCl}_2</math> in the presence of a reductor. Hence, two electron reduction of the starting <math>[\text{Mo}_3\text{S}_4(\text{dmpe})_3\text{Cl}_3]^+</math> complex, rather than <math>\text{FeCl}_2</math> reduction, seems to be the driving force of iron incorporation (collaboration: Universitat Jaume I, Castelló, Spain).</p>
3	<p>The understanding of the magnetic and strongly correlated electron behaviour of intermetallics containing f-elements (in particular the role of f-electrons) has been the subject of a long-term project in the Solid State group of IST/ITN.</p> <p>The magnetism of intermetallic compounds based on uranium and 3d metals is mainly determined by the 5f-3d hybridization. This hybridization delocalizes the 5f electrons leading to a reduction or even disappearance of the U magnetic moment. Simultaneously, the 3d magnetic moment might vanish as well (e.g., UFeAl or UFeGe which display paramagnetic behavior down to the lowest temperatures). Nevertheless, U-T compounds exist where at least one sublattice is magnetic. An example is provided by a hexagonal Laves phase <math>\text{U}_2\text{Fe}_3\text{Ge}</math> and by <math>\text{U}_3\text{Fe}_4\text{Ge}_4</math> phase found recently in the ternary U-Fe-Ge phase diagram at 900°C. Although both compounds are ferromagnets below 55 K and 18 K, respectively, Mössbauer spectroscopy excluded long-range magnetic ordering as well as spin-glass behavior within the iron sublattices.</p>
4	<p>In collaboration with other IST groups as well as other research institutions the following Mössbauer studies in the area of environmental science and technology were performed in 2012:</p> <p>A study of Fe speciation during weathering of volcanic top soils in semi arid climates, Cabo Verde, was initiated as part of a larger project, for the establishment of an environmental geochemical atlas of Cape Verde archipelago (GeoLuc group, IST/ITN)</p> <p>Investigation on clay minerals and iron oxides has shown that these mineral phases may be used as fingerprints of fire effects in limestone monuments (CEPGIST, Centro de Petrologia e Geoquímica, IST).</p> <p>Fe crystalchemistry study of mine tailings and of their acid drainage in the Ribeira da Água Forte, Aljustrel mining area in the Iberian Pyrite Belt. The results obtained have shown that, although the mixing process of both acid and organic-rich waters can suppress and briefly mitigate some adverse effects of acid drainage, the continuing discharge of these waste waters into a dry stream promotes the remobilization of metals fixed in the secondary solid phases in the stream bed back into solution (Geology Dept. Fac. Sciences, Univ. Lisbon).</p>
5	<p>Coordination of the Mössbauer spectroscopy facility in IST/ITN. This facility was developed in ITN in order to support local research projects.</p> <p>The acquired expertise has been, in the last years, able to assist other national or foreign research institutions in the frame of joint research projects. Recent work has been performed in the areas of materials science and environmental science and technology (see above).</p> <p>During 2012 <math>\gamma</math>-ray transmission with the sample in the 300-1.4 K temperature range, and backscattering as well as conversion electron spectra were regularly obtained. <math>^{57}\text{Co}</math>, <math>^{119}\text{Sn}</math> and <math>^{151}\text{Sm}</math> sources were used.</p> <p>In 2012 an up-dated Radiological Protection Program of the Mössbauer spectroscopy laboratory was elaborated and the corresponding operating license was reviewed.</p> <p>International recognition of the research performed in this facility is reflected in the requests from foreign research institutions to perform Mössbauer measurements, peer reviewing for international scientific journals (<i>J. Appl. Phys.</i>, <i>J. Magn. Magn. Mater.</i>, <i>J. Alloys and Comp.</i>, etc.) as well as of research projects (<i>Mutual interactions of compounds containing iron in different oxidation states studied by means of Mossbauer spectroscopy</i>, submitted to the Czech Science Foundation).</p>
6	<p>Supervision of post-doctoral grant, Ekaterina Tsipis (<i>PhD</i>), <i>Novel ferrite-based mixed conductors for electrochemical applications</i>. (January - December 2012).</p> <p>Supervision of research grant Joana Coutinho (<i>MSc</i>) in the frame of the project <i>Novel methodological approaches to analyze ion transport mechanism in complex crystal lattices and to</i></p>

*forecast performance-determining parameters of the oxide materials* (since September 2012).

Training in Mössbauer spectroscopy. Applications to mixed conducting and mixed valence oxides.

Among other compounds, in 2012, thermomechanical, transport and electrode properties of perovskite-type  $(\text{La,Sr})_{0.95}(\text{Cr,M})\text{O}_{3-\delta}$  ( $\text{M} = \text{Ti, Mn, Fe}$ ) were studied. The incorporation of moderate amounts of iron into acceptor-doped  $\text{LaCrO}_3$  enable to stabilize  $\text{Fe}^{3+}$  states in a wide  $p(\text{O}_2)$  range necessary for the electrochemical applications. Perovskite-type  $(\text{La,Sr})(\text{Cr,Fe})\text{O}_{3-\delta}$  exhibit moderate TECs, relatively low oxygen-stoichiometry variations, substantially high oxygen permeability and ionic conduction in reducing atmospheres. These perovskites possess a higher electrochemical activity under anodic conditions and lower costs in comparison with  $(\text{La,Sr})(\text{Cr,Mn})\text{O}_{3-\delta}$ .

$\text{YBaCo}_4\text{O}_{7+d}$  - based phases are promising as oxygen storage materials. In combination with computer simulations, magnetization and Mössbauer spectroscopy analyses threw light on the oxidation mechanisms. Oxidation of Fe-containing  $\text{YBaCo}_4\text{O}_{7+\delta}$  was found to lead to penta rather than hexa-coordination of  $\text{Co}^{3+}$ .

## PAPERS

- J. C. Waerenborgh, E. V. Tsipis, L. C. J. Pereira, M. Avdeev, E. N. Naumovich, V. V. Kharton, Magnetization, Mössbauer and isothermal dilatometric behavior of oxidized  $\text{YBa}(\text{Co,Fe})_4\text{O}_{7+\delta}$ , *Dalton Trans.* 41, 667-678 (2012), doi:10.1039/c1dt11212k.
- M. F. Lü, E. V. Tsipis, J. C. Waerenborgh, A. A. Yaremchenko, V. A. Kolotygin, S. Bredikhin, V. V. Kharton, Thermomechanical, transport and anodic properties of perovskite-type  $(\text{La}_{0.75}\text{Sr}_{0.25})_{0.95}\text{Cr}_{1-x}\text{Fe}_x\text{O}_{3-\delta}$ , *Journal of Power Sources* 206, 59-69 (2012), doi:10.1016/j.jpowsour.2012.01.100.
- A. L. Shaula, A.A. Markov, E.N. Naumovich, J.C. Waerenborgh, Y. V. Pivak, V. V. Kharton, Redox behavior and transport properties of brownmillerite  $\text{Ca}_2(\text{Fe,M})_2\text{O}_{5\pm\delta}$  ( $\text{M} = \text{Mn, Co}$ ), *Solid State Ionics* 225, 206-210 (2012), doi:10.1016/j.ssi.2011.11.016.
- F. Maia, C. Pinto, J. C. Waerenborgh, M. A. Gonçalves, C. Prazeres, O. Carreira, S. Sérgio, Metal Partitioning in Sediments and Mineralogical Controls on the Acid Mine Drainage in Ribeira da Água Forte (Aljustrel, Iberian Pyrite Belt, Southern Portugal), *Appl. Geochem.* 27, 1063-1080 (2012), doi:10.1016/j.apgeochem.2012.02.036
- M. F. Lü, X. Deng, J. C. Waerenborgh, X. Wu, J. Meng "Redox chemistry and magnetism of  $\text{LaSrM}_{0.5}\text{Ru}_{0.5}\text{O}_{4\pm\delta}$  ( $\text{M} = \text{Co, Ni and Zn}$ ) Ruddlesden Popper phases" *Dalton Trans.* 41 (2012) 11507-11518 (2012), doi:10.1039/c2dt31462b
- I. Sorribes, F. Lloret, J. C. Waerenborgh, V. Polo, R. Llusar, C. Vicent, Cubane-type  $\text{Mo}_3\text{FeS}_4^{4+,5+}$  Complexes Containing Outer Diphosphane Ligands: Ligand Substitution Reactions, Spectroscopic Studies and Electronic Structure, *Inorg. Chem.* 51, 10512-10521 (2012), doi:10.1021/ic300368z.
- A. Dionísio, M. A. Sequeira Braga, J. C. Waerenborgh, Fire-Induced Colour Modifications on Limestones used as Building Materials in Portuguese Monuments. A Case Study for Built Heritage, chapter 7 (pp. 221-244) in "Advances in Materials Science Research. Volume 13". Ed. Maryann C. Wythers, *Nova Science Publishers, Inc.*, (2012) [ISBN: 978-1-62100-749-4].

## COMMUNICATIONS

- *Kinetic and thermomechanical stability, oxygen permeability and ionic conductivity of iron-containing mixed conductors for membrane applications*, E. V. Tsipis, V. V. Kharton, V. A. Kolotygin, E. N. Naumovich, M. V. Patrakeev, A. L. Shaula, A. P. Viskup, J. C. Waerenborgh, *10th International Symposium on Ceramic Materials and Components for Energy and Environmental Applications*, Dresden, Germany, May 20-22 (2012). Oral.
- *Enhanced metal release from acid mine drainage sediments due to the interaction with municipal waste water*, M. A. Gonçalves, J. C. Waerenborgh, F. Maia, C. Pinto, C. Prazeres, S. Sérgio, *Goldschmidt 2012*, Montréal, Canada, June 24-29 (2012). Oral.
- *Structural and magnetic transitions in the  $\text{LnBaFe}_4\text{O}_{7+d}$  ( $\text{Ln} = \text{Y, Dy-Lu}$ ) 114 ferrite family*, V. Duffort, V. Caignaert, V. Pralong, N. Barrier, B. Raveau, M. Avdeev, E. V. Tsipis, J. C. Waerenborgh, H. Zheng and

J. F., Mitchell, *4th International Symposium on Structure-Property Relationships in Solid State Materials*, Bordeaux, France, June 24-29 (2012). Oral.

- *Iron speciation in volcanic soils from Fogo Island (Cape Verde)*, R. Marques, J.C. Waerenborgh, M.I. Prudêncio, F. Rocha, E. Ferreira da Silva, *9th ISEG - International Symposium on Environmental Geochemistry*, Univ. Aveiro, Portugal, July 15-22 (2012). Oral.
- *Uranium-iron-germanium intermetallic compounds*, M.S. Henriques, D. I. Gorbunov, J. C. Waerenborgh, L. C. J. Pereira, E. B. Lopes, L. Havela, A. V. Andreev, T. Klimczuk, A. Rudajevová, O. Tougait, R. Vilar, A. P. Gonçalves, *10<sup>th</sup> Prague Colloquium on f-Electron Systems (PCFES)*, Prague, Czech Republic, August 21-24 (2012), oral.
- *Oxygen ionic transport in brownmillerite type  $Ca_2Fe_2O_{5+\delta}$  and calcium-ferrite based composites*, A. L. Shaula, V. A. Kolotygin, E. N. Naumovich, J. C. Waerenborgh, Y. V. Pyvak, V. V. Kharton, *International Conference on Oxide Materials for Electronic Engineering OMEE-2012*, Lviv, Ukraine, September 3-7 (2012). Oral.
- *Surface analysis of ferrite mixed-conducting membranes under air/ $CH_4$  gradient by conversion-electron Mössbauer spectroscopy*, J. C. Waerenborgh, E. Tsipis, A. A. Yaremchenko, V. V. Kharton, *18th International Conference on Solid Compounds of Transition Elements*, Lisbon, Portugal, March 31- April 5 (2012). Poster.
- *Oxo-bridged tri-nuclear Fe(III) complexes: structural and magnetic properties*, M. Ramos Silva, J.N.J.Nogueira, P.A.O.C.Silva, C. Yuste-Vivas, L.C.J.Pereira, J. C. Waerenborgh *18th International Conference on Solid Compounds of Transition Elements*, Lisbon, Portugal, March 31- April 5 (2012). Poster.
- *Low-temperature properties of orthorhombic  $UFeGe$* , A. P. Gonçalves, M. S. Henriques, L. C. J. Pereira, M. Almeida, L. Havela, J. C. Waerenborgh, E. B. Lopes, S. Mašková, O. Tougait, J. S. Brooks, A. Kiswandhi, E. Steven, T. Klimczuk *18th International Conference on Solid Compounds of Transition Elements*, Lisbon, Portugal, March 31- April 5 (2012). Poster.
- *Thermomechanical, transport and anodic properties of perovskite-type  $(La_{0.75}Sr_{0.25})_{0.95}Cr_{1-x}Fe_xO_{3-\delta}$*  V. V. Kharton, S. Bredikhin, V. A. Kolotygin, M. F. Lü, E. V. Tsipis, J. C. Waerenborgh, A. A. Yaremchenko, *10th International Symposium on Ceramic Materials and Components for Energy and Environmental Applications*, Dresden, Germany, May 20-22 (2012). Poster.
- *Ni/oxide catalyst composites for oxygen electrodes in alkaline media*, J. F. Monteiro, A. V. Kovalevsky, A. Yaremchenko, J. Waerenborgh, J. R. Frade, *Electroceramics XIII*, Univ. Twente, Enschede, Netherlands, June 24-27, (2012). Poster.
- *Defect formation and interaction in Ruddlesden-Popper type  $Sr_3LaFe_{3-x}Al_xO_{10-\delta}$* , E. N. Naumovich, P. V. Anikina, E. V. Tsipis, M. V. Patrakeev, J. C. Waerenborgh, E. N. Naumovich, V. V. Kharton *10th International Symposium on Systems with Fast Ionic Transport*, Chernogolovka, Russia, July 1-4 (2012). Poster.

## PROJECTS

- *Novel methodological approaches to analyze ion transport mechanism in complex crystal lattices and to forecast performance-determining parameters of the oxide materials (PTDC/CTM-CER/114561/2009)*. Leading Institution: CICECO, Univ. Aveiro, Portugal. IST/ITN Coordinator: J. C. Waerenborgh (15%).

## CONFERENCE ORGANIZATION / COMMITTEES

- Member of the International Advisory Committee of the *International Symposium on the Industrial Applications of the Mössbauer Effect*, Dalian, China, 2-7 September 2012.

## COLLABORATIONS

- Minfeng Lü, State Key Laboratory of Rare Earth Resource Utilization, Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun, P.R. China, 1-29 February 2012, Redox chemistry and magnetism of  $LaSrM_{0.5}Ru_{0.5}O_{4+\delta}$  (M = Co, Ni and Zn) Ruddlesden Popper phases.

**NAME: António Cândido Lampreia Pereira Gonçalves****CATEGORY:** Principal Researcher**ID NUMBER:** 126811**R&D ACTIVITIES**

Nº	Activity Description	R&D
1	Study of Ternary Phase Diagrams based on f and d elements	25
2	Magnetic and strongly correlated electron behaviour in intermetallics	30
3	New targets for particle accelerators	25
4	New Thermoelectric Systems	15
5	Nanostructured magnetic nitrides	5
Total		100

**WORK SUMMARY**

Nº	Work Summary and main Achievements
1	<p>The main objective of this research line is to explore (f-element)-(d-metal)-X ternary phase diagrams in order to establish the phase relations and identify, synthesize and characterize new ternary intermetallic compounds. Fundamental information for the pure compounds synthesis and growth of single crystals is also expected.</p> <p>A preliminary study of the isothermal sections of the U-Fe-Sb, Ce-Zn-Ga and Eu-Zn-Ga was made.</p> <p>The crystal structures of the new ternary <math>GdZn_2Ga_2</math> and <math>RZnSn_2</math> intermetallic compounds were characterized by X-ray diffraction, pointing to their crystallization in the <math>BaAl_4</math> and <math>HfCuSi_2</math> structure types, respectively.</p> <p>TEM investigations were made on Nd:11Fe:Ti samples, which pointed to preferred orientation relations between the <math>ThMn_{12}</math>- and <math>Th_2Zn_{17}</math>-type structure phases.</p>
2	<p>The understanding of the magnetic and strongly correlated electron behaviour of intermetallics containing f-elements (in particular the role of f-electrons) has been subject of a long-term project in the Solid State group.</p> <p>Preliminary studies were made on the low temperature physical properties of UFeGe samples, which indicated that the structural distortion is due to the increase on the density of states at the Fermi level.</p> <p>Large single crystals of <math>U_2Fe_3Ge</math> were grown by the Czochralski method. The characterization of the low temperature physical properties of these crystals was started. An abnormally small magnetic anisotropy was observed in this compound.</p> <p>The crystal structures and physical properties of the <math>UFe_3B_2</math> and <math>UCu_{7-x}Al_{3+x}</math> (<math>x=0.32</math>) uranium ternary phases were studied, indicating, between 2 and 300K, a ferromagnetic and paramagnetic behavior, respectively. A novel actinoid superconductor, <math>ThPt_3B</math>, was identified.</p> <p>The magnetic, electrical transport and/or thermal properties of <math>CePt_3Ge</math>, <math>RZnSn_2</math> and <math>CuS</math> single crystals were also studied.</p>
3	<p>The object of this project is to develop novel submicron structured UC2-C2 targets for RIB production, using innovative material technology for preparing nano-structured uranium materials.</p> <p>In 2012 the electrospinning system was installed and different nanowires and nanodots with Yb and Eu were prepared by changing the operational conditions. The nanomaterials were submitted to thermal treatments under different oxidant and neutral atmospheres.</p> <p>In parallel, uranium powders were prepared by hydrogen decrepitation: <math>UH_3</math> was first prepared by reaction of U with <math>H_2</math>, followed by its decomposition at 450°C under vacuum. <math>UC_x</math> nanopowders were then prepared by the reaction of the uranium powders with <math>CH_4</math> at 700°C.</p> <p>The X-ray diffraction characterization of the prepared materials was started.</p>
4	<p>The aim of this project is the synthesis, identification and characterization of new thermoelectrical</p>

	<p>materials with high ZT.</p> <p>New strategies to improve the thermoelectric properties of CePd<sub>3</sub> were developed. Nanostructured CePd<sub>3+x</sub> (-0.5&lt;=x&lt;=0.3) samples were prepared by splat cooling and their electrical transport properties were studied. Good thermoelectrical properties were observed for compositions close to CePd<sub>2.7</sub>.</p> <p>Several potential thermoelectrical glasses were investigated. The CuAsTe family show interesting properties at room temperature, with power factors as high as 110 μWK<sup>-2</sup>m<sup>-1</sup>. It was observed that the addition of Se stabilizes the glass, while not significantly disturbing the thermoelectric properties of the CuAsTe glasses.</p>
5	<p>In this project the objective is to use ion implantation to produce nitrides, correlating direction of implantation with the crystalline structure of the host, and the comparison between the results obtained for these nitride nanostructured systems in the form of films and nano-particles with films and nano-particles prepared using the usual techniques (reactive sputtering for films and chemical synthesis for nano-particles) for the same set substrates and conditions.</p> <p>CoN films were prepared by reactive sputtering. The Co-N films display strong ferromagnetic behaviour at room temperature and a magnetic anisotropy related with the substrate used.</p>

## PAPERS

- A.P. Gonçalves, E.B. Lopes, G. Delaizir, J. B. Vaney, B. Lenoir, A. Piarristeguy, A. Pradel, J. Monnier, P. Ochin, C. Godart, Semiconducting Glasses: A New Class of Thermoelectric Materials?, *J. Solid State Chem.*, **193**, 26-30 (2012), DOI: 10.1016/j.jssc.2012.03.031.
- M. Dias, P. A. Carvalho, L. C. J. Pereira, I. C. Santos, O. Tougait, V. H. Tran, A. P. Gonçalves, Crystal structure and magnetism of UFe<sub>3</sub>B<sub>2</sub>, *J. Magn. Magn. Mater.*, **324**, 2649-2653 (2012), DOI: 10.1016/j.jmmm.2012.03.036.
- J. P. Vejpravova, J. Prokleska, J. Pospisil, H. Kitazawa, A. P. Gonçalves, T. Komatsubara, C. Ritter, O. Isnard, V. Sechovsky, Magnetic and transport properties of CePt<sub>3</sub>Ge Kondo lattice in crystalline and sub-micron state, *J. Alloys Compd.*, **520**, 22-29 (2012), DOI: 10.1016/j.jallcom.2011.11.086.
- Y. Gong, L. Andrews, A.P. Gonçalves, C.C.L. Pereira, J. Marcalo, Infrared Spectra of (RhC)-C-12 and (RhC)-C-13 in Solid Neon and Solid Argon, *Chemical Physics Letters*, **528**, 7-10 (2012), DOI: 10.1016/j.cplett.2012.01.021.
- Crystal structure and magnetic properties of GdZn<sub>2</sub>Ga<sub>2</sub>, Yu. Verbovyskyy, K. Łątka, J. Przewoźnik, A.P. Gonçalves, *Intermetallics*, **22**, 106-109 (2012), DOI: 10.1016/j.intermet.2011.10.012.
- Casaca, E. B. Lopes, A. P. Gonçalves, M. Almeida, Electrical transport properties of CuS single crystals, *Journal of Physics: Condensed Matter.*, **24**, 015701 (2012), DOI: 10.1088/0953-8984/24/1/015701.
- Y. Verbovyskyy, K. Łątka, J. Przewoźnik, N. Leal, A. P. Gonçalves, On the new ternary RZnSn<sub>2</sub> compounds with HfCuSi<sub>2</sub> structure type, *Intermetallics*, **20**, 176-182 (2012), DOI: 10.1016/j.intermet.2011.08.024.

## COMMUNICATIONS

- *A Novel Actinoid Superconductor, ThPt<sub>3</sub>B*, P. Rogl, E. Bauer, E. Royanian, J. Bursik, H. Kaldarar, E.-W. Scheidt, H. Michor, D. Reith, W. Wolf, R. Podloucky, O. Sologub, A.P. Gonçalves, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Oral Presentation.
- *Studies on the UFe<sub>3</sub>B<sub>2</sub> uranium boride*, A. P. Gonçalves, M. Dias, P. A. Carvalho, L. C. J. Pereira, I. C. Santos, O. Tougait, V. H. Tran, *42èmes Journées des Actinides, Bristol, United Kingdom, April 18-21, 2012*, Oral Presentation.
- *Improving thermoelectrics in CePd<sub>3</sub>*, A.P. Gonçalves, E.B. Lopes, A. Jacquot, C. Godart, *E-MRS 2012 Spring Meeting, Strasbourg, France, May 14-18, 2012*, Oral Presentation.

- *CePd<sub>3</sub>: a strongly correlated system for low temperature thermoelectric applications*, A.P. Gonçalves, E.B. Lopes, A. Jacquot, C. Godart, *10th Prague Colloquium on f-Electron Systems, Prague, Czech Republic, 21st – 24th August 2012*, Oral Presentation.
- *Uranium-iron-germanium intermetallic compounds*, M.S. Henriques, D.I. Gorbunov, J.C. Waerenborgh, L.C.J. Pereira, E.B. Lopes, L. Havela, A.V. Andreev, T. Klimczuk, A. Rudajevová, O. Tougait, R. Vilar, A.P. Gonçalves, *10th Prague Colloquium on f-Electron Systems, Prague, Czech Republic, 21st – 24th August 2012*, Oral Presentation.
- *Isothermal sections of the U-Fe-Sb ternary system*, M.S. Henriques, T. Malnoe, O. Tougait, R. Vilar, A.P. Gonçalves, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Poster Presentation.
- *The Ce-Zn-Ga and Eu-Zn-Ga systems*, Yu. Verbovytsky, A. P. Gonçalves, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Poster Presentation.
- *CuAsTe a Family of Thermoelectric Glasses*, E. B. Lopes, A.P. Gonçalves, G. Delaizir, C. Godart, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Poster Presentation.
- *Characterization of Co/N thin films deposited by reactive sputtering*, C. Silva, A. Vovk, R. C. da Silva, P. Štrichovanec, P. A. Algarabel, A. P. Gonçalves, R. P. Borges, M. Godinho, M. M. Cruz, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Poster Presentation.
- *Low-temperature properties of orthorhombic UFeGe*, A.P. Gonçalves, M.S. Henriques, L.C.J. Pereira, M. Almeida, L. Havela, J.C. Waerenborgh, E.B. Lopes, S. Mašková, O. Tougait, J.S. Brooks, A. Kiswandhi, E. Steven, T. Klimczuk, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Poster Presentation.
- *Thermodynamic properties of RZnSn<sub>2</sub> (R = Y, Er, Lu) compounds with HfCuSi<sub>2</sub> structure type*, K. Łątka, J. Przewoźnik, Yu. Verbovytsky, A.P. Gonçalves, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April 2012*, Poster Presentation.
- *Crystal structure and physical properties of the new UCu<sub>7-x</sub>Al<sub>4+x</sub> (x = 0.32) phase*, Yu. Verbovytsky and A.P. Gonçalves, *42èmes Journées des Actinides, Bristol, United Kingdom, April 18-21, 2012*, Poster Presentation.
- *On the structural distortion of UFeGe*, M.S. Henriques, L. Havela, S. Mašková, T. Klimczuk, A. Rudajevová, O. Tougait, R. Vilar, A.P. Gonçalves, *42èmes Journées des Actinides, Bristol, United Kingdom, April 18-21, 2012*, Poster Presentation.
- *Magnetic properties of single crystalline U<sub>2</sub>Fe<sub>3</sub>Ge*, M.S. Henriques, D.I. Gorbunov, L. Havela, A.V. Andreev, A.P. Gonçalves, *The 19th International Conference on Magnetism, Bexco, Busan, Korea, July 8 - 13, 2012*, Poster Presentation.
- *Thermal stability and thermoelectric properties of Cu<sub>x</sub>As<sub>40-x</sub>Te<sub>60-y</sub>Se<sub>y</sub> semiconducting glasses*, J. B. Vaney, A. Piarristeguy, A. Pradel, E. Alleno, B. Lenoir, C. Candolfi, A. Dauscher, A.P. Gonçalves, E.B. Lopes, G. Delaizir, J. Monnier, C. Godart, *31st International & 10th European Conference on Thermoelectrics, July 9th-12th, 2012, Aalborg, Denmark*, Poster Presentation.
- *Study of substrate induced anisotropy in Co-N thin films*, C. Silva, A. Vovk, R.C. da Silva, P. Štrichovanec, P.A. Algarabel, A.P. Gonçalves, R.P. Borges, M. Godinho, M.M. Cruz, *Joint European Magnetic Symposia 2012, Parma, Italy, September 9th to 14th, 2012*, Poster Presentation.
- *TEM studies of ThMn<sub>12</sub>-type and Th<sub>2</sub>Zn<sub>17</sub>-type phases in the Nd-Fe-Ti system*, D. Nunes, A.P. Gonçalves, P.A. Carvalho, *SPMicros2012, Lisbon, September 24-25, 2012*, Poster Presentation.
- *High susceptibility and low anisotropy in single crystalline U<sub>2</sub>Fe<sub>3</sub>Ge*, M.S. Henriques, D.I. Gorbunov, L. Havela, A.V. Andreev, A.P. Gonçalves, *Workshop on Synchrotron and Neutron Applications of High Magnetic Fields, Grenoble, October 17-19, 2012*, Poster Presentation.

## EDUCATION

- Supervisor, Post Doc, *Peculiarity of the structures and properties of metallic phases with Ce, Eu, Yb, U, zinc, magnesium and p-metals*, Y. Verbovysky, Program in Chemistry.
- Co-Supervisor, PhD Thesis, *Estudo e caracterização de compostos ternários dos sistemas U-Fe-X (X= C, Te) e produção de nanopartículas com urânio para alvos de espalação*, by M. I. S. Henriques, PhD Program in Materials Engineering at IST.
- Supervisor, *Ciência Viva* training course, *Uma Química diferente*, by Afonso Miranda Pereira Gonçalves and Diogo Melo Cabrita. Program “Ciência Viva no Laboratório - Ocupação Científica de Jovens nas Férias” June-July 2012.

## PROJECTS

- *Emergent phenomena in intermetallic compounds with f elements and their hydrides*, Scientific Cooperation Program FCT/ASCR, 2010-2012. IST/ITN Coordinator: A.P. Gonçalves (10%).
- *New targets for particle accelerators*, FCT project CERN/FP/123588/2011, 2012-2014. Leading Institution: IST/ITN. IST/ITN Coordinator: A.P. Gonçalves (25%).

## CONFERENCE ORGANIZATION

- Chairman of the Organizing Committee of *18th International Conference on Solid Compounds of Transition Elements*, Faculdade de Ciências da Universidade de Lisboa, Lisbon, Portugal, March 31 - April 5, 2012.
- Member of the International Advisory Committee of the international conference *Journées des Actinides* (2008-date).
- Member of the International Advisory Committee of the *International Conference on Solid Compounds of Transition Elements* (2010-date).

## COLLABORATIONS

- G. Delaizir, SPCTS, UMR CNRS 7315, Centre Européen de la Céramique, Limoges, France, January 2012, Interdisciplinary Approaches to Functional Electronic and Biological Materials Program.
- L. Havela, Charles University, Prague, Czech Republic, April 2012, Scientific Cooperation Program FCT/ASCR, 2010-2012.

---

## NAME: Vasco Pires Silva da Gama

**CATEGORY:** Principal Researcher

**ID NUMBER:** 5384

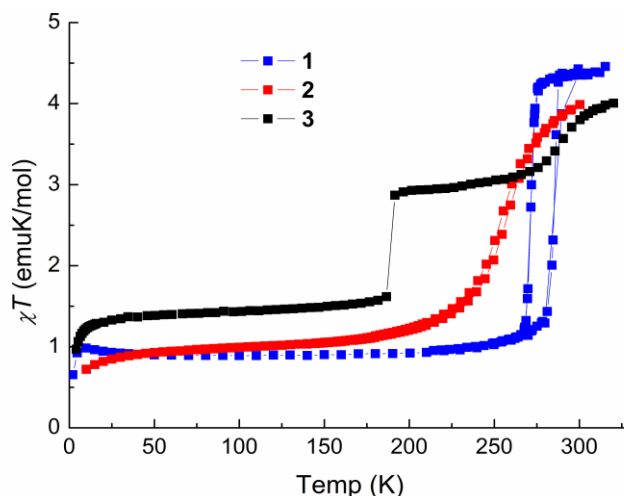
## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Spin crossover in Fe <sup>III</sup> complexes and its application in the preparation of multifunctional materials	100%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	The incorporation of metal complexes displaying spin-crossover (SCO) on lattices with radical anions seemingly able to insure electrical conduction lead us to attempt the preparation of switchable molecular conductors, where the SCO network could provide the switchable functionality, which can be triggered by the variation of temperature and/or pressure and by light irradiation. A series of SCO Fe <sup>III</sup> cationic complexes were prepared with the crystal structure containing a variety of anions and solvent molecules. A quite interesting and exemplar situation occurs in case of the compounds [Fe(Br-qsal) <sub>2</sub> ][Ni(dmit) <sub>2</sub> ]Solv (Solv=CH <sub>2</sub> Cl <sub>2</sub> , Me <sub>2</sub> CO, MeCN, <b>1</b> , <b>2</b> , <b>3</b> ). The solvent inclusion in the crystal lattice leads to distinct SCO behaviours, which for <b>1</b> is a

single step gradual process at 257K, while it is sharp process with a hysteresis of 13K for **2**, at 277K and a two-step process in **3**, at 192 and 294K. The 1/2 spins of the anions are weakly AFM interacting in case of **3**, and strongly interacting in **1** and **2**. An ordering process occurs for **2** at low temperature (~5K), which can be ascribed to a glassy behaviour. This work has been realized in the framework of the project PTDC/QUI/65379/2006 and PhD grant SFRH/BD/65237/2009.



## PAPERS

- B. J. C. Vieira, J. T. Coutinho, I. C. Santos, L. C. J. Pereira, J. C. Waerenborgh, V. Gama; [Fe(nsal2trien)]SCN, a new two-step iron (III) spin crossover compound, with symmetry breaking spin-state transition and an intermediate ordered state; *Inorg. Chem.* (accepted for publication)

## EDUCATION / THESES SUPERVISION

- PhD. Thesis, by Bruno José Cardoso Vieira, Instituto Superior Técnico, Universidade Técnica de Lisboa (in progress).

## PROJECTS

- Switchable Molecular Conductors*, Fundação para a Ciência e Tecnologia (Portugal), contract PTDC/QUI/65379/2006. IST/ITN Coordinator: V. Gama (50%), terminated in 2012.

**NAME: Joaquim Carrasqueiro Marçalo de Almeida**

**CATEGORY:** Principal Researcher

**ID NUMBER:** 5365

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Gas-phase chemistry/mass spectrometry of lanthanides and actinides	30%
2	Coordination and organometallic chemistry of lanthanides and actinides	20%
3	Functional hybrid materials with f-elements	10%
4	Gas-phase chemistry of transition metals	10%
5	Coordination of the Inorganic and Organometallic Chemistry Group	10%
6	Supervision of post-docs, PhD and research students	10%
7	Services to the community	10%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<i>Gas-phase chemistry and thermochemistry of elementary actinide species:</i> LDI-FTICR/MS and ESI-QIT/MS were used to explore the chemical properties of elementary actinide species (An=Th-Cm) involving p-block elements (C, O, S). [Performed by PhD student A.F. Lucena, “Ciência-



	<p>2007” researcher C.C.L. Pereira and researcher J.M. Carretas, under my supervision.]</p> <p><i>Mass spectrometry studies of the coordination chemistry of lanthanides and actinides:</i> ESI-QIT/MS and LDI-FTICR/MS were used to perform gas-phase and solution-phase coordination chemistry studies of An(III) and Ln(III) species (<math>\text{MX}_2^+</math>, <math>\text{MX}_4^-</math>; X=chloride, nitrate; An=Am, Cm; Ln=La-Lu) with N- and O-donor organic molecules. [Performed by PhD student A.F. Lucena, post-doc B. Monteiro and researcher J.M. Carretas, under my supervision.]</p> <p><i>Gas-phase chemistry of actinides with biomolecules:</i> ESI-QIT/MS was used to examine the interactions of Th(IV), U(V) and U(VI) ions with amino-acids (gly, his, cys, asp), in an attempt to understand fundamental aspects of the bio-inorganic chemistry of actinides. [Performed by PhD student A.F. Lucena and “Ciência-2008” researcher L. Maria, under my supervision.]</p> <p>[Collaborations with J.K. Gibson (LBNL); M.C. Michelini (U. Calabria); C.J. Marsden (U. Paul Sabatier-Toulouse III); L. Berthon (CEA-Marcoule); A.P. Gonçalves (GES-UCQR); I. Paiva (GRRR-UPSR).]</p>
2	<p><i>Thorium and uranium complexes with diamine-bis(phenolate) ligands:</i> Reactivity studies of <math>[\text{An}\{\text{salan-R}_2\}\text{X}_2]</math> complexes (An=Th, U; X=Cl, I) were performed, including the synthesis of alkyl derivatives and their reactions with <math>\text{CO}_2</math>. [Performed by “Ciência-2008” researcher L. Maria that also supervised, technician A. Cruz and researcher J.M. Carretas.]</p> <p><i>Lanthanide and uranium complexes with functionalized aza-macrocyclic ligands:</i> The chemistry of the Ln(III) and U(III) complexes <math>[\text{M}\{(\text{Ar}^{\text{R}2}\text{O})_2\text{Me}_2\text{-Cyclam}\}\text{X}]</math> (M=La, Sm, Yb, U; X=Cl, I) was studied, particularly electron-transfer reactions of <math>[\text{U}\{(\text{Ar}^{\text{tBu}2}\text{O})_2\text{Me}_2\text{-Cyclam}\}\text{I}]</math> with unsaturated organic substrates. [Performed by “Ciência-2008” researcher L. Maria that also supervised and technician A. Cruz.]</p> <p><i>Lanthanide metalla-diaminocarbene complexes:</i> New Ln(II) (Sm, Yb) complexes with isonitriles using poly(pyrazolyl)borates and bis(phenolate)-cyclams as ancillary ligands were prepared. [Performed by “Ciência-2008” researcher L. Maria that also supervised and research student E. Mora.]</p> <p><i>Uranium complexes with the <math>(\text{Me}_2\text{SiNPh})_3\text{-tacn}</math> ligand:</i> Reactions of the complex <math>[\text{U}^{\text{III}}\{(\text{Me}_2\text{SiNPh})_3\text{-tacn}\}]</math> with <math>\text{S}_8</math>, <math>\text{S}=\text{PPh}_3</math>, <math>\text{CO}_2</math>, <math>\text{CS}_2</math> and <math>\text{O}_2</math> were examined. [Performed by post-doc M.A. Antunes (GES-UCQR).]</p> <p><i>Magnetic properties of uranium complexes:</i> New U(III) complexes with poly(pyrazolyl)borate ligands were synthesized, structurally characterized and their behavior as single-molecule magnets examined. [Performed by post-doc M.A. Antunes (GES-UCQR).]</p> <p>[Collaborations with M. Mazzanti (CEA-Grenoble); K. Luzyanin (CQE-IST); L.C. Pereira, M. Almeida, I.C. Santos (GES-UCQR); H. Bolvin (U. Paul Sabatier-Toulouse III).]</p>
3	<p><i>Layered Lanthanide Hydroxides:</i> The synthesis and characterization of Layered Lanthanide Hydroxides (LLHs) and their intercalation products, as a new family of functional materials containing only lanthanide cations (Ln=Eu, Tb, Dy), were performed, and the optical and magnetic properties of these materials were examined. [Work implemented by post-doc B. Monteiro and “Ciência-2007” researcher C.C.L. Pereira that supervised the work.]</p> <p><i>Metal-Organic Frameworks of the actinides:</i> The synthesis and characterization of Metal-Organic Frameworks (MOFs) based on actinides (U, Th) were performed and their optical and catalytic properties examined. [Work implemented by post-doc B. Monteiro, researcher J. Branco and “Ciência-2007” researcher C.C.L. Pereira that supervised the work.]</p> <p>[Collaborations with L.C. Pereira, M. Almeida (GES-UCQR); D. Ananias, F. Almeida-Paz (CICECO-U. Aveiro).]</p>
4	<p>The gas-phase chemistry and thermochemistry of d-transition metal oxide ions is being examined by FTICR/MS, to provide fundamental chemical models to complex multi-charged systems and obtain new thermodynamic data for ionic and neutral species. Reactions of doubly-charged Hf, Zr, Nb, Mo and W ions with the oxidants <math>\text{N}_2\text{O}</math>, <math>\text{O}_2</math>, <math>\text{CO}_2</math> and CO were studied and the structures and energetics of the species formed were investigated both experimentally and computationally. [Experimental work carried out by research student C. Lourenço, under supervision of M.C. Oliveira (CQE-IST) and me; collaborations with J.K. Gibson (LBNL) and M.C. Michelini (U. Calabria).]</p>
5	<p>The coordination of the Inorganic and Organometallic Chemistry Group involved typical tasks of such an occupation.</p>
6	<p>Supervision or co-supervision within the research activities described in 1-4:</p>

	<p>Post-doc B. Monteiro (FCT grant SFRH/BPD/47087/2008, Jan-Jul 2012, supervision).  PhD student A.F. Lucena (FCT grant SFRH/BD/70475/2010, Jan-Dec 2012, supervision, co-supervisors J.K. Gibson/LBNL and J.P. Leal/FCUL).  Research student C. Lourenço (FCT project PTDC/QUI-QUI/108977/2008 grant, Jan-Dec 2012, co-supervision, supervisor M.C. Oliveira/CQE-IST).</p> <p>Supervision of technical research student V. Sousa (FCT grant SFRH/BTI/51253/2010, Jan-Dec 2012, co-supervisor J. Branco) in CHNS elemental analysis (UCQR service).</p> <p>Co-supervision of post-doc Solange Muralha (FCT grant SFRH/BPD/42286/2007, Jan-Dec 2012, supervisor A. Pires de Matos) in Conservation Sciences of Ceramics and Glass (Research Unit “VICARTE – Vidro e Cerâmica para as Artes”, FCT-UNL).</p>
7	<p>Support to other research groups of UCQR through ca. 120 MS analyses (ESI-QIT and EI/LDI-FTICR) of organic compounds and metal complexes.</p> <p>Support to UCQR and IST/ITN in the management of the acquisitions of gases and cryogenic liquids.</p>

## PAPERS

- J.M. Carretas, J. Cui, I.C. Santos, A. Cruz, L. Maria, J. Marçalo, Uranium(III, IV) and thorium(IV) pyrazolylmethane complexes: synthesis and structures, *Inorganica Chimica Acta*, 385, 53-57 (2012), doi:10.1016/j.ica.2011.12.033.
- Y. Gong, L. Andrews, A.P. Gonçalves, C.C.L. Pereira, J. Marçalo, Infrared spectra of Rh<sup>12</sup>C and Rh<sup>13</sup>C in solid neon and solid argon, *Chemical Physics Letters*, 528, 7–10 (2012), doi:10.1016/j.cplett.2012.01.021.
- M. Santos, M.C. Michelini, C. Lourenço, J. Marçalo, J.K. Gibson, M.C. Oliveira, Gas-phase oxidation reactions of Ta<sup>2+</sup> — Synthesis and properties of TaO<sup>2+</sup> and TaO<sub>2</sub><sup>2+</sup>, *Journal of Physical Chemistry A*, 116, 3534–3540 (2012), doi:10.1021/jp300294c.
- D. Rios, M.C. Michelini, A.F. Lucena, J. Marçalo, T.H. Bray, J.K. Gibson, Gas-phase uranyl, neptunyl, and plutonyl: hydration and oxidation studied by experiment and theory, *Inorganic Chemistry*, 51, 6603–6614 (2012), doi:10.1021/ic3001625.
- D. Rios, M.C. Michelini, A.F. Lucena, J. Marçalo, J.K. Gibson, On the origins of faster oxo exchange for uranyl(V) versus plutonyl(V), *Journal of the American Chemical Society*, 134, 15488–15496 (2012), doi:10.1021/ja305800q.
- J.T. Coutinho, M.A. Antunes, L.C.J. Pereira, H. Bolvin, J. Marçalo, M. Mazzanti, M. Almeida, Single-ion magnet behaviour in [U(Tp<sup>Me2</sup>)<sub>2</sub>I], *Dalton Transactions*, 41, 13568–13571 (2012), doi:10.1039/c2dt31421e.
- C. Lourenço, M.C. Michelini, J. Marçalo, J.K. Gibson, M.C. Oliveira, Gas-phase reaction studies of dipositive hafnium and hafnium oxide ions: generation of the peroxide HfO<sub>2</sub><sup>2+</sup>, *Journal of Physical Chemistry A*, 116, 12399–12405 (2012), doi:10.1021/jp3088385.
- E. Mora, L. Maria, B. Biswas, C. Camp, I.C. Santos, J. Pécaut, A. Cruz, J.M. Carretas, J. Marçalo, M. Mazzanti, Diamine bis(phenolate) as supporting ligands in organoactinide(IV) chemistry. Synthesis, structural characterization, and reactivity of stable dialkyl derivatives, *Organometallics*, Publication Date (Web): December 18, 2012, doi: 10.1021/om3010806.
- A.A.S.C.M. Machado, J. Cardoso, J. Marçalo, J.A.L. Costa, M.C. Magalhães, M.H. Garcia, O. Pellegrino, O.A. Serra, R.B. Faria, A propósito das novas massas atómicas relativas médias de alguns elementos químicos, *Química (Boletim da Sociedade Portuguesa de Química)*, 126, 51-55 (2012).

## COMMUNICATIONS

- *Actinide Chemistry from a Gas-Phase Perspective*, J.K. Gibson, J. Marçalo, M.C. Michelini, D. Rios, A.F. Lucena, P.X. Rutkowski, 243rd ACS National Meeting & Exposition, San Diego, California, USA, Mar 25-29 (2012), Oral.
- *Slow Magnetic Relaxation in f-Element Compounds; from Lanthanide Double Chain Magnets to Uranium Single-Ion Magnets*, M.A. Antunes, P.I. Girginova, J.T. Coutinho, L.C.J. Pereira, I.C. Santos, M.

Mazzanti, J. Marçalo, M. Almeida, *SCTE2012 - 18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, Mar 31 - Apr 5 (2012)*, Oral.

- *Single-Molecule-Magnet Behaviour in  $[U(Tp^{Me_2})_2]I$* , J.T. Coutinho, M.A. Antunes, L.C.J. Pereira, I.C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, *SCTE2012 - 18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, Mar 31 - Apr 5 (2012)*, Poster.
- *The Gas-Phase Thermochemistry of  $Hf^{2+}$  and  $Ta^{2+}$  Oxide Ions*, C. Lourenço, M.C. Michelini, M. Santos, J. Marçalo, J.K. Gibson, M.C. Oliveira, *10th European FTMS Workshop, Warwick, UK, Apr 1-5 (2012)*, Poster.
- *Actinide Polysulfides in the Gas Phase*, A.F. Lucena, C.C.L. Pereira, C.J. Marsden, J.K. Gibson, J. Marçalo, *EUFENI - Meeting of COST Action CM1006: European f-Element Network, Tarragona, Spain, Apr 2-4 (2012)*, Oral.
- *Diamine Bis-Phenolates as Supporting Ligands in Organoactinide (IV) Chemistry*, L. Maria, E. Mora, B. Biswas, I.C. Santos, J. Pécaut, A. Cruz, J.M. Carretas, J. Marçalo, M. Mazzanti, *EUFENI - Meeting of COST Action CM1006: European f-Element Network, Tarragona, Spain, Apr 2-4 (2012)*, Poster.
- *Magnetic Properties of a Dysprosium Layered Lanthanide Hydroxide and its Intercalation for 2,6-Naphthalenedicarboxylate*, C.C.L. Pereira, L.C.J. Pereira, B. Monteiro, H.M. Dung, J. Marçalo, M. Almeida, *EUFENI - Meeting of COST Action CM1006: European f-Element Network, Tarragona, Spain, Apr 2-4 (2012)*, Poster.
- *III/IV Oxidation State Stabilities of Lanthanides and Actinides in the Gas Phase*, A.F. Lucena, C. Lourenço, J.M. Carretas, P.X. Rutkowski, M.C. Michelini, N. Zorz, L. Berthon, J.K. Gibson, J. Marçalo, *EUFENI - Meeting of COST Action CM1006: European f-Element Network, Tarragona, Spain, Apr 2-4 (2012)*, Poster.
- *Uranium(III) Tris(pyrazolyl)borate Complexes as Single-Ion Magnets*, M.A. Antunes, J. Coutinho, L.C.J. Pereira, I.C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, *EUFENI - Meeting of COST Action CM1006: European f-Element Network, Tarragona, Spain, Apr 2-4 (2012)*, Poster.
- *Synthetic Actinide Chemistry in the Gas Phase*, J.K. Gibson, D. Rios, P.X. Rutkowski, J. Marçalo, A.F. Lucena, C. Lourenço, J.M. Carretas, M.C. Michelini, *2012 MRS Spring Meeting & Exhibit, San Francisco, California, USA, Apr 9-13 (2012)*, Oral.
- *Advancing Organoactinyl Chemistry by In-Situ Ligand Synthesis in the Gas-Phase*, D. Rios, M.C. Michelini, A.F. Lucena, J. Marçalo, J.K. Gibson, *Symposium Honoring the 100th Birthday of Glenn T. Seaborg, Berkeley, California, USA, Apr 21 (2012)*, Poster.
- *f-Element Centers for Single Molecule Magnetic Behaviour; from Lanthanides to Uranium*, M.A. Antunes, P.I. Girginova, J.T. Coutinho, L.C.J. Pereira, I.C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, *62nd Fujihara Seminar, Frontier and Perspectives in Molecule-Based Quantum Magnets, Sendai, Japan, May 7-10 (2012)*, Oral.
- *Gas-Phase Studies of the Relative Affinities of N- and O-donor Bases toward Ln(III) and An(III) Ions*, C. Lourenço, A.F. Lucena, J.M. Carretas, B. Monteiro, I. Paiva, J. Marçalo, N. Zorz, L. Berthon, *ATALANTE 2012 – Nuclear Chemistry for Sustainable Fuel Cycles, Montpellier, France, Sep 2-7 (2012)*, Poster.
- *Inorganic and Organometallic Actinide Chemistry Studied by Tandem Mass Spectrometry*, J.K. Gibson, D. Rios, Y. Gong, A.F. Lucena, J. Marçalo, M.C. Michelini, *SciX 2012 - 39th Annual Meeting of FACSS, Kansas City, Missouri, USA, Sep 30 - Oct 5 (2012)*, Oral.
- *Gas-Phase Reactions of Dipositive Hafnium and Hafnium Oxide Ions*, C. Lourenço, M.C. Michelini, J. Marçalo, J.K. Gibson, M.C. Oliveira, *Warwick Mass Spectrometry 80/60 Conference, Warwick, UK, Dec 10-11 (2012)*, Poster.

## EDUCATION / THESES SUPERVISION

- Member of the Scientific Board and Lecturer on Mass Spectrometry of the Course *Modern Methods of Structure Elucidation–2012*, Centro de Química Estrutural - Instituto Superior Técnico, Lisbon, 12-16 Nov 2012 (<http://cqeq.ist.utl.pt/events/mmse/next.php>).

