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# *IONISING RADIATION TECHNOLOGIES*

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## *Annual Activity Report 2013*

### **UNIT: Physics and Accelerators**

#### **TEAM**

<b>Name</b>	<b>Category</b>	<b>R&amp;D (%)</b>
Fernanda Margaça	Principal Researcher	100%
Luis Cerqueira Alves	Auxiliary Researcher	70% (C <sup>2</sup> TN) + 30% (LATR)
Luis Ferreira	Auxiliary Researcher	100%
Maria Teresa Pinheiro	Auxiliary Researcher	100%
Sandra Cabo Verde	Auxiliary Researcher (Ciência)	100%
Helena Marcos	Informatics Technician	100%
Pedro Santos	Post-Doc grant	100%
Rita Melo	Post-Doc grant	100%
Joana Lancastre	MSc grant	100%
Telma Silva	MSc grant	100%
Joana Madureira	MSc grant	100 %

#### **OBJECTIVES**

The main objectives of the group for 2013 can be summarized in the following three points:

1. The application of Ionizing Radiation Technologies, with quality, safety and environmental sustainability, for research in the framework of the ongoing funded projects and for services.
2. Maintenance and upgrading of both the Ionizing Radiation Installation (IRIS) and the associated laboratories.
3. Extension and/or to strengthen collaborations in particular with respect to international networks.

Concerning the first point, Ionizing Radiation Technologies were to be applied for I&D in order to:

- Develop or modify new materials, both polymeric and hybrids prepared from a mixture of polymer and metallic alkoxides, for a wide range of applications;
- Perform a feasibility study on the decontamination of fresh fruits and vegetables for immunocompromised patients;
- Assessment of Ionizing Radiation application as a decontamination tool for viral threat agents in the environment, studying their survival and inactivation patterns;
- Progress in the study of the treatment of cork industry wastewaters and the possibility of valorisation of the treated wastewater;
- Kinetic studies of biorecalcitrant compounds degradation by pulse radiolysis;
- Conservation of cultural heritage: ionizing radiation application to artwork;
- Provide services to various national industries upon request or tests for future service.

The second point concerns regular maintenance and upgrading of the Ionizing Radiation infrastructure and associated laboratories. Namely it was planned to start the installation of a new laboratory dedicated to biomaterials assays such as bioactivity, biocompatibility, etc.

Finally, by the third point it is meant to increase the group collaborations, both international and national, mainly by accessing to new funding programs.

## MAIN ACHIEVEMENTS

### *Application of Ionizing Radiation Technologies for Research and Development*

#### **ENVIRONMENT and FOOD**

Research on the survival and inactivation patterns of viral threat agents in the environment progressed via the optimization and validation of the methods to assess the virucidal effect of gamma radiation on Murine Norovirus (MNV) that is a surrogate model of the Human Norovirus. The data obtained showed that MNV titer could be effectively reduced by a gamma radiation dose of 10 kGy, but the viral genome or a fragment of it was still detectable by RT-PCR. The discrepancy observed between the detection of viral genomic copies and infectivity after radiation treatment shows that the presence of genomic copies is not necessarily associated with infectious virus particles. This approach cannot inform as to whether the signals detected represent infectious virus that poses a threat, or remnants from inactivated virus that are harmless. The plaque method will be used to evaluate the viral inactivation by gamma radiation.

Wastewater treatment by ionizing radiation was studied to find out if this treatment could increase the biodegradability of recalcitrant compounds in cork wastewater using a microbial consortium and a mixed solution of four phenolic acids as a model. Chemical and microbiological analyses were performed in non-irradiated and irradiated (100 kGy) phenolic acids cultures. The Total Phenolic content of mixed phenolic acids cultures during incubation time indicated a decrease of 38% for 100 kGy. However it was also found a decreasing tendency along the incubation time for phenolic acids cultures (0 kGy and 100 kGy) suggesting a non-degradation trend, for the selected microbial consortium that was unable to metabolize the phenolic compounds solutions at the used conditions. This could be due to the detected radiolytic degradation dynamics of the phenolic acids considering their antimicrobial activity.

The study of valorization of radiation treated wastewaters focused on the extraction of new powerful antioxidants by activated carbon and also on the irradiation of activated carbon to potentiate its applicability (e.g.: increase of adsorption capacity). This approach will allow the optimization of the irradiation parameters (e.g. energy type, geometry, absorbed doses and dose rates) to be implemented in a pilot plant on cork industry.

Evaluation of the radiation effects on blackberries and sweet cherries and the potential extension of their shelf-life. Samples of packed fruits were gamma irradiated at dose range of 0.5 to 4 kGy. Microbiological, physico-chemical and sensorial parameters were assessed after irradiation and during storage time (4°C). Generally, results indicated that irradiation caused a decrease in firmness compared with non-irradiated fruit, pointing to the texture as the critical parameter for fruit irradiation. It was observed that irradiated fruits preserve higher antioxidant activity compared with non-irradiated samples. It was found similar acceptability among irradiated and non-irradiated fruits along storage. Studies showed that degradation of mycotoxins occurs with doses above 3.0 kGy, but only when irradiated in aqueous environment. Dehydrated samples showed no significant reduction.