## PROJECTS

- *ACSEPT-Actinide reCycling by SEPARation and Transmutation*, FP7-Euratom/CP-2007-211267. Leading Institution: CEA-Marcoule, France; IST/ITN Coordinator: I. Paiva; GQIO Coordinator: J. Marçalo [until 30 Sep 2012].
- *Exploring the chemical differences between trivalent lanthanides and actinides by mass spectrometry techniques*, ACTINET-I3/FP7-III-232631/JRP17. Leading Institution: IST/ITN (Collaboration with CEA-Marcoule and LBNL); IST/ITN Coordinator: J. Marçalo [until 30 Jun 2012].
- *Portuguese Mass Spectrometry Network – ITN-Node*, FCT - REDE/1503/REM/2005. Leading Institution: CQB-FCUL; IST/ITN Coordinator: J. Marçalo [until 30 Jun 2012].
- *Gas-phase thermochemistry of 4d and 5d transition metal oxides: a study by FTICR-MS*, FCT - PTDC/QUI-QUI/108977/2008. Leading Institution: CQE-IST; IST/ITN Coordinator: J. Marçalo [until 31 Dec 2012].
- *Actinide-biomolecule interactions - a gas-phase perspective*, FCT - PTDC/QEQ-QIN/1693/2012. Leading Institution: IST/ITN; Coordinator: J. Marçalo [not approved].
- *Biomolecular Mass Spectrometry Network*, FCT - RECI/QEQ-QAN/0251/2012. Leading Institution: CQB-FCUL; IST/ITN Coordinator: J. Marçalo [not approved].

## COMMITTEES

- Member of the Management Committee of COST Action CM1006 - EUFEN: European f-Element Network.

## COLLABORATIONS

- John K. Gibson, Lawrence Berkeley National Laboratory, USA, 19-27 Jul 2012, collaborative work in gas-phase chemistry.

---

## NAME: Maria De Fátima Duarte de Araújo

**CATEGORY:** Principal Researcher

**ID NUMBER:** 5372

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Ancient Metallurgy of the Portuguese Territory– Provenance, metal composition and manufacturing techniques	35%
2	Characterization and provenance of metallic artefacts museological collections.	5%
3	Sedimentary geochemistry of the Portuguese coastal area	20%
4	Coordination of the Environmental and Analytical Chemistry Group	15%
5	Student supervision	25%
6	Services/Other	
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>Studies on the elemental, isotopic and microstructural characterization of archaeological metallic artefacts from various archaeological sites of the Portuguese territory have been carried out to investigate the metallurgical evolution from Chalcolithic period till Iron Age. Provenance studies by Pb isotopic determination were developed by the analysis of Bronze Age leaded bronzes from NE Portugal and a collection of Pb Roman artefacts.</p> <p>Most of the work resulted in scientific publications and besides the PhD and MSc thesis and listed papers other results are being published:</p> <p>E. Figueiredo, R.J.C. Silva, M.F. Araújo, A. Melo, J.C. Senna-Martinez Early metallic weights</p>

	<p>from Western Iberian Peninsula: composition, manufacture and metrology. <i>Archaeometry</i> (accepted).</p> <p>F. Pereira, R.J.C. Silva, A.M.M. Soares, M.F. Araújo. The role of arsenic in Chalcolithic copper artefacts - insights from Vila Nova de São Pedro (Portugal). <i>Journal of Archaeological Science</i> (<a href="http://dx.doi.org/10.1016/j.jas.2012.12.015">http://dx.doi.org/10.1016/j.jas.2012.12.015</a>).</p> <p>P. Valério, A.M.M. Soares, R.J.C. Silva, M.F. Araújo, P. Rebelo, N. Neto, R. Santos, T. Fontes (in press) Bronze production in Southwestern Iberian Peninsula: the Late Bronze Age metallurgical workshop from Entre Águas 5 (Portugal). <i>Journal of Archaeological Science</i> (<a href="http://dx.doi.org/10.1016/j.jas.2012.07.020">http://dx.doi.org/10.1016/j.jas.2012.07.020</a>).</p> <p>P. Valério, A.M. Monge Soares, M.F. Araújo, R.J.C. Silva, F.J.C. Santos. The distinctive grave goods from Palhais (Beja, Portugal). New insights into the metallurgical evolution under Orientalizing influence in the southwestern end of Iberia. <i>Trabajos de Prehistoria</i> (in press).</p>
2	<p>Composition and microstructures of imperial Chinese coins. Research involves to establish the evolution on the production of the Cu-based coins in China during a large time period (300 a.C. - 1854 d.C.), based on the study of the large collection of Chinese coins from the Macao Scientific and Cultural Centre's Museum (Lisbon, Portugal). The obtained results using EDXRF spectrometry, metallographic techniques, SEM-EDS, radiography and micro-XRD were gathered revealing different types of alloys (coppers, bronzes and brasses) with variable elemental, confirm the production process (sand casting), and allowed to associate elemental contents and some metallic phases. Besides, comparison between the corrosion susceptibility of metallic phases in bronze coins showed preferential transglobular corrosion of lead-rich globules; and also that the deposition of particular corrosion by-products at the surface of these coins. Brass coins main corrosion process consists of dezincification. Obtained results support the coins authenticity.</p> <p>Study on the Portuguese silverware alloys from the XV till XVII centuries, mostly from the large collection of National Museum of Ancient Art in Lisbon (MNAA), was started aiming at the establishment of composition patterns, technological production and provenance of these museological silver artefacts.</p>
3	<p>Elemental and isotopic geochemical approaches were applied in the study of sedimentary coastal systems evolution. Sedimentary records of salt-marshes from protected settings of several estuaries of the W coast (Minho, Tagus and Mira rivers) were studied to evaluate recent environmental changes. Changes in the marine environment and in the continental hinterland are often identifiable in the sediments sequences, including o different anthropogenic activities (e.g. damming, urbanization, deforestation and dredging) and natural events (floodings and tsunamis). The chronological framework was established by using a combination of techniques (210Pb, 137Cs and 14C). Some enhanced values anthropogenic trace elements (e.g. Cu, Zn, As and Pb), determined in specific periods could be related to the effects of Human occupation and industrialization. Temporal variations on the elemental contents in the lithogenic/continental (e.g. Ti, Zr, K, Rb) could be related with stronger terrestrial sources (flood periods), whereas high Ca, Sr, Cl and Br were associated with a dominant marine contribution. Besides, the sources of organic matter also indicate variable and complex mixtures with different marine and continental contributions related to the alternation of dry and flood periods.</p>
4	<p>Specific duties involve the coordination of the EAC group, including the management and maintenance of some laboratories and infrastructures, coordination of technical staff, research planning and discussions with the other research team members, organization of team reports, processes of acquisition, and elaboration of project proposals.</p>
5	<p>Besides thesis (1 PhD and 1 MSc) presented during the current year, others are running, under my supervision or co-supervision, in collaboration with <i>Universidade Nova de Lisboa</i>. The PhD dissertation of Maria João Furtado (supervision) was recently finished "Chinese coins in copper based alloys: elemental and microstructural characterization", and oral defense presentation will occur in a couple of months at <i>UNL</i>. Other PhD works (co-supervision) are currently being developed: Filipa Pereira (The first metallurgical steps in the prehistory of the Portuguese Estremadura) and Rui Borges (Portuguese silverware alloys from the fifteenth to seventeenth centuries – Characterization and provenance of silver alloys). Besides, MSc. Filipa Lopes and Susana Sousa Gomes have been developing research on chemical, microstructural and isotopic</p>

characterization of ancient metal artefacts with project research grants of the project EarlyMetal Territory, PTDC/HIS-ARQ/110442/2008. Recently, they have been awarded with PhD grants “The copper metallurgy at the <i>Lusitania</i> in Roman period: Archaeometallurgical study of <i>Situlae</i> of Conimbriga” and “Lead in the Roman architecture of <i>Lusitania</i> : provenance and metallurgical techniques used in the hydraulic system of Conimbriga”, which will start during 2013 under my supervision. A research student (Ana Medeiros) is carrying out research work on geochemistry of coastal sediments (WestLog project, PTDC/CTE-GIX/105370/2008).
--

## PAPERS

- J.M. De la Rosa, M.F. Araújo, J.A. González-Pérez, F.J. González-Vila, A.M. Soares, J.M. Martins, E. Leorri, R. Corbett, F. Fatela (2012). Organic matter sources for tidal marsh sediment over the past two millennia in the Minho River estuary (NW Iberian Peninsula), *Organic Geochemistry* (2012) 53, 16-24.
- J. M. De la Rosa, M. F. Araújo, H. Knicker, J. A. González-Pérez, F. J. González-Vila, A. M. Soares, J. M. Martins, E. Leorri, R. Corbett, F. Fatela. Assessment of environmental changes in the salt marshes of the Tagus estuary (Portugal), Proceedings VII Symposium on the Atlantic Iberian Margin - MIA12, 16-20 December 2012, Lisbon, ISBN:978-989-20-3447-8, 79.
- P. Duarte, L. Silva, A. Mateus, M. F. Araújo, M. Reis, R. Trindade, Isabel Paiva. Radiological and geochemical characteristics of an ultramafic massif (NE Portugal) regarding the site aptness to host a near surface repository for low and intermediate level radwaste. *Environmental Earth Sciences* (2012) DOI 10.1007/s12665-012-1758-0.
- E. Figueiredo, F. Lopes, M.F. Araújo, R.J. Silva, J.C. Senna-Martinez, E. Luís. Os primeiros bronzes do território Português: uma primeira abordagem arqueometalúrgica a um conjunto de machados Bujões/Barcelos. *Estudos Arqueológicos de Oeiras* (2012) 19, 71-78.
- S. Moreira, C. Freitas), M. F. Araújo, C. Andrade. Metric spatial variability in Carrasqueira Marsh (Sado Estuary – Portugal), Proceedings VII Symposium on the Atlantic Iberian Margin - MIA12, 16-20 December 2012, Lisbon, ISBN:978-989-20-3447-8, 81.
- F. Pereira, R.J. Silva, A.M.M. Soares, M.F. Araújo. Estudo arqueometalúrgico de artefactos provenientes do Castro de Vila Nova de São Pedro (Azambuja, Portugal). *Estudos Arqueológicos de Oeiras*, (2012) 19,163-172.
- Pereira, M.F. Araújo, M.C. Freitas, F. Fatela. Recent Evolution of the Caminha salt marsh: sedimentological and geochemical considerations, Proceedings VII Symposium on the Atlantic Iberian Margin - MIA12, 16-20 December 2012, Lisbon, ISBN:978-989-20-3447-8, 47-48.
- P. Valério, P., R.J.C. Silva, M.F. Araújo, A.M.M. Soares, L. Barros (2012). A multianalytical approach to study the Phoenician bronze technology in the Iberian Peninsula - a view from Quinta do Almaraz. *Materials Characterization* 67, 74-82.
- P. Valério, R.J. Silva, T.R.N. Ponte, M.F. Araújo, A.M.M. Soares. Estudo arqueometalúrgico das dádivas funerárias dos hipogeus do Bronze Pleno do Sudoeste da Horta do Folgão (Serpa, Portugal). *Estudos Arqueológicos de Oeiras* (2012) 19, 203-208.
- Pereira, M.F. Araújo, M.C. Freitas, F. Fatela. Recent Evolution of the Caminha salt marsh: sedimentological and geochemical considerations, Proceedings VII Symposium on the Atlantic Iberian Margin - MIA12, 16-20 December 2012, Lisbon, ISBN:978-989-20-3447-8, 47-48.
- S. Moreira, C. Freitas), M. F. Araújo, C. Andrade. Metric spatial variability in Carrasqueira Marsh (Sado Estuary – Portugal), Proceedings VII Symposium on the Atlantic Iberian Margin - MIA12, 16-20 December 2012, Lisbon, ISBN:978-989-20-3447-8, 81.

## COMMUNICATIONS

- *Avaliação de impactes antrópicos na zona costeira portuguesa: variações regionais e temporais*. M. Fátima Araújo, J.A. Dias, II Meeting BRASPOR - Scientific network on Interactions Man-Environment on Coastal Areas, 1 - 05 de April (2012), Paraty, Rio de January, Brazil, invited talk.

- *Distribution patterns of trace elements bound to sedimentary HAs as “not labile” forms from the Atlantic side of the Gulf of Cadiz (SW Iberian Peninsula)*, J.M. De la Rosa, M.F. Araújo, A.M.M. Soares, *II Meeting BRASPOR - Scientific network on Interactions Man-Environment on Coastal Areas*, 1 - 05 de April (2012), Paraty, Rio de Janeiro, Brazil, poster.
- *O radiocarbono e a navegação fenícia na Ibéria Atlântica*. A.M.M. Soares, J. M. M. Martins, P. J.C. Portela, M.F. Araújo, *II Meeting BRASPOR - Scientific network on Interactions Man-Environment on Coastal Areas*, 1 - 05 de April (2012), Paraty, Rio de Janeiro, Brazil, poster.
- *Microstructural characterisation of a collection of Prehistoric bronzes*, E. Figueiredo, R.J.C. Silva, M.F. Araújo, R. Vilaça, *XLVI Congress of the Portuguese Society for Microscopy*, Lisbon, Portugal, Sep 24-25 (2012), talk.
- *Characterization of archaeological metal artifacts*, E. Figueiredo, M.F. Araújo, R.J.C. Silva, M.A. Stanojev Pereira, J.G.Marques, J.P. Santos, *IAEA Regional Workshop on Use of Nuclear Technology for Cultural Heritage Characterization, Dating and Preservation*, Belgrade, Serbia, Sep 4-6 (2012), talk.
- *A microstructural characterization of some Late Bronze Age metals from Fraga dos Corvos site: fibula, pendants, riveted sheet and droplet*, F. Lopes, R.J. Silva, E. Figueiredo, M.F. Araújo, J. Reprezas, E. Luíz, J.C. Senna-Martinez, *XLVI Congress of the Portuguese Society for Microscopy*, Lisbon, Portugal, Sep 24-25 (2012), poster.
- *Characterization of Bronze Age plain axes from the Portuguese territory by EDXRF, micro-EDXRF, SEM-EDS and optical microscopy* F. Lopes, E. Figueiredo, M.F. Araújo, R.J.C. Silva, J.C. Senna-Martinez, E. Luíz, *2nd International Workshop on Physical and Chemical Analytical Techniques in Cultural Heritage*, Lisbon, Portugal, Jun 4-5 (2012), poster.
- *Lead isotope rations in archaeological bronzes by Q ICPMS*, S.S. Gomes, M.L. Afonso, M.F. Araújo, E. Figueiredo, *2nd International Workshop on Physical and Chemical Analytical Techniques in Cultural Heritage*, Lisbon, Portugal, Jun 4-5 (2012), poster.
- *Archaeometallurgical study of copper-based artefacts from the Portuguese territory. ISDM 2012*, Freiberg, Alemanha, K. Kolářová, J. Děd, M.F. Araújo, P. Valério, A.M. Monge Soares, R.J.C. Silva, F. Pereira 15-17 March (2012), oral.
- *Elemental and microstructural signatures of Phoenician presence on copper-based artefacts from Southern Portugal*. P. Valério, R.J.C. Silva, M.F. Araújo, A.M.M. Soares, F.M. Braz Fernandes, 2as Jornadas do CENIMAT, Monte de Caparica, 22 de June (2012), oral.
- *A metalurgia do bronze na bacia do Guadiana entre os sécs. VIII e VI a.C. Metalurgia indígena versus metalurgia Orientalizante*. P. Valério, A.M.M. Soares, M.F. Araújo, R.J.C. Silva, *SIDEREUM ANA III – El Río Guadiana y Tartessos*, Mérida, Espanha, 19-21 September (2012), 34-35, oral.
- *Bell Beaker gold foils from Perdigoões (Southern Portugal) – manufacture and use*. Soares, A.M.M., Alves, L., Frade, J., Valério, P., Araújo, M.F., Candeias, A., Silva, R., Valera A. *39<sup>th</sup> International Symposium on Archaeometry*, Leuven, Belgium, 28 May - 1 June (2012), poster.
- *Primeiros achados em território português no Cabeço Redondo (Sobral da Adiça, Moura)*. R. Monge Soares, P. Valério, A.M.M. Soares, M.F. Araújo. *Rodas de oleiro no pós-Orientalizante. VI Encontro de Arqueologia do Sudoeste Peninsular. Villafranca de los Barros, Espanha*, 4-6 October (2012), oral.
- *Os metais (2): metodologias e problemas analíticos*. Maria de Fátima Araújo. *Arqueometalurgia: Sociedades e Técnica, dos Camponeses-Metalurgistas às Primeiras Cidades (Calcolítico-1<sup>a</sup> Idade do Ferro)*; Museu Nacional de Arqueologia, Lisbon, 12-13 October 2012, invited talk.
- *X-Ray Spectrometry, Principles and Applications, in the framework of the Master degree in "Conservation and Restoration" and "Conservation Sciences", FCT/UNL, invited lecture.*

## EDUCATION / THESES SUPERVISION

- Supervisor, PhD. Thesis, *Archaeometallurgical Study of Pre and Protohistoric Production Remains and Artefacts from Southern Portugal*, by Pedro Manuel Francisco Valério, Departamento de Conservação e Restauro, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, March 2012.

- Supervisor, MSc. Thesis, *Análise Isotópica do Pb em Metais Arqueológicos por Q-ICPMS*, by Susana Alves de Sousa e Silva Gomes, Departamento de Química e Bioquímica, Faculdade de Ciências, Universidade de Lisboa, November 2012.
- Organization of IST/ITN participation in “Festa da Arqueologia – As Ciências da Arqueologia”, Caracterização de Materiais Arqueológicos e Métodos de Datação, Museu Arqueológico do Carmo, 5-6 May 2012.
- Member of the juri, PhD. Thesis, *Archaeometallurgical Study of Pre and Protohistoric Production Remains and Artefacts from Southern Portugal*, by Pedro Manuel Francisco Valério, Departamento de Conservação e Restauro, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, March 2012.
- Member of the juri, MSc. Thesis, *Análise Isotópica do Pb em Metais Arqueológicos por Q-ICPMS*, by Susana Alves de Sousa e Silva Gomes, Departamento de Química e Bioquímica, Faculdade de Ciências, Universidade de Lisboa, November 2012.

## PROJECTS

- *Early Metallurgy in the Portuguese Territory (EarlyMetal)* - PTDC/HIS-ARQ/110442/2008. Leading Institution IST/ITN. Coordinator: M. Fátima Araújo (30%).
- *Evolução recente dos estuários da costa oeste portuguesa: estudo do registo geológico dos sapais em alta resolução (WesTLog)* - PTDC/CTE/105370/2008. Leading Institution FCUL. IST/ITN Coordinator: M. Fátima Araújo (10%).
- *The first 4000 years metallurgy in the Portuguese territory* – EXCL/EPH-ARQ/0615/2012. Leading Institution IST/ITN. Coordinator: M. Fátima Araújo (Submitted, not approved)

## CONFERENCE ORGANIZATION / COMMITTEES

- Coordination Committee of the *VII Symposium on the Atlantic Iberian Margin - MIA12*, Lisbon, Portugal, 16-20 December 2012.
- Chairperson of the of the *VII Symposium on the Atlantic Iberian Margin - MIA12*, Lisbon, Portugal, 16-20 December 2012.
- Chairperson of the *2nd International Workshop on Physical and Chemical Analytical Techniques in Cultural Heritage*, Lisbon, Portugal 4-5 June 2012

## COLLABORATIONS

- Jose Maria de La Rosa, Instituto de Recursos Naturales y Agrobiología, IRNAS-CSIC, Seville, Spain, May and December, Collaboration research work on environmental geochemistry of fluvial and coastal environments.

**NAME: António Manuel Monge Soares**

**CATEGORY:** Principal Researcher

**ID NUMBER:** 25351

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Project PTDC/HIS-ARQ/110442/2008, Early Metallurgy in the Portuguese Territory (EARLYMETAL)	30%
2	Project PTDC/CTE-GIX/105370/2008, Recent evolution of Portuguese W coast estuaries: high resolution studies from marshes geological record (WesTLog)	5%
3	Project PTDC/CTE-GIX/104035/2008, Fluvio-marine interactions over the last 5000 yrs (FMI 5000)	5%
4	Supervision of the Radiocarbon and IRMS Laboratories	30%
5	Supervision of PhD and M. Sc. Thesis	20%
6	Services	10%
Total		100%



## WORK SUMMARY

N°	Work Summary and Main Achievements
1	Metallurgical activities include a series of processes which begin with the concentration and subsequent reduction of ores and continue with the treatment of the metal, including the shaping of the object. In this project the chemical and structural characterization of final archaeological metallic artefacts, tools and materials employed in the metallurgical process (ores, moulds, crucibles and tuyeres) as well as by-products that were originated during metallurgical operations (slags and metal droplets) are made. Several archaeological and metallurgical contexts have been analyzed. On the other hand, radiocarbon dating of the most part of these contexts have allowed to set up a chronological framework where the metallurgical evolution, namely changes in the 'chaîne opératoire' and in the content of the alloys used for the manufacture of the artefacts, can be anchored. In this way, the introduction of the bronze alloys in the Southwestern Iberia was dated to the second quarter of the II millennium BC, perhaps as imports, but earlier than it was thought.
2	Estuaries are highly productive environments that have been strongly impacted by human activities during the last 200 years, but where some natural profound changes may also happen. Data from Portuguese marshes are essential to support reliable interpretation of the geological record in a regional as well as in a global context. The IST/ITN team of this project has been in charge of some geochemical analysis of some sediment cores, namely those concerning the determination of elemental (C,N) and isotopic ( $\delta^{13}\text{C}$ , $\delta^{15}\text{N}$ ) composition of the sediment samples. Besides this soot-black carbon (BC) content has been determined in some sediments namely from those collected in the lower course of the Guadiana River. Higher soot-BC contents are found in samples located close to residential areas (Alcoutim and Ayamonte towns, Ayamonte Harbour). Carbon poor sediments contained a greater contribution of soot-BC, which confirms the selective preservation of soot carbon.
3	The estuarine environment is one of the most sensitive areas in the climatic change framework and sea level rise scenarios as they are an interface between fluvial and marine influence and they support not only important wetland biodiversity but also strategic economic activities. Over the last 5000 years different trends of sea level, climatic fluctuations, Bond events or humid episodes have been recorded in the Iberian Peninsula, as well as the increase of human intervention in the landscape, particularly sensitive since the Middle Bronze Age, all imprinted in the filling up of alluvial plain estuaries. In this Project estuarine sedimentary organic matter is characterized using geochemical methods, including elemental (C, N) and stable isotope analysis ( $\delta^{13}\text{C}$ , $\delta^{15}\text{N}$ ). The data concerning the evolution of these proxies along the sedimentary record allow to identify variations in the predominant sedimentary sources, the evolution of fluvial and marine influences, the responses to climatic events and the impact of land use changes in the estuarine environmental conditions over the last 5000 years.
4	The radiocarbon dating and the IRMS laboratories are unique in Portugal. If the radiocarbon lab started to work in the eighties, the IRMS only started last year. Although the first one works in a routine base each sample is unique and, consequently, the decontamination procedure, the time for the benzene synthesis and the set up of the batch for counting is of my responsibility. Also the interpretation of results concerning their reliability. As mentioned before the mass spectrometry of light elements (C; O; N) using very small samples is new in Portugal and a great care is needed in order to settle the ideal conditions for measurements. All these procedures are highly time consuming.
5	Several PhD and M. Sc. Thesis have been supervised by me in the field of radiocarbon and environmental isotope applications and also in the field of Archaeometallurgy. Radiocarbon and environmental stable isotopes (namely C, O and N) are of paramount importance in the study of palaeoenvironments and in palaeoclimatology. Two of the Thesis are in these fields, while the other two are concerned with the study of Pre-historic metallurgy, a field still poorly developed in Portugal.
6	As mentioned above the laboratories that I am in charge are unique in our country and for that reason since the start of the laboratories our team are concerned in order to offer good services to people interested in using these capabilities (archaeologists, geologists, oceanographers). In last year a new field of radiocarbon application is open – the determination of biobased content of fuels and RDFs (refuse derived fuels). Our experience with the Portucel Soporcel Group has been good and it is expected an increment of applications in this field in the future.

## PUBLICATIONS

### Papers (ISI)

- H.F.V. Cardoso, K. Puentes, A.M.M. Soares, A. Santos, T. Magalhães (2012) The value of radiocarbon analysis in determining the forensic interest of human skeletal remains found in unusual circumstances. *Journal of Forensic and Legal Medicine*, **19**, 97-100.
- J.M.M. Martins, A. Mederos Martín, P.J.C. Portela, A.M.M. Soares (2012) Improving the 14C Dating of Marine Shells from the Canary Islands for Constructing More Reliable and Accurate Chronologies, *Radiocarbon*, **54(3-4)**, 943-952.
- V. Martins, R.C.L.Figueira, E.J. França, P.A.L. Ferreira, P. Martins, J.F. Santos, J.A. Dias, L.L.M. Laut, A.M.M. Soares, E.F. Silva, F. Rocha (2012) Sedimentary processes on the NW Iberian Continental Shelf since the Little Ice Age, *Estuarine, Coastal and Shelf Science*, **102-103**, 48-59.
- J.M. de la Rosa, M.F. Araújo, J.A. González-Pérez, F.J. González-Vila, A.M.M. Soares, J.M. Martins, E. Leorri, R. Corbett, F. Fatela (2012) Organic matter sources for tidal marsh sediment over the past two millennia in the Minho River estuary (NW Iberian Peninsula), *Organic Geochemistry*, **53**, 16-24.
- P. Valério, R.J.C. Silva, M.F. Araújo, A.M.M. Soares, L. Barros (2012) A multianalytical approach to study the Phoenician bronze technology in the Iberian Peninsula - a view from Quinta do Almaraz. *Materials Characterization*, **67**, 74-82.
- P. Valério, A.M. Monge Soares, R.J.C. Silva, M.F. Araújo, P. Rebelo, N. Neto, R. Santos, T. Fontes (2013) Bronze production in Southwestern Iberian Peninsula: the Late Bronze Age metallurgical workshop from Entre Águas 5 (Portugal). *Journal of Archaeological Science*, **40/1**, 439-451.
- P. Valério, A.M. Monge Soares, M.F. Araújo, R.J.C. Silva, F.J.C. Santos (*in press*) The distinctive grave goods from Palhais (Beja, Portugal). New insights into the metallurgical evolution under Orientalizing influence in the southwestern end of Iberia. *Trabajos de Prehistoria*.

### Other Publications

- A.S.T. Antunes, M. Deus, A.M.M. Soares, F. Santos, L. Arêz, J. Dewulf, L. Baptista, L. Oliveira (2012) Povoados abertos do Bronze Final no Médio Guadiana. In J. Jiménez Ávila (ed), *Sidereum Ana II – El río Guadiana en el Bronce Final* (Anejos de AEspA LXII), Mérida, 277-308.
- M. Deus, A.S. Antunes, A.M.M. Soares (2012) Santa Margarida (Serpa) no contexto do Bronze Final do Sudoeste, *Actas do V Encontro de Arqueologia do Sudoeste Peninsular*, Almodovar, 171-188.
- A.M.M. Soares, A.S.T. Antunes, M. Deus (2012) O Passo Alto no contexto dos Povoados Fortificados do Bronze Final do Sudoeste. In J. Jiménez Ávila (ed), *Sidereum Ana II – El río Guadiana en el Bronce Final* (Anejos de AEspA LXII), Mérida, 249-276.
- A.A.M. Soares, A.R. Pereira, J.M.M. Martins, P.J. Portela (2012) Radiocarbon dating of aeolianite formation. In A.C. Almeida, A.M.S. Bettencourt, D. Moura, S.M. Rodrigues, M.I.C. Alves (eds), *Environmental Changes and Human Interaction along the Western Atlantic Edge*, Coimbra: APEQ/CITCEM/CEGOT/CGUP/CCT, 27-41.
- F. Pereira, R.J. Silva, A.M.M. Soares, M.F. Araújo (2012) Estudo arqueometalúrgico de artefactos provenientes do Castro de Vila Nova de São Pedro (Azambuja, Portugal). *Estudos Arqueológicos de Oeiras*, **19**, 163-172.
- P. Valério, R.J. Silva, T.R.N. Ponte, M.F. Araújo, A.M.M. Soares (2012) Estudo arqueometalúrgico das dádivas funerárias dos hipogeus do Bronze Pleno do Sudoeste da Horta do Folgão (Serpa, Portugal). *Estudos Arqueológicos de Oeiras*, **19**, 203-208.
- P. Valério, R.J.C. Silva, T.R.N. Ponte, M.F. Araújo, A.M.M. Soares (*in press*) Estudo arqueometalúrgico das dádivas funerárias dos hipogeus do Bronze Pleno do Sudoeste da Horta do Folgão (Serpa, Portugal). *Estudos Arqueológicos de Oeiras*.

## COMMUNICATIONS

### Oral

- K. Kolářová, J. Děd, M.F. Araújo, P. Valério, A.M. Monge Soares, R.J.C. Silva, F. Pereira (2012) Archaeometallurgical study of copper-based artefacts from the Portuguese territory. *ISDM 2012*, Freiberg, Alemanha, 15-17 March, 7p.
- P. Valério, R.J.C. Silva, M.F. Araújo, A.M.M. Soares, F.M. Braz Fernandes (2012) Elemental and microstructural signatures of Phoenician presence on copper-based artefacts from Southern Portugal. *2<sup>as</sup> Jornadas do CENIMAT*, Monte de Caparica, 22 June, 27.
- R.M. Soares, A.M.M. Soares (2012) O Cabeço Redondo (Moura) – um edifício monumental e singular na margem esquerda do Guadiana. *SIDEREUM ANA III – El Río Guadiana y Tartessos*, Mérida, Espanha, 19-21 September.
- A.S. Antunes, A.M.M. Soares, M. Deus, R.M. Soares (2012) Povoamento orientalizante na margem esquerda do Guadiana. Uma leitura a partir do Passo Alto e de Serpa. *SIDEREUM ANA III – El Río Guadiana y Tartessos*, Mérida, Espanha, 19-21 September.
- A.S. Antunes, M. Deus, S. Estrela, J. Larrazábal, A.M.M. Soares, R.M. Salvador Mateos (2012) Monte do Bolor, Monte do Pombal 2, Salsa 3 e Torre Velha 3: Contextos de planície da I Idade do Ferro do Alentejo Interior. *SIDEREUM ANA III – El Río Guadiana y Tartessos*, Mérida, Espanha, 19-21 September.
- P. Valério, A.M.M. Soares, M.F. Araújo, R.J.C. Silva (2012) A metalurgia do bronze na bacia do Guadiana entre os sécs. VIII e VI a.C. Metalurgia indígena versus metalurgia Orientalizante. *SIDEREUM ANA III – El Río Guadiana y Tartessos*, Mérida, Espanha, 19-21 September.
- F.J.R. Henriques, A.M.M. Soares, T.F.A. António, F. Curate, P. Valério, S.P. Rosa (2012) O *Tholos* Centirã 2 (Brinches, Serpa) – construtores e utilizadores; práticas funerárias e cronologias. *VI Encuentro de Arqueología del Suroeste Peninsular*, Villafranca de los Barros (Badajoz) (4-6 October).
- A.M.M. Soares, J.A. Pérez Macías, A. Martins, R.M. Soares, C. Pereira (2012) As ocupações do Bronze Final e da época romana do Cerro da Mangancha – resultados preliminares de duas campanhas de escavação. *VI Encuentro de Arqueología del Suroeste Peninsular*, Villafranca de los Barros (Badajoz) (4-6 October).
- L. Baptista, L. Oliveira, A.M.M. Soares (2012) A construção da paisagem nas bacias das Ribeiras do Álamo e do Pisão nos III e II Milénios a.C. *VI Encuentro de Arqueología del Suroeste Peninsular*, Villafranca de los Barros (Badajoz) (4-6 October).
- R.M. Soares, P. Valério, A.M.M. Soares, M.F. Araújo (2012) Rodas de Oleiro no Pós-Orientalizante – primeiros achados em território português no Cabeço Redondo (Sobral da Adiça, Moura). *VI Encuentro de Arqueología del Suroeste Peninsular*, Villafranca de los Barros (Badajoz) (4-6 October).
- A.R. Pereira, J. Trindade, C. Ramos, A.M.M. Soares, R. Danielson, H. Granja, A. Torres, A. Ribeiro, J. Martins, P. Portela (2012) A multi-proxy analysis in the assessment of fluvio-marine interactions over the last 5000 years. *EGU General Assembly 2012*, Vienna (Austria) (22-27 April).
- J.M.M. Martins, P.J.C. Portela, M.F. Araújo, O. Ferreira, J.M.A. Dias, A.M.M. Soares (2012) Elemental and stable isotope study of sedimentary organic matter in the continental shelf off the Guadiana river (SW Iberian Peninsula). *9th International Symposium on Environmental Geochemistry*. Aveiro (15-21 July).

### Poster

- J. Frade, A.M.M. Soares, A. Candeias, I. Ribeiro, T. Ponte, M. Serra, E. Porfírio (2012) Bees wax and propolis as sealants of funerary chambers during the Middle Bronze Age in South-western Iberian Peninsula. *39th International Symposium on Archaeometry (ISA 2012)*, Leuven (28 May - 1 June).
- J.M. de la Rosa, M.F. Araújo, H. Knicker, J.A. González-Pérez, F.J. González-Vila, A.M.M. Soares, J.M. Martins, E. Leorri, R. Corbett, F. Fatela (2012) Assessment of environmental changes in the salt marshes of the Tagus estuary (Portugal). *VII Simpósio sobre a Margem Ibérica Atlântica*, Lisbon, 16-20 December, 79.

- A.M.M. Soares, L. Alves, J. Frade, P. Valério, M.F. Araújo, A. Candeias, R. Silva, A. Valera (2012) Bell Beaker Gold Foils from Perdigões (Southern Portugal) – Manufacture and Use. *39th International Symposium on Archaeometry (ISA 2012)*, Leuven (28 May - 1 June).
- J. Martins, P. Portela, A.M.M. Soares, A.R. Pereira, J. Trindade (2012) Elemental and stable isotope analysis in the assessment of fluvio-marine interactions over the last 5000 years. *EGU General Assembly 2012*, Vienna (Austria) (22-27 April).
- J.M. de la Rosa, J.M. Martins, A.M.M. Soares, M.F. Araújo (2012) Organic matter sources and Soot-Black carbon contribution in sediments from the Guadiana estuary (SW Iberian Peninsula). *9th International Symposium on Environmental Geochemistry*. Aveiro (15-21 July).

## COMMUNICATIONS

- O sistema de povoamento do Bronze Final na Bacia do Guadiana (Baixo Alentejo). Colóquio “*Sistemas de povoamento do Centro e Sul do território português no decurso do Bronze Final*”, Centro de Estudos Arqueológicos do Concelho de Oeiras/ Câmara Municipal de Oeiras, 23 October 2012. Invited talk.
- Lectures in “Isotope Analysis”, “Radiocarbon dating” and “Luminescence Dating” in the framework of one semester course on “Examination and Analysis Methods II” for the Master degrees in “Conservation and Restoration” and “Conservation Sciences”, FCT/UNL. Invited Lecturer.

## EDUCATION / THESES SUPERVISION

- Supervisor, PhD Thesis, *Plataforma Continental Algarvia como Arquivo de Paleo-ambientes e Paleoclimas Holocénicos no Algarve Costeiro e Marinho. O papel do radiocarbono no seu estudo*, by José Manuel de Matos Martins, Universidade do Algarve (on-going).
- Co-supervisor, PhD Thesis, *The first metallurgical steps in the prehistory of the Portuguese Estremadura*, by Filipa Isabel Peralta da Silva Pereira, Faculdade de Diências e Tecnologia, Universidade Nova de Lisboa (on-going).
- Supervisor, MSc. Thesis, *Análise Elementar e Isotópica de Sedimentos Estuarinos do Rio Alcabrichel (Torres Vedras) e da Ribeira de Bensafrim (Lagos)*, by Paulo Jorge Cesário Portela, Faculdade de Ciências, Universidade de Lisboa (on-going).
- Jury membership of the PhD Thesis “*Archaeometallurgical study of pre and protohistoric production remains and artefacts from southern Portugal*” by Pedro Valério, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa.

## PROJECTS

- PTDC/HIS-ARQ/110442/2008, Early Metallurgy in the Portuguese Territory (EARLYMETAL). IST/ITN Coordinator: M.F. Araújo
- PTDC/CTE-GIX/105370/2008, Recent evolution of Portuguese W coast estuaries: high resolution studies from marshes geological record (WesTLog). IST/ITN Coordinator: M.F. Araújo
- PTDC/CTE-GIX/104035/2008, Fluvio-marine interactions over the last 5000 yrs (FMI 5000). IST/ITN Coordinator: A.M.M. Soares
- RECI/EPH-ARQ/0548/2012, Radiocarbon Dating using AMS (SacvA). IST/ITN Coordinator: A.M.M. Soares (submitted).
- EXCL/EPH-ARQ/0615/2012, The first 4000 years of metallurgy in Portuguese territory (Copper2Brass). IST/ITN Coordinator: M.F. Araújo (submitted).
- PTDC/EPH-HIS/4055/2012, The Walled Tomb: Exploring the ‘Lost Tomb’ of Fernão Telles de Menezes and Maria de Noronha (17<sup>th</sup> century) (TWTomb) (submitted)

## CONTRACTS

- PORTUCEL SOPORCEL – Determination of the biobased content of the fuel used by the Portucel Soporcel Group in its paper mill at Setúbal (one sample per month, 2400 € + IVA)

- Associação de Defesa do Património Histórico e Arqueológico de Aljezur – radiocarbon dating of 5 samples (1125 € + IVA)
- FCSH/ Universidade Nova de Lisboa – radiocarbon dating and  $^{13}\text{C}$  +  $^{15}\text{N}$  content of 5 bone samples (1375 € + IVA)
- Campo Arqueológico de Mértola – radiocarbon dating of 5 samples (1250 € + IVA)

### CONFERENCE ORGANIZATION / COMMITTEES

- Member of the Editorial Advisory Board of the book “Environmental Changes and Human Interaction along the Western Atlantic Edge”.
- Member of Scientific Committee of The VII Symposium on the Atlantic Iberian Margin.
- Member of the Scientific Board of the Journal “Quaternary Studies” (Journal of the Portuguese Association for Quaternary Research)

**NAME: João Paulo Arriegas Estevão Correia Leal**

**CATEGORY:** Auxiliary Researcher with habilitation

**ID NUMBER:** 5364

### R&D ACTIVITIES

Nº	Activity Description	R&D
1	Catalytic applications of f-element inorganic compounds	20%
2	Molecular energetics of organic, inorganic and organometallic compounds	30%
3	Degradation and valorization of bio-recalcitrant compounds and Synthesis of hybrid materials for biomedical applications	25%
4	Teaching and Orientation	20%
5	Services	5%
Total		100%

### RESUMO DO TRABALHO

Nº	Work Summary and Main Achievements
1	<p><i>Nanoparticles and nanostructured compounds for the elimination of gaseous primary pollutants</i></p> <p>The focus of this activity is to obtain f-element containing intermetallic nanoparticle compounds and use them as catalysts for the elimination/valorization of pollutants as methane, carbon dioxide or nitrous oxide. Some catalysts were synthesized as nanoparticles and results obtained so far show a superior performance when compared with existing commercial ones.</p> <p><i>Molten metals and molten salts for the elimination of urban waste.</i></p> <p>This activity resumes a previous partnership between ITN/Sociedade Ponto Verde (SPV), which leads to a patent (Pt-103302). On addition to molten metals, fused salts containing an f-element are an alternative to metals since they are cheaper. A new project was submitted to continue this type of studies, upgrading now to a pilot plant.</p>
2	<p><i>Energetics of diols with alkaline-earth metals, silicon and lanthanides</i></p> <p>This work follows quite closely project PTDC/QUI/65507/2006. Enthalpies of formation of several compounds resulting from the synthesis with diols was made. Also reactivity and catalytic properties were determined. Stress should be put in a mixed silicon/diol/lantanide obtained in a one pot synthesis, with unexpected properties.</p> <p><i>Thermochemical and thermophysical properties of ionic liquids and other new materials</i></p> <p>Density and viscosity of several ionic liquids and solutions containing them were measured at various temperatures. Enthalpies of formation of several ionic liquids were made. Also some experimental measurements and simulation procedures of some new materials obtained on projects PTDC/QUI-QUI/104229/2008 and PTDC/CTM/101115/2008 are under study.</p> <p><i>Thermochemical properties databases and properties prediction</i></p> <p>A database of thermochemical properties developed by a portuguese team</p>

	( <a href="http://www.therminfo.com">http://www.therminfo.com</a> ) was improved both in their internal structure and in the number of accessed compounds, being implemented new models for properties prediction.
3	<i>Degradation studies of bio-recalcitrant compounds</i> (PTDC/QUI-QUI/104229/2008) Degradation and valorization of recalcitrant compounds were studied by using radiation as a tool. Results obtained so far were the core of a Ph.D. Thesis presented December 2012 (Rita Paiva Melo, Supervision J. P. Leal, M. L. Botelho).  <i>Hybrid materials for biomedical applications</i> (PTDC/CTM/101115/2008) Studies had proceed despite being slower than expected. It was possible to synthesize new materials and to identify a new “abrasion” mechanism of grafted polymers, what was unexpected.
4	<i>Delivering of classes of Química I (Licenciatura Ciências da Saúde)</i> <i>Supervision and Co-supervision of Ph.D. and Master Thesis</i>
5	<i>Representation of Portuguese Chemical Society (SPQ) on the GAVE-MEC.</i>

## PUBLICATIONS

### Papers

- G. Lopes, A. C. Ferreira, J. P. Leal, J. B. Branco, Catalytic oxidation of methane on KCl-MCl<sub>x</sub> (M=Li, Mg, Co, Cu, Zn) eutectic molten salts, *Journal of Molecular Liquids*, 171, 1-5 (2012), <http://dx.doi.org/10.1016/j.molliq.2012.04.001>.
- L.M. Ferreira, J.P. Leal, P.A. Rodrigues, L.C. Alves, A.N. Falcão, M. H. Gil, Characterization of PE-g-HEMA films prepared by gamma irradiation through nuclear microprobe techniques, *Radiation Physics and Chemistry*, 81, 1319-1323 (2012), <http://dx.doi.org/10.1016/j.radphyschem.2012.01.045>.
- Rui C. Santos, J. P. Leal, A Review on Prediction Methods for Molar Enthalpies of Vaporization of Hydrocarbons - The ELBA Method as the Best Answer, *Journal of Physical and Chemical Reference Data*, 41, 043101 (2012), <http://dx.doi.org/10.1063/1.4754596>.

### Proceedings

- M. Varela, J. P. Leal, The effectiveness of materials disclosure depends on the Web platform choice?, *EduLearn12 Proceedings*, ISBN 978-84-695-3491-5, L. Gómez Chova, D. MartíBelenguer, I. Candel Torres, Editors, International Association of Technology, Education and Development IATED, Valencia (2012), pp. 6709-6710, <http://library.iated.org/view/VARELA2012EFF>

### Other publications

- J. P. Leal, Concurso de Financiamento de Projetos pela FCT: uma reflexão, *CiênciaHoje – Jornal de Ciência, Tecnologia e Empreendedorismo* (2012), <http://www.cienciahoje.pt/index.php?oid=54652&op=all>.
- J. P. Leal, Uso de Software no Ensino da Química, Teaching Program – Presented at Aggregation examination at Universidade de Lisboa, Mar 2012.
- J. P. Leal, Ponto de fusão, WikiCiências 3, 650 (2012), [http://wikiciencias.casadasciencias.org/index.php/Ponto\\_de\\_Fus%C3%A3o](http://wikiciencias.casadasciencias.org/index.php/Ponto_de_Fus%C3%A3o)
- J. P. Leal, Ponto de ebulição, WikiCiências 3, 652 (2012), [http://wikiciencias.casadasciencias.org/index.php/Ponto\\_de\\_ebuli%C3%A7%C3%A3o](http://wikiciencias.casadasciencias.org/index.php/Ponto_de_ebuli%C3%A7%C3%A3o)
- J. P. Leal, Tabela Periódica, WikiCiências 3, 667 (2012), [http://wikiciencias.casadasciencias.org/index.php/Tabela\\_Perio%C3%B3dica\\_dos\\_Elementos](http://wikiciencias.casadasciencias.org/index.php/Tabela_Perio%C3%B3dica_dos_Elementos)

## COMMUNICATIONS

- *A Química do dia a dia*, J. P. Leal, *Escola EB2,3 Belém-Restelo (Paula Vicente)*, Lisbon, Portugal, Jan (2012), Invited Talk.
- *A Química do dia a dia*, J. P. Leal, *Escola EB 2,3 Telheiras nº1*, Lisbon, Portugal, Feb(2012), Invited Talk.
- *E se não houvesse aspirina?*, J. P. Leal, *Escola EB 2,3 Benavente*, Portugal, Mar(2012), Invited Talk.

- *Recursos digitais em sala de aula*, J. P. Leal, R. Amadeu, *Seminário sobre a Casa das Ciências, Peniche, Portugal, Apr(2012)*, Invited Talk.
- *Estudar Química no computador*, J. P. Leal, *Externato da Luz, Lisbon, Portugal, Apr(2012)*, Invited Talk.
- *A Magia da Química*, J.P. Leal, Aggregation Examination, Universidade de Lisboa, Portugal, Mar (2012).
- *Syngas Production over M-Ni nano-particles (M=Pr, Gd, Th and U)*, A. C. Ferreira, J. P. Leal, J. B. Branco, *11th 3rd PYChem, Porto, Portugal, May (2012)*, Oral communication.
- *e-lab: a didactic interactive experiment. An approach to the Boyle-Mariotte law*, S. C. Leal, J. P. Leal, H. Fernandes, *11th 3rd PYChem, Porto, Portugal, May (2012)*, Oral communication.
- *The effectiveness of materials disclosure depends on the Web platform choice?*, M. Varela, J. P. Leal, *EDULEARN12, Barcelona, Spain, Jul (2012)*, Oral communication.
- *Evidence of structural order recovery in LDPE based copolymers prepared by gamma irradiation*, L.M. Ferreira, J.P. Leal, M.H. Casimiro, C.Cruz, J.J.H. Lancastre, A.N. Falcão, *10th Meeting of the Ionizing Radiation and Polymers Symposium, IRaP'2012, Cracóvia, Polónia, Oct (2012)*, Oral communication.
- *Synthesis of intermetallic nanoparticles containing f-elements*, A. C. Ferreira, T. A. Gasche, J. P. Leal, J. B. Branco, *COST-EUFEN, Tarragona, Espanha, Apr (2012)*, Poster communication.
- *Effect of ionizing radiation on antioxidant compounds present in cork wastewater*, J. Madureira, R. Melo, M. L. Botelho, J. P. Leal, I. M. Fonseca, *1st International Congress on Water, Waste and Energy Management, Salamanca, Espanha, May (2012)*, Poster communication.
- *Synthesis and Characterization of Novel Alkaline and Lantánide Metal Alkoxides*, P. G. Rosado, J. B. Branco, J. P. Leal, L. M. Ferreira, Joana Lancastre, *3rd PYChem, Porto, Portugal, May (2012)*, Poster communication.
- *Oxidative coupling of methane using nitrous oxide as oxidant over calcium-rare earth oxides nanoparticles*, A.C. Ferreira, J. P. Leal, J. B. Branco, *3rd PYChem, Porto, Portugal, May (2012)*, Poster communication.
- *Pedagogical material for the teaching of Organic Chemistry in the primary level*, S. C. Leal, J. P. Leal, *3rd PYChem, Porto, Portugal, May (2012)*, Poster communication – P100.
- *Adaptation d'un accélérateur linéaire d'électrons pour la radiolyse pulsée*, P. Santos, A. Vieira, R. Melo, T. Silva, H. Marcos, J.P. Leal, J. Noronha, G. Justino, E. Fernandes, M.L. Botelho, *JECR 2012 - 16èmes Journées d'Études de la Chimie sous Rayonnement, Sines, Portugal, May (2012)*, Poster communication.
- *O e-lab e o ensino experimental de Física no ensino básico e secundário*, S. C. Leal, J. P. Leal, H. Fernandes, *18ª Conferência Nacional de Física e 22º Encontro Ibérico para o Ensino da Física, Aveiro, Portugal, Sep(2012)*, Poster communication .
- *Estudo da Interação Catião-Anião em Líquidos Iónicos*, J. Vitorino, J. P. Leal, M. E. Minas da Piedade, *XVIII Encontro Luso-Galego de Química, Vila Real, Portugal, Nov (2012)*, No. LI-08, p 224, Poster communication.

## EDUCATION / THESES SUPERVISION

- J. P. Leal was submitted to examination to obtain the Aggregation in Chemistry, specialty Chemistry, at Universidade de Lisboa in March 1 and 2, 2012, being unanimously approved.

### Supervision

- Co-supervisor (with Maria Luisa Botelho), PhD. Thesis, *Application of ionizing radiation to persistent organic pollutants decomposition*, by Rita Lourenço Paiva de Melo, Faculdade de Ciências, Universidade de Lisboa, concluded December 14, 2012.
- Supervisor, PhD. Thesis, *Novas tecnologias da informação e comunicação e trabalho laboratorial: desmistificação de factores de insucesso e produção de materiais didáctico/pedagógicos*, by Sérgio Carreira Leal, 3<sup>rd</sup> Year (FCT grant – SFRH/BD/44889/2008) (FCUL/IST-ITN).