#### **MATERIALS**

Hybrid materials were developed with successful addition of Calcium and Strontium compounds to the precursors to promote the bioactive behaviour. A novel hybrid material was obtained, with calcium and strontium release capability where, for the first time, the incorporation of strontium in a PDMS-TEOS hybrid system was achieved and evaluated. PDMS-TEOS-CaO-TiO<sub>2</sub> hybrid materials were also prepared and characterized.

LDPE based copolymers were prepared by gamma irradiation to be used as catalyst support in catalytic membrane reactors (CMR) for biodiesel production. The evaluation of materials structural stability as a function of grafting degree and irradiation dose revealed an unknown ability of the high grafted films to partially recover the structural order. This effect allows a new approach to mechanical functionalization of such materials.

In search for efficient heterogeneous catalysts for methanolysis of vegetable oils, to be supported in polymeric membranes for catalytic membrane reactors, mesoporous silicas (SBA-15 and KIT-6) with anchored guanidine (TBD) were prepared and tested in methanolysis of soybean oil, in batch reactor. The results are very promising. Future work will continue in mesoporous silicas with anchored guanidines in polymeric catalytic membranes.

## SERVICES

EFICARE (QREN 30399/2013) – Services in samples collection and study on indoor air quality analysis, in the framework of this project coordinated by a national company (Integridade) in cooperation with IST, ISQ, Quadrante and Centro Hospitalar de Setúbal. The project aims to integrate and optimize the energy efficiency, the indoor air quality and the management of the maintenance in Health Units.

## RELEVANT PAPERS

- J. Madureira, R. Melo, M.L. Botelho, J.P. Leal, I.M. Fonseca, Effect of ionizing radiation on antioxidant compounds present in cork wastewater, *Water Sci. Technol.*, 67, 374-379 (2013), doi:10.2166/wst.2012.544
- S. Cabo Verde, M.J. Trigo, M.B. Sousa, A. Ferreira, A.C. Ramos, I. Nunes, C. Junqueira, R. Melo, P.M.P. Santos, M.L. Botelho, Effects of gamma radiation on raspberries: safety and quality issues, *Journal of Toxicology and Environmental Health, Part A*, 76, 291-303, (2013), doi: 10.1080/15287394.2013.757256
- M. Oliveira, J. Pereira, S. Cabo Verde, M. G.Lima, P. Pinto, P.B. de Oliveira, C. Junqueira, H. Marcos, T. Silva, R. Melo, C.N. Santos, M.L. Botelho. Evaluation of potential of gamma radiation as a conservation treatment for blackberry fruits. *Journal of Berry Research* 3 (2013) 93-112 DOI:10.3233/JBR-130050.
- Nunes, N. Mesquita, S. Cabo Verde, A. M. L. Bandeira, M. M. Carolino, A. Portugal, M. L. Botelho. Characterization of an airborne microbial community: A case study in the archive of the University of Coimbra, Portugal. *International Biodeterioration & Biodegradation* (2013) 79: 36-41, doi: 10.1016/j.ibiod.2013.01.013
- M.H. Casimiro, M.C. Corvo, A.M. Ramos, E.J. Cabrita, A.M. Ramos, L.M. Ferreira, Synthesis and characterization of gamma-induced porous HEMA-IL composites, *Materials Chemistry and Physics*, 138, 11-16 (2013), doi: 10.1016/j.radphyschem.2012.01.036.
- A.G.B. Castro, J.C. Almeida, I.M.M.Salvado, F.M.A. Margaça, M.H.V. Fernandes, A novel hybrid material with calcium and strontium release capability, *Materials Letters* 88 (2013) 12-15, doi:10.1016/j.matlet.2012.08.022

## FUNDS

Project/Service	Reference	Timeframe	2013
Application of Ionizing Radiation for a Sustainable Environment	FCT Project RECI/AAG-TEC/0400/2012	2013- 2015	74 920,35 €
Kinetic Study of Biorecalcitrant Compounds Degradation by Pulse Radiolysis	FCT Project PTDC/QUI-QUI/104229/2008	2010 - 2013	16 887,68 €
Preparation of polymeric materials catalytically actives on biodiesel production by vegetable oils methanolysis	FCT Project PTDC/CTM-POL/114579/2009	2010 - 2014	-
Hybrid materials for biomedical applications	FCT Project PTDC/CTM/101115/2008	2009 - 2013	10 358,54 €
Radiation treatment of wastewater for reuse with particular focus on wastewaters containing organic pollutants	IAEA CRP Project No. 16513	2010 - 2014	5 000 €
Ionization radiation treatment of fruits and vegetables for immunocompromised patients – feasibility study	IAEA Research Contract No. 16281	2011-2014	6 000 €
Survival and inactivation patterns of viral threat agents in the environment: assessment of	IAEA Research Contract No. 17474	2012-201 5	10 000 €

ionizing radiation as decontamination tool			
Services	LETAL/IRIS	2013	20 000 €
<b>Total</b>			<b>132 818,39 €</b>

## INTERNATIONALIZATION

- COST Action TD1208 “Electrical discharges with liquids for future applications”. Non-thermal plasma, produced by a dielectric barrier discharge was applied to study the degradation of hemoglobin that is a recalcitrant pollutant in slaughterhouses wastewaters. The plasma-liquid interactions and the treatment efficiency are to be compared to those involved in ionizing radiation treatment of same wastewaters. C2TN coordinator: Rita Melo.
- LLP-ERASMUS Training Programme Abroad 2013/2014 between C2TN of IST and the Faculty of Physics of Alexandru Ioan Cuza University, Iasi, Romania. C2TN coordinator: Fernanda Margaça.
- IAEA Regional Training Course *on Microbiological Aspects of Sterilization Validation Process*, held at CTN/IST, Bobadela, Portugal. 2-6 December 2013. Course Director: Sandra Cabo Verde.
- ERASMUS + Programme, Key Action 1 – Mobility for learners and staff – Higher Education Student and Staff Mobility, Inter-institutional agreement 2014/15–2020/21 between programme countries. Agreement between C2TN of IST and the Faculty of Physics of Alexandru Ioan Cuza University of Iasi, Romania. C2TN coordinator: Fernanda Margaça.

## CONTRACTS

- Contract IST-Edol, Laboratórios Edol - Study of the resistance/degradation of ophthalmic ointments to gamma radiation for maximum dose (Dmax) assessment, ongoing, 1.2 k€.
- Contract IST-EFACEC (Apr. 2013- Apr. 2014) -Microbiological analysis for Indoor Air Quality in the scope of the Energy Certification for Buildings, 2.7 k€.
- Contract IST-Tradelabor (Apr. 2013- Apr. 2014) - Microbiological analysis for Indoor Air Quality in clean rooms, 3.9 k€.
- IST/CTN/N3800803, Universidade do Minho - Irradiation of dextrin hydrogels for maximum dose (Dmax) assessment, Jul. 2013, 1.5 k€.
- IST/CTN/N381200008/N3800583/N3800584/N3800720/N3800721/N3800840, Iberfar-indústria Farmacêutica SA, Jan., Mar.-Apr. 2013 - Determination of Neomycin Sulfate for Nodryl product batches, 6.7 k€.
- IST/CTN/N3800580, Hovione - Study of the resistance/degradation of API compounds to gamma radiation for maximum dose (Dmax) assessment, 1.5 k€.
- IST/CTN/N3800586, Lusomedicamenta - Sociedade Técnica Farmacêutica SA. - Substantiation of 25 kGy for Sterilization Dose of Pharmaceutical Tubes, 2.5 k€.

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## *TEAM RESEARCHERS*

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**NAME: Fernanda Maria Amaro Margaça**

CATEGORY: Principal Researcher

IST-ID: 5346

## ACTIVITIES

Nº	Activity Description	R&D (%)
1	Application of Ionizing Radiation for a Sustainable Environment –ARIAS; RECI/AAG-TEC/0400/2012 (2013-2015)	30
2	Hybrid Materials for biomedical applications; PTDC/CTM/101115/2008 (2010 – 2013)	25

3	Kinetic study of biorecalcitrant compounds degradation by pulsed radiolysis-RPUL; PTDC/QUI-QUI/104229/2008 (20010-2013)	25
4	Study of bio-degradation behaviour of recalcitrant degradation by-products ... after irradiation; AIEA Research contract 16513/R0 (2013 – 2014)	5
5	Coordination and other activities	15
Total		100