- Supervisor, Ph.D. Thesis, *O Ensino da Química no Século XXI: as novas tecnologias ao serviço da Química*, by Maria Manuela Lameiras Varela, 3<sup>rd</sup> Year (FCUL/IST-ITN).
- Co-supervisor (with A. Falcão, FCUL), Ph.D. Thesis, *ThermInfo: Técnicas de Data-Mining para Previsão de Propriedades Termoquímicas*, by Ana Isabel Lino Teixeira, 3<sup>rd</sup> Year (FCT grant–SFRH/BD/69942/2010-2014) (FCUL/IST-ITN).
- Co-supervisor (with J. Marçalo, IST-ITN and J. K. Gibson, Lawrence Berkeley Natl Lab), Ph.D. Thesis, *Exploring the chemical properties of elementary actinide species in the gas phase*, by Ana Filipa Folgado de Lucena, 2<sup>nd</sup> Year (FCT grant–SFRH/BD/69942/2010-2014) (FCUL/IST-ITN).
- Co-supervisor (with J. B. Branco, IST/ITN), Ph.D. Thesis, *Nanopartículas de Compostos Intermetálicos para a Eliminação Catalítica de Poluentes Primários*, by Ana Cristina Gomes Ferreira, 2<sup>nd</sup> Year (FCT grant–SFRH/BD/69942/2010) (FCUL/IST-ITN).
- Supervisor, Ph.D. Thesis, *Livro de Química Geral para o Ensino Básico e Secundário*, by Rute Isabel Carvalho Amadeu, 1<sup>st</sup> Year (FCUL/IST-ITN).
- Supervisor, Master Thesis, *Evolução temporal dos conceitos em Química*, by Paula Neves, 1<sup>st</sup> Year (FCUL/IST-ITN).
- Co-supervisor, Research Grant, *Energética de polialcóxidos metálicos*, by Pedro Rosado (PTDC/QUI/65507/2006 (2009-2012)).
- Co-supervisor, “Ciência Viva no Laboratório” - Ocupação Científica de Jovens nas Férias, *Uma Química Diferente*, by Afonso Miranda Pereira Gonçalves and Diogo Melo Cabrita (2012).

#### Teaching

- Theoretical-practical and laboratory classes of “Química I” (Licenciatura de Ciências da Saúde), FCUL.

#### Jury's

- Examiner in the Master Jury of “Correlação da função antioxidante com a energia de ligação O-H em compostos fenólicos” by Ana Rita Raimundo Gomes, Faculdade de Ciências, Universidade de Lisboa, Dec 2012.
- Member in the Ph.D. Jury of “Application of ionizing radiation to persistente organic pollutants decomposition” by Rita Melo, Faculdade de Ciências, Universidade de Lisboa, Dec 2012.

#### Other

- Contributor of WikiCiências/Casa das Ciências project, <http://wikiciencias.casadasciencias.org/>

## PROJECTS

#### Running

- *Energetics of metal polialkoxides (PTDC/QUI/65507/2006) (2009-2012)*. Leading Institution: IST/ITN. IST/ITN Coordinator: J. P. Leal (40%).
- *Estudo cinético da degradação de compostos biorecalcitrantes por radiólise pulsada (PTDC/QUI/104229/2008), (2010-2013)*. Leading Institution: IST/ITN. Team member: J. P. Leal (15%).
- *Materiais híbridos para aplicações biomédicas (PTDC/CTM/101115/2008), (2010-2013)*. Leading Institution: U. Aveiro. Team member: J. P. Leal (5%).

#### Submitted

- *Implementação do processo de extração catalítica para o tratamento químico de resíduos sólidos orgânicos: plásticos não conformes e resíduos orgânicos (IMPEC-TRESOR)*, Sociedade Ponto Verde, IST/ITN, Team member: J. P. Leal (25%), under evaluation.
- *Application of Ionizing Radiation for a Sustainable Environment (RECI/AAG-TEC/0400/2012) (2013-2015)*. Leading Institution: IST/ITN. Team member: J. P. Leal (15%), recommended for funding (499469 Euros).



- *Unique Gas-Phase Chemistry by FTICR (RECI/QEQ-QFI/0152/2012. Leading evaluation: IST/ITN. Coordinator: J. P: Leal (40%), Rated excellent not funded.*

## CONFERENCE ORGANIZATION / COMMITTEES

- Representation of Portuguese Chemical Society (Sociedade Portuguesa de Química - SPQ) at Conselho Consultivo do Gabinete de Avaliação Educacional (GAVE) of Ministério da Educação e Ciência (MEC).
- Member of the Editorial Board of E-Journal of Chemistry (<http://www.hindawi.com/journals/chem/>).

## SCIENTIFIC VISITORS

- M. E. Minas da Piedade and J. M. Vitorino, Centro de Química e Bioquímica, FCUL, several periods, Reaction of Ionic Liquids in the Gas-phase.

## NAME: Célia Maria da Cruz Fernandes

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5452

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Synthesis, Characterization and Biological Assessment of Multi-Functional Bone-Seeking Agents (PTDC/QUI-QUI/115712/2009). In collaboration with Prof. Luis Costa and Dr <sup>a</sup> Sandra Casimiro from the Unit of Clinical and Translational Oncology Research Unit of IMM, Faculty of Medicine, University of Lisbon.	35%
2	Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for Targeted Radiotherapy of Tumors (PTDC/QUI-QUI/111891/2009).	25%
3	Albumin binding-domain fusions to improve protein pharmacokinetics (PTDC/SAU-FAR/115846/2009). In collaboration with Prof. João Gonçalves (PI) from the Unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon.	15%
4	Radiolabelled neuropeptide Y (NPY) analogues for Y1 receptor-targeting in breast cancer.	10%
5	Radiochemical and Biological Evaluation of Novel Heteronuclear Lanthanide-Ruthenium Complexes	5%
6	Management of the HPLC lab/equipments	5%
7	Management of a chemical synthesis laboratory (SQII)	5%
Total		100

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	The main goal of the project entitled "Synthesis, characterization and biological assessment of multi-functional bone-seeking agents" is the assessment of the simultaneous delivery of radiation/bisphosphonates/chemotherapy to bone metastatic lesions, using novel and well-defined multifunctional chemical identities. By using a bifunctional chelating approach, the bone-uptake of the bisphosphonate (BP) is expected to be preserved, reducing toxicity exposure to extra-skeletal sites. A synergistic effect of such combination, in pain therapy and/or cancer progression, compared to the conventional sequential treatment, and an understanding of the underlying mechanisms is expected. Under the framework of this project we have successfully synthesized and characterized a set of novel organometallic compounds of the type $fac-[M(CO)_3(k^3-Pz-BP)]^+$ , which contain a bisphosphonate unit (bone seeking agent), and the metal fragment $fac-[M(CO)_3]$ ( $M = {}^{99m}Tc, Re$ ). The biological evaluation (e.g. cytotoxicity, bone-targeting properties) of the complexes both in cell lines and animals (mice and rats) is currently underway.

	<p>In this project I have been deeply involved in the synthesis and characterization of the compounds described herein, as well as in the radiolabelling with <math>^{99m}\text{Tc}(\text{I})</math> and stability studies. All the synthesis and radiolabelling assays performed by Patrícia Mendes (Master student) and Sofia Monteiro (BI) were made under my direct supervision.</p>
2	<p>Estrogen receptor (ER) is a relevant tumour target for molecular imaging and radionuclide therapy. This project explores a new strategy of using estradiol-based complexes as specific vehicles for inserting the short-range Auger electron-emitters (<math>^{111}\text{In}</math>, <math>^{67}\text{Ga}</math>) into ER overexpressing cells allowing a more selective anti-tumour therapy. A set of <math>16\alpha</math>-estradiol derivatives, containing diverse spacer chains, were coupled to the bifunctional chelating agents DOTA and DTPA. The cold indium and gallium complexes were synthesized by reaction with <math>\text{InCl}_3</math> and <math>\text{Ga}(\text{NO}_3)_3</math>, respectively. The radioactive congeners labeled with <math>^{111}\text{In}</math> and <math>^{67}\text{Ga}</math> were prepared by reaction with <math>^{111}\text{InCl}_3</math> and <math>^{67}\text{GaCl}_3</math>, respectively and were obtained in high radiochemical yield and purity. Stability of radioactive complexes was evaluated in the presence of human blood serum and at physiological concentrations of apo-transferrin. Lipophilicity was determined through octanol/PBS partition coefficient (<math>\text{LogP}_{\text{o/w}}</math>) using the “shakeflask” method. The preclinical evaluation of the radioactive complexes is currently underway in order to get insight on the estradiol derivatives structure relationship with their potential as imaging/therapeutic agents. My contribution in this project has been fundamental in the proposal of new estradiol derivatives synthetic strategies and <math>^{67}\text{Ga}/^{111}\text{In}</math> radiolabelling, together with the supervision of the work performed by Susana Cunha (PhD student) and Filipe Vultos (BI).</p>
3	<p>Small domain antibodies are a promising class of biopharmaceuticals with very high potential in therapeutic applications, however, due to their small size, are rapidly cleared from circulation. The unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon, proposed a bacterial albumin-binding domain (Zag) derived from <i>Streptococcus zooepidemicus</i> fused to an anti-TNF VHH small domain antibody as a strategy to improve the pharmacokinetic properties of therapeutic proteins. Profiting from the presence of hexahistidine tags in the proteins VHH and VHH fused with the ZAG albumin-binding domain, both antibodies were labeled with <math>[\text{}^{99m}\text{Tc}(\text{CO})_3]^+</math> and purified (&gt; 95%). The radioactive VHH-based antibodies are stable towards transchelation reactions in the presence of histidine or cysteine, as well as in human serum for 24 hours. The biodistribution studies in healthy CD-1 mice indicated that the ZAG domain affected the pharmacokinetic profile of <math>^{99m}\text{Tc}(\text{I})\text{-PL-VHH}</math> with a remarkable 10-25 fold decrease of blood clearance. I have been participating in this project suggesting radiolabelling conditions of antibodies with <math>^{99m}\text{Tc}</math>, new purification strategies and radiochemical purity analysis of the labeled compounds.</p>
4	<p>The overexpression of many peptide receptors on human tumors makes such peptides attractive agents for diagnosis and therapy of cancer. Breast carcinomas have shown extremely high incidence and density of Neuropeptide Y receptor subtype 1 (NPY Y1) whereas normal breast tissue mainly expresses Y2-receptors. Thus, the use of radiolabeled (<math>\alpha</math>-emitting radionuclides) analogs of the Neuropeptide Y (NPY) has emerged as a promising approach for <i>in-vivo</i> targeting of the highly expressed Y1 receptors in breast cancer. Based on the smallest and selective Y1R agonist <math>[\text{Pro}^{30}, \text{Nle}^{31}, \text{Bpa}^{32}, \text{Leu}^{34}]\text{NPY}(28\text{-}36)</math> (NPY1), several DOTA-NPY1 derivatives were synthesized and labeled with <math>^{67}\text{Ga}</math> with high radiochemical yields and purity. Stability of the radioactive compounds was evaluated in physiological conditions, in the presence of human blood serum and at physiological concentrations of apo-transferrin. The <i>in vivo</i> stability as well as the pharmacokinetic profile of radiopeptides was evaluated in healthy mice. Cellular uptake kinetics was assessed in different human breast cancer cell lines, such as MCF-7 and MDA-MD-231.</p> <p>In the scope of this project I have optimized the labelling of DOTA-NPY1 analogs with <math>^{67}\text{Ga}</math> as well as their purification. Isabel Rodrigues (Master Science student) performed most of the radiolabeling assays, purification and stability studies under my supervision.</p>
5	<p>In collaboration with Prof. Michel Picquet, Institut de Chimie Moléculaire de l'Université de Bourgogne, Dijon, France, novel heteronuclear lanthanide ruthenium complexes were explored at IST/ITN for their potential as future imaging probes.</p> <p><math>^1\text{H}</math> and <math>^{31}\text{P}</math> NMR, Mass spectrometry and HPLC were used to establish the stability in solution of the dota like ligands bearing a Ru pendent arm (prepared in the Institut de Chimie Moléculaire de l'Université de Bourgogne) and the corresponding Ru-lanthanide complexes (prepared in IST/ITN). Radiolabelling of the ligands was performed with <math>^{153}\text{Sm}</math> produced in the Portuguese Research</p>

	<p>Reactor.</p> <p>The preliminary results show that the kinetics of the radiolabelling reaction with <math>^{153}\text{Sm}</math> is dependent on temperature and on the molar ratio M:L.</p> <p>My contribution to this project was the HPLC analysis of the inactive and radioactive compounds in order to characterize the radiochemical species allowing to optimize the labeling conditions and to determine more accurately the radiochemical yield and purity.</p>
6	<p>High performance liquid chromatography is a crucial technique in the development of radioprobes for in vivo imaging or therapy. This technique is also important in the purification, identification and evaluation of the chemical purity of bioactive peptides and others biomolecules. However, this technique demands accurate HPLC systems and training of the users.</p> <p>I am responsible for the management/maintenance of four HPLC equipments (three analytical and a new semi-preparative one) and for the training of the new users.</p>
7	<p>Responsible for the management/maintenance of chemical synthesis laboratory (SQII) namely chemicals and equipment. Responsible for providing information and training to the laboratory workers about chemicals handling and chemistry synthesis techniques and the safe use of apparatus available on the laboratory namely on vacuum line techniques for handling air-sensitive compounds. Organize disposal of hazardous chemicals and solvents.</p>

## PUBLICATIONS

- C. Neto, C. Fernandes, M.C. Oliveira, L. Gano, F. Mendes, T. Kniess, I. Santos, Radiohalogenated 4-anilinoquinazoline-based EGFR-TK inhibitors as potential cancer imaging agents, *Nuclear Medicine & Biology*, 39, 247–260 (2012), doi:10.1016/j.nucmedbio.2011.09.001.
- D. Can, B. Spingler, P. Schmutz, F. Mendes, P.D. Raposinho, C. Fernandes, F. Carta, A. Innocenti, I. Santos, C.T. Supuran, R. Alberto, [(Cp-R)M(CO)<sub>3</sub>] (M=Re or  $^{99\text{m}}\text{Tc}$ ) Arylsulfonamide, Arylsulfamide, and Arylsulfamate conjugates for selective targeting of human Carbonic Anhydrase IX. *Angew Chem Int Ed Engl*, 51, 3354-3357 (2012), DOI:10.1002/ange.201107333.
- F. Mendes, L. Gano, C. Fernandes, A. Paulo, I. Santos, Studies of the myocardial uptake and excretion mechanisms of a novel  $^{99\text{m}}\text{Tc}$  heart perfusion agent, *Nuclear Medicine & Biology*, 39; 207-213 (2012).
- F. Vultos, S. Cunha, C. Fernandes, L. Gano, I. Santos. Estradiol based indium complexes towards the estrogen receptor. *Acta of the International Symposia on Metal Complexes – ISMEC Acta*, Volume 2, 352-353, (2012) (proceeding).
- S. Cunha, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, Synthesis and preclinical evaluation of  $^{67}\text{Ga}/^{111}\text{In}$ -estradiol based complexes for tumour imaging, *Q. J. Nucl. Med. Mol. Imag.*, 56-Suppl. 1- N2, 40, (2012).
- S. Cunha, F. Vultos, C. Fernandes, M.C. Oliveira, M. F. Botelho, I. Santos; L. Gano, Novel  $^{111}\text{In}$ -estradiol based complexes: preclinical evaluation for oestrogen positive tumour targeting, *Eur J Nucl Mol Imaging*, 39 (Suppl 2):S530, (2012).

## COMMUNICATIONS

- *Radiometallated neuropeptide Y analogs for breast cancer imaging*, C. Fernandes, P. Antunes, P. D. Raposinho, I. Rodrigues, I. Santos, *XIII Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Synthesis and preclinical evaluation of  $^{67}\text{Ga}/^{111}\text{In}$ -estradiol based complexes for tumour imaging*, S. Cunha, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *16th European Symposium on Radiopharmacy and Radiopharmaceuticals, ESRR'12, Nantes, France, 26-29 April, (2012)*, Poster.
- *Estradiol Based Indium Complexes Towards the Estrogen Receptor*, F. Vultos, S. Cunha, C. Fernandes, L. Gano, I. Santos, *International Symposium in Metal Complexes (ISMEC'12), Lisbon- PORTUGAL, 18-22 June (2012)*, Poster.
- *Synthesis and characterization of novel DOTA – Estradiol derivatives targeting the Estrogen Receptor*, S. M. Cunha, F. J. Vultos, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, 2-7 September, (2012)*, Poster.

- *BP-Containing M(CO)<sub>3</sub>-Complexes (M=<sup>99m</sup>Tc/Re) as Multi-Functional Bone-Seeking Agents*, S. Monteiro, P. Mendes, C. Fernandes, L. Gano, E. Palma, J. D.G. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, 2-7 September, (2012)*, Poster.
- *Influence of polar substituents on the biodistribution and metabolic stability of pyrazolyldiamine <sup>99m</sup>Tc(I) Organometallic complexes*, A.R. Palma, C. Fernandes, L. Gano, A. Paulo, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, 2-7 September, (2012)*, Poster.
- *Novel <sup>111</sup>In-estradiol based complexes: preclinical evaluation for oestrogen positive tumour targeting*, S. Cunha, F. Vultos, C. Fernandes, M.C. Oliveira, M. F. Botelho, I. Santos; L. Gano, *25th EANM Congress, Milan, Italy, 27-31 October, (2012)*, Poster.

## EDUCATION / THESES SUPERVISION

- Supervisor, M. Sc. Thesis, *Síntese, Caracterização e Avaliação Biológica de Compostos Multifuncionais Osteotópicos*, by Patrícia Raquel Henriques Serra Mendes, Faculdade de Ciências, Universidade de Lisboa, 23 November 2012.
- Main Jury member (arguente): M. Sc. Thesis, *Análogos do Neuropeptido Y marcados com <sup>99m</sup>Tc para detecção de receptores Y1 expressos no cancro da mama*, by Marta Sofia de Oliveira Antunes, Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), 6 December 2012.

## PROJECTS

### Team Member

- (25%) *Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for Targeted Radiotherapy of Tumors* (PTDC/QUI-QUI/111891/2009). Leading Institution: IST/ITN, Lisbon, Portugal. Principal Researcher: Maria de Lurdes Barreia Patrício Gano.
- (15%) *Albumin binding-domain fusions to improve protein pharmacokinetics*, PTDC/SAU-FAR/115846/2009. Leading Institution: Associação para o Desenvolvimento do Ensino e Investigação da Microbiologia (ADEIM), Faculdade de Farmácia, Universidade de Lisboa. Principal Researcher: João Manuel Braz Gonçalves.

### Submitted in 2012

#### *Team Member (35%)*

- *Molecular and Nano Tools for Cancer Theranostics*, EXCL/QEQ-MED/0233/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. IST/ITN Principal Researcher: I. Santos *Recommended for funding*.

**NAME: Elsa Maria Simões Branco Lopes**

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5358

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	New Thermoelectric Systems	40%
2	Electronic properties studies of Charge Transfer Salts	10%
3	Magnetic and strongly correlated electron behaviour in intermetallics	5%
4	Magnetotransport properties of single crystal CuS	10%
5	Characterization of electronic properties of Perylene compounds	20%
6	Supervision and training of students	10%
7	IST/ITN Helium Liquefactor	5%
Total		100%

## WORK SUMMARY

N°	Work Summary and Main Achievements
1	<p>The aim of this project is the search for new thermoelectrical materials with high ZT. We have been focusing our attention on chalcogenide glasses, several potential chalcogenide glasses were investigated. The CuAsTe family shows interesting properties at room temperature, with power factors as high as <math>110 \mu\text{WK}^{-2}\text{m}^{-1}</math>. However the glass transition temperatures and thermal stabilities of these glasses are still low when compared with traditional bulk materials, the addition of Se in the CuAsTe family stabilizes the glass, while not significantly disturbing the thermoelectric properties.</p> <p>Samples of <math>\text{Cu}_x\text{A}_y\text{Te}_z</math> system (<math>\text{A} = \text{Ge}, \text{Ga}</math> and <math>\text{Si}</math>) were prepared by melt spinning, it can be seen that alloying with other elements does not significantly change the electrical transport properties observed in the CuAsTe family. Nevertheless, some general trends can be taken. In particular, for <math>\text{Cu}_{x+y}\text{A}_{20-x}\text{Te}_{80-y}</math> (<math>\text{A} = \text{Ge}, \text{Ga}</math> and <math>\text{Si}</math>) glasses the increase of copper concentration decreases the electrical resistivity, while higher tellurium content is related with an increased Seebeck coefficient.</p> <p>New strategies to improve the thermoelectric properties of <math>\text{CePd}_3</math> were developed. Nanostructured <math>\text{CePd}_{3+x}</math> (<math>-0.5 \leq x \leq 0.3</math>) samples were prepared by splat cooling and their electrical transport properties were studied. Good thermoelectrical properties were observed for compositions close to <math>\text{CePd}_{2.7}</math>.</p>
2	<p>The chemistry of thiophene-TTF donors, is very rich, and has led, in the last years, to a wide variety of salts with very interesting magnetic and transport properties.</p> <p>Recently the <math>(\alpha\text{-DT-TTF})_2[\text{Au}(\text{mnt})_2]</math> was obtained and found to share the same ladder structure of the DT-TTF analogue but with some cis-trans/orientation disorder. The transport and magnetic properties observed confirm this salt to be a weakly disordered molecular spin ladder system</p> <p>Two new organic salts <math>(\alpha\text{-DT-TTF})_2(\text{PF}_6)_{0.6}</math> and <math>(\alpha\text{-DT-TTF})_2(\text{PF}_6)</math> were identified by X-ray diffraction, revealing different stoichiometries and some disorder in the various preparations. These salts are semiconducting with sample dependent conductivities and activation energies, in good agreement to what was observed in the X-ray studies. The best sample had a 9 S/cm conductivity and a 38meV activation energy. The thermopower is positive with a sample dependent semiconducting behavior, confirming hole dominated conduction.</p> <p>A new <math>(\text{DT-TTF})_2[\text{Pd}(\text{mnt})_2]</math> salt was obtained and found to be a quasi-one-dimensional organic semiconductor with a low room temperature conductivity of <math>6 \times 10^{-2}</math> S/cm and a 172meV activation energy, which could be expected since the donors are strongly dimerised at room temperature in the observed structure.</p>
3	<p>Preliminary studies were made on the low temperature physical properties of UFeGe samples, which indicated that the structural distortion is due to the increase on the density of states at the Fermi level.</p>
4	<p>The ITN high magnetic field facility permits the study of electrical transport properties under magnetic fields with different orientations up to 18 T and for temperatures in the range 0.3-300 K.</p> <p>Covellite (<math>\text{CuS}</math>) is a natural mineral with a high metallic conductivity with a potential for applications in optical, photovoltaic and electronic devices. The high quality single crystals studied were grown by a high temperature solution method. <math>\text{CuS}</math> undergoes a structural transition at 55K and has metallic hole type conductivity from room temperature down to the superconducting transition at 1.6K. The structural phase transition is observable in the electrical resistivity but not in the Seebeck coefficient or the magnetoresistance, indicating that the carrier scattering mechanisms and the density of states at the Fermi level are not too much affected by the transition. The unusual temperature variation of the Seebeck coefficient is probably a result of a complex band structure where both electrons and holes are involved with a complex temperature variation. The transverse magnetoresistance appears mainly bellow 30K, reaching values as high as 470% at 5K under a 16Tesla field. The transverse magnetoresistance does not saturate, following a power law <math>\propto H^{1.4}</math> indicative of existence of open orbits for the carriers at the Fermi level.</p>
5	<p>The 1-D <math>\text{Per}_2[\text{X}(\text{mnt})_2]</math> <math>\text{X}=\text{Au}, \text{Pt}, \text{Pd}, \dots</math> family has unique physical properties like Peierls, spin Peierls, CDW instabilities and presents even more exotic properties under pressure and high magnetic fields. However the study of this interesting family has been limited by the growth of good</p>

	quality single $\alpha$ -phase crystals, since there are 2 polymorphs the $\alpha$ (metallic) and $\beta$ (semiconducting) phase. Several samples of this family were prepared by different methods and the electrical transport properties were studied. A $\beta$ -phase was identified for $\text{Per}_2[\text{Pd}(\text{mnt})_2]$ , for samples prepared by electrocrystallization. The semiconducting transport properties observed are similar to those of the Cu, Ni and Pt $\beta$ -phases. Several preparations of $\text{Per}_2[\text{Pt}(\text{mnt})_2]$ crystals prepared by electrocrystallization were studied but unfortunately they were $\beta$ -phase.
6	Supervisor, research work of Graduate Student Timóteo Mendes in the scope of FCT's Project: New Thermoelectric Systems, (PTDC/CTM/102766/2008). Supervisor, research work of M.Sc. Rui Freitas in the scope of FCT's Project: Electrocrystallisation of charge transfer salts; from crystallogenesis to electronic devices (PTDC/QUI-QUI/101788/2008).
7	I supervise the Helium Linde L70 Liquefier that supplies different cryogenic equipment at the Campus a few outside research institutions, mainly in the Lisbon area. This liquefier has been installed in 2010, it has a 2000 liter reservoir and a nominal capacity of 27 l/hr. The total liquid helium production in 2012 was 10600 liters.

## PAPERS

- A. P. Gonçalves, E. B. Lopes, G. Delaizir, B. Lenoir, A. Piarristeguy, A. Pradel, J. Monnier, P. Ochin, C. Godart, Semiconducting glasses: A new class of thermoelectric materials?, *Journal of Solid State Chemistry* 193, 26-30 (2012). <http://dx.doi.org/10.1016/j.jssc.2012.03.031>
- A. Casaca, E. B. Lopes, A. P. Gonçalves, M. Almeida, Electrical transport properties of CuS single crystals, *J. Phys. Condens. Matter* 24, 015701 (2012). <http://dx.doi.org/10.1088/0953-8984/24/1/015701>
- M. L. Afonso, R. A. L. Silva, M. Matos, E. B. Lopes, J. T. Coutinho, L. C. J. Pereira, R. T. Henriques, M. Almeida, Growth of (Perylene)<sub>2</sub> [Pd(mnt)<sub>2</sub>] crystals, *J. Crystal Growth*, 340, 56-60 (2012). <http://dx.doi.org/10.1016/j.jcrysgro.2011.11.083>.
- R. A. L. Silva, M. L. Afonso, I. C. Santos, D. Belo, R. R. Freitas, E. B. Lopes, J. T. Coutinho, L. C. J. Pereira, R. T. Henriques, M. Almeida, C. Rovira, (DT-TTF)<sub>2</sub>[Pd(mnt)<sub>2</sub>]: An unusual ionic salt, *Phys. Status Solidi C* 9, No. 5, 1134-1136 (2012). <http://dx.doi.org/10.1002/pssc.201100631>.
- M. L. Afonso, R. A. Silva, L. C. J. Pereira, J. T. Coutinho, R. R. Freitas, E. B. Lopes, M. Matos, R. T. Henriques, A. Viana, M. Almeida, Electrocrystallisation of (Per)<sub>2</sub> [Pd(mnt)<sub>2</sub>], *Phys. Status Solidi C* 9, No. 5, 1131-1133 (2012). <http://dx.doi.org/10.1002/pssc.201100632>.
- Neves, E.B. Lopes, M. Almeida, D. Belo, New copper thiophenedithiolenes for single component molecular metals, *Physica Status Solidi C* 9, 1137-1139 (2012). <http://dx.doi.org/10.1002/pssc.201100635>.
- E. Laukhina, V. Lebedev, V. Laukhin, A.P. del Pino, E.B. Lopes, A.I.S. Neves, D. Belo, M. Almeida, J. Veciana, C. Rovira, Polycarbonate films metalized with a single component molecular conductor suited to strain and stress sensing applications, *Organic Electronics* 13, 894-898 (2012). <http://dx.doi.org/10.1016/j.orgel.2012.01.031>
- R.A.L. Silva, A.I.S. Neves, M.L. Afonso, I.C. Santos E.B. Lopes, F. del Pozo, R. Pfattner, M. Mas-Torrent, C. Rovira, M. Almeida, D. Belo,  $\alpha$ -DT-TTF; a detailed study of an electronic donor and its derivatives, accepted for publication in *European Journal of Inorganic Chemistry*. <http://dx.doi.org/10.1002.ejic.201201362>
- R.A.L. Silva, A.I.S. Neves, J.T. Coutinho, L.C.J. Pereira, I.C. Santos, E.B. Lopes, C. Rovira, D. Belo, M. Almeida, (a-DT-TTF)<sub>2</sub> [Au(mnt)<sub>2</sub>]; a weakly disordered organic spin-ladder, submitted to *Advanced Functional Materials*.

## COMMUNICATIONS

- *Improving thermoelectrics in CePd<sub>3</sub>*, A.P. Gonçalves, E.B. Lopes, A. Jacquot, C. Godart, *E-MRS 2012 Spring Meeting, Strasbourg, France, May 14-18( 2012)*, Oral.
- *CePd<sub>3</sub>: a strongly correlated system for low temperature thermoelectric applications*, A.P. Gonçalves, E.B. Lopes, A. Jacquot, C. Godart, *10th Prague Colloquium on f-Electron Systems, Prague, Czech Republic, 21st – 24th August (2012)*, Oral.

- *Uranium-iron-germanium intermetallic compounds*, M.S. Henriques, D.I. Gorbunov, J.C. Waerenborgh, L.C.J. Pereira, E.B. Lopes, L. Havela, A.V. Andreev, T. Klimczuk, A. Rudajevová, O. Tougait, R. Vilar, A.P. Gonçalves, *10th Prague Colloquium on f-Electron Systems, Prague, Czech Republic, 21st – 24th August (2012)*, Oral.
- *CuAsTe a Family of Thermoelectric Glasses*, E.B. Lopes, A.P. Gonçalves, G. Delaizir, C. Godart, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April (2012)*, Poster.
- *Low-temperature properties of orthorhombic UFeGe*, A.P. Gonçalves, M.S. Henriques, L.C.J. Pereira, M. Almeida, L. Havela, J.C. Waerenborgh, E.B. Lopes, S. Mašková, O.Tougait, J.S. Brooks, A. Kiswandhi, E. Steven, T. Klimczuk, *18th International Conference on Solid Compounds of Transition Elements, Lisbon, Portugal, 31st March -5th April (2012)*, Poster.
- *Thermal stability and thermoelectric properties of  $Cu_xAs_{40-x}Te_{60-y}Sey$  semiconducting glasses*, J. B. Vaney, A. Piarristeguy, A. Pradel, E. Alleno, B. Lenoir, C. Candolfi, A. Dauscher, A.P. Gonçalves, E.B. Lopes, G. Delaizir, J. Monnier, C. Godart, *31st International & 10th European Conference on Thermoelectrics, July 9<sup>th</sup> -12<sup>th</sup> (2012), Aalborg, Denmark*, Poster.
- *$\alpha$ -DT-TTF ; a new electronic donor*, R.A.L. Silva, A.I.S. Neves, M.L. Afonso, I.C. Santos, E.B. Lopes, M. Mas-Torrent, C. Rovira, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, 23th -24th October (2012)*, Invited talk.
- *Single Component molecular metals in plastic electronics*, E. Laukhina, V. Lebedev, V. Laukhin, A.P. del Pino, E.B. Lopes, A.I.S. Neves, M. Almeida, J. Veciana, C. Rovira, D. Belo, *in the scope of subject Sistemas Químicos e Reactividade do 2º Ciclo em Química, Lisbon, Faculdade de Ciências da Universidade de Lisboa, 12nd April (2012)*. Invited Class.
- *New bisditholene complexes based on substituted thiophenic ligands for magnetic and conducting materials*, A. I. S. Neves, I. C. Santos, J. T. Coutinho, L. C. J. Pereira, E. B. Lopes, R. T. Henriques, H. Alves, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, 23th -24th October (2012)*, Invited talk.

## PROJECTS

- *New Thermoelectric Systems*, PTDC/CTM/102766/2008. Leading Institution:ITN Coordinator: E.B. Lopes (40%).

## CONFERENCE ORGANIZATION / COMMITTEES

- Member of the Organizing Committee, *18th International Conference on Solid Compounds of Transition Elements*, Lisbon, Portugal, 31st March -5th April (2012).

## COLLABORATIONS

- G. Delaizir, SPCTS, UMR CNRS 7315, Centre Européen de la Céramique, Limoges, France, January 2012, Interdisciplinary Approaches to Functional Electronic and Biological Materials Program.

**NAME: Fernanda Marujo Marques**

**CATEGORY:** Auxiliary Research

**ID NUMBER:** 005359

## R&D ACTIVITY

Nº	Activity Description	R&D
1	Chemical, Radiochemical and Biological Studies of Pyrazolyl-Alkylamine Pt(II) Complexes: Application on the Development of Novel Anti-cancer Drugs, PTDC/QUI/66813/2006-... (Scientific Coordinator: A. Paulo IST/CTN).	10%
2	Ruthenium complexes for anti-tumour application PTDC/QUI-QUI/101187/2008-... (Scientific Coordinator: A. I Tomáz, FCUL).	20%
3	Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for	20%

	Targeted Radiotherapy of Tumors, PTDC/QUI-QUI/111891/2009-... (Scientific Coordinator: L. Gano, IST/CTN).	
4	Synthesis, Characterization and Biological Assessment of Multi-Functional Bone-Seeking Agents, PTDC/QUI-QUI/115712/2009-... (Scientific Coordinator: I. Santos, IST/CTN).	15%
5	Preclinical evaluation of ruthenium potential drugs for cancer therapy, PTDC/QUI-QUI/118077/2010-... (Scientific Coordinator: M. H. Garcia, FCUL).	15%
6	Novel boron compounds for localized therapy, PTDC/QEQ-MED/0833/2012, (submitted) (Scientific Coordinator: F. Marques, IST/CTN).	15%
7	Chemical characterization and biological properties of novel heteronuclear lanthanide ruthenium complexes (collaboration with Institut de Chimie Moléculaire de l'Université de Bourgogne).	5%
Total		100%

## WORK SUMMARY

N°	Work Summary and Main Achievements
1	<p>Synthesis of new Pt(II) complexes anchored by pyrazolyl-diamine (pz*NN) ligands bearing different substituents at the azolyl rings and anthracenyl or acridine orange DNA-binding groups with the aim to assess their interest in the design of novel anticancer drugs. All complexes have been characterized by classical analytical methods and by X-ray diffraction analysis. Their solution behavior has been evaluated (conductivity measurements and ESI-MS) together with lipophilicity measurements. The cellular uptake (ICP-MS and confocal microscopy), antiproliferative properties (MTT assay) and ultrastructural analysis (TEM microscopy) have been done with the cisplatin sensitive and resistant ovarian carcinoma cells, A2780 and A2780cisR. DNA interaction was studied <i>in vitro</i> by monitoring the complexes-induced conformational change of plasmid DNA (agarose gel electrophoresis). The high cytotoxic potency found for the anthracenyl derivative may be due to the interaction with biological target(s) different from nuclear DNA. The ultrastructural analysis seemed to be in agreement with the viability and cellular uptake studies.</p> <p>In the scope of this project my contribution has been the cellular uptake studies, the evaluation of the antiproliferative properties and the ultrastructural analysis (cellular morphological changes).</p>
2	<p>Synthesis and characterization of new Ru/Fe/Ga complexes and the evaluation of parameters that could be related with their activity, for instance their lipo-hydrophilic balance, their electrochemical behavior, their interaction with biological targets, their antitumor potential. The interaction with biological molecules (<i>e.g.</i>, DNA, transferrin and albumin) has been assessed by several techniques: capillary electrophoresis, spectroscopy, atomic force imaging and differential scanning calorimetry. The antitumor activity has been evaluated in tumor cell models by different approaches to evaluate the cytotoxicity (MTT, acid phosphatase). Results have shown that some of these complexes are promising as antitumor agents. Their activity is not affected by serum protein binding <i>in vitro</i>, an important parameter that should be evaluated as part of a drug development process. Their mode of action is still not fully understood, it was demonstrated by different techniques (ICP-MS, electrophoresis) that DNA is not the unique target. The identification of the cellular targets involved in cell death is under investigation.</p> <p>In the scope of this project my contribution has been the cellular uptake studies, the evaluation of the antiproliferative properties, studies of the interaction with biological molecules and the identification of the cellular targets involved in cell death.</p>
3	<p>Synthesis of estradiol-based complexes of In-111 containing different bifunctional chelators (DTPA and DOTA) and characterization as specific vehicles for inserting the Auger electron-emitter In-111 into ER expressing tumor cells with the goal of predicting their therapeutic efficacy. Cellular uptake (confocal microscopy), cytotoxicity and cell proliferation studies have been conducted in ER over-expressing cancer cell lines. The <i>in vitro</i> estrogen receptor binding affinity has been evaluated using the human recombinant ER subtypes, ER<math>\alpha</math> and ER<math>\beta</math>. Biodistribution studies of selected complexes have been performed in tumour-bearing mice in order to get insight on their pharmacokinetics, <i>in vivo</i> stability and ability to target and/or treat tumour.</p> <p>In the scope of this project my contribution has been the cellular uptake studies and the evaluation</p>



	of the relative binding affinity of the compounds with the estrogen receptors subtypes.
4	<p>Synthesis of multi-functional specific agents which combines a bisphosphonate group (zoledronic acid mimetic) a cytostatic unit (docetaxel) and a beta emitter metal fragment for systemic radionuclide therapy. Chemical/Radiochemical characterization of the compounds has been done with the <sup>99m</sup>Tc congeners to evaluate the cellular uptake on human breast and prostate cancer cells and the pharmacokinetic profile in healthy mice and breast and prostate tumor bearing mice model.</p> <p>In the scope of this project my contribution has been the evaluation of the antiproliferative properties. Studies of the cellular uptake with the radioactive compounds are underway.</p>
5	<p>Preclinical evaluation of ruthenium potential drugs for cancer therapy aiming to contribute to the field of chemotherapy in the search for better alternatives.</p> <p>A set of selected Ru/Fe/Ga complexes has been screened to evaluate their cytotoxicity against several cancer cell lines, the uptake and selectivity by tumor and health cells and also the mechanisms of cell death. Some complexes have been involved in biodistribution studies using nude mice in order to evaluate their therapeutic efficacy. Biopsies from tumors collected before and after drug treatment will be analysed by histology and immunohistochemistry and the content of Ru of some tumor samples will be evaluated by ICP-MS. We expect from these studies <i>in vivo</i> to get information on whether any of the Ru-complexes may have potential therapeutic interest, by the preclinical evaluation of the compounds in human xenograft tumor models. The background for this project is supported by our previous achievements recently published concerning the cytotoxicity against several cancer cell lines of a range of Ru-complexes, together with interaction studies involving these compounds and biological proteins.</p> <p>In the scope of this project my contribution is the coordination of all the biological studies conducted at the IST/CTN and the others participating institutions.</p>
6	<p>Development of novel boron compounds for BNCT, a binary radiotherapeutic technique that combines a boron compound (B-10) with thermal neutrons to treat incurable forms of cancer. BNCT has been used with sodium borocaptate (BSH) and boronophenylalanine (BPA). However these drugs lack selectivity and efficacy, justifying the need to develop novel boron carriers capable of overcome these drawbacks. A number of requirements are: good tumour cell selectivity, ability to deposit sufficient amounts of boron, close proximity to DNA and low toxicity. The employed strategy for achieving cell selectivity and sufficient amounts of boron inside cells involves the design of agents that incorporate carboranes due to their high boron content, good biological stability, low toxicity, easy functionalization. The proposal is the synthesis of carboranes functionalized with DNA binding compounds, acridines, acridones and tumour seeking compounds, porphyrins and phthalocyanines. Combining the ability to deposit sufficient amounts of boron, DNA targeting and neutron irradiation we expect to obtain enhanced damage in tumour cells that accumulate these novel carborane carriers when compared with BSH and BPA in clinical use.</p> <p>In the scope of this project my contribution is the coordination of all the work. So far some boron compounds have been synthesized (Aveiro Group) and are now under evaluation (cellular uptake by ICP-MS and confocal microscopy). The best compounds will be selected for the studies with neutron irradiation.</p>
7	<p>Novel heteronuclear lanthanide ruthenium complexes (collaboration with Institut de Chimie Moléculaire de l'Université de Bourgogne). Stability studies of compounds in solution by electrospray ionization mass spectrometry (ESI-MS analysis), cytotoxicity assays (MTT), radiochemical labeling with Sm-153 and biodistribution in healthy mice have been done. Synthesis of cold Sm complexes to characterize the radioactive ones has also been done to predict the potential antitumor activity of the compounds.</p> <p>In the scope of this collaboration my contribution has been the production of Sm-153 in the Portuguese Research Reactor, the radiochemical labeling of the compounds with Sm-153 and the radiochemical control.</p>

## PAPERS

- S. Gama, F. Mendes, T. Esteves, F. Marques, A. Matos, J. Rino, J. Coimbra, M. Ravera, E. Gabano, I. Santos, A. Paulo, Synthesis and biological studies of pyrazolyl-diamine Pt(II) complexes containing polyaromatic DNA-binding groups, *ChemBiochem.* 13, 2352-2362 (2012).
- T. S. Morais, T. J. L. Silva, F. Marques, M. P. Robalo, F. Avecilla, P. J. A. Madeira, P. J. G. Mendes, I. Santos, M. H. Garcia, Synthesis of organometallic ruthenium(II) complexes with strong activity against several human cancer cell lines, *Journal of Inorganic Biochemistry* 114, 65–74 (2012).
- A. I. Tomaz, T. Jakusch, T. S. Morais, F. Marques, R. F. M. Almeida, F. Mendes, E. A. Enyedy, I. Santos, J. C. Pessoa, T. Kiss, M. H. Garcia, [RuII( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)(bipy)(PPh<sub>3</sub>)]<sup>+</sup>, a promising large spectrum antitumor agent : cytotoxic activity and interaction with human serum albumin, *J Inorg Biochem.* 117, 261-269 (2012).
- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Yasuda, T. Thiemann, T. Kniess, I. Santos, Novel 7 $\alpha$ -alkoxy-17 $\alpha$ -(40-halophenylethynyl)estradiols as potential SPECT/PET imaging agents for estrogen receptor expressing tumours: Synthesis and binding affinity evaluation, *Steroids* 77, 1123–1132 (2012).
- M. C. Oliveira, C. Neto, L. Gano, F. Marques, I. Santos, T. Thiemann, A. C. Santos, F. Botelho, C. F. Oliveira, Estrogen receptor ligands for targeting breast tumours: a brief outlook on radioiodination strategies, *Curr Radiopharm.* 5, 124-141 (2012).
- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Thiemann, I. Santos, Novel estradiol based metal complexes of Tc-99m, *Journal of Inorganic Biochemistry* 111, 1–9 (2012).

## COMMUNICATIONS

- *New anti-tumour ruthenium(II) organometallic complexes: cytotoxicity and protein interaction*, T. S. Morais, M. H. Garcia, A. I. Tomaz, F. Marques, F. Mendes, M. P. Robalo, P. J. A. Madeira, XXV International Conference on Organometallic Chemistry - ICOMC, Lisbon, Portugal, September 2012, poster.
- *Polydentate octahedral Ruthenium complexes: synthesis, characterization, anti-tumour activity and interaction with human serum proteins*, C. P. Matos, A. Valente, F. Marques, P. Adão, M. P. Robalo, R. F. M. Almeida, J. C. Pessoa, M. H. Garcia, A. I. Tomaz, XXV International Conference on Organometallic Chemistry - ICOMC, Lisbon, Portugal, September 2012, poster.
- *Synergy in Cancer Therapy: New Targeted Bifunctional Polymeric Metal Complexes for Drug Delivery*, A. Valente, M. H. Garcia, F. Marques, Y. Miao, P. Zinck, XXV International Conference on Organometallic Chemistry - ICOMC, Lisbon, Portugal, September 2012, poster.
- *New targeted bifunctional polymeric metal complexes for drug delivery in cancer therapy*, A. Valente, M. H. Garcia, T. S. Morais, F. Marques, Y. Miao, P. Zinck, 3rd National Meeting on Medicinal Chemistry, Aveiro, Portugal October 2012, poster.

## EDUCATION / THESES SUPERVISION

- Supervisor, M. Sc. Thesis, *Complexos de Ruténio como potenciais agentes terapêuticos: estudos dos mecanismos de captação celular e modulação de enzimas metabólicos*, by Leonor de Sá Nogueira Côrte-Real, Faculdade de Ciências, Universidade de Lisbon, 31 October 2012.

## PROJECTS

- PTDC/QEQ-MED/0833/2012, Novel boron compounds for localized therapy (submitted)

## COLLABORATIONS

- Cellular ultrastructural analysis, Curry Cabral Hospital (António Matos, Head of electron microscopy Sector, President of Portuguese Society of Microscopy)
- Confocal microscopy, Instituto Medicina Molecular, Faculdade Medicina de Lisboa (José Rino, Head of BioImaging Unit)
- Anatomical pathology - Histology and Immunohistochemistry, Hospital de Santa Maria (Francisco Tortosa)

- Evaluation of Ru compounds in human tumor animal models, IPATIMUP and Instituto de Ciências Biomédicas Abel Salazar, Universidade do Porto (ICBAS-UP) (Fátima Gartner, Vice-President of the Scientific Council - ICBAS, Full Professor of Veterinary Pathology - ICBAS)
- Synthesis of boro compounds for BNCT, Universidade de Aveiro, Departamento de Química Química Orgânica, Produtos Naturais e Agroalimentares (Artur Silva and Augusto Tomé)
- Mechanisms of genetic lesion, Faculdade de Ciências Médicas da Universidade de Lisboa, Laboratório de Genética (Jorge Gaspar)
- Novel heteronuclear lanthanide ruthenium complexes, collaboration with Institut de Chimie Moléculaire de l'Université de Bourgogne (Pierre Le Gendre and Michel Pequet).

## PATENTS

- *Transition Metal Complexes for Pharmaceutical Applications*, Patent pending PT105890.