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	ARIAS is a project that aims to consolidate the competences and resources on Radiation Technologies applications. The project started on June 1 <sup>st</sup> , 2013. As principal researcher of this project, I have coordinated the main activities performed since then, that were the following: i) Fellowships announcement and selection for consolidation of competences – 5 fellowships (2 Post-doc and 3 BI Master) have been granted and are running; ii) Tenders and acquisition of equipment to consolidate the existing infrastructure and associated laboratories - FTIR (with ATR accessory), two Fast Gamma Detectors for PALS, one UPS and the requested lot of Computer Systems have been purchased and were received; iii) Installation and qualification of the acquired equipment - this is currently under way following the particular specifications of each one of them; iv) training activities as well as research work carried out by each of the five fellowship grantees.
2	Research progressed in Hybrid Materials for biomedical applications, in the development of new compositions by incorporating elements that promote the bioactive behaviour with the successful addition of Calcium and Strontium compounds to the precursors. Namely, a novel hybrid material with calcium and strontium release capability was obtained where, for the first time, the incorporation of strontium in a PDMS–TEOS hybrid system was achieved and evaluated. Also PDMS-TEOS-CaO-TiO <sub>2</sub> hybrid materials were prepared and characterized. The results of these studies are presented and discussed in the respective published papers. This FCT research project, carried out in collaboration with the Ceramics Engineering and Glass Department of the University of Aveiro, was successfully concluded and executed on the 31 <sup>st</sup> of May 2013.
3	The aim of the project was the use of pulse radiolysis technique, as a tool of radiation chemistry, to study the mechanistic details of the degradation of biorecalcitrant compounds induced by free radicals formed upon radiolysis of water, for instance in aqueous solutions such as wastewaters. For the implementation of a pulse radiolysis system, the linear accelerator (LINAC) needed to be upgraded to work in a pulsed manner. A transformation was required to achieve pulse radiolysis (individual pulses of 0,1 to 2 microseconds) and to implement an optical detection system for real time observation of the buildup and decay of radical transients. The execution of this project suffered from serious difficulties, mainly due to technical problems with components of LINAC that could not be as quickly solved as desired. However, during 2013 the reparation of its bending chamber was achieved and a special forcing of the project team enabled the project RPUL (PTDC/QUI-QUI/104229/2008) to be completed in due time (September 30 <sup>th</sup> ).
4	This project, of which I am the chief scientific investigator (CSI) and Post-doc Rita Melo is the secondary CSI, is a research contract with the IAEA for the period of one year. Its work program includes to i) study the bio-degradation behaviour of recalcitrant degradation by-products; ii) Evaluate the adsorption behaviour on activated carbon of radiation degradation products formed during irradiation of cork industry wastewater and iii) study degradation behaviour of irradiated wastewater after removal of these recalcitrant compounds. The project has just started in 15-12-2013.
5	<b>Coordination activities:</b> Coordination of the Unit of Physics and Accelerators (UFA) until the election of C2TN that was held in September 2013. During this period I i) chaired several coordination of meetings with the heads of the UFA research groups to address the common issues, make decisions and proceed; ii) coordinated the UFA contribution to the ITN Annual Report 2012 and iii) participated as Member of the IST/ITN Restructuration Committee regular meetings. Coordination of the Ionizing Radiation Technologies (TRI) Group. As head of this group I

i) chaired several group meetings; ii) conclude the group projects that finished in 2013, namely to resume the tasks of project RPUL due to end in September 2013; iii) managed the human resources available, optimizing their allocation to the different sectors/infrastructures operated by TRI, for instance, Principal Researcher António Falcão was appointed to be responsible for the Ionizing Radiations Installation, IRIS, and an operational plan was elaborated for the LINAC recovery; similarly for LETAL whose responsibility was assumed by myself.

**Other activities:**

- Co-supervisor of one MSc researcher under the scope of project PTDC/CTM/101115/2008 – *Hybrid Materials for Biomedical Applications* (until May 2013).
- Co-supervisor of 3 MSc and 3 Post-doc researchers since June 2013 under the framework of project RECI/AAG-TEC/0400/2012, *Application of Ionizing Radiation for a Sustainable –ARIAS*.
- Application to the Inter-institutional agreement 2014/15–2020/21 between IST, Portugal, and Alexandru Ioan Cuza University of Iasi, Romania, no âmbito do *Erasmus+ Programme*, Key Action 1 – Mobility for learners and staff – Higher Education Student and Staff Mobility.
- Participant as Editor in the IST/ITN 2012 Annual Report.
- Referee, by invitation from the *Journal of Sol-Gel Science and Technology*, of several submitted manuscripts.

Participation in the elaboration of the following proposals for funding:

- IAEA proposal for research contract, *Instructive surfaces and scaffolds for tissue engineering using radiation technology*, submitted by Luis Ferreira and Helena Casimiro. (This contract has just been awarded in early 2014).
- FCT proposal for research contract, *Inactivation patterns of enteric virus by ionizing radiation*. Submitted by Sandra Cabo Verde. Project EXPL/DTP-SAP/2338/2013. Recommended for funding: 48 541,00 €. Due to start in 2014.

## PUBLICATIONS

- A.G.B. Castro, J.C. Almeida, I.M.M.Salvado, F.M.A. Margaça, M.H.V. Fernandes, A novel hybrid material with calcium and strontium release capability, *Materials Letters* **88** (2013) 12-15, doi:10.1016/j.matlet.2012.08.022.
- J.C. Almeida, A.G.B. Castro, J.J.H. Lancastre, I.M. Miranda Salvado, F.M.A. Margaça, M.H.V. Fernandes, L.M. Ferreira, M.H. Casimiro, Structural characterization of PDMS-TEOS-CaO-TiO<sub>2</sub> hybrid materials obtained by sol-gel, *Materials Chemistry and Physics* doi: 10.1016/j.matchemphys.2013.09.032.