## NOME: Isabel Maria Fernandes Cordeiro dos Santos

**CATEGORIA:** Auxiliary Researcher

**ID NUMBER:** 5360

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Molecular functional materials based on Thiophene-TTF type molecules: from donors to complexes	20%
2	Molecular Materials based on Extended TTF-type molecule with Pyrazine or pyridine groups: from donors to complexes	20%
3	Spin crossover in FeIII complexes and its application in the preparation of multifunctional materials	20
4	One-dimensional Ln coordination polymers with Single-Chain Magnet behaviour	5%
5	Structural analysis of (Per) <sub>2</sub> [M(mnt) <sub>2</sub> ] compounds M=Fe, Co and low temperature distortions	5%
6	f-Element Chemistry with Multidentate Nitrogen and Oxygen Donor Ligands	15%
7	Collaboration with the Radiopharmaceutical Sciences Group	10%
8	Molecular materials for optoelectronics	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
	The structural analysis of the compounds described in the activities were performed by me. The crystallographic data collections were performed on a diffractometer MACH3 (installed in UCQR-ITN) and APEXII CCD equipped with cooling system which enables the data collection at different temperatures, 100 to 295 K (RX Lab installed on the CQE-IST). For the study of some compounds, very small crystals and/or weak diffracting power, we used the Synchrotron Radiation, ESRF, Grenoble, line ID11 (Experiment HS4500 - 9 shifts beam) dedicated to experiments in X-ray diffraction on single crystal.
1	Thiophene-TTF type donors are an important class of substituted TTFs for molecular functional materials. In this work were synthesized and characterized several compounds based on the donor $\alpha$ -DT-TTF (alpha-dithiophene tetrathiafulvalene) molecule, the neutral molecule, a good electronic donor, some of its charge transfer salts or even as ligand in transition metal complexes. As cation were prepared the PF <sub>6</sub> , I <sub>3</sub> , ClO <sub>4</sub> salts and the family of $[\alpha\text{-DT-TTF}]_x[\text{M}(\text{mnt})_2]$ where x can be 1 or 2 and M = Au, Pt and Ni. Several transition metal complexes were prepared with the $\alpha$ -mtpdt and $\alpha$ -tdt ligands. X-ray diffraction data were collected at 150K and structures were refined for the following compound: $\alpha$ -DT-TTF, $(\alpha\text{-DT-TTF})_2(\text{PF}_6)_{0.6}$ , $(\alpha\text{-DT-TTF})(\text{PF}_6)$ , $[\alpha\text{-DT-TTF}]_2[\text{Au}(\text{mnt})_2]$ , $[\alpha\text{-DT-TTF}]_2[\text{Pt}(\text{mnt})_2]$ , $[\alpha\text{-DT-TTF}]_2[\text{Ni}(\text{mnt})_2]$ , $[\alpha\text{-DT-TTF}][\text{Ni}(\text{mnt})_2]$ , (TPAs) <sub>2</sub> [Pd( $\alpha$ -mtpdt) <sub>2</sub> ], (TPAs) <sub>2</sub> [Co( $\alpha$ -mtpdt) <sub>2</sub> ], TBA[Au( $\alpha$ -mtpdt) <sub>2</sub> ], [(15C5) <sub>2</sub> K][Ni( $\alpha$ -mtpdt) <sub>2</sub> ] and TPAs[Au( $\alpha$ -tdt) <sub>2</sub> ]

2	<p>The recent trend in dithiolene chemistry has been the incorporation of functional groups containing N atoms able to coordinate transition metals, in order to explore new coordination structures relevant in the field of magnetic conductors or magnetic coordination polymers. In this work were synthesized and characterized several compounds based on symmetric and asymmetric molecules. With the characterization of these new compounds by X-ray diffraction techniques in single crystal was possible to identify the molecular structure and analyze its crystalline arrangement, their ability or not to form segregated structures and their interactions in order to contribute to a better understanding of their properties. Diffraction data were collected and refined structure of several compounds with emphasis on some donors as Pyrazine-1,3-dithiole-2-thione, Pyrazine-1,3-dithiole-2-one, 5-(pyridin-4-yl)-5-hydro-6-dihydro-[1,4]dithiin-[2,3]dithio-2-thione, 5-(pyridin-4-y)-5-hydro-6-dihydro-[1,4]dithiin-[2,3]dithio-2-one, 4,5-Bis(2-cyanoethylthio)-4',5'-Bis(2-Pyridylethylsulfanyl)tetrathiafulvalene, pzdc-TTF and complexes (tba) [Au(pesdt)<sub>2</sub>], (tba)<sub>2</sub>[Ni(pztdt)<sub>2</sub>] and (tba)<sub>2</sub>[Pd(pztdt)<sub>2</sub>], Ni(4-pedt)<sub>2</sub>] and [Au(4-pedt)<sub>2</sub>]<sub>2</sub>NaPF<sub>6</sub>, [Ni(cyclam)] [Cu(cbdtd)<sub>2</sub>]<sub>2</sub> (CH<sub>3</sub>CN)<sub>2</sub>, (Ph<sub>4</sub>P)<sub>2</sub>[Cu(cbdtd)<sub>2</sub>], (Ph<sub>4</sub>P) [Au(cbdtd)<sub>2</sub>], (tba)<sub>2</sub>[Ni(cbdtd)<sub>2</sub>], (Ph<sub>4</sub>P)<sub>2</sub>[Co(cbdtd)<sub>2</sub>], (tba)<sub>2</sub>[Pd(cbdtd)<sub>2</sub>].</p>
3	<p>The combination of spin crossover (SCO) compounds with other conducting and magnetic functionalities was a topic pursued in the context of the development of new multifunctional and nanostructured materials. The bistability between the HS and LS states is quite promising for the application as molecular memories and switches, as it is associated with changes in the physical properties (crystal structure, magnetism, color etc) In order to study the structural variations associated with HS and LS state, crystallographic data were collected at different temperature, above and below the phase transition. Structural characterization was performed on single crystals by X-ray diffraction for the following compounds:  [FeIII(Cl-qsal)<sub>2</sub>][Ni(dmit)<sub>2</sub>].2ACN collected at 294K, 255K, 150K  [FeIII(Cl-qsal)<sub>2</sub>] Cl (at 294 K ,150K), [FeIII(Cl-qsal)<sub>2</sub>] BF<sub>4</sub> (294 and 150K),  [FeIII(Cl-qsal)<sub>2</sub>] B(ph)<sub>4</sub> (294 and 150K), [FeIII(Cl-qsal)<sub>2</sub>] ClO<sub>4</sub> (294 and 150K)  [FeIII(Br-qsal)<sub>2</sub>] SCN (294, 200, 150, 120K), [FeIII(Br-qsal)<sub>2</sub>] BF<sub>4</sub> (294, 150 K).</p>
4	<p>Continuing the study begun in 2011 on the series of isostructural lanthanide-containing one dimensional coordination polymers with picolinic (pic) and glutaric acid (glu) Ln(glu)(pic)(H<sub>2</sub>O)<sub>2</sub>, where Ln = Gd III, Tb III, Dy III, and Er III were synthesised and structurally characterized by X-ray diffraction in single-crystal new compounds with Dy and Er.</p>
5	<p>The aim of this work is to investigate the low temperature structural modifications of the low dimensional conducting and magnetic two chain compounds (Per)<sub>n</sub>[M(mnt)<sub>2</sub>] M=Fe and Co by single crystal structural data refinements at temperatures above and below the phase transitions, in order to enlighten the mechanisms of these transitions and structural details involved. Using Synchrotron Radiation (ESRF) diffraction data were collected for several compounds at a large range of temperature (from 40 K to 275 K) in order to obtain information on the details of the dimerization.  The crystallographic data collected in the compounds (Per)<sub>2</sub>[Fe(mnt)<sub>2</sub>] and (Per)<sub>2</sub>[Co(mnt)<sub>2</sub>] at 40 K and 100 K allowed us to observe the phenomena of dimerization and tetramerization of the chain. The use of this intense source allowed us to collect data in other molecular compounds with very small dimensions. Data were collected at 100K for the following compounds: Per<sub>n</sub>[Pd(mnt)<sub>2</sub>], β-Per<sub>2</sub>[Pt (mnt)<sub>2</sub>], β-Per<sub>2</sub>[Ni (mnt)<sub>2</sub>], [(15C5)<sub>2</sub>K][Ni(α-mtpdt)<sub>2</sub>], (α-DT-TTF)[Cu(mnt)<sub>2</sub>], (α-DT-TTF)AgCN, (α-DT TTF)PF<sub>6</sub>, (α-DT-TTF) ClO<sub>4</sub>. The data collected at 70 K and 95 K in the spin ladder compound (DT-TTF)<sub>2</sub>[Cu(mnt)<sub>2</sub>] allowed us to observe the chain dimerization.</p>
6	<p>The objective of this project is the synthesis and characterization of new f-element compounds with multidentate N and O donor ligands in order to study their reactivity and magnetic properties. Structural characterization was performed on single crystal by X-ray diffraction, in order to establish the correlation structure / properties for the following compounds: [U(Tp<sup>Me2</sup>)<sub>2</sub>]I, [U(Tp<sup>Me2</sup>)<sub>2</sub>(bipy)], [U(Tp<sup>Me2</sup>)<sub>2</sub>]I, [U ( Me<sub>2</sub>SiNPh-tacn)<sub>3</sub>], [<sup>1</sup>Pr<sub>2</sub>-TACNCH<sub>2</sub>C<sub>6</sub>H<sub>2</sub>Bu<sub>2</sub>O]YCl<sub>2</sub>, [Th<sub>2</sub>Cl(salan-<sup>t</sup>Bu)<sub>2</sub>(μ-η<sup>1</sup>:η<sup>1</sup>-O<sub>2</sub>CCH<sub>2</sub>SiMe<sub>3</sub>)<sub>2</sub>(μ-η<sup>1</sup>:η<sup>2</sup>-O<sub>2</sub>CCH<sub>2</sub>SiMe<sub>3</sub>)], [Th(salan-<sup>t</sup>Bu)<sub>2</sub>](CH<sub>2</sub>SiMe<sub>3</sub>)<sub>2</sub>], [Th(salan-<sup>t</sup>Bu)<sub>2</sub>]Cl<sub>2</sub>(bipy)], [Th(salan-<sup>t</sup>Bu)<sub>2</sub>], [U(salan-<sup>t</sup>Bu)<sub>2</sub>]Cl<sub>2</sub>(bipy)], [U(salan-<sup>t</sup>Bu)<sub>2</sub>]I<sub>2</sub>(bipy)], [U(salan-<sup>t</sup>Bu)<sub>2</sub>], YbTp<sup>tBu,Me</sup>I(pz<sup>tBu,Me</sup>) and Yb{(Ar<sup>Me2</sup>O)<sub>2</sub>Me<sub>2</sub>-cyclam} YbI<sub>2</sub>(THF)<sub>2</sub> [U{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-cyclam}]I, [U(salan-<sup>t</sup>Bu)<sub>2</sub>](CH<sub>2</sub>SiMe<sub>3</sub>)<sub>2</sub>], [U{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-cyclam}]I]BPh<sub>4</sub>, [Sm{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-cyclam}]. Work in collaboration with Inorganic and organometallic Group.</p>

7	The main objective of this collaboration with the Radiopharmaceutical Sciences Group is the structural characterization of cold congeners by single crystal X-ray diffraction analysis. The data collection was performed using a single crystal diffractometer APEXII CCD equipped with an Oxford Cryosystems low-temperature device. Several compounds were analyzed namely new ligands and new metal complexes of Ga, Re.
8	The main objective of the project is the development of n-type organic semiconductors for electronic applications such as field-effect transistors (OFETs) and photovoltaics (OPVs). The strategy is focused on the perylenediimide family, which has led to some of the best n-type materials. Appropriated functional groups are included in the core perylenediimide in order to manipulate and improve structural organization, charge mobility, band gap, solution processability and environmental stability. Structural characterization was performed on single crystals by X-ray diffraction for the following compounds: PDIBr <sub>4</sub> , PDICl <sub>4</sub> , PDI(C <sub>6</sub> H <sub>5</sub> O) <sub>4</sub> and PDI. Work in collaboration with Dr. Helena Alves, researcher -INESC-MN.

## PAPERS

- S.I.G. Dias, S. Rabaça, I.C. Santos, L.C.J. Pereira, R.T. Henriques and M. Almeida, Bisdithiolene complexes based on an extended ligand with TTF and pyridine moieties, *Inorganic Chemistry Communications*, 15, 102–105 (2012), doi: 10.1016/j.inoche.2011.10.001.
- J. M. Carretas, J. Cui 1, I. C. Santos, A. Cruz, L. Maria, J. Marçalo, Uranium(III, IV) and thorium(IV) pyrazolylmethane complexes: Synthesis and structures, *Inorganica Chimica Acta* 385, 53–57 (2012).
- M. Dias, P.A. Carvalho, L.C.J. Pereira, I.C.Santos, O.Tougait, V.H. Tran, A.P. Gonçalves, Crystal structure and magnetism of UFe<sub>3</sub>B<sub>2</sub>, *Journal of Magnetism and Magnetic Materials* 324, 2649–2653 (2012).
- S. Rabaça, Ana C. Cerdeira, S. Oliveira, Isabel C. Santos, R. T. Henriques, L. C.J. Pereira, J. T. Coutinho, M. Almeida, Neutral gold and nickel bis[1-(pyridin-4-yl)-ethylene-1,2-dithiolene] complexes: Synthesis, structure and physical properties, *Polyhedron* 39, 91–98 (2012), doi: 10.1016/j.poly.2012.03.024.
- C. Cerdeira, M. L. Afonso, I. C. Santos, L. C. J. Pereira, J. T. Coutinho, S. Rabaça, D. Simão, R. T. Henriques, and M. Almeida, Synthesis, Structure and Physical Properties of Transition Metal bis 4-cyanobenzene-1,2-dithiolate Complexes [M(cbd<sub>2</sub>)<sub>2</sub>]<sup>z-</sup> M= Zn, Co, Cu, Au, Ni, Pd (z = 0, 1, 2), *Polyhedron* 44, 228-237 (2012), doi: 10.1016/j.poly.2012.07.010.
- Rafaela A. L. Silva, Mónica L. Afonso, Isabel C. Santos, Dulce Belo, Rui R. Freitas, Elsa B. Lopes, Joana Coutinho, Laura C. J. Pereira, Rui T. Henriques, Manuel Almeida and Concepció Rovira, (DT-TTF)<sub>2</sub>[Pd(mnt)<sub>2</sub>]; A unusual ionic salt, *Physica Status Solidi C* 9, No. 5, 1134–1136 (2012).
- R. A. L. Silva, A. I. S. Neves, M. L. Afonso, I. C. Santos, E. B. Lopes, J. T. Coutinho, L. C. J. Pereira, F. Del Pozo, R. Pfattner, M. Maas, C. Rovira, M. Almeida, D. Belo, α-DT-TTF; a detailed study of an electronic donor and its derivatives, *Eur.J. Inorg. Chem.*, DOI: 10.1002/ejic.201201362.
- G. R. Morais, I.C. Santos, I. Santos, and A. Paulo, X-ray diffraction structures of regioisomers of N-methylated benzimidazole compounds with interest for the synthesis of amyloid probes, *J.Chem. Crystallography* 42:1052–1059(2012)
- E. Mora, L.r Maria, B.b Biswas, C.t Camp, I. C. Santos, J.s Pécaut, A. Cruz, J. M. Carretas, J. Marçalo and M. Mazzanti, Diamine Bis(phenolate) as Supporting Ligands in Organoactinide(IV) Chemistry. Synthesis, Structural Characterization and Reactivity of Stable Dialkyl Derivatives, *Organometallics*, dx.doi.org/10.1021/om3010806.

## COMMUNICATIONS

- *Single-Molecule-Magnet Behaviour in [U(Tp<sup>Me2</sup>)<sub>2</sub>]*, Coutinho, J. T.; Antunes, M. A.; Pereira, L. C. J.; Santos, I. C.; Mazzanti, M.; Marçalo, J.; Almeida, M., 18<sup>th</sup> International Conference on Solid Compounds of Transition Elements, 31<sup>st</sup> March – 5<sup>th</sup> April, Lisbon, Portugal (2012), Poster.
- *Diamine bis-phenolates as supporting ligands in organoactinide (IV) chemistry*, Leonor Maria, Elsa Mora, Biplab Biswas, Isabel C. Santos, Jacques Pécaut, Adelaide Cruz, José M. Carretas, Joaquim Marçalo, Marinella Mazzanti, Meeting of COST Action CM1006: European f-Element Network, Tarragona, Espanha, 2-4 April, (2012), Poster.

- *Uranium(III) Tris(pyrazolyl)borate Complexes as Single-Ion Magnets*, Antunes, M. A.; Coutinho, J.; Pereira, L. C. J.; Santos, I. C.; Mazzanti, M.; Marçalo, J.; Almeida, M., *EUFEN 1, European f-Element Chemistry (COST Action CM1006), 2<sup>nd</sup> April–4<sup>th</sup> April, Tarragona, Spain (2012)*, Poster.
- *Lanthanide Ladder Type Coordination Polymers with Single Ion Magnet Behaviour*, P.I. Girginova, L.C.J. Pereira, J.T. Coutinho, I.C. Santos, M. Almeida, *40 International Conference on Coordination Chemistry, Valencia, Spain, Sep 9-13 (2012)*, Poster.
- *Bisdithiolene Complexes Based on Extended TTF-Derivatives Bearing Pyridine Rings*, S.I.G. Dias, J.T. Coutinho, A.I.S. Neves, L.C.J. Pereira, I. C. Santos, S. Rabaça, J.D. Wallis, M. Almeida, *40th International Conference on Coordination Chemistry, Valencia, Spain, Sep 9-13 (2012)*, Invited talk..
- *$\alpha$ -DT-TTF ; a new electronic donor*, R.A.L. Silva, A.I.S. Neves, M.L. Afonso, I.C. Santos, E.B. Lopes, M. Mas-Torrent, C. Rovira, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, 23<sup>th</sup> -24<sup>th</sup> October (2012)*, Invited talk.
- *New bisdithiolene complexes based on substituted thiophenic ligands for magnetic and conducting materials*, A. I. S. Neves, I. C. Santos, J. T. Coutinho, L. C. J. Pereira, E. B. Lopes, R. T. Henriques, H. Alves, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, 23<sup>th</sup> -24<sup>th</sup> October (2012)*, Invited talk.
- *Bisdithiolene Complexes Containing N-coordinating Groups; Towards New Coordination Structures*, A.C. Cerdeira, S. Rabaça, D. Belo, I.C. Santos. L.C.J. Pereira, J.T. Coutinho, R.T. Henriques, D. Simão, O. Jeannin, M. Fourmigué, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24 (2012)*, Invited Lecture.
- *Extended Bisdithiolene Complexes with Benzocyano and Pyrazine Units, for Molecular Materials*, S. Rabaça, S. Oliveira, I.C. Santos. D. Simão, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24 (2012)*, Invited Lecture.

**NAME: Joaquim Miguel Badalo Branco**

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5366

### R&D ACTIVITIES

Nº	Activity Description	R&D
1	Scientific and technical activities	75%
2	Training and teaching activities	20%
3	Services and managing activities	5%
Total		100%

### WORK SUMMARY

Nº	Work Summary and main Achievements
1	<p>The 2012 activities encompass the synthesis, characterization and reactivity studies of inorganic and intermetallic compounds of the actinides and lanthanides. Chemical properties were evaluated by heterogeneous catalytic studies of important environmental issues such as the activation and valorisation of CH<sub>4</sub> and CO<sub>2</sub> as valuable C1 feedstocks and N<sub>2</sub>O as oxidant either for the production of syngas or C2 hydrocarbons over f block elements based nanocatalysts. The work developed shows that new nickel – f block element bimetallic oxide nanocatalysts were highly active and selective towards synthesis gas production at low temperatures and presents remarkable long term stability and an unusual low deposition of carbon, which is a key advantage compared to other nickel or noble metal commercial catalysts. In contrast, over calcium - f block element bimetallic oxide catalysts the reaction main products were primarily C2 hydrocarbons. To our knowledge, this is the first time that such results are reported in the literature.</p> <p>The synthesis and study of alkaline, alkaline-earth, silicon and lanthanide polyalkoxides properties continued as well. Namely, for which concerns its energetic data and reactivity for the activation of</p>

	methane. In particular, new mixed compounds with Si and lanthanide where for the first time synthesized in one step reaction and shown unique properties. Collaborations continued with other research groups within and outside ITN in different areas. Of note is the continued collaboration with the CTN/UFA-Nuclear Instruments Laboratory Group in the field of low temperature gas discharges and its applications to the activation of CH <sub>4</sub> and CO <sub>2</sub> .
2	A significant part of the activity was the training of research students, namely, a Ph.D. and a research grant (FCT, BI) student. The financial support for the work was mostly from FCT, via research projects.
3	A minor part of the activity was dedicated to support and maintenance of UCQR elemental analysis infrastructure and QIO nitrogen filled glove boxes. Managing activities as head of the QIO Catalysis and Catalysts Synthesis and Characterization laboratories continued as well.

## PAPERS

- J.B. Branco, G. Lopes, A.C. Ferreira, J.P. Leal, Catalytic oxidation of methane on KCl-MCl<sub>x</sub> (M=Li, Mg, Co, Cu, Zn) eutectic molten salts, in *Journal of Molecular Liquids*, 1–5, 171 (2012), <http://dx.doi.org/10.1016/j.molliq.2012.04.001>.
- J.B. Branco, A.C. Ferreira, A.M. Botelho do Rego, A.M. Ferraria, T. Almeida-Gasche, Conversion of Methane over Bimetallic Copper and Nickel Actinide Oxides (Th, U) Using Nitrous Oxide As Oxidant, in *ACS Catal.* 2482–2489, 2 (2012), <http://dx.doi.org/10.1021/cs300530h>.
- *Influence of the voltage waveform of a DBD discharge on the conversion of CH<sub>4</sub> and CO<sub>2</sub>*, N. R. Pinhão, A. Janeco, L. M. Redondo, H. Canacsinh, J. Branco, Proceedings *ESCAMPIG XXI*, Viana do Castelo, Portugal, July (2012), P2. 3.10, [http://escampig2012.ist.utl.pt/Proceedings/files/Topic%203/escampig2012\\_submission\\_261.pdf](http://escampig2012.ist.utl.pt/Proceedings/files/Topic%203/escampig2012_submission_261.pdf).

## COMMUNICATIONS

- *Synthesis of intermetallic nanoparticles containing f-elements*, A.C. Ferreira, T. Almeida-Gasche, J.P. Leal, J.B. Branco, *COST Action CM1006 – EUFEN 1, Salou-Tarragona, April (2012)*, Poster.
- *Syngas production over M-Ni nanoparticles*, A.C. Ferreira, J.P. Leal, J.B. Branco, *3rd PYChem, Porto (2012), FC10*, Oral.
- *Synthesis and Characterization of Novel Alkaline and Lanthanide Metal Alkoxides*, P. G. Rosado, J. B. Branco, J. P. Leal, L. M. Ferreira, Joana Lancastre, *3rd PYChem, Porto, Portugal, May (2012)*, Poster communication – P91.
- *Oxidative coupling of methane using nitrous oxide as oxidant over calcium-rare earth oxides nanoparticles*, Ana C. Ferreira, João P. Leal, Joaquim B. Branco, *3rd PYChem, Porto (2012), P6*, Poster.

## EDUCATION / THESES SUPERVISION

- Co-supervisor, Ph.D Thesis, *Nanopartículas de Compostos Intermetálicos para a Eliminação Catalítica de Poluentes Primários*, by Ana Cristina Gomes Ferreira, 2<sup>nd</sup> Year (FCT grant– SFRH/BD/69942/2010-2014) (FCUL/IST-ITN).
- Co-supervisor, Research Grant, *Energética de polialcóxidos metálicos*, by Pedro Rosado (PTDC/QUI/65507/2006 (2009-2012)).

## PROJECTS

- Responsible; *CO<sub>2</sub> mitigation and production of methanol by reforming of CH<sub>4</sub>*, PTDC/AAG-TEC/3324/2012, IST/ITN Coordinator; Joaquim Branco (35%); FCUL partner, recommended for funding (172260 Euros).
- Responsible; *Bimetallic compounds nanoparticles for the selective hydrogenation of nitriles and production of aliphatic amines*, PTDC/QEQ-ERQ/0987/2012, IST/ITN Coordinator (50%), not recommended for funding (165131 Euros).
- Responsible; *Implementação do processo de extração catalítica para o tratamento químico de resíduos sólidos orgânicos: plásticos não conformes e resíduos orgânicos* (IMPEC-TRESOR), Sociedade Ponto Verde, IST/ITN, Coordinator (50%), under evaluation (514854 Euros).

- Team member; *Energética de polialcóxidos metálicos*, FCT, PTDC/QUI/65507/2006 (2009-2012), IST/ITN Coordinator, João Paulo Leal; Joaquim Branco (25%).
- Team member, *Increasing the energy efficiency of plasma conversion of methane*, PTDC/FIS-PLA/2135/2012, IST/ITN Coordinator, Nuno Pinhao, Joaquim Branco (15%), ISEL partner; recommended for funding (102716 Euros).
- Team member; *Application of Ionizing Radiation for a Sustainable Environment*, RECI/AAG-TEC/0400/2012, IST/ITN Coordinator Luisa Botelho; Joaquim Branco (15%), recommended for funding (499469 Euros)

## PATENTS

- N. Pinhão, A. Janeco and J.B. Branco, “*Processo de conversão de metano e um oxidante em gás de síntese e hidrocarbonetos utilizando um plasma não-térmico*”, Assignee: IST/ITN, INPI (patent number Pt-105078) 2012.

**NAME: José Manuel da Cunha Oliveira Figueira Carretas**

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5369

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Mass Spectrometry Studies of the Coordination Chemistry of Lanthanides and Actinides	80%
2	Thorium and Uranium Complexes with Diamino Bis(phenolate) Ligands	20%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	Electrospray ionization quadrupole ion trap mass spectrometry (ESI/QITMS) was used to study the coordination chemistry in gas phase and in solution of trivalent species of An and Ln {AnX <sub>2</sub> <sup>+</sup> , LnX <sub>2</sub> <sup>+</sup> , AnX <sub>4</sub> <sup>-</sup> , LnX <sub>4</sub> <sup>-</sup> (X = halide, nitrate, etc.); An = Th – Cm; Ln = La – Lu, except Pm} with N and O-donor heterocyclic organic molecules. The results obtained showed several differences and similarities in the chemistry of trivalent Ln and An which contribute to explain some An(III)/Ln(III) selectivity in An/Ln separations. This activity is associated with the ACSEPT {Actinide reCYcling by SEPARation and Transmutation (FP7-Euratom/CP-2007-211267)} and the ACTINET (13/FP7-III-232631/JRP17) projects.
2	ESI/QITMS was used in the characterization of new thorium and uranium complexes supported by diamino bis(phenolate) ligands of the type [An{salan-R <sub>2</sub> }X <sub>2</sub> (X = Cl, I; H <sub>2</sub> (salan-R <sub>2</sub> ) = N,N-bis(2-hidroxibenzil-3,5-R-1,2-dimetilaminometano). The results obtained showed that this tetradentate ligand is adequate for the stabilization of Th(IV) and U(IV) alkyl complexes, which were used in reactivity studies with CO <sub>2</sub> .

## PAPERS

- J.M. Carretas, J. Cui, I.C. Santos, A. Cruz, L. Maria, J. Marçalo, Uranium(III, IV) and Thorium(IV) pyrazolylmethane complexes: syntheses and structures, *Inorganica Chimica Acta*, 385, 53-57 (2012), doi:10.1016/j.ica.2011.12.033
- E. Mora, L. Maria, B. Biswas, C. Camp, I.C. Santos, J. Pécaut, A. Cruz, J.M. Carretas, J. Marçalo, M. Mazzanti, Diamine bis(phenolate) as supporting ligands in organoactinide(IV) chemistry. Synthesis, structural characterization, and reactivity of stable dialkyl derivatives, *Organometallics*, dx.doi.org/10.1021/om3010806



## COMMUNICATIONS

- *Diamine bis-phenolate as supporting ligands in organoactinide(IV) chemistry*, L. Maria, E. Mora, B. Biswas, I.C. Santos, J. Pécaut, A. Cruz, J.M. Carretas, J. Marçalo, M. Mazzanti, *1<sup>st</sup> Meeting of the European f-Element Network, Tarragona, Spain, April 1-4 (2012)*, Poster presentation.
- *III/IV Oxidation state stabilities of lanthanides and actinides in the gas phase*, J.M. Carretas, A.F. Lucena, C. Lourenço, P.X Rutkowski, M.C. Michelini, N. Zorz, L. Berthon, J.K. Gibson, J. Marçalo, *1<sup>st</sup> Meeting of the European f-Element Network, Tarragona, Spain, April 1-4 (2012)*, Poster presentation.
- *Synthetic actinide chemistry in the gas phase*, J.K. Gibson, D. Rios, P.X Rutkowski, J. Marçalo, A.F. Lucena, C. Lourenço, J.M. Carretas, M.C. Michelini, *Materials Research Society Spring Meeting and Exhibit, San Francisco, California, USA, April 9-13 (2012)*, Oral presentation.
- *Gas-phase studies of the relative affinities of N- and O-donor bases toward Ln(III) and An(III) ions*, C. Lourenço, A.F. Lucena, J.M. Carretas, B. Monteiro, I. Paiva, J. Marçalo, N. Zorz, L. Berthon, *Atalante Nuclear Chemistry for Sustainable Fuel Cycles, Montpellier, France, September 2-7 (2012)*, Poster presentation.

## PROJECTS

- Covalency in f-element chemistry – a view from the gas phase (PTDC/QEQ-QFI/1697/2012); project not recommended for funding.

---

## NOME: Laura Cristina de Jesus Pereira Waerenborgh

CATEGORY: Auxiliary Researcher

ID NUMBER: 25370

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Management of the magnetic characterization facility in the Solid State group: operation and maintenance of the Maglab2000 and SQUID magnetometers	15%
2	Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds; $\alpha(\text{Per})_2[\text{M}(\text{mnt})_2]$ , PRESSMAG, PTDCI/FIS/113500/2009.	10%
3	Study and development of new molecular magnets, MOLMAG, PTDC/CTM/102284/2008.	10%
4	High-Curie temperature dilute magnetic oxide semiconductors for application in Spintronics, SEMISPIN, PTDC/CTM/101033/2008,	10%
5	f-Element centers for single molecule magnetic behaviour; from lanthanides to uranium	10%
6	Multifunctional conducting materials with spin crossover behavior	10%
7	<u>Ni-2,3-thiophenedithiolate anions as building blocks for molecular magnetic materials</u>	10%
8	Bisdithiolene complexes containing N-coordinating groups; towards new coordination structures	5%
9	Magnetic and strongly correlated electron behavior in intermetallics	5%
10	Supervision and training of research students	15%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>Coordination of the magnetic characterization facility in the Solid State group with the magnetometers, <i>S700X SQUID</i> (Cryogenic Ltd) (REEQ/322/QUI/2005) and <i>Maglab2000</i> (Oxford Instruments).</p> <p>The acquired expertise has been able to contribute to several research projects either from local or foreign institutions. The use of these equipments always require extreme conditions of low temperature and high magnetic fields which lead to also apply expertise in cryogenics technology.</p> <p><i>S700X SQUID</i> has 2 pick-up coils in the main magnet assembly with 7T and operates in the range 1.5-320K in both DC and AC mode (0.01-500Hz). A <math>^3\text{He}</math> insert allows measurements down to 0.3K.</p>

	<p>This equipment has been mainly dedicated to study samples with relatively low moments such as molecular materials, small single crystals and films.</p> <p><i>Maglab2000</i> allows magnetic measurements in the range 1.5-400K under fields up to 12T, either by extraction DC or AC susceptibility (10Hz-10kHz). In 2012 its use was mainly devoted to the magnetic characterization of single molecule magnetic materials. Another type of probe used in this system, allows specific heat measurements of small samples in the range 2-200K using a relaxation technique and under different magnetic fields up to 12T.</p>
2	<p>Charge transfer salts based on perylene and transition metal bis-maleonitrile-dithiolate <math>M(\text{mnt})_2</math> (<math>M=\text{Au, Cu, Ni, Pd, Pt, Co, Fe}</math>) may present different stoichiometries and polymorphs. The <math>\alpha</math>-<math>(\text{Per})_2[M(\text{mnt})_2]</math> phases are of special interest due to unique properties derived from the coexistence in the same solid of two types of chains: conducting chains of partially oxidised perylene molecules <math>(\text{Per})^{1/2+}</math> and chains of monoanionic complexes <math>[M(\text{mnt})_2]^-</math> that depend on the metal can be either diamagnetic or paramagnetic. Recently the conditions that allowed for the first time the growth of <math>(\text{Per})_2[\text{Pd}(\text{mnt})_2]</math> crystals by electrocrystallisation were found in our group. The electrocrystallisation is limited by close proximity of the oxidation potentials of the perylene donor and <math>[\text{Pd}(\text{mnt})_2]^-</math> anion. Depending on the experimental conditions different morphologies can be obtained.</p> <p><math>(\text{Per})_2[\text{Pd}(\text{mnt})_2]</math> crystals were found to be mainly of the <math>\beta</math> -polymorph with properties comparable to the Cu, Ni and Pt previously described. The beta type nature of these needle crystals was confirmed by magnetic susceptibility which shows gradual increase upon cooling in a fashion also comparable to that of the <math>\beta</math>-Ni and <math>\beta</math> -Cu analogues.</p>
3	<p>In the scope of this project the search of molecular magnets based on Cu(II) nitrophenylacetate and oxo-centered Fe(III) carboxylate complexes were pursued with significant structural and magnetic characterization progresses.</p> <p>In the structure of Cu(II) compounds there is the formation of alternated chains where one of the bridging paths between the metal centers is made by four carboxylic groups, in a paddle-wheel configuration. A strong antiferromagnetic behavior was revealed in Catena-(bis(<math>\mu_3</math>-4-nitrophenylacetato-O,O,O<math>\prime</math>)-(bis(<math>\mu_2</math>-4-nitrophenylacetato-O,O<math>\prime</math>)-copper(II) with a coupling constant of <math>-302\text{cm}^{-1}</math>, in close agreement with studies based on broken-symmetry unrestricted density functional theory.</p> <p>The monocationic complexes which contain three high spin Fe(III) centers were some of the polynuclear systems to allow a critical examination of the theory of the exchange interaction. The relatively large metal-metal distances which exclude the possibility of direct metal-metal bonding and their highly symmetrical nature make these “tasty” systems with which to examine magnetic interactions. Our interest is to use these trinuclear clusters as precursors to obtain “ferric wheels”. In the <math>[\text{Fe}_3\text{O}(\text{CNCH}_2\text{COO})_6(\text{H}_2\text{O})_3][\text{NO}_3]\cdot 5\text{H}_2\text{O}</math> complex antiferromagnetic exchange interactions of <math>-22.85\text{cm}^{-1}</math> were obtained that compel the system to a total spin ground state of <math>S=1/2</math>. This is attributed to an indirect exchange mechanism via both the oxide ion and the carboxylate groups.</p>
4	<p>In order to check the magnetic nature for spintronic applications the characterisation of the magnetic of selected <math>\text{Co}:\text{TiO}_2</math>, <math>\text{Co}:\text{SnO}_2</math>, <math>(\text{Co},\text{M}):\text{TiO}_2</math> and <math>(\text{Co},\text{M}):\text{SnO}_2</math> (<math>M=\text{Nb, Mo, Re}</math>) thin films was pursued. In particular, the potential of <math>\text{Mo}^{+6}</math> in <math>(\text{Co},\text{Mo})</math>-co-doped <math>\text{SnO}_2</math> thin films for obtaining diluted magnetic semiconductors with improved properties such as transparency and chemical sensitivity has been explored.</p> <p>Magnetic field dependence of the magnetization at 300K and 4K of several samples was investigated and the results correlated with the morphology and the doping content and element. While the pure <math>\text{SnO}_2</math> film showed diamagnetic behavior the 0.5% Co-doped and (1%Co, 3%Mo) co-doped <math>\text{SnO}_2</math> films show a weak ferromagnetic signal with practically no hysteresis. This behavior is typical of materials displaying superparamagnetism and might be explained by the low concentration of the magnetic transition metal allied with the most likely low carrier mobility. The most promising result was obtained for the film doped with 3%Co, which shows ferromagnetic behavior at low magnetic fields with well-defined hysteresis curves. It could also be verified that the presence of Mo did not contribute either to the increase of films conductivity nor to the enhancement of the ferromagnetic order of the Co-doped films.</p>
5	<p>Considered as a hot topic in the scientific community the main goal of this project is to develop new</p>

	<p><i>f</i>-element complexes as discrete molecules that display single molecule magnetic (SMM) behavior and to establish magneto-structural correlations, mainly the role of the 5<i>f</i> electrons in stronger magnetic exchange environments. These studies are expected to enlighten the origin of the low temperature magnetic relaxation mechanisms and improve the design of new compounds with higher relaxation barriers.</p> <p>In 2012 the magnetic characterization of a series of lanthanide-containing one-dimensional coordination polymers based on picolinic and glutaric acids, Ln(glu)(pic)(H<sub>2</sub>O)<sub>2</sub>, Ln=Gd, Tb, and Dy and mononuclear uranium(III) compounds based on the Tp<sup>Me<sub>2</sub></sup> ligand such as [U(Tp<sup>Me<sub>2</sub></sup>)<sub>2</sub>] were done. All these compounds clearly present at low temperatures slow relaxation of magnetization. In the Ln(glu)(pic)(H<sub>2</sub>O)<sub>2</sub> compounds, in spite of the double chain ladder structure, these effects are due to single ions as in the uranium compounds which are still rare examples of actinide complexes with SMM behavior, however establishing already some important structure-magnetic properties correlations. The identification of mononuclear lanthanide compounds with clear single ion magnet behavior shows that many of the previously claimed single chain magnet behavior with <i>f</i>-elements is due essentially to single ion effects.</p>
6	<p>The main goal of this research item is the development of new multifunctional hybrid molecular materials that display the coexistence or synergism of spin crossover (SCO) with other properties, such as magnetism or electrical conductivity. In 2012 the magnetization of [Fe(nsal<sub>2</sub>trien)]SCN was measured in great detail showing that it displays thermally-induced spin crossover with two well-separated steps at 250 K and 142 K, and an ordered intermediate phase based on the repetition of the High Spin-Low Spin, [HS-LS], motif although none of them showing thermal hysteresis. These results are in good agreement with the Mössbauer spectroscopy and single crystal diffraction data revealing the existence of an intermediate ordered phase with two crystallographic distinct Fe<sup>III</sup> centers separating the isostructural HS and LS phases, each with a single Fe<sup>III</sup> center. The magnetic interactions seem to be rather weak and the origin of the two steps SCO process related to the existence of structural constrains. This behavior and on particular the sequence of phases ([HS]; [HS-LS]; [LS]) and the structural symmetry breaking in the intermediate phase is quite unusual in SCO compounds making these results a main reference in multifunctional materials.</p>
7	<p>The [Ni(α-tpdt)<sub>2</sub>]<sup>-</sup> anion, a small planar paramagnetic S=1/2 specie, has been one of the preferential molecular building blocks for constructing molecular magnetic materials and as a base component for electronic devices. In spite of its relatively small size it exhibits a considerable spin density polarisation over the ligand and consequently the resulting magnetic interactions in its salts are strongly dependent on the geometry of the anionic intermolecular contacts in the crystal structure. This is the reason why, the role of the counter-cation is so important, because it induces and modulates the anionic arrangements in the crystal structures. Since the role of non magnetic K<sup>+</sup> crown-ether cations, acting as a linker between the paramagnetic [Ni(α-tpdt)<sub>2</sub>]<sup>-</sup> anion or inducing new supramolecular structures had remained unexplored in the crystal engineering of such materials, the preparation and structural and magnetic characterization of a new series of compounds based on based on the [Ni(α-tpdt)<sub>2</sub>]<sup>-</sup> anion, and crown-ethers cations, [K(18-crown-6)]<sup>+</sup> and [K(15-crown-5)]<sup>+</sup>, was done These salts present interesting magnetic properties resulting from a competition between AFM and FM interactions with a low temperature cluster glass behaviour associated with the ligand <i>cis-trans</i> disorder.</p>
8	<p>In 2012 the synthesis and characterization of new bimetallic compounds based on transition metal bisdithiolene complexes containing N atoms, such as [M(cbdt)<sub>2</sub>]<sup>2-</sup>, [M(dcbdt)<sub>2</sub>]<sup>2-</sup> and [M(dcdmp)<sub>2</sub>]<sup>2-</sup> with M = Fe, Cu was made in order to study their coordination ability combined with complexes bearing [M(cyclam)]<sup>2+</sup> (M=Ni, Cu) cations. From these combinations, the 5 most promising compounds were characterized and their magnetic properties correlated with their crystal structures. The Cu/Ni compounds usually form regular chains of anions and cations with antiferromagnetic interactions. The effective moments correspond to S= 1 and S=1/2 for Ni and Cu, respectively.</p> <p>In the case of Fe compounds, [Cu(cyclam)]<sub>2</sub>[Fe<sub>2</sub>(cbdt)<sub>4</sub>]<sub>2</sub> and [Ni(cyclam)]<sub>2</sub>[Fe<sub>2</sub>(cbdt)<sub>4</sub>]<sub>2</sub>, both Fe chain anions form dimers with the usual contribution of S=3/2 spins from iron. In the Cu/Fe compound there is also the contribution of two Cu(cyclam) S = 1/2 which remain paramagnetic. Ni/Fe seems to present a different structure since the temperature dependent magnetization down to 1.7 K indicate a weak antiferromagnetic interaction which presume that the expected Ni(cyclam) S=1 contribution is absent in this case.</p>

9	<p>The understanding of the magnetic and strongly correlated electron behavior of intermetallics containing <i>f</i>-elements (in particular the role of <i>5f</i>-electrons) has been subject of a long-term project in the Solid State group.</p> <p>During 2012 preliminary studies were made on the low temperature physical properties of UFeGe samples, which indicated that the structural distortion is due to the increase on the density of states at the Fermi level.</p> <p>The magnetic characterization of the low temperature physical properties of large single crystals of U<sub>2</sub>Fe<sub>3</sub>Ge grown by the Czochralski method was also started. An abnormally small magnetic anisotropy was observed in this compound.</p> <p>In other uranium ternary systems, the crystal structure and magnetic properties of the UFe<sub>3</sub>B<sub>2</sub> was studied, revealing a ferromagnetic behavior in the 2-300K temperature range.</p>
10	<p>Supervision and training of research students, which include the maintenance of the magnetometers and their operation during the measurements performance and further analysis of the results.</p> <p>Training of Penka Girginova (SFRH/BPD/63370/2009), Ana Neves (SFRH/BD/46613/2008), Ana Cerdeira (SFRH/BD/46543/2008), and Rafaela Silva (Master BI under the research project, <i>Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds; <math>\alpha</math>-(Per)<sub>2</sub>[M(mnt)<sub>2</sub>]</i>, PTDC/FIS/113500/2009) from the Solid State group, IST/ITN.</p> <p>Training of João Nuno Jorge Nogueira and Pedro Alberto Oliveira Costa e Silva from the Phys. Dept. University of Coimbra, 1<sup>st</sup> year of Mestrado em Engenharia Física (disciplina de Tecnologias Quânticas), (under the research project <i>Study and development of new molecular magnets</i>, PTDC/CTM/102284/2008).</p> <p>Supervision of Joana Coutinho (master BI under the research project, <i>Pressure and magnetic field effects in two-chain (conducting and magnetic) compounds; <math>\alpha</math>-(Per)<sub>2</sub>[M(mnt)<sub>2</sub>]</i>, PTDC/FIS/113500/2009, from March 2011 until August 2012.</p> <p>PhD supervisor of Bruno Vieira, SFRH/BD/65237/2009, with the title “Condutores moleculares comutáveis”, since October 2012.</p>

## PAPERS

- S.I.G. Dias, S. Rabaça, I.C. Santos, L.C.J. Pereira, R.T. Henriques, M. Almeida, Bisdithiolene complexes based on an extended ligand with TTF and pyridine moieties *Inorg. Chem. Comm* 15, 102-105 (2012). <http://dx.doi.org/10.1016/j.inoche.2011.10.001>
- M. Afonso, R.A.L. Silva, M. Matos, E.B. Lopes, J.T. Coutinho, L.C.J. Pereira, R.T. Henriques, M. Almeida, Growth of (Perylene)<sub>2</sub> [Pd(mnt)<sub>2</sub>] crystals, *J. Crystal Growth*, 340, 56-60 (2012). [10.1016/j.jcrysgro.2011.11.083](http://dx.doi.org/10.1016/j.jcrysgro.2011.11.083).
- A.J. Silvestre, L.C.J. Pereira, M.R. Nunes, O.C. Monteiro, Ferromagnetic Order in Aged Co-Doped TiO<sub>2</sub> Anatase Nanopowders, *Journal of Nanoscience and Nanotechnology*, 12(8), 6850-6854 (2012). <http://dx.doi.org/10.1166/jnn.2012.4550>.
- R.A.L. Silva, M.L. Afonso, I.C. Santos, D.Belo, R.R. Freitas, E.B. Lopes, J.T. Coutinho, L.C.J. Pereira, R.T. Henriques, M. Almeida, C. Rovira, (DT-TTF)<sub>2</sub>[Pd(mnt)<sub>2</sub>]: An unusual ionic salt, *Phys. Status Solidi C* 9, No. 5, 1134–1136 (2012). <http://dx.doi.org/10.1002/pssc.201100631>.
- M.L. Afonso, R.A. Silva, L.C.J. Pereira, J.T. Coutinho, R.R. Freitas, E.B. Lopes, M. Matos, R.T. Henriques, A.Viana, M. Almeida Electrocrystallisation of (Per)<sub>2</sub> [Pd(mnt)<sub>2</sub>], *Phys. Status Solidi C* 9, No. 5, 1131–1133 (2012). <http://dx.doi.org/10.1002/pssc.201100632>.
- D. Belo, A.I.S. Neves, L.C.J. Pereira, M. Almeida, Magnetic properties of [K(18-crown-6)][Ni( $\alpha$ -tpdt)<sub>2</sub>], *Physica Status Solidi C* 9, No.5, 1199–1201 (2012). <http://dx.doi.org/10.1002/pssc.201100637>.
- S. Rabaca, A. Cerdeira, S. Oliveira, I.C. Santos, R.T. Henriques, L.C.J. Pereira, J.T. Coutinho, M. Almeida; Neutral gold and nickel bis[1-(pyridin-4-yl)-ethylene-1,2-dithiolene] complexes: Synthesis, structure and physical properties; *Polyhedron* 39, 91–98 (2012). <http://dx.doi.org/10.1016/j.poly.2012.03.024>.
- A.C. Cerdeira, M.L. Afonso, I.C. Santos, L.C.J. Pereira, J.T. Coutinho, S. Rabaça, D. Simão, R.T. Henriques, M. Almeida; Synthesis, Structure and Physical Properties of Transition Metal bis 4-cyanobenzene-1,2-dithiolate Complexes [M(cbdt)<sub>2</sub>]<sup>z-</sup> (M = Zn, Co, Cu, Au, Ni, Pd, z = 0, 1, 2); *Polyhedron*

44, 228–237 (2012). <http://dx.doi.org/10.1016/j.poly.2012.07.010>.

- J.T. Coutinho, M.A. Antunes, L.C.J. Pereira, J. Marçalo, M. Mazzanti, H. Bolvin, M. Almeida, Single-Ion Magnet behaviour in  $[U(Tp^{Me2})_2I]$ , *Dalton Transactions* **41(44)**, 13568–13571 (2012). <http://dx.doi.org/10.1039/C2DT31421E>.
- M Ramos Silva, J.N.J. Nogueira, P.A.O.C. Silva, C. Yuste-Vivas, L.C.J. Pereira, J.C. Waerenborgh, Oxo-bridged trinuclear Fe(III) complexes: structural and magnetic properties, *Solid State Phenomena*, 194, 162–170 (2013). <http://dx.doi.org/10.4028/www.scientific.net/SSP.194.162>.
- S. Dalui, S. Rout, A.J. Silvestre, G. Lavareda, L.C.J. Pereira, P. Brogueira, O. Conde, Structural, electrical and magnetic studies of Co:SnO<sub>2</sub> and (Co,Mo):SnO<sub>2</sub> films prepared by pulsed laser deposition, *Applied Surface Science in press*. <http://dx.doi.org/10.1016/j.apsusc.2012.12.039>.

## COMMUNICATIONS

- *Slow magnetic relaxation in f-element compounds; from lanthanide double chain magnets to uranium single-ion magnets*, M.A. Antunes, P. Girginova, J. T. Coutinho, L.C.J. Pereira, I.C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), oral.
- *Studies on the UFe<sub>3</sub>B<sub>2</sub> uranium boride*, A.P. Gonçalves, M. Dias, P. Carvalho, L.C.J. Pereira, I. Santos, O. Tougait, V. Tran, 42<sup>èmes</sup> Journées des Actinides (42<sup>nd</sup> JdA), Bristol, England, UK, April 18-21 (2012), oral.
- *f-Element centers for single molecule magnetic behaviour; from lanthanides to uranium*, M.A. Antunes, P.I. Girginova, J.T. Coutinho, L.C.J. Pereira, I. C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, 62<sup>nd</sup> Fujihara Seminar, Frontier and Perspectives in molecule-based quantum magnets, Koyo Grand Hotel, Sendai, Japan, May 7-10 (2012), invited oral.
- *Uranium-iron-germanium intermetallic compounds*, M.S. Henriques, D.I. Gorbunov, J.C. Waerenborgh, L.C.J. Pereira, E.B. Lopes, L. Havela, A.V. Andreev, T. Klimczuk, A. Rudajevová, O. Tougait, R. Vilar, AP Gonçalves, 10<sup>th</sup> Prague Colloquium on f-Electron Systems (PCFES), Prague, Czech Republic, August 21-24 (2012), oral.
- *Bisdithiolene Complexes Based on Extended TTF-Derivatives Bearing Pyridine Rings*, S.I.G. Dias, J.T. Coutinho, A.I.S. Neves, L.C.J. Pereira, I.C. Santos, S. Rabaça, J.D. Wallis, M. Almeida, ICC40, 40<sup>th</sup> International Conference on Coordination Chemistry, Valencia, Spain, September 9-13(2012), oral.
- *Bisdithiolene Complexes Containing N-coordinating Groups; Towards New Coordination Structures*, A.C. Cerdeira, S. Rabaça, D. Belo, I.C. Santos, L.C.J. Pereira, J.T. Coutinho, R.T. Henriques, D. Simão, O. Jeannin, M. Fourmigué, M. Almeida, Workshop on Molecular Materials with Strong Electronic Correlations, Institut des Sciences Chimiques de Rennes, Rennes, France, October 23-24 (2012), Invited oral.
- *New bisdithiolene complexes based on substituted thiophenic ligands for magnetic and conducting materials*, A.I.S. Neves, I.C. Santos, J.T. Coutinho, L.C.J. Pereira, E.B. Lopes, R.T. Henriques, H. Alves, M. Almeida, D. Belo, Workshop on Molecular Materials with Strong Electronic Correlations, at the, Institut des Sciences Chimiques de Rennes, Rennes, France, October 23-24 (2012), Invited oral.
- *Oxo-bridged trinuclear Fe(III) complexes: structural and magnetic properties*, M. Ramos Silva, J.N.J. Nogueira, P.A.O.C. Silva, C. Yuste-Vivas, L.C.J. Pereira, J.C. Waerenborgh, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), poster.
- *Low-temperature properties of orthorhombic UFeGe*, A.P. Gonçalves, M.S. Henriques, L.C.J. Pereira, M. Almeida, L. Havela, J.C. Waerenborgh, E.B. Lopes, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), poster.
- *Single-Molecule-Magnet behaviour in  $[U(Tp^{Me2})_2I]$* , J.T. Coutinho, M.A. Antunes, L.C.J. Pereira, I.C. Santos, M. Mazzanti, J. Marçalo, M. Almeida, 18th International Conference on Solid Compounds of Transition Elements, SCTE2012, Lisbon, Portugal, March 31-April 5 (2012), poster.
- *Uranium(III) Tris(pyrazolyl)borate Complexes as Single-Ion Magnets*, Maria A. Antunes, Joana Coutinho, Laura C.J. Pereira, Isabel C. Santos, Marinella Mazzanti, Joaquim Marçalo, Manuel Almeida, European f-

element Chemistry, EUFEN1, Cost Action CM1006, Univ. Rovira I Vergili, Tarragona, Spain, April 2-4 (2012), poster.

- *Magnetic Properties of a Dysprosium Layered Lanthanide Hydroxide and its intercalation for 2,6-naphthalenedicarboxylate*, Cláudia C.L. Pereira, Laura C.J. Pereira, Bernardo Monteiro, Ho M. Dung, Joaquim Marçalo, Manuel Almeida, *European f-element Chemistry, EUFEN1, Cost Action CM1006, Univ. Rovira I Vergili, Tarragona, Spain, April 2-4 (2012)*, poster.
- *Antiferromagnetic exchange interactions in a Cu(II) alternated chain*, M. Ramos Silva, P.S.P. Silva, B. Milne, L.C.J. Pereira, J.A. Paixão, *27<sup>th</sup> European Crystallographic Meeting, Bergen, Norway, August 6-11 (2012)* poster.
- *A 2D copper(II) complex with paddle-wheel building blocks: structural and magnetic properties*, J.P.M. Rodrigues, C.M.M. Azevedo, C. Yuste-Vivas, J. Coutinho, L.C.J. Pereira, M. Ramos Silva, *Física 2012, 18<sup>a</sup> Conferência Nacional de Física, 22<sup>o</sup> Encontro Ibérico para o Ensino da Física, Univ. Aveiro, Portugal, September 6-8 (2012)*, poster.
- *Lanthanide Ladder Type Coordination Polymers with Single Ion Magnet Behaviour*, P.I. Girginova, L.C.J. Pereira, J.T. Coutinho, I.C. Santos, M. Almeida, *ICCC40, 40<sup>th</sup> International Conference on Coordination Chemistry, Valencia, Spain, September 9-13 (2012)*, poster.
- *Variable Dimensionality in Copper(II) Coordination Polymers*, M. Ramos Silva, C. Yuste-Vivas, N.D. Martins, L.C.J. Pereira, M. Julve, *ICCC40, 40<sup>th</sup> International Conference on Coordination Chemistry, Valencia, Spain, September 9-13 (2012)*, poster.
- *Dimensionality in Copper(II) Coordination Polymers*, C. Yuste-Vivas, M. Ramos Silva, L.C.J. Pereira, J. Ferrando-Soriac, M. Julve, *ICCC40, 40<sup>th</sup> International Conference on Coordination Chemistry, Valencia, Spain, September 9-13, 2012*, poster.

## PROJECTS

- *Study and development of new molecular magnets*, PTDC/CTM/102284/2008, *MOLMAG*, May 2010-May 2013. Leading Institution: Departamento de Física, Universidade de Coimbra Coordinator: Maria Manuela Ramos Silva. IST/ITN Coordinator: L.C.J. Pereira (10%).
- *High-Curie temperature dilute magnetic oxide semiconductors for application in Spintronics*, PTDC/CTM/101033/2008, *SEMISPIN*, Jan. 2010-Dec. 2012, Leading Institution: Departamento de Física, ISEL. Coordination: António J. Silvestre. IST/ITN Coordinator: L.C.J. Pereira (10%).

### 2012 - Responsible Researcher

- *Study and development of single molecule magnets based on f elements*, PTDC/QEQ-QIN/2019/2012. **Evaluation Results: 5 Outstanding**; In face of high competition for funding, this proposal did not reach a position to be funded: Not funded.

## CONFERENCE ORGANIZATION

- Member of the Organizing Committee of *18th International Conference on Solid Compounds of transition Elements* (SCTE 2012), Lisbon, Portugal, March 31-April 5, 2012.

---

**NAME: Maria Cristina das Neves Oliveira**

**CATEGORIA:** Auxiliary Researcher

**ID NUMBER:** 5371

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for Targeted Radiotherapy of Tumors – PTDC/QUI-QUI/111891/2009. <i>Team member.</i> In collaboration with Doutora Lurdes Gano (PI) from Radiopharmaceutical Sciences Group, IST/ITN.	25%

2	Albumin binding-domain fusion to improve protein pharmacokinetics – PTDC/SAU-FAR/115846/2009. <i>Team member.</i> In collaboration with Doutor João Galamba Correia (IST/ITN coordinator) from Radiopharmaceutical Sciences Group, IST/ITN and Prof. João Gonçalves (PI) from the Unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon.	15%
3	Radioligandos para o receptor estrogénico-potencial clínico em imagem e terapia. Fundação Calouste Gulbenkian - 964767/2009. <i>IST/ITN coordinator.</i> In collaboration with Prof. M. Filomena Botelho (PI) from Instituto de Biofísica/Biomatemática, Faculty of Medicine, University of Coimbra.	30%
4	Radiosynthesis and biological evaluation of Ib-KTP-NH <sub>2</sub> - <sup>125</sup> I In collaboration with Prof. Miguel Castanho from Unidade de Bioquímica Física, Instituto de Medicina Molecular, Faculty of Medicine, University of Lisbon.	20%
5	Radioiodination of thioflavin derivatives with high binding affinity for beta-amyloid plaques	10%
Total		100%

## WORK SUMMARY

Nº	Workk Summary and Main Achievements
1	<p>The use of therapeutic radiopharmaceuticals has been an important strategy in the management of cancer since they can deliver radiation doses to specific diseases sites in target organs or tissues while sparing healthy cells. Aiming to contribute for the development of radionuclide targeted therapeutic agents of cancer as safer alternatives to conventional therapies this strategy uses estradiol-based radiometal complexes as specific delivery vectors to insert Auger electron-emitter radionuclides (<i>e.g.</i> <sup>111</sup>In and <sup>67</sup>Ga) within tumor cells over-expressing estrogen receptors (ER). A set of 16<math>\alpha</math>-substituted estradiols, containing diverse spacer chains, were coupled to the bifunctional chelating agent DOTA. The cold gallium and indium complexes were synthesized by reaction with Ga(NO<sub>3</sub>)<sub>3</sub> and InCl<sub>3</sub>, respectively. The radioactive complexes were prepared by reaction with <sup>67</sup>GaCl<sub>3</sub> and <sup>111</sup>InCl<sub>3</sub>, respectively and were obtained in radiochemical purity (&gt;95%). Both complexes are stable in human blood serum and at physiological concentrations of apo-transferrin. The complexes do not undergo relevant transchelation in presence of an excess of DTPA. The preclinical evaluation of the radioactive complexes is underway in order assess their ability to target ER in malignant tumors</p> <p>As team member of this project my contribution has been delineating alternative synthetic strategies, discussing results and supervising students involved in this task1.</p>
2	<p>Small domain antibodies are a promising class of biopharmaceuticals with very high potential in therapeutic applications, however, due to their small size, are rapidly cleared from circulation. The unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon, proposed a bacterial albumin-binding domain (Zag) derived from <i>Streptococcus zooepidemicus</i> fused to an anti-TNF VHH small domain antibody as a strategy to improve the pharmacokinetic properties of therapeutic proteins. Profiting from the presence of hexahistidine tags in the proteins VHH and VHH fused with the ZAG albumin-binding domain, both antibodies were labeled with [<sup>99m</sup>Tc(CO)<sub>3</sub>]<sup>+</sup> and purified (&gt; 95%). The radioactive VHH-based antibodies are stable towards transchelation reactions in the presence of histidine or cysteine, as well as in human serum for 24 hours. The biodistribution studies in healthy CD-1 mice indicated that the ZAG domain affected the pharmacokinetic profile of <sup>99m</sup>Tc(I)-PL-VHH with a remarkable 10-25 fold decrease of blood clearance. The <sup>125</sup>I-labeling of biomolecules within this project is on my responsibility.</p>
3	<p>Fulvestrant is a steroidal pure antiestrogen with high binding affinity for estrogen receptor (ER). Fulvestrant has no known agonist activity and has been approved for breast cancer treatment. Although this treatment will provide clinical benefit, fulvestrant resistant disease will eventually occur. Radiolabelled antiestrogens that retain their antiestrogenic activity, allowing <i>in vivo</i> assessment of tumor uptake and washout, may help to elucidate the cause of resistance to therapy. This study is aimed to investigate the ability of <sup>125</sup>I/<sup>67</sup>Ga/<sup>111</sup>In-labelled in predicting the effect of</p>

	fulvestrant therapy in ER+ tumors. Radioiodination of fulvestrant with $^{125}\text{I}$ was carried out by electrophilic aromatic substitution. Fulvestrant- $^{125}\text{I}$ was obtained in radiochemical purity higher than 98% after HPLC purification. To assess the feasibility of fulvestrant- $^{125}\text{I}$ for functional imaging of ER+ tumors biodistribution studies are presently ongoing. The use of radiometals for labeling requires a bifunctional chelating agent (BCA), such as DOTA, that binds to the molecule and act as an acceptor site for the metal. Since $16\alpha$ -estradiols are known to bind well to the ER, the BCA was attached to the $16\alpha$ -position of fulvestrant by a saturated 4-carbon linker resulting in a novel conjugate fulvestrant-DOTA. The labeling conditions for the synthesis of $^{111}\text{In}$ -DOTA-fulvestrant and $^{67}\text{Ga}$ -DOTA-fulvestrant complexes are currently underway.
4	The neuropeptide Kyotorphin (KTP) is potently analgesic when delivered directly to the central nervous system. However, its inability to cross the blood–brain barrier (BBB) precludes its possible clinical use as an analgesic after systemic administration. The chemical grafting of KTP with ibuprofen (Ib), a non-steroidal analgesic anti-inflammatory drug, has resulted in a highly analgesic peptide able to interact with BBB endothelial cells. Following previous studies with KTP-amide, the novel IbKTP-amide (IbKTP-NH <sub>2</sub> ), with enhanced lipophilicity and good analgesic ability after systemic delivery, was radioiodinated with I-125 to investigate its ability to cross the BBB <i>in vivo</i> . Radiodination was accomplished by electrophilic aromatic substitution at the tyrosyl ring. After optimizing the labeling conditions IbKTP-NH <sub>2</sub> - $^{125}\text{I}$ was obtained in radiochemical purity higher than 98% after HPLC purification. IbKTP-NH <sub>2</sub> - $^{125}\text{I}$ was shown to be radiochemically stable <i>in vitro</i> under physiological conditions. J. Almeida has done some of the radioiodination assays under my supervision. Biodistribution studies to assess the ability of IbKTP-NH <sub>2</sub> - $^{125}\text{I}$ to cross the BBB were subsequently carried out by Lurdes Gano.
5	Alzheimer’s disease (AD) is a brain disorder showing progressive memory loss and decrease of cognitive function. Excessive amounts of beta-amyloid (A $\beta$ ) plaques are commonly detected in the postmortem brains of AD patients. These A $\beta$ plaques are believed to play an important role in the pathogenesis of the disease. A $\beta$ plaque-specific imaging agents for detecting and monitoring the changes of A $\beta$ plaque deposition in living brains that may serve as potential biomarkers for the disease are being developed in our group. Several fluorinated derivatives based on variety of core structures are labeled with radiofluorine as positron emission tomography (PET) imaging agents. To be effective as brain imaging agents these derivatives should display high binding affinity for A $\beta$ aggregates. To assess the binding affinity by competitive binding assays it is necessary to synthesize radioligands with recognized binding characteristics, as radioionated thioflavin derivatives $^{125}\text{I}$ -TZDM and $^{125}\text{I}$ -IMPY. $^{125}\text{I}$ -TZDM and $^{125}\text{I}$ -IMPY were prepared from the corresponding tributyltin derivatives by an iododestannylation reaction, which resulted in high specific activity tracers. Both radioligands display high radiochemical purity and will be used by Lurdes Gano in the determination of binding affinity of the novel compounds for A $\beta$ aggregates.

## PAPERS

- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Yasuda, T. Thiemann, T. Kniess, I. Santos, Novel  $7\alpha$ -alkoxy- $17\alpha$ -(4'-halophenylethynyl)estradiols as potential SPECT/PET imaging agents for estrogen receptor expressing tumors: synthesis and binding affinity evaluation, *Steroids*, 77, 1123-1132 (2012) doi:10.1016/j.steroids.2012.05.004.
- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Thiemann, I. Santos, Novel estradiol based complexes of Tc-99m, *Journal of Inorganic Biochemistry*, 111, 1-9 (2012), doi:10.1016/j.jinorgbio.2012.03.001
- M. Kuchar, M. C. Oliveira, L. Gano, I. Santos, T. Kniess, Radioiodinated sunitinib as a potential radiotracer for imaging angiogenesis-radiosynthesis and first radiopharmacological evaluation of 5- $^{125}\text{I}$ iodo-sunitinib, *Bioorganic & Medicinal Chemistry Letters*, 22, 2850-2855 (2012), doi:10.1016/j.bmcl.2012.02.068.
- M.C. Oliveira, C. Neto, L. Gano, F. Marques, I. Santos, T. Thiemann, A.C. Santos, F. Botelho, C.F. Oliveira, Estrogen receptor ligands for targeting breast tumors: a brief outlook on radioiodination strategies, *Current Radiopharmaceuticals* 5, 124-141 (2012), doi:10.2174/1874471011205020124.



- C. Neto, C. Fernandes, M.C. Oliveira, L. Gano, F. Mendes, T. Kniess, I. Santos, Radiohalogenated 4-anilinoquinazoline-based EGFR-TK inhibitors as potential cancer imaging agents, *Nuclear Medicine & Biology*, 39, 247–260 (2012), doi:10.1016/j.nucmedbio.2011.09.001.
- M. Morais, P.D. Raposinho, M.C. Oliveira, D. Pantoja-Uceda, M.A. Jiménez, I. Santos, J.D.G. Correia, NMR Structural Analysis of MC1R-Targeted Rhenium(I) Metallopeptides and Biological Evaluation of <sup>99m</sup>Tc(I) Congeners, *Organometallics*, 31, 5929–5939 (2012), doi:10.1021/om300502n
- M. Morais, P.D. Raposinho, M.C. Oliveira, J.D. Correia, I. Santos, Evaluation of novel (99m)Tc(I)-labeled homobivalent  $\alpha$ -melanocyte-stimulating hormone analogs for melanocortin-1 receptor targeting, *Journal of Biological Inorganic Chemistry*, 17, 491-505 (2012), doi:10.1007/s00775-011-0871-y

## COMMUNICATIONS

- *Synthesis and preclinical evaluation of <sup>67</sup>Ga-/<sup>111</sup>In-estradiol based complexes for tumour imaging*, S. Cunha, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *16<sup>th</sup> European Symposium on Radiopharmacy and Radiopharmaceuticals*, Nantes, France, April 26-29, (2012), Poster.
- *Synthesis and characterization of novel DOTA – Estradiol derivatives targeting the Estrogen Receptor*, S. M. Cunha, F. J. Vultos, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry*, Lisbon, Portugal, Sep 2-7 (2012), Poster.
- *Novel <sup>111</sup>In-estradiol based complexes: preclinical evaluation for oestrogen positive tumour targeting*, S. Cunha, F. Vultos, C. Fernandes, M.C. Oliveira, M. F. Botelho, I. Santos, L. Gano, *25<sup>th</sup> European Association of Nuclear Medicine Congress*, Milan, Italy, Oct27-31, (2012), Poster.
- *MC1R-targeting properties of <sup>99m</sup>Tc(I)-labeled cyclic  $\alpha$ -MSH analogs with thioether or amine bridge*, J. D. G. Correia, M. Morais, P. D. Raposinho, M. C. Oliveira, I. Santos, M. A. Jiménez, D. Pantoja-Uceda, *XIII Iberian Peptide Meeting*, Alicante, Spain, Feb 1-3 (2012), Poster.
- *Modulation of the Pharmacokinetic Properties of <sup>99m</sup>Tc(CO)<sub>3</sub>- $\beta$ Ala-MTII*, M. Morais, B. L. Oliveira, J. D. G. Correia, M. C. Oliveira, I. Santos, P. D. Raposinho, *XIII Iberian Peptide Meeting*, Alicante, Spain, Feb 1-3 (2012), Poster.
- *Design, characterization and evaluation of cyclized  $\alpha$ -MSH Derivatives for MC1R Targeting*, M. Morais, P. D. Raposinho, M. C. Oliveira, M. A. Jiménez, D. Pantoja-Uceda, J. D. G. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry*, Lisbon, Portugal, Sep 2-7 (2012), Poster.

## EDUCATION

- Invited Lecturer at Escola Superior de Tecnologias de Saúde de Lisboa, Instituto Politécnico de Lisboa. Master Course on Nuclear Medicine: Rádiofármacos com Aplicação em Tomografia por Emissão de Positrões. 2011-2012.

## PROJECTS

### Submitted in 2012

#### Principal Researcher (35%)

- *A new multimodal approach for SPECT/PET imaging and targeted radionuclide therapy of EGFR expressing tumors*, PTDC/QEQ-MED/1976/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. IST/ITN Principal Researcher: M. Cristina Oliveira (35%). *Not recommended for funding.*

**NAME: Maria de Lurdes Barreia Patricio Gano**

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5373

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Coordination of the project, Synthesis and Pre-clinical Evaluation of Novel Estradiol-	30%

	Based Indium Complexes for Targeted Radiotherapy of Tumors, PTDC/QUI-QUI/111891/2009. In collaboration with Prof. Filomena Botelho from IBILI, Faculty of Medicine, University of Coimbra.	
2	Radiolabeled Benzazole Derivatives for In vivo Imaging of Amyloid Aggregation, PTDC/QUI-QUI/102049/2008. <i>Team member.</i>	5%
3	Albumin binding-domain fusion to improve protein pharmacokinetics, PTDC/SAU-FAR/115846/2009. <i>Team member.</i> In collaboration with Prof. João Gonçalves (PI) from the Unit of Retrovirus and Associated Infections, Faculty of Pharmacy, University of Lisbon.	15%
4	Synthesis, characterization and biological assessment of multi-functional bone-seeking agents, PTDC/QUI-QUI/115712/2009. <i>Team member.</i> In collaboration with Prof. Luis Costa from the Unit of Clinical and Translational Oncology Research Unit of IMM, Faculty of Medicine, University of Lisbon.	10%
5	Radioligandos para o Receptor Estrogénico - Potencial Clínico em Imagem e Terapia de Tumores da Mama. CIMAGO/ FCG (Project nº 96476). <i>Team member.</i> In collaboration with Prof. Filomena Botelho (PI) from IBILI, Faculty of Medicine, University of Coimbra.	5%
6	Preclinical evaluation of ruthenium potential drugs for cancer therapy, PTDC/QUI-QUI/118077/2010. <i>Team member.</i> In collaboration with Prof. M. H. Garcia (PI) from Faculty of Sciences, University of Lisbon.	15%
7	Radiolabeling and biological assessment of therapeutic antibodies – Technophage. Services Agreement, between IST/ITN and TECHNOPHAGE company, 15 <sup>th</sup> March 2012.	10%
8	Radiosynthesis and biological evaluation of Ib-KTP- NH <sub>2</sub> - <sup>125</sup> I Collaboration with Prof. Miguel Castanho from Physical Biochemistry Research Unit of IMM, Faculty of Medicine, University of Lisbon.	5%
9	Management of Animal Facilities; Management of Radiation Protection Program in the Radiopharmaceutical Sciences Group	5%
Total		100

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	This projects aims to contribute for the development of radionuclide targeted therapeutic agents of cancer as safer alternatives to conventional cancer therapies. The oestrogen receptor (ER) is an important tumour target due to its overexpression in many malignant cells as compared to normal cells. Thus, we intend to synthesise and evaluate <sup>111</sup> In-estradiol based complexes as specific delivery vectors to insert Auger electrons within tumor cells over-expressing ER. A set of estradiol derivatives have been obtained by reaction of estradiol substituted at the 16 $\alpha$ -position with DTPA or DOTA bifunctional chelators. The <sup>111</sup> In-complexes were prepared in high radiochemical yield and purity. The complexes are stable <i>in vitro</i> in the presence of physiological concentrations of apo-transferrin and in human blood serum. Preliminary animal studies indicate high <i>in vivo</i> stability, a rapid clearance from main organs and fast excretion. Celular uptake studies in breast cancer cells suggest that uptake may occur via an ER-mediated process. The preclinical evaluation of the radioactive complexes is underway in order assess their ability to target ER in malignant tumors. Most of the experimental work of the project has been done by S. Cunha (PhD student) and F. Vultos (BI) under my supervision (PI of the project) and Dr. C. Fernandes.
2	Alzheimer's disease (AD) is a progressive neurodegenerative disorder with significant impact in public health worldwide. The formation of beta-amyloid (A $\beta$ ) deposits is considered a histopathological feature of AD patients. These A $\beta$ plaques are believed to play an important role in

	<p>the pathogenesis of the disease.</p> <p>Within the frame work of this project a family of radiofluorinated styryl benzazole derivatives have been designed and as A<math>\beta</math> deposits-specific imaging agents for detecting and monitoring the changes of A<math>\beta</math> plaque deposition in living brains that may serve as potential biomarkers for the disease. The preliminary biological evaluation of these [<sup>18</sup>F]-compounds consisted on their <i>in vivo</i> biodistribution and metabolism assesment in a well established AD animal model, old transgenic 3xTg-AD mice. Results from these studies indicated brain uptake demonstrating the ability of the compounds to cross the BBB. However a significant femur uptake that increased with time suggests the occurrence of <i>in vivo</i> defluorination. Additionally, HPLC analysis of urine and blood serum samples confirmed the rapid <i>in vivo</i> metabolism.</p>
3	<p>Small domain antibodies are a promising class of biopharmaceuticals with very high potential in therapeutic applications. However, due to their small size they are rapidly cleared from circulation limiting their clinical usefulness. Plasma protein binding can be an effective approach to improve pharmacokinetics properties of short-life molecules. Thus, the unit of Retrovirus and Associated Infections, Faculty of Pharmacy, UL, proposed a bacterial albumin-binding domain (Zag) derived from <i>Streptococcus zooepidemicus</i> fused to an anti-TNF VHH small domain antibody as a strategy to improve the pharmacokinetic properties of therapeutic proteins. Profiting from the presence of hexahistidine tags in the proteins VHH and VHH fused with the Zag albumin-binding domain, both antibodies were labeled with [<sup>99m</sup>Tc(CO)<sub>3</sub>]<sup>+</sup>, purified (&gt; 95%) and their radiochemical stability assessed in our group. The binding ability to albumin and the imunoreactivity of the radiolabelled small domain antibodies was also evaluated. To confirm the longest half-life of the VHH-ZAG antibody comparative biodistribution studies of both <sup>99m</sup>Tc labeled antibodies were carried out in healthy CD-1 mice up to 48 h. These assays indicated that the Zag domain affected the pharmacokinetic profile of <sup>99m</sup>Tc(I)-PL-VHH with remarkable decrease of blood clearance. The animal studies (biodistribution and pharmacokinetics studies) are at my responsibility.</p>
4	<p>The main goal of the project entitled “Synthesis, characterization and biological assessment of multi-functional bone-seeking agents” is the assessment of the simultaneous delivery of radiation/bisphosphonates/chemotherapy to bone metastatic lesions, using novel and well-defined multifunctional chemical identities. By using a bifunctional chelating approach, the bone-uptake of the bisphosphonate (BP) is expected to be preserved, reducing toxicity exposure to extra-skeletal sites. A synergistic effect of such combination, in pain therapy and/or cancer progression, compared to the conventional sequential treatment, and an understanding of the underlying mechanisms is expected. Within this project a set of novel organometallic compounds of the type fac-[M(CO)<sub>3</sub>(k3-Pz-BP)]<sup>+</sup>, which contain a bisphosphonate unit (bone seeking agent), and the metal fragment fac-[M(CO)<sub>3</sub>] (M = <sup>99m</sup>Tc, Re) have been successfully synthesized and characterized. Under the framework of Task 2 the <i>in vivo</i> biological evaluation of the complexes in animals (mice and rats) is on my responsibility. Thus, I have studied the biodistribution profile of two new <sup>99m</sup>Tc tricarbonyl complexes bearing bisphosphonates in Bal-C mice to assess their pharmacokinetic profile and their bone-seeking affinity. These studies demonstrate that complexes present significant differences in their tissue distribution profile but both have high and prolonged bone uptake.</p>
5	<p>Fulvestrant is a steroidal pure antiestrogen with high binding affinity for estrogen receptor (ER). Fulvestrant has no known agonist activity and has been approved for breast cancer treatment. Although this treatment will provide clinical benefit, fulvestrant resistant disease will eventually occur. Radiolabelled antiestrogens that retain their antiestrogenic activity, allowing <i>in vivo</i> assessment of tumor uptake and washout, may help to elucidate the cause of resistance to therapy. This study aims to investigate the ability of <sup>125</sup>I/<sup>67</sup>Ga/<sup>111</sup>In-labelled in predicting the effect of fulvestrant therapy in ER+ tumors.</p> <p>Fulvestrant was already radioiodinated with <sup>125</sup>I to assess the feasibility of fulvestrant-<sup>125</sup>I for functional imaging of ER+ tumors.</p> <p>The use of radiometals, like <sup>67</sup>Ga and <sup>111</sup>In, for labeling is currently underway. This labeling approach requires a bifunctional chelating agent (BCA), such as DOTA, that binds to the molecule and act as an acceptor site for the metal. Since 16<math>\alpha</math>-estradiols are known to bind well to the ER, a BFC was attached to the 16<math>\alpha</math>-position of fulvestrant by a saturated 4-carbon linker resulting in a novel conjugate fulvestrant-DOTA.</p>

	<p>My participation in this project has been the discussion of work strategies, relevant results and the supervision of the post-doc student C. Neto aiming to accomplish the project goals.</p>
6	<p>The preclinical evaluation of ruthenium potential drugs for cancer therapy proposed in this project aims to contribute for the search of more selective and efficient chemotherapeutic drugs than the existing ones.</p> <p>A set of selected Ru/Fe/Ga complexes has been screened to evaluate their cytotoxicity against several cancer cell lines, the uptake and selectivity by tumor and health cells and also the mechanisms of cell death. From those studies two Ru complexes have been selected for animal studies in human xenograft tumour mice to evaluate their therapeutic efficacy. Biopsies from tumors collected before and after drug treatment will be analysed by histology immunohistochemistry and the Ru content of tumors evaluated by ICP-MS.</p> <p>My contribution for this project has been:</p> <ul style="list-style-type: none"> <li>- Preliminary study of acute toxicity of the Ru complexes in healthy mice;</li> <li>- Establishment of adequate animal models for evaluation of therapeutic efficacy of the Ru complexes as chemotherapeutic drugs through biodistribution studies. For that purpose, different cell lines have been used to induce tumors in nude mice and those animals injected with the complexes.</li> </ul> <p>From <i>in vivo</i> studies we expect to get information on the potential therapeutic interest of any of the Ru-complexes.</p>
7	<p>Under the Services Agreement between the Technophage company and the IST/ITN for radiolabeling and biological assessment of therapeutic antibodies, I had the responsibility to carry out the biodistribution studies of the radiolabelled antibodies to assess their <i>in vivo</i> stability and pharmacokinetics profile. The radioalabeling work was done by B. Oliveira, and I performed the animal studies at different time points after i.v. or i.p. injection in different animal models (mice and rats).</p>
8	<p>The neuropeptide Kyotorphin (KTP) is potently analgesic when delivered directly to the central nervous system. However, its inability to cross the blood–brain barrier (BBB) precludes its possible clinical use as an analgesic after systemic administration. Under collaboration with Prof. M. Castanho from IMM, FMUL, a novel KTP-derivative (IbKTP-NH<sub>2</sub>) with enhanced lipophilicity and good analgesic ability after systemic delivery was successfully radioiodinated with I-125 in our lab to investigate its ability to cross the BBB.</p> <p>Biodistribution studies were performed in male Wistar Han rats indicating that IbKTP-NH<sub>2</sub>-<sup>125</sup>I is preferentially taken by the hepatobiliar tract. A high level of radioactivity was found in the blood stream. The very low level of radioactivity found in the brain suggests that the IbKTP-NH<sub>2</sub>-<sup>125</sup>I was not able to cross the BBB. The low radioactivity levels found in thyroid suggest that IbKTP-NH<sub>2</sub>-<sup>125</sup>I is stable <i>in vivo</i> at the studied post-injection time points. The <i>in vivo</i> stability of IbKTP-NH<sub>2</sub>-<sup>125</sup>I was also assessed in rat urine. The total urine radioactivity was excreted as free radioiodide (in approximately 50%) and as IbKTP-NH<sub>2</sub>-<sup>125</sup>I.</p>
9	<p>The management of the animal facilities requires the maintenance of the housing, feeding and care requirements of small rodents (rats and mice) making sure that the guidelines to carry out animal experiments are in accordance with the EU recommendations on the use of living animals in scientific investigation and follow the principles of laboratory animal ethics and care. These principles were essential to get the approval and the working license from the National Authority, DGV in agreement with the National Legislation.</p> <p>The Group of Radiopharmaceutical Sciences is committed to a Radiation Protection Program (RPP) according to the license from DGS n° 987/07, proc n° 1650. This RPP is designed to control operations with radioactive compounds conducted within the research laboratories of the group that may result in the potential exposure to ionizing radiation. It is my responsibility to supervise the maintenance of this RPR as well as the training of personnel on its implementation.</p>

## PAPERS

- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Yasuda, T. Thiemann, T. Kniess, I. Santos, Novel 7 $\alpha$ -alkoxy-17 $\alpha$ -(4'-halophenylethynyl)estradiols as potential SPECT/PET imaging agents for estrogen receptor expressing tumors: synthesis and binding affinity evaluation. *Steroids* 77, 1123-1132 (2012), doi:10.1016/j.steroids.2012.05.004.
- C. Moura, L. Gano, F. Mendes, P. D. Raposinho, A.M. Abrantes, M.F. Botelho, I. Santos, António Paulo, 99mTc(I)/Re(I) Tricarbonyl Complexes for Targeting of Melanotic Melanoma: Synthesis and Biological Evaluation. *Eur J Med Chem* 50, 350-360 (2012), dx.doi.org/10.1016/j.ejmech.2012.02.014
- C. Neto, M. C. Oliveira, L. Gano, F. Marques, T. Thiemann, I. Santos, Novel estradiol based complexes of Tc-99m. *Journal of Inorganic Biochemistry* 111, 1-9 (2012), doi:10.1016/j.jinorgbio.2012.03.001.
- M. Kuchar, M. C. Oliveira, L. Gano, I. Santos, T. Kniess, Radioiodinated sunitinib as a potential radiotracer for imaging angiogenesis-radiosynthesis and first radiopharmacological evaluation of 5-[125I]iodo-sunitinib. *Bioorganic & Medicinal Chemistry Letters* 22, 2850-2855 (2012), doi:10.1016/j.bmcl.2012.02.068.
- M.C. Oliveira, C. Neto, L. Gano, F. Marques, I. Santos, T. Thiemann, A.C. Santos, F. Botelho, C.F. Oliveira. Estrogen receptor ligands for targeting breast tumors: a brief outlook on radioiodination strategies. *Curr Radiopharm* 5, 124-14 (2012), doi:10.2174/1874471011205020124.
- C. Moura, L. Gano, I. C. Santos, A. Paulo, I. Santos. 99mTc(I) Scorpionate Complexes for Brain Imaging: Synthesis, Characterization and Biological Evaluation. *Curr. Radiopharm* 5, 150-157 (2012), doi: 10.2174/1874471011205020150.
- C. Santos, C. M: Matos, B. Oliveiros, T. Almeida, L. Gano, M. Neves, N. Ferreira. Thermolabile Liposomes: a Controlled Release Delivery Tool in Diagnosis/Therapy in Experimental Pulmonary Edema. *Curr. Radiopharm* 5, 166-174 (2012), doi: 10.2174/1874471011205020166.
- F. Mendes, L. Gano, C. Fernandes, A. Paulo, I. Santos, Studies of the myocardial uptake and excretion mechanisms of a novel 99mTc heart perfusion agent. *Nucl Med Biol* 39, 207-213 (2012), doi:10.1016/j.nucmedbio.2011.08.007.
- C. Neto, C. Fernandes, M.C. Oliveira, L. Gano, F. Mendes, T. Kniess, I. Santos. Radiohalogenated 4-anilinoquinazoline-based EGFR-TK inhibitors as potential cancer imaging agents. *Nucl Med Biol* 39, 247-260 (2012), doi:10.1016/j.nucmedbio.2011.09.001.
- J. Caballero, C. Muñoz, J. H. Alzate-Morales, S. Cunha, L. Gano, R. Bergmann, J. Steinbach, T. Kniess, Synthesis, in silico, in vitro, and in vivo investigation of 5-[11C]methoxy-substituted sunitinib, a tyrosine kinase inhibitor of VEGFR-2. *Eur J Med Chem* 58, 272-280(2012), dx.doi.org/10.1016/j.ejmech.2012.10.020.
- F. Vultos, S. Cunha, C. Fernandes, L. Gano, I. Santos, Estradiol based indium complexes towards the estrogen receptor. *Acta of the International Symposia on Metal Complexes – ISMEC Acta*, Volume 2, p. 352-353 (2012).

## COMMUNICATIONS

- *Protecção contra radiação ionizante*, L. Gano, *Curso Avançado de Biofísica, FMUC, Coimbra, (2012)*, Invited Talk.
- *Synthesis and preclinical evaluation of <sup>67</sup>Ga-/<sup>111</sup>In-estradiol based complexes for tumour imaging*, S. Cunha, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *16<sup>th</sup> European Symposium on Radiopharmacy and Radiopharmaceuticals, ESRR'12, Nantes, France, April 26-29 April (2012)*, poster.
- *Albumin-binding domain (Zag) from Streptococcus zooepidemicus increases half-life and affect blood clearance of anti-TNF VHH*, C. Cantante, S. Lourenço, M. Morais, L. Gano, C. Santos, C. Fontes, J. Correia, F. Silva, J. Gonçalves, *8<sup>th</sup> Annual PEGS 2012, Boston, USA, April 30 – May 4 (2012)*, poster.
- *Estradiol based indium complexes towards the estrogen receptor*, F. Vultos, S. Cunha, C. Fernandes, L. Gano, I. Santos, *XXIII International Symposia on Metal Complexes – ISMEC, Lisbon, June 18-22 (2012)*, poster.

- *Alkylamine-bearing N-heterocyclic chelators for hard metal ions*, A. Capelo, L. Areias, M. A. Esteves, L. Gano, S. Chaves, M. A. Santos, *XXIII International Symposia on Metal Complexes – ISMEC, Lisbon, June 18-22 (2012)*, poster.
- *Radiofluorinated benzazole derivatives for in vivo imaging of amyloid aggregation*, G. Ribeiro Morais, L. Gano, T. Kniess, R. Bergamn, A. Abrunhosa, C. Pereira, C. Oliveira, I. Santos, A. Paulo, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 (2012)*, poster.
- *Synthesis and characterization of novel DOTA – Estradiol derivatives targeting the Estrogen Receptor*, S. M. Cunha, F. J. Vultos, C. Fernandes, M. C. Oliveira, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, Sep 2-7 (2012)*, poster.
- *BP-containing M(CO)<sub>3</sub>-complexes (M=99mTc/Re) as multi-functional bone-seeking agents*, S. Monteiro, P. Mendes, C. Fernandes, L. Gano, E. Palma, J. Correia, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, Sep 2-7 (2012)*, poster.
- *Rhenium(i) and technetium-99m(i) tricarbonyl complexes with hybrid scorpionates: chemical studies and biological evaluation*, A. Paulo, C. Moura, L. Gano, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, Sep 2-7 (2012)*, poster.
- *Influence of polar substituents on the biodistribution and metabolic stability of pyrazolyldiamine <sup>99m</sup>Tc(i) organometallic complexes*, A. R. Palma, C. Fernandes, L. Gano, A. Paulo, I. Santos, *XXV International Conference on Organometallic Chemistry – ICOMC 2012, Lisbon, Sep 2-7 (2012)*, poster.
- *Novel <sup>111</sup>In-estradiol based complexes: preclinical evaluation for oestrogen positive tumour targeting*, S. Cunha, F. Vultos, C. Fernandes, M. C. Oliveira, M. F. Botelho, I. Santos, L. Gano, *25<sup>th</sup> EANM Congress, Milan, Italy, Oct 27-31 (2012)*, poster.
- *Multifunctional gold nanoparticles for theranostic applications*, F. Silva, A. Zambre, L. Gano, A. Paulo, R. Kannan, I. Santos, *COST action TD1004 meeting “Theranostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery”*, London, UK, *Oct 29-30 (2012)*, poster.
- *Albumin-binding domain from Streptococcus pyogenes protein H increases half-life and affect blood clearance of anti-TNF VHH*, C. Cantante, S. Lourenço, J. Leandro, M. Morais, L. Gano, C. Fontes, J. Correia, P. Leandro, F. Silva, J. Gonçalves, *PEGS Summit Europe 2012, Vienna, Austria, Nov 6-8, (2012)*, poster.

## EDUCATION / THESES SUPERVISION

- Main Jury member (*arguente*): M. Sc. Thesis, *Efeitos da radiação X e níveis de exposição em exames imagiológicos síntese, caracterização e avaliação biológica de compostos multifuncionais*, by Patrícia Carvalho Veludo, Faculdade de Medicina da Universidade de Coimbra, 14 February 2012.
- Invited Lecturer at the Faculdade de Farmácia da Universidade de Lisboa, Master Course on Clinical Analysis.
- Invited Lecturer at the Faculdade de Farmácia da Universidade de Lisboa, Master Course in Pharmaceutical Sciences: Discipline of Radiopharmacy.
- Supervisor of undergraduated student, Monography, *Marcação da grelina – potencial interesse da sua aplicação em medicina nuclear*, by Joana Castro, Escola Superior de Tecnologia da Saúde de Lisboa, January 2012.
- Supervisor of undergraduated student, Monography, *positrão na doença de Alzheimer*, by Ana Teresa Pinto, Escola Superior de Tecnologia da Saúde de Lisboa, January 2012.
- Supervisor of undergraduated student, Monography, *RGD na monitorização e terapêutica de angiogénese associada a processos patológicos*, by Janete Almeida, Escola Superior de Tecnologia da Saúde de Lisboa, 21 December 2012.

## PROJECTS

### Principal Researcher

- *Synthesis and Pre-clinical Evaluation of Novel Estradiol-Based Indium Complexes for Targeted Radiotherapy of Tumors* (PTDC/QUI-QUI/111891/2009). Leading Institution: ITN, Sacavém, Portugal. IST/ITN Principal Researcher: L. Gano.

### Team Member

- *Radioligandos para o Receptor Estrogénico - Potencial Clínico em Imagem e Terapia de Tumores da Mama*. Centro de Investigação em Meio Ambiente, Genética e Oncobiologia (CIMAGO) supported by Fundação Calouste Gulbenkian (Project nº 96476).
- *Radiolabeled Benzazole Derivatives for In vivo Imaging of Amyloid Aggregation*, PTDC/QUI-QUI/102049/2008. Leading Institution: ITN, Sacavém, Portugal. IST/ITN Principal Researcher: A. Paulo.
- *Synthesis, Characterization and Biological Assessment of Multi-Functional Bone-Seeking Agents*, PTDC/QUI-QUI/115712/2009. Leading Institution: ITN, Sacavém, Portugal. IST/ITN Principal Researcher: I. Santos.
- *Albumin binding-domain fusions to improve protein pharmacokinetics*, PTDC/SAU-FAR/115846/2009. Leading Institution: Associação para o Desenvolvimento do Ensino e Investigação da Microbiologia (ADEIM), Faculdade de Farmácia, Universidade de Lisboa. Principal Researcher: João Manuel Braz Gonçalves.
- *Chemical, Radiochemical and Biological Studies of Pyrazolyl-Alkylamine Pt(II) Complexes: Application on the Development of Novel Anti-cancer Drugs*, PTDC/QUI/66813/2006. Leading Institution: ITN, Sacavém, Portugal. IST/ITN Principal Researcher: A. Paulo.
- *Preclinical evaluation of ruthenium potential drugs for cancer therapy*, PTDC/QUI-QUI/118077/2010. Leading Institution: Fundação da Faculdade de Ciências, Universidade de Lisboa. Principal Researcher: H. Garcia.

---

**NAME: Maria Isabel Marques Dias**

**CATEGORY:** Auxiliary Researcher (Invited)

**ID NUMBER:** 5449

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Responsible of the Luminescence Dating Laboratory	10%
2	Responsible at IST/ITN of the Project: FUNPERD - Death management in Recent Prehistory: funerary practices in Perdigões enclosure. PTDC/CS-ANT/104333/2008	15%
3	Responsible at IST/ITN of the Project: RUPSCIENCE - Analysis of the operational chains, archaeometry and chronology of Rock Art Paintings. An approach to materials technology of Portugal, Spain and Colombia's contexts. PTDC/HIS-ARQ/101299/2008	10%
4	Responsible at IST/ITN of the Project: ROBBIANA - The Della Robbia sculptures in Portugal: History, Art and Laboratory. PTDC/HIS-HEC/116742/2010	10%
5	Member of the Project: RADIART - Diagnosis, decontamination and conservation of cultural heritage: neutrons and ionizing radiation in artwork. PTDC/HIS-HEC/101756/2008	5%
6	Member of the Bilateral Cooperation: Processos Luminescentes-Dosimetricos no Quartzo. Italia128584682220330. Convénio Portugal (FCT) / Itália (CNR) 2011-2012.	5%
7	Supervision of PhD and curricular units in masters degrees	10%
8	Experimental supervisor and local lecturer: IAEA "Regional Training Course on Radiation Technology for Cultural Heritage Preservation" in the frame of the International Atomic Energy Agency TC Project RER/0/034 - Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts. IST, CTN, 4-9 November 2012.	5%

9	Preparation and submission of 2 Projects to FCT as Principal Researcher	5%
10	President of the Iberian Society "Sociedade de Arqueometria Aplicada ao Património Cultural" (SAPaC)	5%
11	Coordination of field-work and sampling activities in geological and archaeological contexts and in Museums.	10%
12	Edition of annual Portuguese scientific magazine	5%
13	Services – compositional characterization of cultural objects.	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	Coordination of the activities of the luminescence dating laboratory. Promotion of teamwork with other international luminescence laboratories especially concerning intercomparison activities. Dissemination and promotion of the main valences of the laboratory to the scientific community, and to the community that deals with objects of cultural heritage. The promotion activities also result on the expertise recognition of the international scientific community through the invitation for research collaboration at several levels, participation in research projects, conferences organization and invitations for articles revision in international magazines.
2	Responsible at IST/ITN of the FUNPERD project ( PTDC/CS-ANT/104333/2008) – coordination of the scientific tasks of ITN team, comprising compositional characterization and absolute dating of archaeological artefacts and contexts of Perdigões archaeological site (Reguengos Monsaraz), as well as fieldwork and sampling, aiming luminescence dating and raw materials (clays) inventory, identification and characterization. In 2012 particular attention was paid to: (i) chemical (INAA) and mineralogical (XRD) composition characterization of Neolithic ceramics; (ii) clay sampling campaign; (iii) in situ dosimetry of Chalcolithic and Neolithic contexts; (iv) presentation of previous obtained results, especially those concerning Chalcolithic artefacts and contexts; publication of one book chapter and two papers in scientific magazines; three oral presentations and one poster at International Conferences. Overall coordination of integration studies of the results obtained by different methodologies of materials/contexts.
3	Responsible at IST/ITN of the RUPSCIENCE project PTDC/HIS-ARQ/101299/2008 - coordination of the scientific tasks of ITN team, comprising compositional characterization and absolute dating of archaeological contexts with rock art paintings, as well as fieldwork and sampling, aiming luminescence dating and raw materials of rock paintings (inorganic) inventory, identification and characterization. In 2012 particular attention was paid to: (i) chemical (INAA) and mineralogical (XRD) composition characterization of background rocks with art paintings; (ii) painting materials characterization by XRD and INAA; (iii) geological sampling campaign; (iv) in situ dosimetry. Overall coordination of integration studies of the results obtained by different methodologies of materials/contexts.
4	Responsible at IST/ITN of the ROBBIANA project PTDC/HIS-HEC/116742/2010 - coordination of the scientific tasks of ITN team, comprising compositional characterization and absolute dating of artworks attributed to De La Robbia artist in the following museums: 1. Museu dos Jerónimos; 2. Museu Nacional de Arte Antiga; 3. Fundação Calouste Gulbenkian. In 2012 particular attention was paid to: (i) establishment of most adequate sampling protocol strategy to be obtained from body paste of this cultural heritage assets; (ii) sampling campaign at statues and sculptures of the artist in the above mentioned museums; (iii) chemical (INAA) and mineralogical (XRD) composition characterization of body samples of work of arts; (iv) in situ dosimetry. Overall coordination of integration studies of the results obtained by different methodologies of materials/contexts.
5	Member of the Project: RADIART (PTDC/HIS-HEC/101756/2008) – coordination of the luminescence activities; sampling work and participation in the integration studies of the results obtained by different methodologies applied to tiles study and characterization.
6	Member of the Bilateral Cooperation: Processos Luminescentes-Dosimetricos no Quartzo. Italia128584682220330. Convénio Portugal (FCT) / Itália (CNR) 2011-2012. Participation in the field work – geological contexts/sampling.
7	Supervision of a PhD on nuclear techniques, geochemistry, mineralogy and luminescence applied to geological and archaeological materials and contexts (around Alqueva dam); application of nuclear techniques on elemental characterization and naturally occurring radioactive materials (NORM).



	Three presentations at international conferences; One publication. Curricular units at Masters degrees in the NORM, geochemistry, archaeometry, clays, and nuclear and isotopic domains.
8	Experimental supervisor and local lecturer: at IAEA "Regional Training Course on Radiation Technology for Cultural Heritage Preservation" in the frame of the International Atomic Energy Agency TC Project RER/0/034 - Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts. IST, CTN, 4-9 November 2012, particularly in the theme (IV) Retrospective evaluation of absorbed dose within objects using stimulated luminescence. Participation in program elaboration. One invited lecture.
9	Several coordinating meetings with partners at the evolved institutions in the two submitted projects to FCT 2012 call at an interdisciplinary perspective, with special emphasis in the visit to the cultural heritage assets of hospitais de Sto. António dos Capuchos, Sta. Marta and S. José (PTDC/EPH-PAT/4635/2012 - Scientific networks for the safeguard of cultural heritage from Civil Hospitals of Lisbon (Cent. XVI-XIX). Art, Heritage and Science in Sto. António dos Capuchos, Sta. Marta and S. José) and in contacts with spa enterprises (PTDC/GEO-FIQ/2191/2012 - Clays and Nanoparticles in Human Health: Radioactivity, Antimicroorganisms activity, and crystal chemistry).
10	Within the framework of President of the Iberian Society "Sociedade de Arqueometria Aplicada ao Património Cultural" (SAPaC) several promotion of the society was performed, namely at a national level, as Portuguese participants needed to be increased. Participation in meetings regarding the archaeometry at an Iberian level and promotion of Iberian scientific networks in this field. The promotion activities and the publications of the research group result on the expertise recognition of the international scientific community through this invitation, as well as for research collaboration, participation in research projects, conferences organization and scientific committees. Also several invitations were received for articles revision particularly in the archaeometric domain.
11	Coordination of geological sampling strategy in Alqueva dam surrounding area and archaeological contexts of sites in the region, aiming a chemical and mineralogical compositional characterization. Coordination of museum exhibition artwork sampling strategy (micro-invasive) more suitable to chemical and mineralogical compositional characterization and luminescence dating (Fundação Calouste Gulbenkian; Museu Nacional de Arte Antiga; Museu Nacional do Azulejo, Museu dos Jerónimos). In situ dosimetry for luminescence dating in geological and archaeological contexts (Reguengos de Monsaraz, Beja, Alqueva dam surrounds, and museums (Fundação Calouste Gulbenkian; Museu Nacional de Arte Antiga; Museu Nacional do Azulejo, Museu dos Jerónimos).
12	Estudos Arqueológicos de Oeiras. vol. 19. Eds. M. Isabel Dias e João L. Cardoso. Proceedings of the IX Iberian Conference of Archaeometry. 310 pag. (2012). Referee, edition work and revisions comprising 36 papers. This volume of EAO corresponds to a special edition including the scientific works presented at the CIA-IX conference organized by M. Isabel Dias in 2011.
13	Coordination of a service from Univ. Algarve, comprising the chemical composition by neutron activation analyses of Neolithic ceramics and clays from archaeological sites of the Estremenho limestone massif and the western Algarve region in archaeological sites from Torres Novas and Vila do Bispo (one report).