## COMMUNICATIONS

- *Exploring the hybrid materials nanostructure by SANS*, F.M.A. Margaça, A.N. Falcão, J.J.H. Lancastre, I.M. Miranda Salvado, *BNC Users Meeting, Budapest, Hungary, November 15 (2013)*, Invited lecture.
- *Ionization radiation treatment of fruits and vegetables for immuno-compromised patients: feasibility study*, S. Cabo Verde, A. António, P. Santos, R. Melo, T. Silva, J. Pereira, M. Oliveira, M. J. Trigo, T. Calado, A. Venâncio, M.L. Botelho, F. Margaça. *3rd RCM of The Development of Irradiated Foods for Immuno-Compromised Patients and other Potential Target Groups, Jeongeup, Republic of Korea, Sep. 9-13 (2013)*, Oral presentation.
- *A biodegradation bench study of cork wastewater using ionizing radiation*. C. Lima, J. Madureira, R. Melo, S. Cabo Verde, M.M. Carolino, J.P. Noronha, F.M.A. Margaça, *WASTES: Solutions, Treatments and Opportunities, Braga, Portugal, Sep. 11-13 (2013)*, Poster Presentation.
- *Extraction of phenolic compounds from cork wastewater by adsorption onto activated carbon*. J. Madureira, R. Melo, S. Cabo Verde, C. Lima, I. Matos, J.P. Noronha, I.M. Fonseca, F.M.A.

Margaça, *WASTES: Solutions, Treatments and Opportunities, Braga, Portugal, Sep. 11-13 (2013)*, Poster Presentation.

- *Valorization of sludges of ink factories by ionizing radiation treatment*. J.J. Lancastre, L.M. Ferreira, R. Melo, M.H. Casimiro, L.C. Alves, F.M.A. Margaça, A.M.T. Aguiar. *WASTES: Solutions, Treatments and Opportunities, Braga, Portugal, Sep. 11-13 (2013)*, Poster Presentation.

## PROJECTS

- *Application of Ionizing Radiation for a Sustainable Environment – ARIAS*; contract ref. FCT - RECI/AAG-TEC/0400/2012 (2013 – 2015). Total budget: 499.469 €, IST-ID budget: 499.469 €. Prime Contractor: IST-ID. Coordinator: F.M.A. Margaça (60%), in progress.
- *Hybrid Materials for biomedical applications*, contract ref. FCT-PTDC/CTM/101115/2008 (2010-2013), Total budget: 125.000 €, IST-ID budget: 51.072 €. Prime Contractor: Univ. de Aveiro (I.M.M. Salvado), ITN Coordinator: F.M.A. Margaça (25%), concluded in 31<sup>st</sup> May 2013.
- *Study of bio-degradation behaviour of recalcitrant degradation by-products ... after irradiation*; AIEA Research contract 16513/R0 (2013 – 2014). Total budget: 5.000 €, IST budget: 5.000 €. Prime Contractor: IST. Coordinator: F.M.A. Margaça, in progress.

## COLLABORATIONS

- I.M. Miranda Salvado, Dept. Glass and Ceramics Eng., CICECO, University of Aveiro, Portugal, monthly visit, Collaboration research on hybrid materials for biomedical applications.
- J.C. Almeida, Dept. Glass and Ceramics Eng., CICECO, University of Aveiro, Portugal, every other month visit, to discuss results obtained in sol-gel prepared hybrid materials for biomedical applications.
- M.H.Casimiro, REQUIMTE, CQFB, Dep. Química, Fac. de Ciências e Tecnologia, Univ. Nova de Lisboa, weekly visit, Collaboration in research of new polymeric materials and their practical use.

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**NAME: Luís Manuel Cerqueira Lopes Alves**

CATEGORY: Auxiliary Researcher

IST-ID: 5454

## ACTIVITIES:

Nº	Activity Description	R&D (%)
1	Nobly Decorated Crystal-NobleDec. Grant AdI/23274/2012, QREN programme COMPETE. Leading Institution: VAA-Vista Alegre/Atlantis.	20
2	Functionalising wide bandgap semiconductor nanowires using ion beams: Novel materials for nano-light emitters and nano-sensors, PTDC/CTM-NAN/2156/2012. Leading Institution: CTN/IST: CTN co-ordinator: K. Lorenz.	10
3	Nanostructured magnetic nitrides-Nanomag. PTDC/FIS /102270/2008. Leading Institution: FFCUL.	5
4	The Stained Glass collection of King Ferdinand II of Portugal - Assembling the puzzle PTDC/EPH-PAT/3579/2012. Leading Institution: FCT-UNL.	10
5	Medieval Tiles (azulejos) in Portugal - a provenance study PTDC/CPC-EAT/4719/2012. Leading Institution: FCT-UNL.	10
6	Depth-selective Ion Microprobe Tomography-Tomo3D. PTDC/FIS/115089/2009. Leading Institution: CTN/IST. PI: A.C. Marques (FCT post-doctoral fellow, 100%).	25
7	External collaborations	20
Total		100