## PUBLICATIONS

### Book chapters

- M. I. Dias, (2012 in press), Geochemistry of Clays of Surficial Materials from the Paleozoic and Cenozoic of Reguengos de Monsaraz Region, Ossa Morena Zone. In: "*Advances in Geochemical Research*" Editor: J. Sanjurjo, ISBN: 2012 Nova Science Publishers, Inc.
- M. Pozo, M.I. Carretero, M. Olías, M. Abad, J. Rodriguez Vidal, L.M. Cáceres, M.I. Prudêncio, M.I. Dias, A.M. Muñoz, A. Toscano (2012 in press) Geochemistry of lower Pliocene to Holocene formations from the Doñana National Park (SW Spain). In: *Advances in Geochemistry Research*, Editor: Jorge Sanjurjo Sánchez, ISBN, 2012, Nova Science Publishers, Inc.
- F. Ruiz, M. L. González-Regalado, J. M. Muñoz, M. Abad, M.I. Prudêncio, M.I. Dias, M.I. Carretero, M. Pozo, A. Toscano (2012). Pollution Sources and Fluxes in the South-western Spanish Littoral. In: *Metal Contamination: Sources, Detection and Environmental Impact*. Chapter 5. Editor: Shao Hong-Bo, ISBN: 978-1-61942-111-0, Nova Science Publishers, Inc., 95-106 (2012). (Hardcover)

- ebook: [https://www.novapublishers.com/catalog/product\\_info.php?products\\_id=30209](https://www.novapublishers.com/catalog/product_info.php?products_id=30209)
- ebook: [https://www.novapublishers.com/catalog/product\\_info.php?products\\_id=32165](https://www.novapublishers.com/catalog/product_info.php?products_id=32165)

### International Scientific Magazines

- M.I. Dias, M.I. Prudêncio, M.A. Matos, M.L. Rodrigues. Locating the origins of blue and white Chinese Porcelain ordered for the Portuguese market during the 16th - 17th centuries using INAA. *Journal of Archaeological Sciences* (accepted).
- M.J. Trindade, M.I. Prudêncio, J. Sanjurjo Sánchez, J.R. Vidal Romaní, T. Ferraz, D. Fernández Mosquera & M.I. Dias, (2013). Post-depositional processes of elemental enrichment inside dark nodular masses of an ancient aeolian dune from A Coruña, Northwest Spain. *Geologica Acta* (accepted, DOI: 10.1344/105.000001838).
- F. Ruiz, M. L. González-Regalado, E. Galán, M.I. González, M.I. Prudêncio, M.I. Dias, M. Abad, A. Toscano, J. Prenda, E.X.M. Garcia, (2012) Benthic foraminifera as bioindicators of anthropogenic impacts in two north African lagoons: a comparison with ostracod assemblages. *Revista Mexicana de Ciencias Geológicas*, v. 29, núm. 3, 2012, p. 527-533 [http://satori.geociencias.unam.mx/29-3/\(01\)Ruiz.pdf](http://satori.geociencias.unam.mx/29-3/(01)Ruiz.pdf)
- M.I. Prudêncio, M. A. Stanojev Pereira, J.G. Marques, M.I. Dias, L. Esteves, C.I. Burbidge, M.J. Trindade, M.B. Albuquerque (2012). Neutron tomography for the assessment of consolidant impregnation efficiency in Portuguese glazed tiles (16th and 18th centuries). *Journal of Archaeological Science* 39, 964-969. <http://dx.doi.org/10.1016/j.jas.2011.11.010>
- M.I. Dias, M.I. Prudêncio, M.J. Trindade, A.C. Valera (2012). Towards a Temporality Approach in Perdigoes, Portugal: Chemical and Mineralogical Composition of Neolithic and Chalcolithic Pottery and Raw Materials. *Revista De La Sociedad Española De Mineralogía*. Macla, nº 16, Junio'12, 28-30. [http://www.ehu.es/sem/macla\\_pdf/macla16/Macla16\\_028.pdf](http://www.ehu.es/sem/macla_pdf/macla16/Macla16_028.pdf)

### National Scientific Magazines

- M.I. Prudêncio, M.I. Dias, M.J. Trindade, M., M. A. Sequeira Braga, (2012). Rare earth elements as tracers for provenancing ancient ceramics. *Estudos do Quaternário*., vol. 8, 6-12 (2012).

### Book of Proceedings

- M.I. Dias, M.J. Trindade, C. Fabião, S. Sabrosa, J. Bugalhão, J. Raposo, A. Guerra, A.L. Duarte, M.I. Prudêncio, (2012). Arqueometria e o estudo das ânforas lusitanas do Núcleo Arqueológico da Rua dos Correiros (Lisbon) e de centros produtores do Tejo. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 57-70.
- T. Silva, S. Cabo Verde, G. Cardoso, A. C. Fernandes, M.J. Trindade, C.I. Burbidge, M.I. Dias, M. L. Botelho, M.I. Prudêncio, (2012). Perfis de contaminação e inativação microbiana em azulejos. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 253-260.
- M. A. Stanojev Pereira, M.I. Prudêncio, J.G. Marques, M. O. Figueiredo, M.I. Dias, T.P. Silva, L. Esteves, C.I. Burbidge, M.J. Trindade, R. Marques, M. B. Albuquerque, (2012). Tomografia de neutrões aplicada a azulejos do século XVI e XVII – visualização para caracterização, diagnóstico e optimização de técnicas de conservação. Perfis de contaminação e inativação microbiana em azulejos. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 261-266.
- G. Cardoso, L. Oosterbeek, M.I. Dias, (2012). Construção de uma base de dados de datações de sítios arqueológicos da Península Ibérica: contribuição para o estudo de sequências cronológicas. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 305-310.
- S.V. Flor, C. Figueiredo, C. Pilão, J. Meco, M.I. Dias, M.I. Prudêncio, M.J. Trindade, P. Flor, V. Serrão. The adaptation of the main floor of the Palace Melo e Abreu (18th century) to an infirmary of the old asylum of mendicity: history and tile panels compositional characterization. *Proceedings of the International Cong. Azulejar*, 10-12 October 2012 Aveiro, Portugal (37 - ArtAz\_c10\_SFlor)
- M.I. Dias, M.J. Trindade, L. Ribeiro, M.I. Prudêncio, M. T. Bispo, L. Trindade, P. Flor, S. V. Flor, F. T. Rocha (2012). Geochemical patterns and firing technology research on ceramic glazed tiles from the 17th – 20th centuries (Lisbon region, Portugal). *Proceedings of the International Cong. Azulejar*, Aveiro, Portugal (60 - ArtAz\_c10\_MDias).

## Reports

- Análise química de cerâmicas neolíticas e argilas de sítios arqueológicos do maciço calcário estremenho e do barlavento Algarvio por análise por activação neutrónica, associadas aos sítios arqueológicos de Torres Novas e Vila do Bispo: “Gruta do Almonda”; “Pena D’água”; “Cerradinho do Ginete”; “Padrão”; “Rocha das Gaiotas”; “Barranco das Mós”. Universidade do Algarve - Centro de Ciências do Mar. 2012. IST/ITN Coordinator: M.I. Dias.

## COMUNICATIONS

### Oral Invited

- *On the importance of chemical and mineralogical characterization of Cultural Heritage artifacts for preservation.* M. I. Dias, Technical Cooperation Project - IAEA TC Project RER/0/034: "Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts, Sacavém, Portugal, 5 - 9 November 2012.

### Oral

- *Geochemical Patterns and Firing Technology Research On Ceramic Glazed Tiles From The 17th – 20th Centuries (Lisbon Region, Portugal).* M.I. Dias, M.J. Trindade, L. Ribeiro, M.I. Prudêncio, M. T. Bispo, L. Trindade, P. Flor, S. V. Flor, F. T. Rocha, *International Congress Azulejar 2012. Aveiro, Portugal. 10th/12th October, 2012.*
- *The Adaptation Of The Main Floor Of The Palace Melo E Abreu (18th Century) To An Infirmary Of The Old Asylum Of Mendicity: History And Tile Panels Compositional Characterization.* S. V. Flor, C.Figueiredo, C. Pilão, J. Meco, M.I. Dias, M.I. Prudêncio, M.J. Trindade, P. Flor, V.Serrão, *International Congress Azulejar 2012. Aveiro, Portugal. 10th/12th October, 2012.*
- *Towards a Temporality Approach in Perdigões, Portugal: Chemical and Mineralogical Composition of Neolithic and Chalcolithic Pottery and Raw Materials.* M.I. Dias, M.I. Prudêncio, M.J. Trindade, A. C. Valera, *Congreso SEM-SEA 2012. XXXII Reunión Científica de la Sociedad Española de Mineralogía, XXII Reunión Científica de la Sociedad Española de Arcillas, SEM-SEA 2012, 26-30 June 2012.*
- *Laboratory protocols for luminescence techniques applied on Porcelains and Faience from the 16th – 18th centuries.* A. Rodrigues, C. Burbidge, M.I. Dias. *2nd International Workshop Physical and Chemical Analytical Techniques in Cultural Heritage*, Centro de Física Atómica Universidade de Lisboa, 4th and 5th June 2012
- *Heated Flint From Gruta Da Oliveira (Portugal): Comparison Of Tl-Dating Results With Radiocarbon And U-Series Dating.* D. Richter, D.E. Angelucci, C.I. Burbidge, M.I. Dias, M.A. Gouveia, M.I. Prudêncio & J. Zilhão. *2nd Luminescence in Archaeology International Symposium, Lisbon, 5th to the 7th of September, 2012.*
- *OSL Dating At Perdigões Enclosure Complex (Reguengos De Monsaraz, Portugal).* C.I. Burbidge, G. Cardoso, M.I. Dias, M.I. Prudêncio, A. C. Valera, J. Márquez Romero, D. Franco, R. Marques, *2nd Luminescence in Archaeology International Symposium, Lisbon, 5th to the 7th of September, 2012.*
- *Luminescence and mineralogy of profiling samples from negative archaeological features.* A. L. Rodrigues, C.I. Burbidge, M.I. Dias, F. Rocha, A. C. Valera, M.I. Prudêncio, *2nd Luminescence in Archaeology International Symposium, LAIS, Book of Abstracts p. 36, Lisbon, Portugal, September 5-7 (2012), Oral.*

### Posters

- *Geochemistry and mineralogy in a paleosol and in a present-day topsoil developed on pyroclasts, Fogo Island (Cape Verde).* R. Marques, M.I. Prudêncio, F. Rocha, E. Ferreira da Silva, C.I. Burbidge, Dias, M.I, D. Franco. *XI Congresso de Geoquímica de Países de Língua Portuguesa, Luanda, Angola, November 2012.*
- *Quinta do Torel glazed tile panel: a first compositional approach of the ceramic body (Lisbon, Portugal).* M.I. Prudêncio, S. V. Flor, L. Ribeiro, Dias, M.I, M.J. Trindade, M. T. Bispo, L. Trindade, P. Flor. *International Azulejar, 10-12 October 2012 Aveiro, Portugal.*

- *Building A Database Of Absolute Dating In Archaeological Sites Of The Iberian Peninsula: Contribution To The Study Of Timelines Sequences.* G. Cardoso, L. Oosterbeek, M.I. Dias. *2nd Luminescence in Archaeology International Symposium, Lisbon, 5th to the 7th of September, 2012*
- *Distribution Of Natural Radionuclides (K, Th And U) In An Aplite Dyke From The Beira Uraniferous Province (Fornos De Algodres, Portugal).* M.J. Trindade, M.I. Prudêncio, C.I. Burbidge, M.I. Dias, R. Marques G. Cardoso, F. Rocha, *2nd Luminescence in Archaeology International Symposium, Lisbon, 5th to the 7th of September, 2012*
- *Geochemistry And Field Radiometric Measurements Of Naturally Occurring Radionuclides In Several Lithologies Of Fornos De Algodres Area.* M.J. Trindade, M.I. Prudêncio, M.I. Dias, C.I. Burbidge, G. Cardoso, R. Marques, F. Rocha, *2nd Luminescence in Archaeology International Symposium, Lisbon, 5th to the 7th of September, 2012*
- *Geochemical and mineralogical characterization of fill materials from a negative archaeological structure, and relations with luminescence and dosimetric behavior.* A. L. Rodrigues, C.I. Burbidge, M.I. Dias, F. Rocha, D. Franco, M.I. Prudêncio, A C. Valera, *9th International Symposium on Environmental Geochemistry, Aveiro, 15th– 21 th July 2012*
- *Radiogenic elements in soils from Fogo Island (Cape Verde).* R. Marques, C.I. Burbidge, M.I. Dias, M.I. Prudêncio, D. Franco, G. Cardoso, F. Rocha, E. Ferreira da Silva, (2012). *9th ISEG - International Symposium on Environmental Geochemistry, Book of Abstracts: 348-349, 15-22 July 2012, Aveiro, Portugal.*
- *Distribution of Uranium And Other Trace Elements In An Aplyte Dyke From Fornos De Algodres Area (Northern Central Portugal).* M.J. Trindade, M.I. Prudêncio, C.I. Burbidge, M.I. Dias, R. Marques, G. Cardoso, F. Rocha, (2012). *9th Iseg - International Symposium On Environmental Geochemistry, Book of Abstracts: 240, 15-22 July 2012, aveiro, portugal.*
- *Distribution of K, Th and U in aplite and dolerite veins, granite and schist from sobral pichorro area (Fornos de Algodres, Central Portugal).* M.J. Trindade, M.I. Prudêncio, M.I. Dias, C.I. Burbidge, G. Cardoso, R. Marques, F. Rocha, (2012). *9th ISEG - International Symposium on Environmental Geochemistry, Book Of Abstracts: 213, 15-22 July 2012, Aveiro, Portugal.*
- *Chinese porcelain ordered for the portuguese market during the 16th century: study on the compositional differences by neutron activation analysis and indirect provenance issues.* M.I. Dias, M.I. Prudêncio, M. A. Matos, A. L. Rodrigues. *39th International Symposium on Archaeometry, ISA2012, 28 May-1 June 2012, Leuven, Belgium.*
- *Chemical signatures of Coimbra and Lisbon early portuguese faience productions (17th – 18th cent.).* M.I. Dias, M.I. Prudêncio, A. Pais, A. L. Rodrigues. *39th International Symposium on Archaeometry, ISA2012, 28 May-1 June 2012, Leuven, Belgium.*
- *Portuguese glazed tiles (16th-18th centuries): inaa, xrd and luminescence for raw materials characterization and production technologies of the ceramic bodies, and chronology* M.I. Prudêncio, M.I. Dias, C.I. Burbidge, L. Esteves, M.J. Trindade, R. Marques, G. Cardoso, D. Franco. *39th International Symposium on Archaeometry, ISA2012, 28 May-1 June 2012, Leuven, Belgium.*
- *Luminescence Techniques on Earth Sciences and Cultural Heritage.* G. Cardoso, C.I. Burbidge, M.I. Dias, M.I. Prudêncio, F. Rocha *ADVANCEG 1, Erasmus Intensive Programme in Advanced Environmental Geology 1 (Mineral resources suitable for environmental application), Banská Štiavnica, Slovakia. 2–13 Jul, (2012)*
- *Datação por Luminescência,* C.I. Burbidge, M.I. Dias, M.I. Prudêncio. *Festa da arqueologia: ciências da arqueologia. Museu Arqueologico do Carmo, Lisbon. 5-6 May (2012).*
- *Caracterização composicional de artefactos e contextos do património cultural.* M.I. Dias, M.I. Prudêncio, C.I. Burbidge. *Festa da arqueologia: ciências da arqueologia. Museu Arqueologico do Carmo, Lisbon. 5-6 May (2012)*

## EDUCATION / THESES SUPERVISION

- Supervisor, Ph. D. Thesis, *Geoquímica, mineralogia e luminescência de materiais geo-arqueológicos circundantes à barragem do Alqueva*, by Ana Luisa Rodrigues, Universidade de Aveiro, ongoing (2010-2014).
- Master degree in “*Teoria e Métodos da Arqueologia*”. Universidade do Algarve. Curricular Unit: “Arqueometria”. Thematic Unit: *Análises de proveniência de matérias-primas de materiais arqueológicos*.
- ERASMUS MUNDUS – “*International Master on Advanced Clay Science*”, Univ. Aveiro. Curricular Unit: “Clays and biological systems interactions”. Thematic Unit: Nuclear and isotopic studies. Natural Nuclear risk. Harmful effects. Nuclear beneficiation. Selective radio-elimination.
- Experimental supervisor: IAEA “*Regional Training Course on Radiation Technology for Cultural Heritage Preservation*” in the frame of the International Atomic Energy Agency TC Project RER/0/034 - Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts. IST, CTN, 4-9 November 2012.
- *Ciência Viva - “Pais com a Ciência”* – Conference at Escola Secundária Gil Vicente. Theme: “*Ser cientista*”. A Casa do Governador da Torre de Belém. November, 2012

## PROJECTS

### Running

- *The Della Robbia sculptures in Portugal: History, Art and Laboratory (ROBBIANA)*, PTDC/HIS-HEC/116742/2010. Coordenador of Project: FCSH/UNL (P. Flor). Outros parceiros: FL/UL; FCG; IGESPAR; MNAA; IHA/FCSH/UNL (2012-2015). IST/ITN Coordinator: M. I. Dias.
- *Death management in Recent Prehistory: funerary practices in Perdigões enclosure (FUNPERD)*, PTDC/CS-ANT/104333/2008. Coordenador of Project: FCT/UC (A. M. Silva). Outros parceiros: Era Arqueologia SA (2010-2012). IST/ITN Coordinator: M. I. Dias.
- *Analysis of the operational chains, archaeometry and chronology of Rock Art Paintings. An approach to materials technology of Portugal, Spain and Colombia's contexts (RUPSCIENCE)*, PTDC/HIS-ARQ/101299/2008. Coordenador of Project: IPT (L. Osterbeek). Outros parceiros: UTAD, UA. (2009-2011). IST/ITN Coordinator: M. Isabel Dias.

### Submitted

- *Clays and Nanoparticles in Human Health: Radioactivity, Antimicroorganisms activity, and crystal chemistry*. PTDC/GEO-FIQ/2191/2012
- *Scientific networks for the safeguard of cultural heritage from Civil Hospitals of Lisbon (Cent. XVI-XIX). Art, Heritage and Science in Sto. António dos Capuchos, Sta. Marta and S. José*. PTDC/EPH-PAT/4635/2012
- *An interdisciplinary approach to outline socio-economic impact and European trade routes of items with historical and cultural interest. The case study: Clay pipes trade and the study of smoking in the 17th century: Compositional and stylistic features*. HERA Joint Research Programme. Application Template for a Project Idea to attend the Matchmaking Event on 21st February 2012 in Berlin.

## CONTRACTS

- *Chemical analysis of Neolithic ceramics and clays from archaeological sites of the Estremenho limestone massif and the western Algarve region, by neutron activation analyses: archaeological sites from Torres Novas and Vila do Bispo: “Gruta do Almonda”; “Pena D'água”; “Cerradinho do Ginete”; “Padrão”; “Rocha das Gaivotas”; “Barranco das Mós”*. Universidade do Algarve - Centro de Ciências do Mar. IST/ITN Coordinator: M. Isabel Dias. 4 months. 3444,00 €

## CONFERENCE ORGANIZATION / COMMITTEES

- Member of the Organization of the 2nd Luminescence in Archaeology International Symposium, LAIS, Sacavém, Portugal, 5-7 September 2012.

- Member of the Scientific Committee of the 2nd International meeting on Tiles – Azulejar, Aveiro, Portugal, 10-12 October, 2012.

## COLLABORATIONS

Collaboration with national and international scientists/Universities:

- Prof. Fernando Rocha - University of Aveiro: Member, GeoBioTec Research Team, UA; collaboration in clay science: Clays and biological systems interactions; NORM; Natural Nuclear risks and Harmful effects.
- Prof. Fernando Ruiz and Doctor Manuel Abad - University of Huelva: Geochemistry of clays and geoenvironments.
- Doctor C. Odriozola - Univ. Seville: Archaeometry: chemical and mineralogical composition of Bell Beakers from Chalcolithic archaeological sites of Guadiana basin.
- Doctor J. Sanjurjo – Univ. Corunha: Geochemistry and archaeometry: geochemistry of the earth surface and luminescence dating.
- Prof. Mercedes Suarez and Doctor Eva Manchado – Univ. Salamanca: Geochemistry and mineralogy of clays. Collaboration on a Pos-doctoral FCT grant submission as Supervisor, entitled “Nanominerals in Human Health: Characterization, radioisotopes and physic-chemicals properties” (SFRH/BPD/91079/2012).
- As President of the Iberian Society "Sociedade de Arqueometria Aplicada ao Património Cultural" (SAPaC) – scientific activities were performed with directive board of the society, particularly with: Secretary and Treasurer Clodoaldo Roldán García (Universidad de Valencia), Vowels Josefina Perez-Arategui (Universidad de Zaragoza), Blanca Gómez Tubío (Universidad de Sevilla) and Yolanda Carrión Marco (CSIC).

## NAME: Maria Paula Cordeiro Crespo Cabral Campello Aboim de Barros

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 05375

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Design, Synthesis and Characterization of Novel Chelators for Stabilization of Trivalent (Radio)Metals. <i>Coordinator.</i>	40%
2	Targeted-Receptor Bimodal Probe for Sentinel lymph Node Detection. <i>Team member.</i> This project was partially supported by the IAEA.	15%
3	Nanocarriers as Versatile Platforms for Targeted Delivery of Radionuclides to Tumors. <i>Coordinator.</i>	15%
4	Biological Evaluation of Novel Heteronuclear Lanthanide-Ruthenium Complexes. <i>Team member.</i>	10%
5	Kinetic and Thermodynamic Studies of Metal Complexes with Tetraazamacrocyclic Ligands with Carboxylate/Phosphonate Pendant Arms. <i>Team member.</i>	10%
6	Teaching Activities.	5%
7	Management of Laboratory infrastructure – Chemistry Laboratory.	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	Yttrium (Y) and lanthanides (Ln) are trivalent metals that offer different $\beta$ -emitting radioisotopes relevant for therapeutic applications, whereas the post-transition trivalent metals gallium (Ga) and indium (In) present radioisotopes adequate for SPECT ( $\gamma$ -emitters: $^{67}\text{Ga}$ , $^{111}\text{In}$ ) or PET imaging ( $\beta^+$ -emitter: $^{68}\text{Ga}$ ) or for Auger-therapy ( $^{111}\text{In}$ ). Due to their chemical features all these trivalent

	<p>metals are stabilized by polydentate chelators with anionic oxygen donor groups, such as acyclic or macrocyclic ligands.</p> <p>Looking for new ligands suitable for the coordination of trivalent (radio)metals, I've been involved in the synthesis of new <math>N_3O_2</math> donor chelators, which were obtained based of the functionalization of the dien framework with pyrazolyl/pyridyl or salicylaldehyde coordinating groups. These chelators allowed the synthesis of cationic [GaL] + complexes that were fully characterized, including in some cases by X-ray diffraction analysis.</p> <p>To stabilize <math>Ln^{3+}</math>, <math>Y^{3+}</math> and <math>In^{3+}</math>, I have also introduced a novel DOTA-like chelator bearing a thiol arm. This new chelator was also used in the synthesis and stabilization of gold nanoparticles.</p>
2	<p>The availability of bimodal probe will improve the clinical procedure for the sentinel lymph node detection (SLND) allowing fast and accurate localization of the first lymph node involved in metastization process. The synergistic effect of a dual imaging reporter could enable real-time SLND by radio- or near-infrared fluorescent (NIRF) guided surgery as well as fluorescent histology.</p> <p>Aiming at the design of a bimodal probe for specific targeting of SLND by nuclear and optical imaging techniques, we have synthesized dextran derivatives containing three components: mannose units for specific receptor targeting, a bifunctional chelator (dota derivative) suitable to stabilize the radiometal (<math>^{67/68}Ga</math>) and a NIRF dye.</p> <p>The final compounds were characterized by the usual analytical techniques, including SEC- and RP-HPLC, and NMR spectroscopy.</p> <p>The polymeric compounds were labeled with <math>^{67}Ga</math> in high yield and radiochemical purity. Ligand challenge has shown that the radioactive compounds present high in vitro stability towards transchelation.</p> <p>These results prompt not only the in vivo evaluation of the radioactive nanocompounds but also its chemical and physical characterization at the macroscopic level.</p> <p>I've been involved in all the steps of the project, including the supervision of the work of the Msc thesis performed by Filipa Drumond Gonçalves.</p>
3	<p>This work is within the framework of the research projects currently underway at the Group of Radiopharmaceutical Sciences, whose major subject of research is the design of novel specific radioactive probes for nuclear imaging/therapy. Taking advantage of the biological properties of the gold nanoparticles (AuNP) as drug-carrier systems, the main goal is the development of multifunctional AuNP for specific delivery of gamma- or beta-emitting radionuclides into tumor cells in vivo. To accomplish such goal, four main steps have been undertaken. 1) Synthesis of a novel DOTA-like chelator bearing a thiol arm, used on the synthesis of the AuNP for stabilization of the AuNP and the radiometal. 2) Synthesis and characterization of the AuNP (Uv-vis, DLS, TEM, zeta potential). 3) a biomolecule for tumor-targeting was attached to the AuNP and 4) they were labeled with <math>^{67}Ga</math>, in high yield, and characterized by ITLC and SEC and their in vitro stability assessed. The radioactive AuNP presents high in vitro stability.</p> <p>The final step will comprise the biological evaluation of the radioactive AuNP.</p> <p>I've been involved in all the steps of project. The synthesis and characterization of the AuNP (step 2) were performed at Universidade de Aveiro (CICECO) in collaboration with Dr Sergio Pereira.</p>
4	<p>In collaboration with Prof. Michel Picquet, Institut de Chimie Moléculaire de l'Université de Bourgogne, Dijon, France, novel heteronuclear lanthanide ruthenium complexes were explored at IST/ITN for their potential as future imaging probes.</p> <p><math>^1H</math> and <math>^{31}P</math> NMR, Mass spectrometry and HPLC were used to establish the stability in solution of the dota like ligands bearing a Ru pendent arm (prepared in the Institut de Chimie Moléculaire de l'Université de Bourgogne) and the corresponding Ru-lanthanide complexes (prepared in IST/ITN).</p> <p>The antiproliferative properties of the ligands and the dinuclear complexes were assayed by monitoring their ability to inhibit cell growth. Cytotoxic activity was determined on the human ovarian cancer (A2780) cell line, and its cisplatin-resistant variant (A2780cisR). Radiolabelling of the ligands was performed with <math>^{153}Sm</math> (produced the Portuguese research).</p>
	<p>Biodistribution studies will be performed in healthy mice.</p> <p>The preliminary results show that:</p> <ul style="list-style-type: none"> <li>• the stability of the compounds in solution is reasonable.</li> </ul>

	<ul style="list-style-type: none"> <li>• compounds have not shown significant cytotoxicity,</li> <li>• the kinetics of the radiolabelling reaction with <math>^{153}\text{Sm}</math> is dependent on temperature and on the molar ratio M:L.</li> </ul> <p>I have been mainly involved in the synthesis and evaluation of the inactive dinuclear complexes.</p>
5	<p>Ln(III) and Cu(II) complexes are frequently utilized in medicine as magnetic resonance, optical or nuclear probes for diagnostics and/or for cancer treatment. For biomedical applications, such complexes should exhibit a high thermodynamic stability as well as kinetic inertness under physiological conditions. Thus, knowledge of their thermodynamic/kinetic properties (e.g. dissociation rate constants for an estimation of kinetic inertness) is important to evaluate their use in these applications.</p> <p>In collaboration with Prof Premysl Lubal, Faculty of Science, Masaryk University, Czech Republic, the thermodynamic and kinetic properties of Cu(II), Ce(III) and Eu(III) complexes with macrocyclic cyclen-based ligands with acetate and phosphonate pendant arms (H4dota, H5do3ap, <i>trans</i>-H6do2a2p, H7doa3p, H8dotp) have been evaluated.</p> <p>The results have shown that the kinetic inertness of the metal is influenced by the replacement of acetate groups by phosphonate pendent arms. This accuracy should be taken into account in possible <i>in vivo</i> applications of the ligands/complexes.</p> <p>I have been mainly involved in the synthesis and characterization of the Cu(II) and Ln(III) complexes.</p>
6	<p>Invited Coordinator Professor at Escola Superior de Tecnologias de Saúde de Lisboa, Instituto Politécnico de Lisboa. Master Course on Nuclear Medicine: Rádiofarmacos com Aplicação em Tomografia por Emissão de Positrões (PET). 2011-2012.</p>
7	<p>Management of Chemistry Laboratory infrastructure:</p> <ul style="list-style-type: none"> <li>- Training of the new research students, namely on vacuum line techniques for handling air-sensitive compounds,</li> <li>- Maintenance of the equipment,</li> <li>- maintain a safe and clean laboratory environment,</li> <li>- enforced all safety regulations,</li> <li>- organize disposal of hazardous chemicals and solvents.</li> </ul>

## COMMUNICATIONS

- *Kinetic study of metal complexes with tetraazamacrocyclic ligands with carboxylate/phosphonate pendant arms*, Přemysl Lubal, Petr Hermann, Jan Kotek, M. Paula C. Campello, Isabel Santos, *International Symposium, Lisbon, June 18-22 (2012)*, oral presentation.

## EDUCATION / THESES SUPERVISION

- Supervisor, M. Sc. Thesis, *COMPOSTOS DE DEXTRANO-MANOSE MARCADOS COM O  $^{67}\text{Ga}$  PARA A DETEÇÃO DO GÂNGLIO SENTINELA*, by Filipa Antónia Drumond Gonçalves, Instituto Politécnico de Lisboa, Escola superior de Tecnologia de Saúde de Lisboa, Lisbon, 4 December 2012.

## PROJECTS

### Submitted in 2012

- *Biosyringes for Dual Tumor-Targeting*, FCT- EXPL/QEQ-MED/0916/2012. IST/ITN, Coordinator: M. P. C. Campello. Overall Rating: Excellent, Not Recommended for Funding.
- *From drug design to new materials: structural approach in emergent fields*, FCT-RECI/QEQ-QIN/0189/2012 (2013-2016). Total Funding: 498.869.00€. Prime contractor: IST-ID, Coordinator: M Teresa Duarte, Konstantin Luzyanin, M. T. Nunes, Partners: IBB, ICEMS Lisboa/IST/UTL, IST/ITN/UTL. M. P. C Campello: member of the research team (15%).
- *Molecular and Nano Tools for Cancer Theranostics*, FCT- EXCL/QEQ-MED/0233/2012. Total Funding 496.065.00€. Prime Contractor: IST-ID, Coordinator: I. santos. Partners: Instituto de Medicina Molecular (IMM/FM/UL); Instituto de Tecnologia Química e Biológica (ITQB/UNL);



Universidade de Aveiro (UA); Universidade de Coimbra. M. P. C Campello: member of the research team (25%).

## COLLABORATIONS

- Dr. Sergio Pereira, CICECO, Universidade de Aveiro.
- Dr. Michel Picquet, Institut de Chimie Moléculaire de l'Université de Bourgogne (ICMUB), CNRS
- Equipe "Architecture, Réactivité, Electrochimie et Catalyse Organométallique" (ARECO), DIJON.
- -Dr. Ewen Bodio, Institut de Chimie Moléculaire de l'Université de Bourgogne (ICMUB), CNRS, Equipe "Architecture, Réactivité, Electrochimie et Catalyse Organométallique" (ARECO), DIJON.
- Dr. Olga Iranzo, Instituto de Tecnologia Química e Biológica, UNL, Oeiras, Portugal.

## Scientific Visitors

- Prof. Premysl Lubal, Department of Chemistry, Faculty of Science, Masaryk University, Czech Republic, 20 June 2012. Discussion about the ongoing projects.

## NAME: Paula Dolores Galhofas Raposinho

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5382

## R&D ACTIVITY

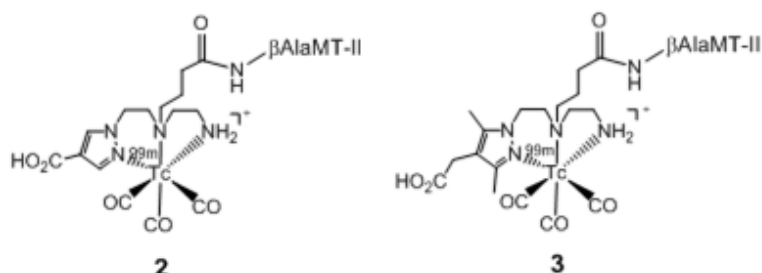
Nº	Activity Description	R&D
1	Development of radiopeptides, based on Melanin Stimulating Hormone ( $\alpha$ -MSH) analogs, for melanoma imaging through Melanocortin receptor 1 (MC1R)-targeting	40%
2	<b>Development of radiopeptides, based on Neuropeptide Y (NPY) analogs, for breast carcinoma imaging through Y1 receptor (Y1R)-targeting</b>	40%
3	<b>Evaluation of the antiproliferative activity of histone deacetylases (HDAC) inhibitors on tumor cells</b>	10%
4	Biological evaluation of radiolabeled glucose derivatives: Cellular uptake mediated by glucose transporter Glut1	10%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>Following our interest to design radioactive probes for melanoma imaging, namely through specific MC1R-targeting, this project, initially funded by Covidean, led to the development of several radiolabeled linear and cyclic <math>\alpha</math>-MSH derivatives. We previously demonstrated the advantages of <math>^{99m}\text{Tc}(\text{CO})_3</math>-labeled lactam bridge-cyclized <math>\alpha</math>-MSH analogs on melanoma uptake. The goal of this work was to improve the pharmacokinetic profile of the cyclic radiopeptide by modifying the structure of the pyrazolyl-diamine chelator.</p> <p>Three new radiopeptides were synthesized and I assessed their MC1R-targeting properties, the metabolic stability and the tissue distribution either by <i>in vitro</i> studies with different melanoma cell lines (competitive binding assay, cellular uptake assays, ...) or by biodistribution in melanoma-bearing mice.</p> <p>The introduction of carboxylate groups on the chelator improved pharmacokinetics without compromising the <i>in vitro/vivo</i> MC1R-targeting properties and highlighted the potential usefulness of <b>2</b> and <b>3</b> as melanoma imaging agents (paper in revision):</p> <ul style="list-style-type: none"> <li>• Morais M, Oliveira BL, Correia JDG, Oliveira MC, Jiménez MA, Santos I, Raposinho PD, Influence of the bifunctional chelator on the pharmacokinetic properties of <math>^{99m}\text{Tc}(\text{CO})_3</math>-labeled cyclic <math>\alpha</math>-MSH analog, <b>2013</b>, <i>J. Med. Chem.</i>, in revision.</li> </ul>

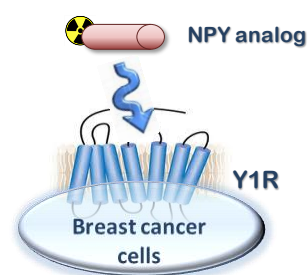


Further studies with these promising radiopeptides were planned for 2012 but, due to ITN integration on IST with the consequent delays in the CO<sub>2</sub> and mice acquisitions (essentials for *in vitro/vivo* studies), were not performed.



2 Aiming the development of radiolabeled Neuropeptide Y (NPY) analogues for efficient and selective targeting of the Y1 receptors abundantly overexpressed in breast cancer, several approaches have been explored leading to the following biological studies:

- Evaluation of the Y1R expression by Western Blot in different tumor cell lines, including breast carcinoma cells. The higher expression observed in MDA-MB-231 comparatively to MCF-7 cells, indicated MDA-MB-231 as a good and not yet explored tumor model for *in vivo* evaluation of radiopeptides.
- *In vitro/in vivo* evaluation of NPY truncated analogs with a modified C-terminal, with/without a neutral/charged spacer to modify the biological profile, and conjugated to pirazolyldiamine/DOTA chelator and <sup>99m</sup>Tc/<sup>67</sup>Ga-labeled. These studies included the evaluation of cellular internalization and retention, receptor-binding specificity and pharmacokinetic properties.
- Synthesis of the full-size NPY analog (non-truncated) [Arg<sup>6</sup>,Pro<sup>34</sup>]-NPY by automated SPPS (microwave irradiation), and its characterization by HPLC and mass spectrometry.



Most of these studies allowed the master's thesis of Marta Antunes under my supervision.

Since the Y1R is a promising target for breast cancer imaging/therapy that needs to be more explored, I was also involved in the elaboration of a project to FCT/ANR (no funding) “**Metal-based bimodal probes for breast cancer imaging: Synthesis, characterization and pre-clinical evaluation**”.

3 Several research projects have been explored in collaboration with the group of Prof. Roger Alberto of University of Zurich (Switzerland), in which my contribution is always the biological evaluation of their compounds, using *in vitro* or *in vivo* tumoral models. Among them, the project aiming the inhibition of histone deacetylases (HDAC), highly expressed in tumors, is a new approach for solid and hematological tumor therapy. Indeed, HDAC inhibitors had immediate application in cancer research because of their ability to reactivate aberrantly silenced tumour suppressor genes and/or block tumour cell growth.

Thus, the antiproliferative activity of several potential HDAC inhibitors designed by Alberto, that are derivatives of SAHA (inhibitor approved by FDA for Cutaneous T-Cell Lymphoma, Zolinza®, Merck), was evaluated using a broad selection of tumor cells lines and several proliferation assays, including the well know MTT assay. Comparison with the antitumor activity of SAHA was made.

Some compounds have shown very high cytotoxicity across cell lines from different tumor entities (a broad activity spectrum), and become quite promising for further investigation. A scientific paper was published.

SAHA

4 The clinical relevance of [<sup>18</sup>F]-2-fluorodesoxyglucose (FDG) in tumor diagnosis, that is taken up by tumor cells mainly by facile diffusion through the glucose transport protein Glut1, prompted

the group of Roger Alberto (Switzerland) to develop inexpensive and readily available  $^{99m}\text{Tc}$  labeled glucose analogues. Apart from the low costs of Tc-99m, a Re-186 or Re-188 labeled “FDG” analogue would open the opportunity for radiotherapy of various tumors with a simple and unspecific tracer.

For the labeling, the organometallic precursor  $[\text{}^{99m}\text{Tc}(\text{H}_2\text{O})_3(\text{CO})_3]^+$  was chosen.

In this collaboration project, I pretend to do the biological characterization of a series of organometallic technetium- and rheniumtricarbonyl complexes of glucose, derivatized at different positions with the bifunctional chelator.

First, a series of experiments for the adequate biological evaluation were delineated and implemented.

Preliminary experiments to evaluate cell internalization and transport via Glut1 were already been done for two compounds using several assay mediums that varying in glucose concentration, and different conditions of incubation. For these experiments, the breast carcinoma cell line MDA-MB-231 and the prostate carcinoma cell line PC3 that express the sodium-independent glucose transporter Glut1, have been used.

## PUBLICATIONS

- M. Morais, P.D. Raposinho, M. C. Oliveira, I. Santos, D. Pantoja-Uceda, M.A. Jiménez, J.D.G. Correia, MC1R-Targeting Properties of  $^{99m}\text{Tc}(\text{I})$ -Labeled Cyclic  $\alpha$ -MSH analogs, *Organometallics*, 31 (16), 5929-5939 (2012).
- M. Morais, P.D. Raposinho, M.C. Oliveira, J.D.G. Correia, I. Santos, Evaluation of novel  $^{99m}\text{Tc}(\text{I})$ -labeled homobivalent  $\alpha$ -melanocyte-stimulating hormone analogs for melanocortin-1 receptor targeting, *J Biol Inorg Chem*, 17(4), 491-505 (2012).
- D. Can, H.W. Peindy N'dongo, B. Spingler, P. Schmutz, P. Raposinho, I. Santos, R. Alberto, The  $[\text{M}(\text{CO})_3\text{Cp}]$  (M=Re or  $^{99m}\text{Tc}$ ) Moiety as a Building Block for Imaging Agents or Bioinorganic Probes: Perspectives and Limitations, *Chem Biodivers.*, 9(9), 1849-66 (2012).
- D. Can, B. Spingler, P. Schmutz, F. Mendes, P.D. Raposinho, C. Fernandes, F. Carta, A. Innocenti, I. Santos, C.T. Supuran, R. Alberto,  $[(\text{Cp-R})\text{M}(\text{CO})_3]$  (M=Re or  $^{99m}\text{Tc}$ ) Arylsulfonamide, Arylsulfamide, and Arylsulfamate conjugates for selective targeting of human Carbonic Anhydrase IX. *Angew Chem Int Ed Engl*, 51, 3354-3357 (2012).
- C. Moura, L. Gano, F. Mendes, P.D. Raposinho, A.M. Abrantes, M.F. Botelho, I. Santos, A. Paulo,  $^{99m}\text{Tc}(\text{I})/\text{Re}(\text{I})$  Tricarbonyl complexes for in vivo targeting of melanotic melanoma: synthesis and biological evaluation, *Eur. J Med. Chem.*, 50, 350-360 (2012).

## COMMUNICATIONS

- *Experimentação Animal (Animal Experimentation)*; Raposinho PD, *Seminars for 4<sup>th</sup> year of ESTeSL* (Escola Superior de Tecnologia da Saúde de Lisboa) graduations (thematic panel of “Ética e Deontologia”, Lisbon, Sep 20 (2012), Invited Talk.
- *Design, characterization and evaluation of cyclized  $\alpha$ -MSH derivatives for MC1R targeting*, M. Morais, P.D. Raposinho, M.C. Oliveira, I. Santos, D. Pantoja-Uceda, M.A. Jiménez, J.D.G. Correia, *ICOMC-2012 : International Conference On Organometallic Chemistry, Lisbon, Portugal, Sep 4-7(2012)*, Poster.
- *Radiometallated neuropeptide Y analogs for breast cancer imaging*, C. Fernandes, P. Antunes, P.D. Raposinho, I. Rodrigues, I. Santos, *EPIXII: Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *Modulation of the pharmacokinetic properties of  $^{99m}\text{Tc}(\text{CO})_3$ - $\beta$ Ala-MTII*, M. Morais, B.L. Oliveira, M.C. Oliveira, J.D.G. Correia, I. Santos, P.D. Raposinho, *EPIXII: Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.
- *MC1R-Targeting properties of  $^{99m}\text{Tc}(\text{I})$ -labeled cyclic  $\alpha$ -MSH analogs with thioether or amine bridge*, J.D.G. Correia, M. Morais, P.D. Raposinho, M.C. Oliveira, I. Santos, M.A. Jiménez, D. Pantoja-Uceda, *EPIXII: Iberian Peptide Meeting, Alicante, Spain, Feb 1-3 (2012)*, Poster.

## EDUCATION / THESES SUPERVISION

- Supervisor, Master's degree Thesis in Nuclear Medicine, *Análogos do Neuropeptido Y marcados com <sup>99m</sup>Tc para detecção de receptores Y1 expressos no cancro da mama*, by Marta Sofia de Oliveira Antunes, Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), Dec 6 (2012).
- Invited Coordinating Professor at Master Course of Nuclear Medicine, *Radiofarmácia Experimental* (40h) and *Inovação em Radiofarmácia* (25h) curricular units, Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), Lisbon, Portugal. 2011-2012.

## PROJECTS

### Team Member (15%)

- *Molecular and Nano Tools for Cancer Theranostics*, EXCL/QEQ-MED/0233/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. IST/ITN Principal Researcher: I. Santos *Recommended for funding*.

---

## NAME: Paula Maria Mimo Carreira Paquete

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5381

## R&D ACTIVITY

Nº	Activity Description	R&D
1	Isotope geochemistry studies of cold and hot mineral groundwaters - Portugal	25%
2	Identification of salinization mechanisms in coastal aquifers through a multidisciplinary approach (isotopic, geochemical and geophysical)	20%
3	National Network for Isotopes in Precipitation	10%
4	Thesis supervision & laboratory formation	20%
5	Laboratory Management	15%
6	Services to the scientific community	10%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p><b><i>Isotope geochemistry studies of cold and hot mineral groundwaters - Portugal</i></b></p> <p>An important part of groundwater resources are linked to the exploitation of the thermomineral waters located, in Portugal, mainly in the region of Minho and Tras-os-Montes and associated with major structural accidents, for example, along the main fault NNE-SSW direction of mega structure Chaves-Verin-Penacova. Throughout these structural accidents are found mineralized hot springs (Chaves) and a large number of cold CO<sub>2</sub> rich mineral waters like Monção, Melgaço, Messegães, Vilarelho Raia, Pedras Salgadas, Vidago, etc.</p> <p>The work in mineral systems, particularly in Melgaço-Messagães and Caldas da Rainha aimed to achieved the characterization of the conceptual models and establish relationship between mineral water (hot and cold) and local infiltration of rainwater. Sampling campaigns, carried out in previous years, were the working base to presented scientific work to the community, with main goals protection and management of natural resources. These investigations are essential to the exploitation and future development of regional water resources and to the delimitation of protection areas.</p> <p>As part of these studies were submitted 3 articles to international journals (1 published, 1 accepted for publication, 1 under revision).</p>
2	<p><b><i>Identification of salinization mechanisms in coastal aquifer through a multidisciplinary approach (isotopic, geochemical and geophysical)</i></b></p> <p>The study of the isotopic variations (<sup>2</sup>H, <sup>3</sup>H, <sup>13</sup>C, <sup>14</sup>C, and <sup>18</sup>O) in groundwater systems has been essential in the identification and quantification of the origin of salinization and as an additional</p>

	<p>tool in hydrogeochemical investigations, which in some cases are not able to clarify these issues (origin of salts). Three case studies in coastal aquifers have been part of our research such as:</p> <p>i) Meso-Cenozoic Basin - S Portugal (Algarve sedimentary basin);  ii) Lower Tagus - Lower Sado Sedimentary Basin;  iii) Santiago Island (Cape Verde) - volcanic island.</p> <p>In all these three areas an increase of salinization of the water resources have been observed, reaching values of several grams of dissolved salts per liter. The source of these high mineralization of the groundwater systems can be: (a) recent seawater intrusion (Algarve sector Portimão-Estombar; Santiago Island - Cape Verde); (b) dissolution of diapirc structures and / or salts dissolution dispersed in geological formations (Algarve sector Faro- Tavira) and influence of marine spray (Cape Verde Islands); (c) dissolution brine at depth (Lower Tagus – Lower Sado Basin).</p> <p>As part of these studies was submitted to an international journal 1 article (under revision).</p>
3	<p><b><i>National Network for Isotopes in Precipitation</i></b></p> <p>Following the joint actions IST/ITN with the International Atomic Energy Agency (IAEA) and the World Meteorological Organization (WMO), we have continue to proceed to the systematic determination of the isotopic composition of precipitation monthly samples in Portugal mainland since 1988.</p> <p>The main objective of this study is to determine the temporal and seasonal variations of environmental isotopes in monthly precipitation samples (<math>^2\text{H}</math>, <math>^{18}\text{O}</math> and <math>^3\text{H}</math>), and consequently, in providing information on the applicability of the isotopic variations in Hydrology, Hydrogeology and Climatology studies, having special attention to the development and a proper management of water resources.</p> <p>The isotopic composition of the precipitation is closely associated with environmental features in the water vapor masses formation, and as well as in the environmental features when the precipitation occurs such as, temperature, altitude, amount of precipitation for example. The results of stable isotopes obtained allowed the definition of the so-called <i>Meteoric Water Line of Portugal</i>.</p> <p>It should be noted that the results obtained have been introduced in the database IAEA (<a href="http://isohis.iaea.org">http://isohis.iaea.org</a>).</p>
4	<p><b><i>Thesis supervision and laboratory formation</i></b></p> <p>Supervisor, MSc. Thesis, <i>Assessment of marine intrusion using geochemical and isotope (<math>^{18}\text{O}</math>, <math>^2\text{H}</math>, and <math>^3\text{H}</math>) data: Cap Bom, N- Tunisia</i>, by António Osório Silva, Instituto Superior Técnico, Universidade Técnica de Lisboa.</p> <p>Co-supervisor, PhD Thesis, <i>Estudo do Modelo conceptual do aquífero de água mineral natural de Caldas de Rainha</i>, by Henrique Ferreira Gago Graça. Instituto Superior Técnico, Universidade Técnica de Lisboa.</p> <p>Co-supervisor , PhD Thesis, <i>Contribuição para o conhecimento da hidrogeologia da região do parque natural da Serra da Estrela (sector de Seia – Torre – Covilhã)</i>, by Alexandra Maria Magalhães Carvalho. Faculdade de Ciências, Universidade do Porto.</p> <p>Scientific Visitor:</p> <p>Visitor : Alexandra Carvalho (1 week)</p> <p>Affiliation: Faculdade de Ciências da Universidade do Porto</p> <p>Objective: Isotope Hydrology in mountain areas. Training in routine operation of LGR for analysis of stable isotopes in water samples; <math>^3\text{H}</math> dating (tritium laboratory).</p>
5	<p><b><i>Laboratory Management</i></b></p> <p>Responsible for the management and setup of the Mass Spectrometry Light Isotope Laboratory in which two guidelines have been established:</p>

	<p>i) development of research projects or participation in research projects in collaboration with other national and international institutions, and</p> <p>ii) Services by performing isotopic analyses and / or as a consultant in Isotope Hydrology area.</p>
6	<p><b>Services to the scientific community:</b></p> <p>The provision of services to the scientific community has been achieved in the form of research projects, consultancy or in the form of provision of services. The entities through their Researchers have used this service (determination of the isotopic composition of light isotopes: <math>^2\text{H}</math>, <math>^3\text{H}</math>, <math>^{13}\text{C}</math>, and <math>^{18}\text{O}</math>) during 2012 were:</p> <ul style="list-style-type: none"> <li>- Faculdade de Ciências da Universidade de Lisboa</li> <li>- Universidade da Madeira</li> <li>- Instituto Superior Técnico – Departamento de Civil – Centro de Geoquímica e Petrologia.</li> </ul>

## PUBLICATIONS

- J.M. Marques, P.M. Carreira, F. Goff, H.G.M. Eggenkamp, M. Antunes da Silva, Input of  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios and Sr geochemical signatures to update knowledge on thermal and mineral waters flow paths in fractured rocks (N-Portugal), *Applied Geochemistry*, 27, 1471-1481 (2012), doi:10.1016/j.apgeochem.2012.03.007.
- Carvalho, J. Espinha Marques, J.M. Marques, P.M. Carreira, R. Moura, A. Guerner Dias, H.I. Chaminé, F. Rocha, R. Saraiva, M. Tavares, C. Mansilha, Contaminação de água subterrânea de limpeza da neve em estradas: o caso do sector da Nave de Santo António – Covão do Curral (Serra da Estrela, Centro de Portugal), *Comunicações Geológicas*, 99 (1), 19-25 (2012), ISSN: 0873-948X
- J.M. Marques, H. Graça, H.G.M. Eggenkamp, P.M. Carreira, B. Mayer, D. Nunes, Contribuição de traçadores geoquímicos e isotópicos para a avaliação das águas termais das Caldas da Rainha, *Comunicações Geológicas*, 99 (2), 43-51 (2012), ISSN: 0873-948X.
- P.M. Carreira, D. Nunes, J.M. Marques, M.R. Carvalho, M. Antunes da Silva, New insights on Melgaço  $\text{CO}_2$ -rich cold mineral waters (NW Portugal) ascribed to isotopes and geochemical composition. *Proceedings International Conference on Groundwater in Fractured Rocks*, (Eds. Z. Hrkal & K.Kovar), Prague, Czech Republic (2012), 69-90.
- J.M. Marques, C. Matos, P.M. Carreira, J. Espinha Marques, H.I. Chaminé, Geochemical and environmental isotope tracers to assess anthropogenic impact in an area of thermal springs. *Proceedings International Conference on Groundwater in Fractured Rocks*, (Eds. Z. Hrkal & K.Kovar), Prague, Czech Republic (2012), 67-68.
- P.M. Carreira, J.M. Marques, D. Nunes, A. Pina. Groundwater degradation by different salinization processes: three case studies on the application of environmental isotopes to assess seawater intrusion vs. dissolution of salt minerals in coastal areas. *Book of Abstracts of 9<sup>th</sup> International Symposium on Environmental Geochemistry* (Eds. E. Ferreira da Silva, A.P. Reis, C. Patinha, E. Pereira & S. Rodrigues). Aveiro, Portugal (2012), 114. ISBN: 978-972-789-365-2.
- J.M. Marques, C. Matos, P.M. Carreira, J. Espinha Marques, H. Graça, H.I. Chaminé, High vs. Low enthalpies geothermal resources: environmental issues. *Book of Abstracts of 9<sup>th</sup> International Symposium on Environmental Geochemistry* (Eds. E. Ferreira da Silva, A.P. Reis, C. Patinha, E. Pereira & S. Rodrigues). Aveiro, Portugal (2012), 76-77. ISBN: 978-972-789-365-2.
- P.M. Carreira, J.M. Marques, D. Nunes, Multi-isotopic and geochemical approach in the identification of groundwater degradation by different salinization processes in coastal aquifers – Portugal, *Book of Abstracts of 39<sup>th</sup> IAH Congress, Confronting Global Change*, (Eds. IAH – Canadian Chapter), Niagara Falls, Canada (2012), 302-303.
- J.M. Marques, C. Matos, H.G.M. Eggenkamp, O. Neves, P.M. Carreira, D. Nunes, H. Graça, B. Mayer, Use of oxygen-18 as a natural tracer to elucidate shallow /thermal groundwater interactions in a karst region (Central Portugal), *Book of Abstracts of 39<sup>th</sup> IAH Congress, Confronting Global Change*, (Eds. IAH – Canadian Chapter), Niagara Falls, Canada (2012), 363.