## WORK SUMMARY

N°	<p style="text-align: center;"><b>Work Summary and Main Achievements</b></p> <p style="text-align: center;">Research has been carried out through National projects funding and collaborations:</p>
1	<p><i>Nobly Decorated Crystal-NobleDec.</i></p> <p>Study of gold decorated commercial glasses from Atlantis. Characterization of gold glass layers produced with new methods (gold ink laser and/or induction annealing furnace) at University of Aveiro and comparison with the original industrial decorative method. The characterization involved not only the use of ion beam analytical techniques (RBS and PIXE) but also FTIR, RAMAN and SEM spectroscopy on account of the continued collaborations with FCT/UNL groups. Results suggest the possibility of obtaining similar quality results in the decorated glasses by less expensive means. However, problems like adhesion of the new formed gold layer must still be addressed.</p>
2	<p><i>Functionalising wide bandgap semiconductor nanowires using ion beams: Novel materials for nano-light emitters and nano-sensors.</i></p> <p>Started in September, the project aims to be able to individually characterize Ga<sub>2</sub>O<sub>3</sub> and GaN nanowires in what accounts to their electrical properties and their behaviour during and after irradiation with an ion beam. The study of their electrical properties will be combined with the study of their optical properties and their behaviour dependence with different ion REE implanted elements. The efforts have been concentrated on: the choice and acquisition of the proper electronic equipment for the sensitive measurements to be performed; alterations in the vacuum chamber for conducting experiments under ion beam irradiation conditions with the possibility of altering the sample temperature from liquid nitrogen temperature up to room temperature; sample mounting devices and procedures for allowing the analysis of a single nanowire.</p>
3	<p><i>Nanostructured magnetic nitrides-Nanomag.</i></p> <p>Determination of the fluence of Fe and Co co-implanted species on TiO<sub>2</sub>. Comparison with the nominal implanted fluence reveals deviations up to 21% in the lower fluence implanted samples (3x10<sup>16</sup>cm<sup>-2</sup>).</p>
4	<p><i>The Stained Glass collection of King Ferdinand II of Portugal - Assembling the puzzle.</i></p> <p>The project started in April and a first “on local” (Palácio da Pena, Sintra) stained glass elemental analysis was accomplished using both a portable and hand-held X-ray equipment. Some stained glass fragments were also analysed using microprobe ion beam techniques. Data is being analysed and results compared.</p>
5	<p><i>Medieval Tiles (azulejos) in Portugal - a provenance study.</i></p> <p>Raw material and colour pigments composition of XVII century tiles (Monastery of Sta Clara-a-Velha), are being analysed for establishing type, production techniques and provenance.</p>
6	<p><i>Depth-selective Ion Microprobe Tomography-Tomo3D</i></p> <p>The development of an experimental system for tomography of thin samples using PIXE and STIM techniques with micrometer spatial resolution was continued. Due to the experiments performed, a new design gas detector was proposed and is being carried away by the LIP-Coimbra researchers. Implementations to the rotation stage in what accounts to its positioning through a motorized stage were accomplished. Software routines were developed for a faster image reconstruction.</p>
7	<p>Apart from the research carried out through National projects funding other research has been carried away through collaborations with researchers from other institutions:</p> <ul style="list-style-type: none"> <li>- Cultural heritage</li> <li>a) Metal objects</li> </ul> <p>Characterization of Indo-Portuguese Silver Jewellery, with the analysis of several pieces from the Museu Nacional de Arte Antiga and private collectors, in collaboration with Rui Borges (FCT PhD). This collaboration also involves coeval silver coins from the Imprensa Nacional Casa da Moeda collection.</p> <p>Museu Nacional de Arqueologia – material composition and identification of brazing or</p>



<p>soldering techniques in Iron Age gold bracelets.  b) Ancient ceramics and glasses  Raw material elemental composition of glassware from the Lisbon Roman Theatre for establishing type, production techniques and provenance.</p>
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## PUBLICATIONS

- R. Mateus, P.A. Carvalho, N. Franco, L.C. Alves, M. Fonseca, E. Alves, Carbon deposition on beryllium substrates and subsequent delamination *Mat. Science. Forum*, 730-732 (2013) 179-184. <http://dx.doi.org/10.4028/www.scientific.net/MSF.730-732.179>
- R. Mateus, P.A. Carvalho, N. Franco, L.C. Alves, M. Fonseca, C. Porosnicue, C.P. Lungu, E. Alves, Formation and delamination of beryllium carbide films, *J. Nucl. Mat.* 442, 1-3, (2013) S320-S324. <http://dx.doi.org/10.1016/j.jnucmat.2013.04.009>.
- Ricardo Araújo, Rui Castanhinha, Rui M. S. Martins, Octávio Mateus, Christophe Hendrickx, F. Beckmann, N. Schell, L. C. Alves, Filling the gaps of dinosaur eggshell phylogeny: Late Jurassic Theropod clutch with embryos from Portugal. *Sci. Rep.* 3, 1924; <http://dx.doi.org/10.1038/srep01924> (2013). [www.nature.com/scientificreports](http://www.nature.com/scientificreports)
- R. Mendes Godinho, J. Raimundo, C. Vale, B. Anes, P. Brito, L.C. Alves, T. Pinheiro, Micro-scale elemental partition in tissues of the aquatic plant *Lemna minor* L. exposed to highway drainage water, *Nucl. Instr. and Meth. B* 306 (2013) 150-152. <http://dx.doi.org/10.1016/j.nimb.2012.10.032>
- A.C. Marques, M.M.F.R. Fraga, P. Fonte, D.G. Beasley, L.C. Alves, R.C. da Silva, New gas detector setup for on-axis STIM tomography experiments, *Nucl. Instr. and Meth. B* 306 (2013) 104-108, <http://dx.doi.org/10.1016/j.nimb.2012.12.038>
- J. Rodrigues, S.M.C. Miranda, M. Peres, E. Nogales, L.C. Alves, E. Alves, G. Tourbot, B. Daudin, B. Méndez, K. Lorenz, T. Monteiro, A comparative study of photo-, cathodo- and ionoluminescence of GaN nanowires implanted with rare earth ions, *Nucl. Instr. and Meth. B* 306 (2013) 201-206, <http://dx.doi.org/10.1016/j.nimb.2012.12.028>
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- I.Tissot, M. Tissot, M. Manso, L.C. Alves, M.A. Barreiros, T. Marcelo, M.L. Carvalho, V. Corregidor, M.F. Guerra, The earrings of Pancas treasure: Analytical study by X-ray based techniques – A first approach, *Nucl. Instr. and Meth. B* 306 (2013) 236-240, <http://dx.doi.org/10.1016/j.nimb.2012.11.054>
- V. Corregidor, L.C. Alves, N. Franco, M.A. Barreiros, N.V. Sochinskii, E. Alves, CdTe nanostructures for photovoltaic devices, *Nucl. Instr. and Meth. B* 306 (2013) 218-221, <http://dx.doi.org/10.1016/j.nimb.2012.11.051>
- N.F. Santos, A.J.S. Fernandes, L.C. Alves, N.A. Sobolev, E. Alves, K. Lorenz, F.M. Costa, T. Monteiro, Microprobe analysis, iono- and photo-luminescence of Mn<sup>2+</sup> activated ZnGa<sub>2</sub>O<sub>4</sub> fibres, *Nucl. Instr. and Meth. B* 306 (2013) 195-200, <http://dx.doi.org/10.1016/j.nimb.2012.12.029>
- A.Redondo-Cubero, M.D. Ynsa, M.F. Romero, L.C. Alves, E. Muñoz, Effect of rapid thermal annealing on the composition of Au/Ti/Al/Ti ohmic contacts for GaN-based microdevices, *Nucl. Instr. and Meth. B* 306 (2013) 212-217, <http://dx.doi.org/10.1016/j.nimb.2012.12.030>
- V. Corregidor, L.C. Alves, J. Cruz, Analysis of surface stains on modern gold coins, *Nucl. Instr. and Meth. B* 306 (2013) 232-235, <http://dx.doi.org/10.1016/j.nimb.2012.11.039>
- D.G. Beasley, A.C. Marques, L.C. Alves, R.C. da Silva, Fast simulation of Proton Induced X-Ray Emission Tomography using CUDA, *Nucl. Instr. and Meth. B* 306 (2013) 109-112, <http://dx.doi.org/10.1016/j.nimb.2012.12.053>
- C.Alves, T. Marcelo, F.A.C. Oliveira, L.C. Alves, J. Mascarenhas, B. Trindade, On the influence of silica type on the structural integrity of dense La<sub>9.33</sub>Si<sub>2</sub>Ge<sub>4</sub>O<sub>26</sub> electrolytes for SOFCs, *Journal of the European Ceramic Society*, 33, 12, (2013) 2251-2258, <http://dx.doi.org/10.1016/j.jeurceramsoc.2012.12.024>