## EDUCATION / THESES SUPERVISION

- Co-supervisor, PhD Thesis, *Estudo do Modelo conceptual do aquífero de água mineral natural de Caldas de Rainha*, by Henrique Ferreira Gago Graça. Seminário de Apresentação Pública da Tese, Instituto Superior Técnico, Universidade Técnica de Lisboa, 21 de March 2012 (on-going).

## PROJECTS

- *The Cabeço de Vide mineral waters (Central Portugal): a natural analogue to increase understanding of the origin of life on Earth and possibly elsewhere*. PTDC/AAG-MAA/2891/2012 – IST/ITN Coordenador: P. Carreira Paquete (20 %) Financiamento Aprovado pela FCT.
- *Environmental isotopic geochemistry and geophysics as a multidisciplinary approach in the identification of groundwater mineralization origin in Sousse region, NE - Tunisia*. Cooperação Transnacional; Concurso dos Acordos Bilaterais Portugal – Tunisia, Coordenador P. Carreira Paquete. Aguarda avaliação.
- *Vulnerability and sustainability of groundwater systems. A multi-isotopic and geochemical approach a tool to assess regional hydrological resources (PTDC/AAG-REC/3797/2012)*, IST/ITN Coordenador de Projecto P. Carreira Paquete (45 %)- Não financiado.
- *NTrace - Evaluation of the nitrogen cycle in the evaluation of water resources degradation - Aveiro Region*. (PTDC/AAG-MAA/4048/2012), IST/ITN Coordenador: P. Carreira Paquete (15%). Não financiado.

## CONFERENCE ORGANIZATION

- Chair-person in the 9th International Symposium on Environmental Geochemistry – Theme 6: *Water Resources and Aquatic Environments*.

---

## NAME: Maria Teresa Oliveira de Almeida Gasche

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5376

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Scientific and technical activities	75%
2	Training and teaching activities	20%
3	Services activities	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>Studies concerning important environmental issues such as the activation and valorization of methane and carbon dioxide as valuable C1 feedstock's, namely through the catalytic partial oxidation of CH<sub>4</sub> (POM reaction) using N<sub>2</sub>O as oxidant were continued.</p> <p>Research concerning the synthesis of binary intermetallic compounds (IC) nanoparticles containing, f-block elements were performed. Nickel lanthanide and actinide nanoparticles catalysts were obtained using the sol-gel method. Their catalytic activity and stability to produce synthesis gas through partial oxidation of methane (POM) were studied. It was seen that these compounds were very active and selective for the partial oxidation of methane and synthesis gas production. The nanoparticles size of nickel oxide seems to have some influence on the activity and selectivity of catalysts. It was also seen, that the formation of nanoparticles catalysts by the sol gel method showed that the carbon deposition to be very low and a huge improvement catalysts stability. The characterization of nanoparticles was done with (SEM), (XRD), elemental analysis and (TEM).</p> <p>Industrial processes involving ionic liquids demand reliable thermodynamic or physical data of pure components and mixtures. Our research concerning ionic liquids (ILs) properties continued. Viscosity and density measurements of pure ILs and mixtures were done.</p>

2	The training and teaching activities concerns the work performed with research students, namely, a Ph.D. student and a research student. The financial support for the work related to these two students was mostly from FCT, via research projects.
3	The services to the community consisted in the organization of internal seminars in the research group.

## PAPERS

- J.B. Branco, A.C. Ferreira, A.M. Botelho do Rego, A.M. Ferraria, T. Almeida-Gasche, Conversion of Methane over Bimetallic Copper and Nickel Actinide Oxides (Th, U) Using Nitrous Oxide As Oxidant, *in ACS Catal.* 2482–2489, 2 (2012), [doi.org/10.1021/cs300530h](https://doi.org/10.1021/cs300530h).

## COMMUNICATIONS

- Synthesis of intermetallic nanoparticles containing f-elements*, A.C. Ferreira, T. Almeida-Gasche, J.P. Leal, J.B. Branco, *COST Action CM1006 – EUFEN 1, Salou-Tarragona, April (2012)*, Poster.

## PROJECTS

- Team member (50%)*: “CO<sub>2</sub> mitigation and production of methanol by reforming of CH<sub>4</sub>”, PTDC/AAG-TEC/3324/2012, IST/ITN Coordinator; Joaquim Branco (35%); FCUL partner, recommended for funding (172260 Euros).

## NAME: Christopher Ian Burbidge

**CATEGORIA:** Auxiliary Researcher (Contract)

**IFD NUMBER:** 5491

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Principal Researcher. FCT research project PTDC/AAC-AMB/121375/2010.	40%
2	Coordinator and Researcher Responsible - Portugal. Convене Portugal (FCT) / Itália (CNR) 2011-2012.	5%
3	Co-Researcher. IAEA Technical Cooperation Project RER/0/034	1%
4	Co-Researcher. FCT research project PTDC/CS-ANT/104333/2008	5%
5	Co-Researcher. FCT research project PTDC/HIS-HEC/101756/2008	10%
6	Co-Researcher. FCT research project PTDC/HIS-ARQ/101299/2008	10%
7	Co-Researcher. FCT Strategic Project: PEst-C/CTE/UI4035/2011 - UI 4035 - 2011-2012	-
8	Preparation and submission of proposals for research projects.	2%
9	Co- supervision of 2 doctoral students: FCT Doctoral Fellowship SFRH/BD/62396/2009; Doctoral project funded by the Estrada Foundation.	10%
10	Organization and hosting of L.A.I.S. 2012, Lisbon. Guest Editor, Mediterranean Archaeology and Archaeometry.	10%
11	Review of research project proposals and journal articles	1%
12	European Radiation Dosimetry Group: Member and WG Secretary	1%
13	Preparation of presentations and publications in relation to previous services and projects	3%
14	Establishment of gamma spectrometry analysis of non-neutron activated samples in the GeoLuC group.	2%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	Principal Researcher. Spatial Variation of Dose Rate in Soils and Sediments - VADOSE. PTDC/AAC-AMB/121375/2010. €198k. Coordinator of Project: ITN (C.I. Burbidge). Partners: U. Aveiro, GEOBIOTEC (Portugal), SUERC (U.K.).  Work on this project has so far consisted of fieldwork, sample preparation, initial studies in radiation transport modelling, calibration of in situ dosimeters. Seven ca. 100 kg soil and sediment samples were collected from contrasting lithological settings, in 1 week based at UA, from six



	<p>locations across north-central Portugal. Sampling was combined with detailed in situ measurements and area surveys by gamma spectrometry, including the first application in this context of a novel backpack system developed by the group of the project consultant. Granulometric separation is underway in GeoLuC and feeding into laboratory mineralogical, geochemical and radiometric analyses. Initial studies in radiation transport modelling are being for mixed electron-photon fields extending to low energies, and dosimeter calibration irradiations have been made at UPSR, CTN. Training of junior staff has included an ERASMUS course on Advanced Environmental Geology and employment of a research assistant. This project is helping to develop gamma spectrometry of non-neutron-activated materials in the GeoLuC group (14), with associated outputs in addition to 1 dedicated presentation.</p>
2	<p>Project Coordinator and Researcher Responsible-Portugal. Processos Luminescentes-Dosimetricos no Quartz. italia128584682220330. Convénio Portugal (FCT) / Itália (CNR) 2011-2012. Researcher Responsible-Italy, Prof. M. Martini, CUDaM, UNIMIB.</p> <p>This project aims to establish a basis in international collaboration for the development of new understanding of trapping, transport and recombination of the electronic charges that produce dosimetric luminescence signals in quartz. In 2012 a visit was made to the Italian partner to deliver samples and make radioluminescence measurements. Members of the Italian laboratory visited CTN in combination with the LAIS2012 conference, where initial results were presented (listed below). Ionoluminescence measurements have been conducted in collaboration with UFA, CTN. In addition, 1 article has been submitted for publication based on the theoretical background, and another will shortly be submitted based on initial thermally and optically stimulated-, radio- and iono- luminescence results.</p> <p>Burbidge, C.I. Submitted. A geometric analysis of dose response based on saturating exponential functions, focussing on the standardized OSL response of quartz to ionizing radiation exposure. Radiation Measurements.</p> <p>Burbidge, C.I., Martini, M., Fasoli, M., Alves, L., Cardoso, G., Villa, I. In Prep. Luminescence signals and emissions from grains of quartz prepared from Portuguese granite and aplite-pegmatite. Mediterranean Archaeology and Archaeometry.</p>
3	<p>Co-Researcher. Technical Cooperation Project - IAEA TC Project RER/0/034 "Enhancing the Characterization, Preservation and Protection of Cultural Heritage Artefacts". M. Isabel Prudêncio: Portuguese nuclear scientist nominated, designated Responsible Person from Counterpart Institute (Instituto Superior Técnico) (2012-2013).</p> <p>As part of this project an IAEA regional training course was hosted at CTN on Radiation Technology for Cultural Heritage Preservation. I was Responsible for Theme IV. Retrospective evaluation of absorbed dose within objects using stimulated luminescence. This involved the design, organization, presentation and management of a lecture (see list) and an experimental program to train participants in basic aspects of theory, micro-invasive sampling, measurement and interpretation of luminescence signals from ceramics, with the objective of retrospectively identifying objects that had been subject to radiation treatment using material from the object concerned, in a total of ca. 3 hrs contact time.</p>
4	<p>Co-Researcher. Gestão da morte na Pré-História Recente: práticas funerárias no recinto dos Perdigões. PTDC/CS-ANT/104333/2008. FCT, €142k. Coordinator of Project: UC, Centro de Investigação em Antropologia (Ana M. Silva). Partners: NIA-ERA Arqueologia S.A. ITN.</p> <p>Luminescence dating and profiling of soils/sediments and ceramic sherds is being conducted in parallel to understand the formation history of negative archaeological features (ditches, pits, sepulchres), and hence the chronology of development of the Perdigões site. Latest results provide absolute evidence for a longer sequence of occupation periods than initially thought, and indicate episodes of remobilization of archaeological material, helping archaeologists to understand the site stratigraphy. Initial results were presented at LAIS2012.</p>
5	<p>Co-Researcher. Diagnóstico, descontaminação e conservação da herança cultural: neutrões e radiação ionizante em objectos de arte (RADIART). PTDC/HIS-HEC/101756/2008. FCT, €140k. Coordinator of Project: ITN (M. Isabel Prudêncio). Partners: IMC.</p> <p>Having evaluated and performed high-dose radiation treatment monitoring of historic tiles, and assisted in neutron tomography studies, luminescence dating analyses of ca. 30 untreated historic</p>

	<p>tiles are presently underway. Quartz grains ca. 11-40 micron have been prepared and are being evaluated for their luminescence-dosimetric behavioural characteristics. In addition to 3 publications and 2 presentations listed below, 1 article has been submitted for publication:</p> <p>Stanojev Pereira, M.A., Marques, J.G., Santos, J.P., Prudêncio, M.I., Burbidge, C.I. Submitted. Neutron imaging techniques applied in the study of the archaeological and cultural heritage field. Mediterranean Archaeology and Archaeometry.</p>
6	<p>Co-Researcher. RUPSCIENCE - Analysis of the operational chains, archaeometry and chronology of Rock Art Paintings. An approach to materials technology of Portugal, Spain and Colombia's contexts. PTDC/HIS-ARQ/101299/2008. FCT, €84k. Coordinator of Project: IPT (Luiz Oosterbeek). Other partners: ITN; UTAD; GIPRI, Bogota; IRP-UPV, Valencia; MAE/USP, São Paulo.</p> <p>Samples of quartz rich iron oxide (raw material for the rock art of interest), and quartzite (medium upon which the rock art is emplaced) sampled in 2011 have been prepared, and testing of their luminescence-dosimetric behaviour is ongoing.</p>
7	<p>Co-Researcher. GeoBioTeC – GeoBioSciences, GeoTechnologies and GeoEngineering - Strategic Project - referência: PEst-C/CTE/UI4035/2011 - UI 4035 - 2011-2012; Strategic Project - UI 4035 - 2011-2012; (Financiamento global da Unidade 2001-2012: 497.938 k€. Coordinator of Project: Fernando Rocha, U.A.</p> <p>Participation in GEOBIOTEC has contributed in a cross-cutting manner to many collaborations and projects, particularly in relation to obtaining complementary analyses of geomaterials, sampling/samples, and training of junior staff and students in geoscience methods and applications. Rodrigues is registered in UA. UA is a partner in VADOSE.</p>
8	<p>Preparation and submission of proposals for research projects.</p> <p>I have been involved in two project submissions in 2012:</p> <p>Submitted to FCT, 2012. Principal Researcher. COLUMA - Combining Radiation Induced Luminescence Methods for Archaeomaterials. PTDC/EPH-ARQ/5070/2012 Coordinator of Project: IST/ITN (Burbidge). Partners: GEOBIOTEC (Portugal), UNIMIB (Italy), SUERC (U.K.), HAS-CER (Hungary). Not approved for funding.</p> <p>Submitted to the EUROPEAN COMMISSION, 2012. Co-Researcher. DeepElectroMetal. FP7-NMP-2013-LARGE-7. NMP.2013.4.1-2 Breakthrough Solutions for Mineral Extraction and Processing in Extreme Environments. Coordinating person: Prof. Ludo Diels (VITO). Coordinating person at IST: M.I. Prudêncio. Proposed duration of the project: 42 months. Accepted for the second stage. Total: 17 530 k€, IST/ITN: 492.5 k€.</p>
9	<p>Co-supervision of 2 doctoral students: FCT Doctoral Fellowship SFRH/BD/62396/2009; Doctoral project funded by the Estrada Foundation.</p> <p>Co-supervisor. FCT Doctoral Fellowship SFRH/BD/62396/2009 “Geoquímica, mineralogia e cronologia absoluta de materiais geo-arqueológicos circundantes à barragem do Alqueva. Contribuição para o conhecimento e valorização do património cultural”, A. L. Sebastião Rodrigues. Supervisor Prof. F. Rocha. Co-supervisors M. I. Dias (A. Valera). Partners: ITN, UA, NIA-ERA Arqueologia S.A.</p> <p>Co-supervisor. Doctoral project funded by the Estrada Foundation “Archeometry and Dating of Ceramics”, J. Mungur Medhi. Supervisor L. Oosterbeek, Polytechnic of Tomar. Co-supervisor M.I. Dias. Partners: ITN, IPT, UTAD.</p> <p>In addition to 1 publication by Mungur Medhi and 3 presentations by Rodrigues listed below, 1 article has been submitted for publication:</p> <p>Rodrigues, A.L., Burbidge, C.I., Dias, M.I., Rocha, F., Valera, A., Prudêncio, M.I. Submitted. Luminescence and mineralogy of profiling samples from negative archaeological features. Mediterranean Archaeology and Archaeometry.</p>
10	<p>Principal organizer and host of L.A.I.S. 2012, Lisbon.</p> <p>Guest Editor, Mediterranean Archaeology and Archaeometry.</p> <p>The first international conference focussed on the luminescence dating research community to be held in Portugal, and the second Luminescence in Archaeology International Symposium (L.A.I.S. 2012, Lisbon), was hosted by the GeoLuC group at IST/ITN from the 5<sup>th</sup>-7<sup>th</sup> September 2012. I</p>

	<p>attracted the conference and managed its organization from start to finish, with crucial contributions from the president of the standing committee, the local organizing committee, other GeoLuC members, and the CTN technical staff, administration and direction. Although small, the 45 participants, from Asia, Africa, North and South America, and across Europe, represented a ca. 30% increase on the first meeting and contributes to the establishment of a new fully international conference series in which CTN and Lisbon will be remembered positively. Following organization of the conference I am acting as guest editor for the special issue of the ISI journal <i>Mediterranean Archaeology and Archaeometry</i>, in which the proceedings will be published. I am presently managing the submission and review process.</p>
11	<p>Review of Research Project Proposals and Submitted Papers.  Review of a project proposal to the Ministero dell'Istruzione, dell'Università e della Ricerca, Italy.  Reviewer of articles submitted to <i>Radiation Measurements and Quaternary Geochronology</i>: the two principal journals of the luminescence dating community; respectively technical and applied.</p>
12	<p>European Radiation Dosimetry Group: Member and WG Secretary.  As a full member of EURADOS and Secretary of Working Group 10 "Retrospective dosimetry", I attend each annual meeting, maintain contact details of WG members, prepare and collate minutes of group meetings etc. The annual meeting is a medium for establishing participation in international exercises, continuing professional development, and dissemination of my own research activities.  During 2012 I began participation in the MULTIBIODOSE (FP7-SECURITY 241536) WP5 / EURADOS WG10, Intercomparison of Physical Dosimetry Methods. This is a series of controlled evaluations of the ability of different luminescence and EPR dosimetry laboratories around Europe to reconstruct accidental radiation exposures using different components from mobile phones. I am also participating in a task aiming to evaluate the potential for harmonizing statistical evaluation in physical and biological methods in retrospective accident dosimetry.  At EURADOS Annual Meeting 2012, IAEA, Vienna International Centre (6-8/02/2012), I attended the workshop "Dosimetry for secondary cancer risk estimation in radiotherapy". 1 oral presentation and 1 poster are listed below.</p>
13	<p>Preparation of presentations and publications in relation to previous services and projects.  In addition to 1 publication and 3 presentations listed below, 1 article has been submitted for publication:  Rebêlo, L., Costas, S., Brito, P., Ferraz, M., Prudêncio, I. and Burbidge, C. Submitted. Imprints of the 1755 tsunami in the Tróia Peninsula shoreline, Portugal In: Conley, D.C., Masselink, G., Russell, P.E. and O'Hare, T.J. (eds.), <i>Proceedings 12th International Coastal Symposium</i> (Plymouth, England), <i>Journal of Coastal Research</i>, Special Issue No. 65.</p>
14	<p>Establishment of gamma spectrometry analysis of non-neutron activated samples in the GeoLuC group.  Gamma spectrometry analysis at GeoLuC is being extended from neutron activated samples of geological and cultural heritage material, to include evaluation of natural emissions from K, Th and U. Taking advantage of existing detectors and geostandards, this complements existing INAA and field gamma spectrometry analyses to enable a more complete picture of radionuclide concentration, spatial distribution, and temporal mobility to be obtained for geochemical and luminescence dating studies. Although at an early stage, it has already contributed to a range of research, post-doctoral, and student projects, and collaborative work. In addition to 7 presentations listed below, 2 articles have been submitted:  Trindade, M.J., Prudêncio, M.I., Burbidge, C.I., Dias, M.I., Cardoso, G., Marques, R., Rocha, F. Submitted. Distribution of naturally occurring radionuclides (K, Th and U) in weathered rocks of various lithological types from the uranium bearing region of Fornos de Algodres, Portugal. <i>Mediterranean Archaeology and Archaeometry</i>.  Trindade, M.J., Prudêncio, M.I., Burbidge, C.I., Dias, M.I., Cardoso, G., Marques, R., Rocha, F. Submitted. Study of an aplite dyke from the Beira uraniumiferous province in Fornos de Algodres area (Central Portugal): trace elements distribution and evaluation of natural radioactivity. <i>Applied Geochemistry</i>.</p>

## PUBLICATIONS

- Burbidge, C.I. Facets of Luminescence for Dating. *Spectroscopy Letters* 45, 118–126 (2012)
- Gilliland, K., Simpson, I.A., Adderley, W.P., Burbidge, C.I., Cresswell, A.J., Sanderson, D.C.W., Coningham, R.A., Manuel, M., Strickland, K.. The dry tank: Development and disuse of water management infrastructure in the Anuradhapura hinterland, Sri Lanka. *Journal of Archaeological Science* 40, 1012-1028. (2013).
- Prudêncio, M.I., Stanojev Pereira, M.A., Marques, J.G., Dias, M.I., Esteves, L., Burbidge, C.I., Trindade, M.J., Albuquerque, M.B. Neutron tomography for the assessment of consolidant impregnation efficiency in Portuguese glazed tiles (16th and 18th centuries). *Journal of Archeological Science* 39, 964-969 (2012)
- Silva, T., Cabo Verde, S., Cardoso, G., Fernandes, A. C., Trindade, M.J., Burbidge, C. I., Dias, M. I., Bothelho, M. L., Prudêncio, M.I. Perfis de contaminação e inativação microbiana em azulejos. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 253-260. (2012).
- Stanojev Pereira, M.A., Prudêncio, M.I., Marques, J.G., Figueiredo, M.O. , Dias, M.I., Silva, T.P., Esteves, L., Burbidge, C.I., Trindade, M.J., Marques, R, Alberquerque. M.B. Tomografia de neutrões aplicada a azulejos do século XVI e XVII – visualização para caracterização, diagnóstico e optimização de técnicas de conservação. *Estudos Arqueológicos de Oeiras*, vol. 19, pp. 261-266. (2012).
- Munghur-Medhi, J., Burbidge, C.I., Dias, M.I., Coroado, J. Multi-Analytical Approach in the study of Ceramics, In Oosterbeek, L., Cerezer, J.F. (eds). *Estudos de Tecnologia Cerâmica*, ARKEOS 31. CEIPHAR, Tomar. 83-94. (2012).

## COMMUNICATIONS

- *Dating and dosimetry using thermally- and optically- stimulated luminescence from minerals*. Burbidge, C.I. *Colóquios Dept. Física, Instituto Superior Técnico, Alameda. Lisbon. 28th Nov. (2012)*, Invited Seminar.
- *Retrospective evaluation of absorbed dose within objects using stimulated luminescence*. Burbidge, C.I. *Regional Training Course on Radiation Technology for Cultural Heritage Preservation, IST/ITN, Sacavém. 06 Nov. (2012)*, Oral Presentation.
- *Data Structure in Luminescence Retrospective Dosimetry*. Burbidge, C.I. *WG10 meetings, EURADOS Annual Meeting 2012. IAEA, Vienna International Centre. 6-8, Feb (2012)*, Oral Presentation.
- *OSL dating at Perdigões enclosure complex (Reguengos de Monserraz, Portugal)*. Burbidge, C.I., Cardoso, G., Dias, M.I., Prudêncio, M.I., Valera, A., Márquez Romero, J., Franco, D., Marques, R. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Oral Presentation.
- *Heated flint from Gruta de Oliveira (Portugal): comparison of TL-dating results with radiocarbon and U-series dating*. Richter, D., Angellucci, D.E., Burbidge, C.I., Dias, M.I., Gouveia, M.A., Prudêncio, M.I., Zilhão, J. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Oral Presentation - Coauthor.
- *Luminescence and mineralogy of profiling samples from negative archaeological features*. Rodrigues, A.L., Burbidge, C.I., Dias, M.I., Rocha, F., Valera, A., Prudêncio, M.I. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Oral Presentation - Coauthor.
- *Geochemical and mineralogical characterization of fill materials from a negative archaeological structure, and relations with luminescence and dosimetric behavior*. Rodrigues A.L., Burbidge C.I., Dias M.I., Rocha F., Franco D., Prudêncio M.I., Valera A.C. *9th ISEG - International Symposium on Environmental Geochemistry, University of Aveiro, Portugal.15-22 Jul. (2012)*. Oral Presentation - Coauthor.
- *Distribution of U, Th and K in aplite and dolerite veins, granite and schist from the Sobral Pichorro area (Fornos de Algodres, Central Portugal)*. Trindade, M.J., Prudêncio, M.I., Dias, M.I., Burbidge, C.I., Cardoso, G., Marques, R., Rocha, F. *9th ISEG - International Symposium on Environmental Geochemistry, University of Aveiro, Portugal.15-22 Jul. (2012)*. Oral Presentation - Coauthor.

- *Luminescence Techniques on Earth Sciences and Cultural Heritage*. Cardoso, G., Burbidge, C., Dias, M.I., Prudêncio, M.I., Rocha, F. *ADVANCEG 1, Erasmus Intensive Programme in Advanced Environmental Geology 1 (Mineral resources suitable for environmental application)*, Banská Štiavnica, Slovakia. 2–13 Jul, (2012), Oral Presentation - Coauthor.
- *Laboratory protocols for luminescence techniques applied on Porcelains and Faience from the 16th – 18th centuries*. Rodrigues, A., Burbidge, C., Dias, M.I., Cardoso, G. *2nd International Workshop on Physical and Chemical Analytical Techniques in Cultural Heritage*. Centro de Física Atómica da Universidade de Lisboa, Portugal. 4-5 Jun, (2012), Oral Presentation - Coauthor.
- *How can the EURADOS Network on Retrospective Dosimetry contribute to research in low doses?* Fattibene P., Ainsbury L., Burbidge C., Chumak V., Romm H., Rothkamm K., Trompier F., Woda C., Bajinskis A., Barquinero P., Bassinet C., Bernhardsson C., Cauwels V., Correcher V., Della Monaca S., Ekendahl D., Gregoire E., Hole Eli O., Jaworska A., Kouroukla E., Kulka U., Marrale M., Maznyk N., Michalec B., Monteiro Gil O., Moquet J., Oestreicher U., Pajic J., Testa A., Veronese I., Vinnikov V., Voisin P., Wieser A., Wojcik A. *4th International MELODI Workshop, Helsinki, Finland 12-14 Sept, (2012)*, Poster Presentation.
- *Luminescence signals and emissions from grains of quartz prepared from Portuguese granite and pegmatite*. Burbidge, C.I., Martini, M., Fasoli, M., Cardoso, G., Alves, L., Villa, I., Marques, C.P. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Poster Presentation.
- *VADOSE - A new project to investigate spatial variation of dose rates in soils and sediments*. Burbidge, C.I., Teles, P.M., Trindade, M.J., Reis, M.J., Prudêncio, M.I., Andrejkovicova, S., Sanderson, D.C.W., Rocha, F., Cardoso, J.V., Santos, L., Carvalho, G., Abrantes, J., Marques, R., Cardoso, G.J.O., Romanets, Y., Franco, D., Sequeira, M.C., Gouveia, M.A., Dias, M.I. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Poster Presentation.
- *Distribution of natural radionuclides (K, Th and U) in an Aplite dyke from the Beira uraniferous province (Fornos de Algodres, Portugal)*. Trindade, M.J., Prudêncio, M.I., Burbidge, C.I., Dias, M.I., Marques, R., Cardoso, G.J.O., Rocha, F. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Poster Presentation.
- *Geochemistry and field radiometric measurements of naturally occurring radionuclides in several lithologies of Fornos de Algodres area (Central Portugal)*. Trindade, M.J., Prudêncio, M.I., Dias, M.I., Burbidge, C.I., Marques, R., Cardoso, G.J.O., Rocha, F. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Poster Presentation.
- *Scintillators applied in neutron imaging techniques*. Stanojev Pereira, M.A., Marques, J.G., Prudêncio, M.I., Burbidge, C.I., Santos, J.P., Burbidge, C.I. *2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012)*, Poster Presentation.
- *Distribution of uranium and other trace elements in an aplite dyke from Fornos de Algodres area (Northern Central Portugal)*. Trindade, M.J., Prudêncio, M.I., Burbidge, C.I., Dias, M.I., Marques, R., Cardoso, G., Rocha, F. *9th ISEG - International Symposium on Environmental Geochemistry, University of Aveiro, Portugal. 15-22 Jul. (2012)*. Poster Presentation.
- *Radiogenic elements in soils from Fogo island (Cape Verde)*. Marques, R., Burbidge, C.I., Dias, M.I., Prudêncio, M.I., Franco, D., Cardoso, G., Rocha, F., Ferreira da Silva, E. *9th ISEG - International Symposium on Environmental Geochemistry, University of Aveiro, Portugal. 15-22 Jul. (2012)*.
- *Datação por Luminescência. Festa da arqueologia: ciências da arqueologia*. Burbidge, C.I., Dias, M.I., Prudêncio, M.I. *Museu Arqueologico do Carmo, Lisbon. 5-6 May (2012)*,
- *Portuguese Glazed Tiles (16th-18th Centuries): INAA, XRD and Luminescence for Raw Materials Characterization and Production Technologies of the Ceramic Bodies, and Chronology* Prudêncio, M.I., Dias, M.I., Burbidge, C.I., Esteves, L., Trindade, M.J., Marques, R., Cardoso, G., Franco, D. *39th International Symposium on Archaeometry, Leuven, Belgium. 28 May - 1 June (2012)*, Poster Presentation.

## EDUCATION / THESES SUPERVISION

- Responsible, Theme IV. *Retrospective evaluation of absorbed dose within objects using stimulated luminescence*. Regional Training Course on Radiation Technology for Cultural Heritage Preservation, IAEA TC Project RER/0/034, “Using Nuclear Techniques for the Characterization and Preservation of Cultural Heritage Artefacts in the European Region”. Director: M. Isabel Prudêncio. IST/ITN, Sacavém 05-09 Nov. 2012.
- Co-supervisor. FCT Doctoral Fellowship SFRH/BD/62396/2009, *Geoquímica, mineralogia e cronologia absoluta de materiais geo-arqueológicos circundantes à barragem do Alqueva. Contribuição para o conhecimento e valorização do património cultural*, by A. L. Sebastião Rodrigues. Supervisor Prof. F. Rocha. Co-supervisors M. I. Dias (A. Valera). Partners: ITN, UA, NIA-ERA Arqueologia S.A. Ongoing.
- Co-supervisor. Doctoral project funded by the Estrada Foundation, *Archeometry and Dating of Ceramics*, J. Mungur Medhi. Supervisor L. Oosterbeek, Polytechnic of Tomar. Co-supervisor M.I. Dias. Partners: ITN, IPT, UTAD. Ongoing.

## PROJECTS

- *COLUMA - Combining Radiation Induced Luminescence Methods for Archaeomaterials*. PTDC/EPH-ARQ/5070/2012 Coordinator of Project: IST/ITN (Burbidge). Partners: GEOBIOTEC (Portugal), UNIMIB (Italy), SUERC (U.K.), HAS-CER (Hungary). Principal Researcher. Submitted to FCT, not approved for funding.
- *A datação por luminescência na avaliação e previsão dos efeitos de fogos no meio ambiente e no património*. Acções Integradas Luso-Espanholas 2012 (CRUP). Partners: U. Aveiro, Portugal; U. a Coruña, Spain. CoResearcher, responsible for activities in ITN. Submitted to CRUP, not approved for funding.
- *Spatial Variation of Dose Rate in Soils and Sediments - VADOSE*. PTDC/AAC-AMB/121375/2010. €198k. Coordinator of Project: ITN (C.I. Burbidge). Partners: U. Aveiro, GEOBIOTEC (Portugal), SUERC (U.K.). Principal Researcher (40%).
- *Processos Luminescentes-Dosimetricos no Quartzzo*. italia128584682220330. Convénio Portugal (FCT) / Itália (CNR) 2011-2012. Researcher Responsible-Italy, Prof. M. Martini, CUDaM, UNIMIB. Project Coordinator and Researcher Responsible-Portugal.

## CONFERENCE ORGANIZATION

- President (principal organizer) of the 2nd Luminescence in Archaeology International Symposium, IST/ITN, Sacavém, Loures-Portugal. 5 - 7 Sept. (2012).

## COLLABORATIONS

- MULTIBIODOSE (FP7-SECURITY 241536) WP5 / EURADOS WG10. Participant in Intercomparison of Physical Dosimetry Methods.
- EURADOS Annual Meeting, 6-8 Feb. 2012. IAEA, Vienna International Centre, including the Workshop "Dosimetry for secondary cancer risk estimation in radiotherapy".
- Secretary, EURADOS WG10 “Retrospective dosimetry”.
- Integrated Member, GeoBioTec Research Team, Universidade de Aveiro.
- Guest Editor, L.A.I.S. 2012 special issue. Mediterranean Archaeology and Archaeometry. 2012/2013
- Review of project proposals to the Ministero dell’Istruzione, dell’Università e della Ricerca, Italy
- Reviewer of articles submitted to Radiation Measurements and Quaternary Geochronology.
- Member, Sociedad de Arqueometría Aplicada al Patrimonio Cultural.

**NAME: Cláudia Cristina Lage Pereira**CATEGORY: Auxiliary Researcher (*Ciência 2007*)

ID NUMBER: 005490

**R&D ACTIVITIES**

Nº	Activity Description	R&D
1	Synthesis of ionic liquids with optical and magnetic properties	20%
2	Gas-phase chemistry/mass spectrometry of actinides	30%
3	Layered Lanthanide Hydroxides (LLHs) as materials with magnetic and optical properties	25%
4	Synthesis and characterization of Metal-Organic Frameworks (MOFs) based on actinides and lanthanides (U, Th and Eu), with relevant optical and catalytic properties.	25%
Total		100%

**WORK SUMMARY**

Nº	Work Summary and Main Achievements
1	<p>Three different compounds of general formula <math>\text{Ln}(\text{NTA})_4\text{PC}_{32}\text{H}_{68}</math> (<math>\text{Ln}=\text{Dy, Tb e Gd}</math>, <math>\text{NTA}=\text{naphthoyltrifluoroacetate}</math>) were synthesized and characterized with the purpose of studying their optical and magnetic properties. These complexes have higher melting points (near <math>100^\circ\text{C}</math>) when compared with the europium congener <math>\text{Eu}(\text{NTA})_4\text{PC}_{32}\text{H}_{68}</math> that has a melting point of <math>63^\circ\text{C}</math> (Pereira CCL, Dias S. Coutinho I, Leal, JP, Branco LC, Laia CAT, <i>Inorganic Chemistry</i>, 2012* just accepted).</p> <p>Presently its luminescence and magnetic behaviour is being evaluated in collaboration with Photochemistry Group from Faculdade de Ciências e Tecnologia /FCT/UNL) and Solid State Group from IST (ES/IST/ITN)</p>
2	<p>Laser ablation of <math>\text{AnC}_4</math> alloys (<math>\text{An}=\text{Th and U}</math>) yielded in the gas phase molecular thorium and uranium carbide cluster cations of composition <math>[\text{An}_m\text{C}_n]^+</math>, with <math>m = 1, n = 2-14</math>, and <math>m = 2, n = 3-18</math>. <math>\text{AnC}_{13}^+</math> ions have an unexpected high abundance standing out in the spectra, opposing to the gradual decreases in intensity of <math>\text{AnC}_n^+</math> species.</p> <p>In the case of thorium, <math>[\text{Th}_m\text{C}_n]^+</math> cluster ions with <math>m = 3-13</math> and <math>n = 5-30</math> could also be produced, with a unexpected high intensity for <math>\text{Th}_{13}\text{C}_n^+</math> cations.</p> <p>High abundances of <math>[\text{AnC}_2]^+</math> and <math>[\text{AnC}_4]^+</math> ions were observed, consistent with an enhanced stability of <math>\text{MC}_2</math> and <math>\text{MC}_4</math> species attributed to strong metal-dicarbide (<math>\text{M}-\text{C}_2</math> and <math>\text{C}_2-\text{M}-\text{C}_2</math>) bonds.</p> <p>For <math>\text{An}_2\text{C}_3^+</math> and <math>\text{An}_2\text{C}_4^+</math> some computational studies were performed regarding the structure and energetics. The most abundant bimetallic ion was for thorium, <math>\text{Th}_2\text{C}_3^+</math> while for uranium <math>\text{U}_2\text{C}_4^+</math> species was the most intense (Laura Gagliardi, University of Minnesota).</p>
3	<p>Dysprosium and Gadolinium/Europium materials of type Layered Lanthanide Hydroxide (LLH) with general formula <math>\text{Ln}_8(\text{OH})_{20}\text{Cl}_4 \cdot n\text{H}_2\text{O}</math> were synthesized and characterized with the purpose of studying their optical and magnetic properties.</p> <p>In collaboration with Solid State Group (ES/IST/ITN), the magnetic behaviour of LLH-Dy and the corresponding intercalation material with naphthalene dicarboxylate (LLH-NDC) was determined for the first time in these kind of materials with very interesting results.</p> <p>LLH of Gadolinium/Europium (95/5) and its intercalation material with naphthalene dicarboxylic acid were synthesized and characterized. Presently their optical properties are being evaluated in collaboration with Photochemistry Group from FCT/UNL</p>
4	<p>Metal-Organic frameworks (MOFs) of uranium (as <math>\text{UO}_2^{2+}</math>) and thorium (<math>\text{Th}^{4+}</math>) and <math>\text{UO}_2/\text{Eu}</math> (1:1) were synthesized and characterized. The selected ligands used for the construction of these frameworks were of the type Phosphonate with both aromatic and aliphatic chains. The all family was characterized by powder x-ray diffraction and in some cases also by single crystal x-ray diffraction in collaboration with University of Aveiro (CICECO).</p> <p>Luminescence of mixed MOFs of <math>\text{UO}_2</math> and Eu is presently being evaluated at University of Aveiro.</p>

**PAPERS**

- Gong Yu, Andrews Lester, Goncalves Antonio P, Pereira Cláudia CL, Marçalo Joaquim Infrared Spectra of (RhC)-C-12 and (RhC)-C-13 in Solid Neon and Solid Argon, *Chemical Physics Letters*, 528, 2012, 7-10. DOI: 10.1016/j.cplett.2012.01.021.

- Pereira CCL, Dias S. Coutinho I, Leal, JP, Branco LC, Laia CAT, Inorganic Chemistry, 2012 (Just accepted).

## COMMUNICATIONS

- *Actinide Polysulfides in the Gas Phase*, Ana F. Lucena, Cláudia C. L. Pereira, Colin J. Marsden, John K. Gibson, Joaquim Marçalo, *European f-Element Chemistry, COST Action CM1006, 2-4 de April, 2012, Tarragona*
- *Magnetic properties of a Dysprosium Layered Lanthanide Hydroxide and its intercalation for 2,6-naphthalenedicarboxylate*, Cláudia C. L. Pereira, Laura C. J. Pereira, Bernardo Monteiro, Ho M. Dung, Joaquim Marçalo, Manuel Almeida, *European f-Element Chemistry, COST Action CM1006, 2-4 de April, Tarragona*

## PROJECTS

- *Selective sequestration of uranium through immobilization as metal-organic frameworks* FCT (EXPL/QEQ-PRS/0251/2012). IST/ITN Coordinator Cláudia Pereira (50%). Not Funded.

## COLLABORATIONS

- César Laia, FCT/UNL
- Filipe Paz, CICECO/U. Aveiro

## NAME: Maria Dulce Jesus Pombo Belo

**CATEGORY:** Auxiliary Researcher

**ID NUMBER:** 5466

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	Thiophenic TTF type donors and its derivatives.	40%
2	Transition metal thiophenic bisdithiolenes complexes for plastic electronics and magnetic molecular materials.	40%
3	Management of the synthesis laboratory of the Solid State Group, at CTN.	10%
4	Career development and research fund search.	10%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	The chemistry of thiophene-TTF donors, is very rich, and has lead, in the last years, to a wide variety of salts with very interesting magnetic and transport properties. Recently we prepared and fully characterized the electronic donor $\alpha$ -DT-TTF (alpha-dithiophene tetrathiafulvalene), the missing link in the thiophenic-TTF derivatives family. This donor was obtained efficiently from the homocoupling of 5,6-thieno[2,3-d]-1,3-dithiol-2-one and its redox properties are intermediate between those of DT-TTF and BET-TTF. When used as active material in a field-effect transistor it presents a mobility $\mu_{FE} = 5 \times 10^{-5} \text{ cm}^2/\text{Vs}$ . This new synthesis enables the use of this donor to prepare a variety of potentially interesting charge transfer salts. Actually the ability of this new donor to provide conducting charge transfer salts was already demonstrated by preparing its $\text{PF}_6^-$ salts. This line of research gives rise to 2 papers, in per review journals and to 1 another in preparation and to an invited talk. It also includes the supervision of the research work of the M.Sc. Rafaela Silva in the scope of FCT's Project "Electrocristalização de sais de transferência de carga; da cristalogénese aos dispositivos eletrónicos" (PTDC/QUI-QUI/ 101788/2008), providing advanced training of this young researcher in organic and inorganic chemistry and materials science.
2	The synthesis and study of transition metal bisdithiolene complexes based on ligands with thiophenic moieties, namely the synthesis of "thiophenic" Single Component Molecular Metals and Molecular Magnetic Materials is one of our focus of interest. By significantly enlarging the number of molecular compounds based on thiophenic units, a detailed comparison of the physical properties and a clear establishment of the relationships between the crystal structure and the physical



	properties can be made, enlightening the role of the sulphur atom position on the solid state mediation of electronic and magnetic interactions. Recently we prepare a new family of transition metal complexes based on the methyl substituted 2,3-thiophene-dithiolate, which are more soluble than the related unsubstituted complexes, opening the way of its use as the base components of electronic devices. A new series of compounds based on the $[\text{Ni}(\alpha\text{-tpdt})_2]^-$ anion and crown-ethers cations, presenting a cluster glass behaviour, as also been studied. From this line of research emerge two papers, in peer review journals, and to one invited talk and one invited class. It also includes the supervision of the PhD Thesis “Complexos de Metais de Transição Baseados em Ligandos Ditiolatos Tiofênicos para Compostos Condutores e Magnéticos”, by Ana Neves, at IST.
3	The management of the synthesis laboratory includes the purchase of the solvents and reagents and its stock administration and the detection and supervision of all needs concerning repairation of the equipments and facilities.
4	Proposals submission to the last calls for Investigador FCT, intituled “Soluble Single Component Molecular Materials”, that was not funded, and for R&D FCT Projects, that was recommended for funding, with a total budget of 162.632 €.

## PAPERS

- A.I.S. Neves, I.C. Santos, L.C.J. Pereira, E. Ruiz, C. Rovira, M. Almeida, D. Belo, Ni-2,3-thiophenedithiolate Anions in New Architectures: An In-Line Mixed-Valence Ni Dithiolene ( $\text{Ni}_4\text{S}_{12}$ ) Cluster, *Physica Status Solidi C*, 9, 1199-1201 (2012).
- E. Laukhina, V. Lebedev, V. Laukhin, A.P. del Pino, E.B. Lopes, A.I.S. Neves, D. Belo, M. Almeida, J. Veciana, C. Rovira, Polycarbonate films metalized with a single component molecular conductor suited to strain and stress sensing applications, *Organic Electronics*, 13, 894-898 (2012).
- A.I.S. Neves, E.B. Lopes, M. Almeida, D. Belo, New copper thiophenedithiolenes for single component molecular metals, *Physica Status Solidi C*, 9, 1137-1139 (2012).
- R.A.L. Silva, M.L. Afonso, I.C. Santos, D. Belo, R.R. Freitas, E.B. Lopes, J.T. Coutinho, L.C.J. Pereira, R.T. Henriques, M. Almeida, C. Rovira,  $(\text{DT-TTF})_2[\text{Pd}(\text{mnt})_2]$ : An unusual ionic salt, *Physica Status Solidi C*, 9, 1134-1136 (2012).
- R. A. L. Silva, A. I. S. Neves, M. L. Afonso, I. C. Santos, E. B. Lopes, F. Del Pozo, R. Pfattner, M. Maas, C. Rovira, M. Almeida, D. Belo,  $\alpha$ -DT-TTF; a detailed study of an electronic donor and its derivatives, *Eur. J. Inorg. Chem.*, DOI: 10.1002/ejic.201201362.

## COMMUNICATIONS

- $\alpha$ -DT-TTF ; a new electronic donor , R.A.L. Silva, A.I.S. Neves, M.L. Afonso, I.C. Santos, E.B. Lopes, M. Mas-Torrent, C. Rovira, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations, at the Institut des Sciences Chimiques de Rennes, Rennes, France, 23<sup>th</sup> -24<sup>th</sup> October (2012)*, Invited talk.
- *Single Component molecular metals in plastic electronics*, E. Laukhina, V. Lebedev, V. Laukhin, A.P. del Pino, E.B. Lopes, A.I.S. Neves, M. Almeida, J. Veciana, C. Rovira, D. Belo, *in the scope of subject Sistemas Químicos e Reactividade do 2º Ciclo em Química, Lisbon, Faculdade de Ciências da Universidade de Lisboa, 12<sup>nd</sup> April (2012)*. Invited Class.
- *New bisditholene complexes based on substituted thiophenic ligands for magnetic and conducting materials*, A. I. S. Neves, I. C. Santos, J. T. Coutinho, L. C. J. Pereira, E. B. Lopes, R. T. Henriques, H. Alves, M. Almeida, D. Belo, *Workshop on Molecular Materials with Strong Electronic Correlations, at the Institut des Sciences Chimiques de Rennes, Rennes, France, 23<sup>th</sup> -24<sup>th</sup> October (2012)*, Invited talk.

## EDUCATION / THESES SUPERVISION

- Supervisor, PhD Thesis, *Complexos de Metais de Transição Baseados em Ligandos Ditiolatos Tiofênicos para Compostos Condutores e Magnéticos*, by Ana I.S. Neves, IST, Universidade Técnica de Lisboa.

- Supervisor, research work of the M.Sc. Rafaela A.L. Silva in the scope of FCT's Project *Electrocristalização de sais de transferência de carga; da cristalogénese aos dispositivos eletrónicos* (PTDC/QUI-QUI/ 101788/200).

## PROJECTS

- *Processable neutral based molecule conductors for electronic applications (FCT PTDC/QEQ-SUP/1413/201)*. Leading Institution: IST-ID Coordinator: D. Belo (35%).

### NAME: Filipa Fernandes Mendes

**CATEGORY:** Auxiliary Researcher (*Ciência 2007*)

**ID NUMBER:** 05493

## R&D ACTIVITIES

Nº	Activity Description	R&D
1	<sup>99m</sup> Tc Complexes as Probes for Tumoral Detection and Monitoring of Multidrug Resistance. In collaboration with Dr. António Paulo and Dr. Isabel Santos (PIs)	20%
2	A Molecular Imaging Approach to Cystic Fibrosis - <i>Coordinator</i> In collaboration with Prof. Carlos Farinha – DQB, FCUL	15%
3	Nitric Oxide Synthase Targeting with Re(I)/ <sup>99m</sup> Tc(I)-complexes containing L-Arg Derivatives: a Structure-activity Study – PTDC/QUI-QUI/121752/2010 - <i>Team Member</i> In collaboration with Dr. João DG Correia (PI)	5%
4	Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation – PTDC/QUI-QUI/102049/2008 - <i>Team member</i> In collaboration with Dr. António Paulo (PI)	5%
5	Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies – <i>Acções Integradas Luso Espanholas E-23/12 - Team member</i> In collaboration with Prof. Adoracion Quiroga, Universidad Autónoma de Madrid, Spain	15%
6	Preclinical Evaluation of Ruthenium Potential Drugs for Cancer Therapy - PTDC/QUI-QUI/118077/2010 - <i>Team member</i> In collaboration with Prof Helena Garcia, DQB, FCUL (PI)	5%
7	Gold Anticancer Drugs - COST Action CM1105 - EU In collaboration with Dr. Angela Casini, U.Groningen, Netherlands	5%
8	New Pt(II) Complexes containing Polyaromatic DNA-binding Groups - COST Action CM1105 - EU In collaboration with Prof. Mauro Ravera, Università del Piemonte Orientale “Amedeo Avogadro”, Italy	10%
9	Novel Heteronuclear Lanthanide-ruthenium Complexes In collaboration with Prof. Michel Picquet, Institut de Chimie Moléculaire de l'Université de Bourgogne, Dijon, France	5%
10	Teaching	10%
11	Management of laboratory infrastructure	5%
Total		100%

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<sup>99m</sup> Tc Cationic Complexes as Probes for Tumoral Detection and Monitoring of Multidrug Resistance Some cationic radiotracers originally developed as myocardial perfusion agents tend to localize in

	<p>tumour cells due to the increased negative mitochondrial potentials and have been used for cancer detection and non-invasive monitoring of MDR by SPECT. On the framework of a project led by I.Santos, we showed that <math>^{99m}\text{Tc}</math>-DMEOP and <math>^{99m}\text{Tc}</math>-TMEOP complexes are able to accumulate in a variety of human cancer cell lines. The low uptake in drug-resistant cells indicates a selective Pgp mediated efflux of the complexes. Results in nude mice bearing MDR-negative and MDR-positive tumour xenografts indicate that the tumour uptake is almost 2 times higher in the former. This work was performed by the MSc student F. Toscano and the undergraduate student A.T. Pinto under my supervision.</p> <p>Additionally, A.Paulo started a new line of research, which focused on <math>^{99m}\text{Tc}</math>-labeled phosphonium cations as potential tumoral radiotracers. A group of complexes with different ligands and chelators was synthesized and their uptake was studied in a panel of cancer cell lines and in isolated mitochondria. In general, these phosphonium-containing <math>^{99m}\text{Tc}</math> complexes showed moderate cellular and mitochondrial uptake values, dependent on the mitochondrial and plasma membrane potentials. This work was performed by the undergraduate student A. Pereira under my supervision.</p>
2	<p><b><i>A Molecular Imaging Approach to Cystic Fibrosis</i></b></p> <p>Cystic fibrosis (CF) is the most common lethal autosomic recessive disease among Caucasians. The gene responsible for the disease encodes the CF transmembrane conductance regulator (CFTR) protein, a polytopic integral membrane protein that functions as a cyclic AMP-activated chloride channel and regulator of other channels at the apical membrane of epithelial cells. The main goal of this project, which started in September 2012, is to develop radioactive probes for detect the expression of rescued trafficking mutants at the membrane of epithelial pulmonary cells. New radiolabelled molecules – <i>antibodies (Abs) and small organic inhibitors</i> - will be prepared and tested as molecular imaging radioprobes in human pulmonary immortalized and primary cell lines. We started with the optimization of the <math>^{99m}\text{Tc}</math>-labelling of the anti-CFTR Abs MA1-935 and ECL1. Furthermore, following the bifunctional approach, we have also prepared and characterized the conjugates CFTRinh-PzNN and GPinh-5a-PzNN, which comprise small molecule drug inhibitors and a pyrazolyl-diamine-coordinating unit for labeling with <math>^{99m}\text{Tc}(\text{CO})_3</math>.</p> <p>The synthetic and characterization work, as well as the radiolabeling studies have been performed by the student V. Ferreira (as part of her MSc. Thesis work) and by B. Oliveira under my supervision (PI of the project) and Dr. João Correia (labelling optimization).</p>
3	<p><b><i>Nitric Oxide Synthase Targeting with Re(I)/<math>^{99m}\text{Tc}</math>(I)-complexes containing L-Arg Derivatives: a Structure-activity Study</i></b></p> <p>Aiming to probe Nitric Oxide Synthase (NOS) levels <i>in vivo</i> by SPECT-imaging we have introduced complexes containing L-Arg derivatives and the core <math>^{99m}\text{Tc}(\text{CO})_3</math> separated by 3-(<b>Tc1</b>) or 6-carbon linkers (<b>Tc2</b>). The complexes are stabilized by a pyrazoly-diamine bifunctional chelator. Enzymatic assays with purified iNOS have shown that the non-radioactive surrogates <b>Re1</b> and <b>Re2</b> are stronger inhibitors than the respective metal-free conjugates <b>L1</b> and <b>L2</b>, with <b>Re2</b> displaying an inhibitory potency that is comparable to that of <math>\text{N}^{\circ}\text{-NO}_2\text{-L-Arg}</math>. To get a better insight into the structural parameters responsible for this behavior, molecular docking and molecular dynamics simulations have also been performed. I have participated on the biological evaluation of these complexes. Dr. JGD Correia is responsible for the overall coordination of this research project.</p>
4	<p><b><i>Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation</i></b></p> <p>The <i>in vivo</i> detection of protein deposits in the brain of patients suffering from neurodegenerative disease using molecular imaging modalities, such as the nuclear techniques PET and SPECT, could provide an early diagnostic tool and a model for monitoring novel treatments. Therefore, the finding of PET probes for amyloid imaging remains an important topic in radiopharmaceutical research.</p> <p>In the framework of this ongoing project I have performed initial biological evaluation of styryl-benzazole derivatives labeled with <math>^{18}\text{F}</math> aiming to assess their relevance for imaging beta-amyloid aggregates. To achieve such goal, fluorinated styryl-benzoxazole and styryl-benzothiazole derivatives were synthesized as amyloid-avid molecules. The pre-clinical evaluation of the radiofluorinated molecules as potential radiotracers for <i>in vivo</i> imaging of amyloid deposits comprised <i>ex vivo</i> autoradiographic studies with transgenic animal models of AD. The autoradiography with the radiofluorinated compounds was used to assess their ability to detect amyloid plaques and fluorescence microscopy with Thioflavin S was performed to confirm the presence of amyloid plaques in sections of brain of transgenic mouse model. These studies were performed in collaboration with other team members – G. Morais and L. Gano at IST/ITN and</p>

	<p>ICNAS, Coimbra. Dr A. Paulo is responsible for the overall coordination of this research project.</p>
5	<p><b><i>Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies</i></b></p> <p>This bilateral project has as main goal the synthesis/characterization of novel target-specific and heterobimetallic platinum complexes, aiming to assess their interest as novel anticancer drugs. Thus, special attention was devoted to the understanding of their antitumor activity, pharmacokinetics and selectivity.</p> <p>Two PhD students – M.A. Medrano and J.Herrera have visited IST/ITN and under my supervision have performed advanced studies (for 5 months and 1 month respectively). M.A. Medrano performed mechanistic studies of several cis and trans Pt(II)(amine)<sub>2</sub> complexes, with a special focus on the interaction of the complexes with Zn finger proteins models, to rationalize the influence of structural variations in the action of the novel complexes. Moreover she also evaluated the ability of the complexes to interact with DNA. J. Herrera evaluated the DNA interaction and cytotoxic activity of novel Pt(II) and Pt(IV) complexes bearing intercalative ligands synthesized at U. Autonoma Madrid. For a comparative study of the biological data, the intercalative ligands without complexation to the platinum were also studied.</p>
6	<p><b><i>Preclinical Evaluation of Ruthenium Potential Drugs for Cancer Therapy</i></b></p> <p>A new organometallic complex of Ru-Cp, TM34, has been found to be very active against all tumorigenic cell lines, its efficiency largely surpassing that of cisplatin. Apoptosis had previously been found to be the major mechanism of cell death exerted by TM34 and, in this context, it is quite relevant to evaluate its ability to bind DNA, the main target of cisplatin. I have studied the DNA damage induced by the Ru complexes TM34, TM85 and TM102 (2 other members of the same family) and cisplatin in vitro by monitoring the drug-induced conformational change of supercoiled fX174 plasmid DNA. Supercoiled DNA was treated at 37° C for a 24 h incubation period in phosphate buffer with various concentrations of the Ru complexes or cisplatin. The dose-dependent conformational changes of the treated DNA were detected by agarose gel electrophoresis. Results have shown that the electrophoretic mobilities of both the nicked and closed circular DNA's change after incubation with cisplatin, but not with the ruthenium complexes, indicating no formation of adducts in the latter. This seems to indicate that the DNA double helix is not a primordial target of these type of ruthenium complexes.</p>
7	<p><b><i>Gold Anticancer Drugs</i></b></p> <p>Metal-based drugs are nowadays among the most effective therapeutic agents for the treatment of cancer, with cisplatin, carboplatin, and oxaliplatin being widely used in clinics. Following our recently published results with gold and ruthenium compounds, and in order to elucidate the mechanism of action of novel potential anticancer drugs, we screened two Au compounds, Auphen and AuL12, as PARP inhibitors. Poly-(ADP-ribose) polymerase (PARP) plays a key role in DNA repair mechanisms by detecting and initiating repair after DNA strand breaks. Inhibition of PARP in DNA repair-defective tumors can lead to cell death. Several drugs designed to inhibit PARP are currently in clinical development, many following a development path different from that of typical anticancer agents.</p> <p>Both complexes are able to efficiently inhibit PARP-1 in A2780 and Hela cell extracts reducing its activity to 20%. However, they have no effect on PARP-1 activity in cell extracts from A2780cisR and MCF7, indicating that the specific protein composition of each cancer cell line orients the reactivity of the compounds towards different targets. Additionally, cytotoxicity was evaluated in the same cells lines and the IC50 determined. These studies have been performed on the framework on an ongoing collaboration with Prof. Angela Casini.</p>
8	<p><b><i>New Pt(II) Complexes containing Polyaromatic DNA-binding Groups</i></b></p> <p>Cisplatin is one of the most successful anticancer agents, being used worldwide in treatment of solid tumours. However, its use has serious disadvantages, namely severe toxic side effects and resistance of a large number of tumors. For this reason, the development of new and more efficient antitumor-active platinum compounds still remains an important topic of research in biomedical inorganic chemistry. In the framework of an ongoing collaboration with Prof. Mauro Ravera from the Universita del Piemonte Orientale “Amedeo Avogadro”, Italy, I have studied 4 Pt(II) complexes with naphthalene derivatives as DNA binding groups. To assess their interest in the design of novel anticancer drugs, I studied the DNA adduct formation by electrophoretic mobility shift studies. For the tested ligands there was no change on the rate of migration of both DNA forms when compared</p>

	with the control. However, all Pt(II) complexes induced changes in the mobility of plasmid DNA forms. The occurrence of a combined intercalation/platination effect was also studied. Taken together, the data obtained for the 4 complexes show that they have different DNA-binding abilities, being more evident the contribution of the intercalating binding mode in the case of L1Pt. These studies were performed at IST/ITN in collaboration with Sofia Gama.
9	<b><i>Novel Heteronuclear Lanthanide-ruthenium Complexes</i></b> Novel heteronuclear lanthanide ruthenium complexes prepared at the Institut de Chimie Moléculaire de l'Université de Bourgogne were explored at IST/ITN for their potential as future imaging probes. The physicochemical characterization and evaluation of the biological properties of the complexes (and respective ligands) included the following: stability studies of compounds in solution by electrospray ionization mass spectrometry (ESI-MS analysis), cytotoxicity assays, radiochemical labeling with Sm-153 produced in the Portuguese research reactor and biodistribution in healthy mice. Moreover, synthesis of cold Sm complexes to characterize the radioactive analogs has also been done, in order to allow the study of the potential antitumoral activity of the compounds. I have been primarily involved in the cytotoxicity experiments and in the preparation of progress reports. Dr I.Santos is responsible for the overall coordination of this research project.
10	<b><i>Teaching</i></b> Lecturer (Prof. Auxiliar Convivada) at Universidade Lusófona de Humanidades e Tecnologias, <i>Pharmacogenomics</i> , Master in Pharmaceutical Sciences, 4th academic school trimester, 2012.
11	<b><i>Management of the Laboratory of Biochemistry and Molecular Biology</i></b> - Responsible for the DNA and protein analysis scientific equipment - Training of new users

## PAPERS

- A.I. Tomaz, T. Jakusch, T.S. Morais, F. Marques, R.F.M. Almeida, F. Mendes, E.A. Enyedy, I. Santos, J.C. Pessoa, T. Kiss, M.H. Garcia, [RuII( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)(bipy)(PPh<sub>3</sub>)<sub>2</sub>]<sup>+</sup>, a promising large spectrum antitumor agent: cytotoxic activity and interaction with Human Serum Albumin, *Journal Inorganic Biochemistry*, 117, 261-269 (2012), doi: 10.1016/j.jinorgbio.2012.06.016.
- C. Moura, L. Gano, F. Mendes, P.D. Raposinho, A.M. Abrantes, M.F. Botelho, I. Santos, A. Paulo, <sup>99m</sup>Tc(I)/Re(I) Tricarbonyl Complexes for In Vivo Targeting of Melanotic Melanoma: Synthesis and Biological Evaluation, *European Journal of Medicinal Chemistry*, 50, 350-360 (2012), doi: 10.1016/j.ejmech.2012.02.014.
- C. Neto, C. Fernandes, M.C. Oliveira, L. Gano, F. Mendes, T. Kniess, I Santos, Radiohalogenated 4-anilinoquinazoline-based EGFR-TK inhibitors as potential cancer imaging agents, *Nuclear Medicine and Biology*, 39, 247–260 (2012), doi: 10.1016/j.nucmedbio.2011.09.001.
- D. Can, B. Spingler, P. Schmutz, F. Mendes, P. Raposinho, C. Fernandes, F. Carta, A. Innocenti, I. Santos, C. Supuran, R. Alberto, [(Cp-R)M(CO)<sub>3</sub>] (M = Re or <sup>99m</sup>Tc) Sulphonamide Conjugates for Selective Targeting of Human Carbonic Anhydrase IX, *Angewandte Chemie*, 51, 3354–3357 (2012), doi: 10.1002/anie.201107333.
- F. Mendes, C.M. Farinha, V. Felício, P.C. Alves, I. Vieira, M.D. Amaral, BAG-1 Stabilizes Mutant F508del-CFTR in an Ubiquitin-Like-Domain-Dependent Manner, *Cellular Physiology and Biochemistry*, 30, 1120-1133 (2012), doi: 10.1159/000343303.
- F. Mendes, L. Gano, C. Fernandes, A. Paulo, I. Santos, Studies of the myocardial uptake and excretion mechanisms of a novel <sup>99m</sup>Tc heart perfusion agent, *Nuclear Medicine and Biology*, 39, 207–213 (2012), doi: 10.1016/j.nucmedbio.2011.08.007.
- H. Li, W. Yang, F. Mendes, M.D. Amaral, D. Sheppard, Impact of the cystic fibrosis mutation F508del-CFTR on renal cyst formation and growth, *American Journal of Physiology - Renal Physiology*, 303, F1176-186 (2012), doi: 10.1152/ajprenal.00130.2012.
- M. Serratrice, F. Edefe, F. Mendes, R. Scopelliti, S.M. Zakeeruddin, M. Graetzel, I. Santos, M.A. Cinellu, A. Casini A, Cytotoxic gold compounds: synthesis, biological characterization and investigation of their inhibition properties of the zinc finger protein PARP-1, *Dalton Transactions*, 41, 3287-3293 (2012), doi: 10.1039/c2dt11913g.

- S. Gama, F. Mendes, T. Esteves, F. Marques, A. Matos, J. Rino, J. Coimbra, M. Ravera, E. Gabano, I. Santos, A. Paulo, Synthesis and biological studies of pyrazolyl-diamine Pt(II) complexes containing polyaromatic DNA-binding groups, *ChemBiochem*, 13, 2352-2362 (2012), doi: 10.1002/cbic.201200472.

## COMMUNICATIONS

- *Bidentate and tridentate pyrazolyl-containing Pt(II) complexes: synthesis, characterization and in vitro evaluation*, E. Gabano, S. Gama, T. Esteves, F. Mendes, F. Marques, I. Santos, J. Coimbra, M. Ravera, A. Paulo, D. Osella, *XII Workshop on Pharmaco-Bio-Metallics (Biomet 12), Padova, Italy, October (2012)*, Poster presentation.
- *Pyrazolyl-diamine Pt(II) complexes bearing DNA-intercalating moieties: Synthesis, characterization and in vitro evaluation*, S. Gama, T. Esteves, F. Mendes, F. Marques, I. Santos, J. Coimbra, A. Matos, M. Ravera, E. Gabano, A. Paulo, *ISMEC2012- International Symposium on Metal Complexes, Lisbon, Portugal, June 18-22 (2012)*, Poster presentation.

## SEMINARS

- *Sondas para Imagiologia Cardiovascular* (2012). Workshop “Biomarcadores sanguíneos e imagiologia da placa aterosclerótica”, IST/ITN, Sacavém, Portugal, 10 December, Invited presentation.
- *Imaging in the era of molecular oncology: new probes for detection of multidrug resistance* (2012). Department of Bioengineering, Instituto Superior Técnico, Lisbon, Portugal, 6 December, Invited talk.
- *From cardiology to oncology: new radioactive probes for detection of cancer multidrug resistance* (2012). ChemForum – 2012 Autumn edition, Centro Química Estrutural, Instituto Superior Técnico, Lisbon, Portugal, 24 October, Invited presentation.

## EDUCATION / THESES SUPERVISION

### Supervision

- Supervisor, M. Sc. Thesis, *Biological Evaluation of cationic <sup>99m</sup>Tc(I) complexes as probes for tumoral detection and functional monitoring of multidrug resistance*, by Fernando Toscano, Faculdade de Ciências, Universidade de Lisboa – tese em preparação
- Supervisor, M.Sc. Thesis, *A Molecular Imaging approach to Cystic Fibrosis*, by Vera Ferreira, Faculdade de Ciências, Universidade de Lisboa – tese em preparação
- Supervisor, Undergraduate research thesis, *<sup>99m</sup>Tc(I) tricarbonyl complexes for mitochondria targeting*, by Ana Bárbara Pereira, Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), 22 December 2012
- Supervisor, Undergraduate research thesis, *In vitro evaluation of <sup>99m</sup>Tc(I) complexes as probes for tumoral detection: influence of the plasma membrane and mitochondrial membrane potential on the cell uptake*, by Ana Teresa Pinto, Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), 4 July 2012

### Jury

- Main Reviewer (*arguente principal*): M. Sc. Thesis, *Complexos de Ruténio como potenciais agentes terapêuticos: estudos dos mecanismos de captação celular e modulação de enzimas metabólicos* by Leonor Corte-Real, Faculdade de Ciências, Universidade de Lisboa, 31 October 2012.
- Reviewer (*arguente*): PhD. Thesis, *Tc(I)/Re(I) Organometallic for Molecular Imaging of Neoplastic Tissues* by Carolina Moura, Faculdade de Ciências, Universidade de Lisboa, 28 February 2012.

### Teaching

Lecturer (Prof. Auxiliar Convidada) at Faculdade de Ciências e Tecnologias da Saúde, Universidade Lusófona de Humanidades e Tecnologias. *Pharmacogenomics*, Master in Pharmaceutical Sciences, May-July (2012).

## PROJECTS

### Team member

- *Functional metal complexes that bind to biomolecules*, COST Action CM1105 – EU. Principal Researcher: I. Santos.

- *Target-specific and Heterobimetallic Platinum Complexes: Synthesis, Characterization and Mechanistic Studies*, Acções Integradas Luso-Espanholas E-23/12. Principal Researcher: I. Santos.

#### 15%

- *Nitric Oxide Synthase targeting with Re(I)/<sup>99m</sup>Tc(I)-complexes containing L-Arg derivatives: A structure-activity study*, FCT - PTDC/QUI-QUI/121752/2010. Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. Principal Researcher: J. D. G. Correia.
- *Targeting telomerase inhibition with new anti-tumoral Cu(II) Complexes*, FCT- PTDC/QUI-QUI/114139/2009. Leading Institution: Instituto Superior Técnico (IST), Lisbon, Portugal, Principal Researcher: Sofia Gama.
- *Preclinical evaluation of ruthenium potential drugs for cancer therapy*, FCT - PTDC/QUI-QUI/118077/2010. Leading Institution: Fundação da Faculdade de Ciências da Universidade de Lisboa (FFCUL), Lisbon, Portugal. Principal Researcher: Maria Helena Garcia.

#### 8%

- *Radiolabeled Benzazole Derivatives for In Vivo Imaging of Amyloid Aggregation*, FCT- PTDC/QUI-QUI/102049/2008- Leading Institution: Instituto Superior Técnico (IST), Lisbon, Portugal, Principal Researcher: António Paulo.

#### **Submitted in 2012**

##### Principal Researcher - 50%

- *A Molecular Imaging Approach to Cystic Fibrosis*, FCT - EXPL/BIM-MEC/0115/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. Principal Researcher: Filipa Mendes, *Recommended for funding*.

##### Team Member

- *30%- Molecular and Nano Tools for Cancer Theranostics*, FCT - EXCL/QEQ-MED/0233/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. Principal Researcher: I. Santos *Recommended for funding*.
- *15% - Albumin-binding proteins as drug carriers*, FCT- PTDC/DTP-FTO/0189/2012, Leading Institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), Lisbon, Portugal. Principal Researcher: J. D. G. Correia. *Not recommended for funding*.

#### **COLLABORATIONS**

- Maria de Los Angeles Medrano, PhD student, Universidad Autónoma de Madrid, Spain, 31 Jan-30 June, Training on DNA and Protein interaction study methodologies - Acções Integradas Luso-Espanholas E-23/12.
- Jacqueline Herrera, PhD student, Universidad Autónoma de Madrid, Spain, 1-30 November, Training on evaluation of cytotoxicity and DNA interaction methodologies - Acções Integradas Luso-Espanholas E-23/12.
- Prof. Adoracion Quiroga, Universidad Autónoma de Madrid, Spain 20-22 February and 28-29 June – discussion of results and overall strategies - Acções Integradas Luso-Espanholas E-23/12.
- Prof. Angela Casini, Research Institute Pharmacy, University of Groningen, Netherlands, 20-22 February and 18-22 June – discussion of results and future work - COST Action CM1105, EU.

#### **PATENTS**

- Patent pending - “Two novel human epithelial cell lines to be used in assays for traffic studies/ screens of CFTR protein (wild-type and with the F508del mutation)” 105697.
- Patent pending - “Transition Metal Complexes for pharmaceutical applications” 105890H.

**NAME: Goreti Jesus Ribeiro Morais**CATEGORY: Auxiliary Researcher (*Cência 2008*)

ID NUMBER: 430

**R&D ACTIVITIES**

Nº	Designação da Atividade	R&D
1	Benzazole derivatives with fluorine-18 and technetium-99m for in vivo imaging of amyloid deposits– PTDC/QUI/102049/2008-...(Scientific Coordinator: A. Paulo IST/CTN)	35%
2	Bimodal PET-MRI molecular imaging technologies and applications for in vivo monitoring of diseases and biological processes – COST Action TD1007	20%
3	Radiofluorinated compounds targeting fibrillar alpha-synuclein (Scientific Coordinator: G. Ribeiro Morais IST/CTN)	20%
4	Supervision of M. Sc. Students (collaboration with the Bioorganic Chemistry Group of the Instituto de Química Orgânica General)	20%
5	Management of the Organic Chemistry Laboratory III	5%
Total		100%

**WORK SUMMARY**

Nº	Work Summary and Main Achievements
1	<p><i>Benzazole derivatives with fluorine-18 and technetium-99m for in vivo imaging of amyloid deposits</i></p> <p>This multidisciplinary project involves the IST/ITN, ICNAS and IMM. The main goal of this project is the design of radiolabeled amyloid-avid probes for the early diagnosis of neurodegenerative diseases by Positron Emission Tomography (PET) or Single Photon Emission Computed Tomography (SPECT).</p> <p>I have designed, synthesized and fully characterized several fluorinated organic molecules expected to recognize beta-amyloid aggregates. I have radiofluorinated the precursors at the ICNAS, using the cyclotron-produced <math>^{18}\text{F}</math>. I have also characterized the radioactive compounds by HPLC comparison with the cold congeners. To perform the radiofluorinations, I have carried out several short-term at the ICNAS.</p> <p>I have also synthesized the <math>^{125}\text{I}</math>-labeled TZDM, a known beta-amyloid ligand used for the in vitro competitive binding assays to the beta-amyloid aggregates.</p> <p>Within this project I have supervised the M. Sc student Rafael Gomes (ongoing Thesis) and the BI Patrique Nunes (hired for this project).</p>
2	<p><i>Bimodal PET-MRI molecular imaging technologies and applications for in vivo monitoring of diseases and biological processes</i></p> <p>This COST Action merges several technological areas from Nuclear Physics, Instrumentation, Computer Technology, and (Bio-) Chemistry and Life Sciences. This COST action is expected to promote the development of: 1) new PET/MR compatible detectors and imaging prototypes; 2) new bimodal tracers; 3) new image reconstruction and processing algorithms and software; and 4) new preclinical and clinical protocols for bimodal imaging.</p> <p>In the scope of this project I have designed, synthesized and characterized a small library of peptides. These peptides will be further conjugated to a macrocyclic and to a prosthetic group for the chelation with Gd(III) and labeling with <math>^{18}\text{F}</math>, respectively.</p>
	<p><i>Radiofluorinated compounds targeting fibrillar alpha-synuclein</i></p> <p>Deposition of alpha-synuclein aggregates is the neuropathological feature that defines Parkinson disease (PD) and Dementia with Lewy Bodies (DLB). These neurodegenerative diseases affect millions of persons worldwide and pose a significant impact in public health. The <i>in vivo</i> detection of alpha-synuclein by molecular imaging may allow an early diagnosis of the synucleinopathies (PD and DLB), increasing the potential of their successful early treatment and would be useful in the therapeutic follow-up and on the high-throughput screening of new therapies. So far, the development of radiotracers targeting fibrillar alpha-synuclein is an unmet goal. This work aims to find new useful tools to visualize alpha-synuclein aggregates, using optical and/or PET imaging techniques.</p>



3	In the scope of this project I have designed ASI peptide-based analogues, bearing in their structure a fluorescein, a glucose residue and a prosthetic group to introduce fluorine ( $^{19}\text{F}/^{18}\text{F}$ ). I have also been involved in the synthesis, purification and characterization of the ASI peptides analogues. Within this project I have supervised the M. Sc Student Leticia Quental (ongoing Thesis)
4	<i>Supervision of M. Sc. Students</i> In this activity I have supervised the M. Sc Students Nuno Martins and Inês Rodrigues in collaboration with Prof. Dr. Alfonso Fernández-Mayorales, from the Bioorganic Chemistry Group, "Instituto de Química Orgánica General" (IQOG), Madrid, Spain. This collaboration was within the ERASMUS program. In the scope of our collaboration, I designed the synthetic strategies for the preparation of (radio)fluorinated glycolipid and fluorinated mannosamine derivatives and have supervised the respective synthesis and fully characterization by the M.Sc students.
5	<i>Management of the Organic Chemistry Laboratory III</i> - Train new team members at the Organic Chemistry Lab III - Maintenance of the equipment - Maintain a safe and clean laboratory environment - Enforce all safety regulations - Organize disposal of hazardous chemicals and solvents

## PUBLICATIONS

- G. Ribeiro Morais, I. C. Santos, I. Santos, A. Paulo, X-ray diffraction structures of regioisomers of *N*-methylated benzimidazole compounds with interest for the synthesis of amyloid probes, *J Chem Crystallogr*, 42, 1052-1059 (2012)
- G. Ribeiro Morais, T. Thiemann, Synthesis and in vitro cytotoxicity of estradiol-cinnamide conjugates *J Chem Res*, 549-554 (2012)
- G. Ribeiro Morais, A. Paulo, I. Santos, Organometallic complexes for SPECT Imaging and/or Radionuclide Therapy, *Organometallics*, 31, 5693-5714 (2012)
- G. Ribeiro Morais, A. Paulo, I. Santos, A synthetic overview of radiolabeled compounds for  $\beta$ -amyloid targeting, *Eur J Org Chem*, 1279-1293 (2012) (Cover Picture)
- F. Kong, G. Ribeiro Morais, R. A. Falconer, C. W. Sutton, An optimized method for the synthesis of amino functionalized phosphatidylcholine, *Tetrahedron Lett*, 53, 546-549 (2012)

## COMUNICATIONS

### Oral presentations

- *Compounds for visualization of amyloid aggregates in Alzheimer's patients*, G. Ribeiro Morais, A. Paulo, I. Santos, *Department of Chemistry, University of Évora, Évora, May 9<sup>th</sup> (2012)*, Invited Talk
- *Peptide-based Probes for Amyloid and Cancer Imaging*, A. Paulo, G. Ribeiro Morais, I. Santos, *WG3 meeting – COST TD1007, London, 29<sup>th</sup> November (2012)*

### Poster presentations

- *Fluorescent and radionuclide labeling of a synthetic neuroactive glycoside*, N. R. Martins, I. F. Rodrigues, I. Garcia-Álvarez, G. Corrales, G. Ribeiro Morais, I. Santos, E. Doncel-Pérez, A. Fernández-Mayorales, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 July (2012)*, P91
- *Radiofluorinated benzazole derivatives for in vivo imaging of amyloid aggregation*, G. Ribeiro Morais, L. Gano, T. Kniess, R. Bergamn, A. Abrunhosa, C. Pereira, C. Oliveira, I. Santos, A. Paulo, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 (2012)*, P96
- *Metabolic oligosaccharide engineering: synthesis of N-acetyl-D-mannosamine analogs and their evaluation as substrates of the sialic acid aldolase*, I. F. Rodrigues, N. R. Martins, I. Garcia-Álvarez, G. Ribeiro Morais, I. Santos, E. Doncel-Pérez, I. Oroz-Guinea, E. Garcia-Junceda, A. Fernández-Mayorales, *6th Spanish-Portuguese-Japanese Organic Chemistry Symposium, Lisbon, July 18-20 (2012)*, P115.

## EDUCATION

- Co-Supervisor, M. Sc. Thesis, *Fluorescent and radionuclide labeling of a synthetic neuroactive glycoside*, by Nuno R. Martins, Faculdade de Ciências, Universidade de Lisboa, 6th July 2012
- Co-Supervisor, M. Sc. Thesis, *Metabolic Engineering Applied to Neural Stem Cells*, by Inês Rodrigues, Faculdade de Ciências, Universidade de Lisboa, 6th July 2012
- Supervisor, M. Sc. Thesis, *Compostos radiofluorados para deteção de estruturas amilóides*, by Rafael Gomes, Escola Superior Tecnologia e Saúde de Lisboa, Thesis under preparation
- Co-Supervisor, M. Sc. Thesis, *Compostos peptídicos para visualização de agregados de alfa-sínucleína*, by Leticia Quental, Faculdade de Farmácia, Universidade de Lisboa, Thesis under preparation

## PROJECTS

### *Ongoing*

#### Team member

- *Benzazole derivatives with fluorine-18 and technetium-99m for in vivo imaging of amyloid deposits*, Fundação para a Ciência e Tecnologia (FCT), PTDC/QUI/102049/2008 (team member, 15%)
- *Bimodal PET-MRI molecular imaging technologies and applications for in vivo monitoring of diseases and biological processes*, COST Action TD1007

### *Submitted in 2012*

#### Principal Researcher

- *Radiofluorinated compounds targeting fibrillar alpha-synuclein*, FCT- EXPL/QEQ-MED/0252/2012- Leading Institution: IST-ID
- *<sup>18</sup>F-Labeled peptides for Imaging of alpha-synuclein aggregates*, Rapid Response Innovation Awards 2013, Michael J Fox Foundation. Leading Institution: IST-I

## COLABORATIONS

- Torsten Knies, PET-center, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany – Training on the radiochemistry of the cyclotron-produced <sup>18</sup>F.
  - Antero Abrunhosa, ICNAS, Coimbra – Production of <sup>18</sup>F.
  - Alfonso Fernández-Mayorales, Bioorganic Chemistry Group, “Instituto de Química Orgánica General” (IQOG), Madrid, Spain - Synthesis of biologically active compounds for the radiolabeling with <sup>18</sup>F.
  - Tiago Outeiro, Unidade de Neurociência Celular e Molecular, IMM, /Department of NeuroDegeneration and Neurorestoration, University of Göttingen, Germany – Preparation of beta-amyloid, alpha-synuclein and insulin aggregates.
  - Cristina Pereira, Centro Neurociências (CNC), Coimbra – Triple Transgenic animal models of Alzheimer’s disease.
  - Miguel Castanho, Unidade Bioquímica física, IMM, Lisbon – Cellular model of the bran-blood
-

**NAME: Leonor Maria de Jesus Maria****CATEGORY:** Auxiliary Researcher (*Ciência 2008*)**ID NUMBER:** 4833**R&D ACTIVITIES**

Nº	Activity Description	R&D
1	Thorium and uranium complexes with amine-bis(phenolate) ligands	30%
2	Lanthanide(III) complexes with functionalized aza-macrocyclic ligands	30%
3	Lanthanide metallo-diaminocarbene complexes	20%
4	Gas-phase chemistry of actinides with biomolecules	15%
5	Supervision of research student	5%
Total		100%

**WORK SUMMARY**

Nº	Work Summary and Main Achievements
1	<p>The goal of this research is to develop new actinide complexes that are potential (pre)-catalysts or intermediates in organic transformations and electron transfer reactions.</p> <p>The work with the tetradentate salan-R<sup>2</sup> ligand (H<sub>2</sub>salan-R<sub>2</sub> = N,N'-bis(2-hydroxybenzyl-3,5-di-R)-1,2-dimethylamino-methane) started in the previous years, within the project PTDC/QUI/66187/2006 (2010-2011). It was demonstrated that it allowed the stabilization of bis-alkyl complexes [An<sup>IV</sup>(salan-<sup>t</sup>Bu<sub>2</sub>)(CH<sub>2</sub>SiMe<sub>3</sub>)<sub>2</sub>] (An = Th, U). During 2012, the synthesis and purification of these new alkyls were optimized and solution NMR studies revealed that the compounds are stable for weeks. Reactions of the bis-alkyls with CO<sub>2</sub> showed that it inserts rapidly into the An(IV)-C(alkyl) bonds with formation of carboxylate ligands. A rare example of a thorium CO<sub>2</sub> insertion structure [Th<sub>2</sub>Cl(salan-<sup>t</sup>Bu<sub>2</sub>(μ-η<sup>1</sup>:η<sup>1</sup>-O<sub>2</sub>CCH<sub>2</sub>SiMe<sub>3</sub>)<sub>2</sub>(μ-η<sup>1</sup>:η<sup>2</sup>-O<sub>2</sub>CCH<sub>2</sub>SiMe<sub>3</sub>)] was identified by X-ray diffraction [<b>Ref. 2, 4</b>]. This work is a collaboration with Dr. Marinella Mazzanti (CEA-Grenoble).</p> <p>The reactivity of the new complex [U<sup>III</sup>{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}I], involving a N-functionalized tetraazamacrocyclic ligand, with redox-active substrates (azides, azobenzene, I<sub>2</sub>, TIBPh<sub>4</sub>) was studied: Preliminary results showed that this uranium(III) compound allows access to U(IV) and U(VI) compounds. [U<sup>IV</sup>{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}I]I and [U<sup>IV</sup>{(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}I]BPh<sub>4</sub> were characterized by elemental analysis, <sup>1</sup>H NMR and X-ray diffraction analysis.</p> <p>The X-ray diffraction analyses were done in collaboration with Dr. Isabel C. Santos (Solid State Group).</p>
2	<p>Alkyl and amide lanthanide(III) complexes have been used as pre-catalysts in organic transformations and the synthesis of biologically relevant molecules. One of the goals of this work is to synthesize potential lanthanide catalysts.</p> <p>In the previous years, it was demonstrated that dianionic bis(phenolate) cyclam ligand {(Ar<sup>R2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam} (1,8-bis(2-hydroxy-3,5-di-alkylbenzyl)-4,11-dimethyl-1,4,8,11-tetraazacyclo-tetradecane) is adequate for the stabilization of lanthanide(III) metals with the formation of [Ln{(Ar<sup>R2</sup>O)<sub>2</sub>Me<sub>2</sub>-Cyclam}Cl] (Ln = Y, La, Sm, Yb), leaving at the same time one Ln-Cl reactive bond [<b>Ref. 3</b>]. During 2012, the reactivity of the Y and Sm compounds with LiCH<sub>2</sub>SiMe<sub>3</sub> was studied.</p>
3	<p>Within the project PTDC/QUI-QUI/109846/2009, new lanthanide complexes with isonitriles and aminocarbenes, using nitrogen and oxygen-donor ligands as stabilizers of the metallic center, will be prepared. The structural and chemical properties of the compounds will be studied to evaluate their potential in catalytic processes of metal-mediated C-X bond formation:</p> <p>[Yb<sup>II</sup>(Tp<sup>tBu,Me</sup>)I(CNR)] (R = <sup>t</sup>Bu, Cy) complexes were prepared and characterized by NMR. The addition of amines to the complexes led to the substitution of the isonitrile ligands instead of activation of the isonitrile and formation of aminocarbenes.</p> <p>The bulky dianionic hexadentate bis(phenolate) ligand [(Ar<sup>tBu2</sup>O)<sub>2</sub>Me<sub>2</sub>cyclam]<sup>2-</sup> was used to try to stabilize complexes of the large divalent lanthanides Sm(II) and Yb(II), and to leave vacant coordinated positions for incoming isonitriles. The reaction of SmI<sub>2</sub>(THF) and YbI<sub>2</sub>(THF)<sub>3</sub> with K<sub>2</sub>{(Ar<sup>tBu2</sup>O)<sub>2</sub>cyclam} resulted in the formation of dark-green and orange solids, whose NMR and elemental analysis correspond to the complexes containing one</p>

	<p>ligand per metal center. The structure of <math>[\text{Sm}\{(\text{Ar}^{\text{tBu}_2}\text{O})_2\text{Me}_2\text{cyclam}\}]</math> was confirmed by X-ray diffraction analysis.</p> <p>The experimental work was partially by a research student (BI grant) under my supervision. This work is a collaboration with Dr. Konstantin Luzyanin (Centro de Química Estrutural, IST; in August 1<sup>st</sup> K. Luzyanin moved to the Dept. Chemistry, Univ. Liverpool, UK).</p>
4	<p>Nuclear technology bears the possibility of contamination by the actinides, which can act as chemical poisons as well as radiological hazards. The actinides can compete for the biological sites of essential metallic ions, interact with biomolecules and exert undesirable effects on enzymes, proteins or nucleic acids. However, the interactions of actinides with biomolecules, even in the more common case of uranium, are not entirely understood.</p> <p>Mass spectrometry (ESI-QIT/MS) was used to examine the interactions of actinide ions, specifically <math>\text{UO}_2^{2+}</math>, in the gas-phase with simple amino-acids, namely, glycine, histidine, aspartic acid and cysteine, in an attempt to understand fundamental aspects of the bio-inorganic chemistry of the actinides and correlate to what occurs in biological systems. This work was done in collaboration with Dr. Joaquim Marçalo and PhD student Ana F. Lucena.</p>
5	<p>In the framework of the project PTDC/QUI-QUI/109846/2009 the experimental work of a research student (July 2011-Fev. 2012) was done under my supervision (Jan-Fev.2012).</p>

## PAPERS

- J. M. Carretas, J. Cui, I. C. Santos, A. Cruz, L. Maria, J. Marçalo, Uranium(III, IV) and thorium(IV) pyrazolylmethane complexes: Synthesis and structures, *Inorg. Chim. Acta*, **2012**, 385, 53-57, DOI: 10.1016/j.ica.2011.12.033 (Co-author) [REF1].
- E. Mora, L. Maria, B. Biswas, C. Camp, I. C. Santos, J. Pécaut, A. Cruz, José M. Carretas, J. Marçalo, M. Mazzanti, Diamine Bis(phenolate) as Supporting Ligands in Organoactinide(IV) Chemistry. Synthesis, Structural Characterization and Reactivity of Stable Dialkyl Derivatives, *Organometallics*, XXXX, XXX, XXX-XXX (Publication Date in Web: December 18, 2012), DOI: 10.1021/om3010806 (Corresponding author) [REF2].
- L. Maria, I. C. Santos, L. G. Alves, J. Marçalo, A. M. Martins, Rare Earth Metal Complexes Anchored on a New Dianionic Bis(phenolate)dimethylamine-Cyclam Ligand, *J. Organomet. Chem.*, in press, accepted in 13<sup>th</sup> December 2012 (Corresponding author) [REF3].

## COMMUNICATIONS

- *Diamine bis-phenolates as supporting ligands in organoactinide (IV) chemistry*, Leonor Maria, Elsa Mora, Biplab Biswas, Isabel C. Santos, Jacques Pécaut, Adelaide Cruz, José M. Carretas, Joaquim Marçalo, Marinella Mazzanti, Meeting of COST Action CM1006: European f-Element Network, Tarragona, Espanha, 2-4 April de 2012 (Poster) [REF4].

## EDUCATION / THESES SUPERVISION

- Member of the Organizing Committee and tutor of the *School on Modern Methods of Structure Elucidation-2012*, Centro de Química Estrutural-Instituto Superior Técnico (in Collaboration with IST/ITN), UT, Lisbon, 12-16<sup>th</sup> November 2012 (<http://cqe.ist.utl.pt/events/mmse/next.php>).

## PROJECTS

- *Chiral metalla-diaminocarbene precatalysts for asymmetric catalytic reactions obtained by the metal-mediated approach*, PTDC/QUI-QUI/109846/2009 (2011-2014), Leading Institution: Centro de Química Estrutural, Instituto Superior Técnico. IST/ITN Coordinator: Leonor Maria (25 %)
  - *Small molecules harvesting: an organometallic approach*, PTDC/QEQ-QOR/1914/2012, Leading Institution: Centro de Química Estrutural, Instituto Superior Técnico. IST/ITN Coordinator: Leonor Maria (NOT ACCEPTED).
  - *From drug design to new materials: structural approach in emergent fields*, RECI/QEQ-QIN/0189/2012), Leading Institution: Centro de Química Estrutural, Instituto Superior Técnico. IST/ITN Member of the team: Leonor Maria (15 %) (ACCEPTED).
-

**NAME: Sandra Maria Baptista Rabaça Rodrigues**

CATEGORY: Auxiliary Researcher

ID NUMBER: 171735

**R&D ACTIVITY**

Nº	Activity Description	R&D
1	Synthesis and Characterization of the Novel Extended TTF-type Donors With N Coordinating groups	20%
2	Extended Bisdithiolene Complexes With N Coordinating groups for Molecular Materials	20%
3	Bisdithiolene Complexes Containing N-coordinating Groups; Towards New Coordination Structures	25%
4	Asymmetrical TTF-type Donors with N Coordination Ability	25%
5	Career development and research found seek	10%
Total		100%

**WORK SUMMARY**

Nº	Work Summary and Main Achievements
1	<p>The thione pyrazine-1,3-dithiole-2-thione and oxo compound pyrazine-1,3-dithiole-2-one, recently synthesized by us, were the beginning of a new project aiming at the synthesis and characterization of a novel extended TTF-type donors with pyrazine groups, pyrazinedicyanoethylthiotetrafulvalene (pzdc-TTF). The novel extended donor have been synthesized via coupling reaction between the corresponding thiones and ketones leading to the extended TTF-type donor, the coupling reaction also gives rise to other by-products resulting mainly from the self-coupling of the reactants. However a reasonable yield, 41%, was achieved after column separation. The redox behavior of the donor have been be characterized by Cyclic Voltammetry studies. This electrochemical characterization is an essential step necessary to establish the stability range of these donors in the subsequent compounds to be obtained with them.</p>
2	<p>Square planar complexes with extended TTF-dithiolene ligands were prepared and characterised, these complexes are interesting due to their extended <math>\pi</math>-conjugation system and possibility of displaying high electrical conductivity in the neutral state. The complexes were obtained under anaerobic conditions as diamagnetic dianionic tetrabutylammonium salts <math>TBA_2[M(pztdt)_2]</math> in case <math>M=Ni, Pd</math> and <math>Pt</math> (<math>pztdt</math>=pyrazinetetrafulvalenedithiolate) or as diamagnetic monoanionic tetrabutylammonium salt <math>TBA[M(pztdt)_2]</math> in case <math>M=Au</math>.</p> <p>The electrochemical properties of these compounds were studied by cyclic voltammetry (CV) techniques and their crystal structures determined, they confirm the ability of these molecules to established interactions with their neighbours through the pyrazine moieties.</p>
3	<p>Synthesis and characterization of new bimetallic compounds based on transition metal bisdithiolene complexes containing N atoms, such as <math>[M(cbdt)_2]^{2-}</math>, <math>[M(dcbdt)_2]^{2-}</math> and <math>[M(dcdmp)_2]^{2-}</math> with <math>M = Fe, Cu</math>. The coordination ability of these complexes was explored, combining them with complexes bearing <math>[M(cyclam)]^{2+}</math> (<math>M=Ni, Cu</math>) cations. The obtained bimetallic complexes were characterised by infrared spectroscopy, elemental analysis, X-ray diffraction, electron paramagnetic resonance (EPR) and magnetic susceptibility. This work was partially developed in collaboration with MaCSE group (Matière Condensée et Systèmes Electroactifs) from Université de Rennes 1, Rennes, France.</p> <p>Thesis supervision of the PhD Student Ana Cláudia Cerdeira, (SFRH/BD/46543/2008). "Redes heterometálicas e novas arquiteturas supramoleculares baseadas em complexos de metais de transição com ligandos dito-azo".</p>
4	<p>The TTF molecule, due to its unique <math>\pi</math>-donor properties, has been at the basis of many charge transfer salts with unique electronic and magnetic properties since its preparation and the discovery of first organic conductors, more than 30 years ago. Its ability to form partially oxidized states gave rise to many molecular conductors, and in fact the large majority of organic metals and superconductors known are based on TTF derivatives. These asymmetrically TTF-type donors fused with N coordination ability moieties donors are excellent candidates to be used to coordinate transition metals via the N atoms. In this project we aimed to explore the coordination ability of these new TTFs and verify, in the solid state, their capability to form segregated and partially</p>

	<p>oxidized structures. Also motif of interest is the effect of the coordinated metal in these segregated and partially oxidized structures.</p> <p>Within this work new thiones with N-coordination ability have been synthesized and characterized (4,5-cyanobenzene-1,3-dithiole-2-thione, 4-cyanobenzene-1,3-dithiole-2-thione). The previous thiones were combined in cross-coupling reactions with other thiones/ketones for the asymmetrically TTF-type donors.</p> <p>Thesis co-supervision of the PhD Student Sandrina Oliveira, (SFRH/BD/72722/2010/J031084NL49A). "Novas unidades estruturais para condutores e magnetos moleculares: sais de tetratiafulvaleno contendo grupos coordenantes de metais de transição".</p>
5	Proposal submission to the last call for FCT R&D Projects and Investigador FCT.

## PAPERS

- S.I.G. Dias, S. Rabaça, I.C. Santos, L.C.J. Pereira, R.T. Henriques and M. Almeida, Bisdithiolene complexes based on an extended ligand with TTF and pyridine moieties, *Inorganic Chemistry Communications*, 15, 102–105 (2012), doi: 10.1016/j.inoche.2011.10.001.
- S. Rabaça, A. Cerdeira, S. Oliveira, I.C. Santos, R.T. Henriques, L.C.J. Pereira, J.T. Coutinho, Manuel Almeida, Neutral gold and nickel bis[1-(pyridin-4-yl)-ethylene-1,2-dithiolene] complexes: Synthesis, structure and physical properties, *Polyhedron*, 39, 91-98 (2012), doi: 10.1016/j.poly.2012.03.024.
- A.C. Cerdeira, M.L. Afonso, I.C. Santos, L.C.J. Pereira, J.T. Coutinho, S. Rabaça, D. Simão, R.T. Henriques, M. Almeida, Synthesis, Structure and Physical Properties of Transition Metal bis 4-cyanobenzene-1,2-dithiolate Complexes [M(cbdt)<sub>2</sub>]<sup>z-</sup> (M = Zn, Co, Cu, Au, Ni, Pd, z = 0, 1, 2)", *Polyhedron*, 44,228-237 (2012), doi: 10.1016/j.poly.2012.07.010.

## COMMUNICATIONS

- *Bisdithiolene Complexes Based on Extended TTF-Derivatives Bearing Pyridine Rings*, S.I.G. Dias, J.T. Coutinho, A.I.S. Neves, L.C.J. Pereira, I. C. Santos, S. Rabaça, J.D. Wallis, M. Almeida, *40th International Conference on Coordination Chemistry, Valencia, Spain, Sep 9-13 (2012)*, Contributed Lecture.
- *New TTF Derivatives with Cyano Coordination Groups*, S. Oliveira, S. Rabaça, I.C. Santos. D. Simão, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24(2012)*, Invited Lecture.
- *Bisdithiolene Complexes Containing N-coordinating Groups; Towards New Coordination Structures*, A.C. Cerdeira, S. Rabaça, D. Belo, I.C. Santos. L.C.J. Pereira, J.T. Coutinho, R.T. Henriques, D. Simão, O. Jeannin, M. Fourmigué, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24 (2012)*, Invited Lecture.
- *Extended Bisdithiolene Complexes with Benzocyano and Pyrazine Units, for Molecular Materials*, S. Rabaça, S. Oliveira, I.C. Santos. D. Simão, M. Almeida, *Workshop on Molecular Materials with Strong Electronic Correlations, Institut des Sciences Chimiques de Rennes, Rennes, France, Oct 23-24 (2012)*, Invited Lecture.

## PROJECTS

- *Molecular-Based Multifunctional Materials (IF/01289/2012)*, Call for FCT Researcher, host institution: Instituto Superior Técnico, proposal not funded.
- *Molecular-based multifunctional materials: Paramagnetic transition metal complexes coordinated by electroactive asymmetric TTF Units*, (PTDC/QEQ-SUP/1579/2012), FCT Call for R&D Projects, host institution: Associação do Instituto Superior Técnico para a Investigação e o Desenvolvimento (IST-ID), proposal not recommended for funding.