## COMMUNICATIONS

- *Non-destructive analysis of ancient coins of uncertain provenance*, J. Cruz, V. Corregidor, L.C. Alves, *ECAART 2013, 11<sup>th</sup> European Conference on Accelerators in Applied Research and Technology, Namur, Belgium, 8 - 13 Sept. 2013* (oral, J. Cruz).
- *Investigation of Elemental Distribution in Human Femoral Head - Studies of the Paget Disease of Bone*, C. Santos, M. Fonseca, V. Corregidor, L. C. Alves, H. Luis, H. Silva, M. Capelão, J. C. Branco, A. P. Jesus, *ECAART 2013, 11<sup>th</sup> European Conference on Accelerators in Applied Research and Technology, Namur, Belgium, 8 - 13 Sept. 2013* (poster).
- *Defects Produced in IBIL Analysis of Sapphire*, M. Fialho, C. Marques, L.C. Alves, R.C. Silva, E. Alves, *E-MRS 2013 Spring Meeting, Strasbourg, France, May 27-31, 2013* (poster).
- *Compositional studies of ZnO films on lithium niobate single crystals*, V. Corregidor, L. C. Alves, J.L. Plaza, E. Diéguez, E. Alves, *IBA 2013, 21<sup>st</sup> International Conference on Ion Beam Analysis, Seattle, USA, June 23-28, 2013*, (poster).
- *Ion Beam Analytical Techniques applied to the Study of Valuable Artifacts*, V. Corregidor, J. Cruz, L.C. Alves, *1st International Conference on Innovation in Art Research and Technology, Hercules Laboratory – University of Evora, 10th-13th of July 2013* (oral, V. Corregidor).
- *Preliminary Studies on Inks composition using an External Ion Beam*, V. Corregidor, R. Viegas, T. Peña, E. Alves, L.C. Alves, *1st International Conference on Innovation in Art Research and Technology, Hercules Laboratory – University of Evora, 10th-13th of July 2013* (poster).
- *An analytical approach for characterization of Portuguese silverware alloys from the fifteenth to seventeenth centuries*, R.C. Borges, R.J.C. Silva, A. Candeias, M.F. Araújo, L. Penalva, L. C. Alves, V. Corregidor, *MATERIAIS 2013, SPM – Sociedade Portuguesa de Materiais, Coimbra, March 25-27, 2013*, (poster).
- *Compositional characterization of GaInSb grown by LEC method*, M. Streicher, V. Corregidor, L.C. Alves, N. Franco, M. Fialho, E. Alves, E. M. Costa, B.A. Dedavid, *MATERIAIS 2013, SPM – Sociedade portuguesa de Materiais, Coimbra, March 25-27, 2013*, (poster)
- *On the Evolution of Silver tarnishing*, V. Corregidor, J. Cruz, P.C. Chaves, M.A. Reis, N. Franco, L.C. Alves, *13th International Conference on Particle Induced X-ray Emission, Gramado, Brazil, March 3-8, 2013*, (poster).
- *Microprobe study of Portuguese ancient silver coins of uncertain provenance*, V. Corregidor, J. Cruz, L.C. Alves, *SPMICROS2013, 9-10 Dez 2013, Monte da Caparica, Portugal*, (poster).
- *Compositional characterization of iron gall inks in manuscripts; from ingredients until the document*, V. Corregidor, R. Viegas, N. Franco, T. Peña, E. Alves, L.C. Alves, *SPMICROS2013, 9-10 Dez 2013, Monte da Caparica, Portugal*, (poster).
- *Gold layers characterization by Ion Beam Analytical techniques: from Semiconductors to cultural heritage artefacts*, V. Corregidor, L.C. Alves, *SPMICROS2013, 9-10 Dez 2013, Monte da Caparica, Portugal*, (oral, V. Corregidor).
- *Distribution and partitioning of trace element in the cellular compartments of marine phytoplankton exposed to metals*, R. Godinho, T. Cabrita<sup>2</sup>, L.C. Alves, T. Pinheiro, *SPMICROS2013, 9-10 Dez 2013, Monte da Caparica, Portugal* (oral, R. Godinho)
- *PIXE Analysis of Gold Bracelets and Earrings*, L.C. Alves, V. Corregidor, *AuCORRE Workshop “O trabalho do metal. Compreender para preservar”, Museu Nacional de Arqueologia, Lisboa, Jun 17-18, 2013*, (oral).

## COLLABORATIONS

- Alexandra Barreiros, LNEG, Lisboa (Ion beam microanalysis – dye-sensitized solar cells).
- M. Fraga, P. Fonte, R.F. Marques and LIP-Coimbra, Laboratório de Instrumentação e Física Experimental de Partículas, Coimbra, Portugal. Development of a gas detector prototype for on-axis STIM tomography.
- Luisa Penalva, Belmira Maduro, António Candeias - Museu Nacional de Arte Antiga, Portugal. (Ion beam microanalysis – Indo-Portuguese silver jewelry)
- Rui Borges –FCT/UNL PhD student (Ion beam microanalysis – Indo-Portuguese silver jewelry and silver coins).

- Márcia Vilarigues, Solange Muralha, Susana Coentro, Mathilda Larson, Inês Coutinho – Dept. of Conservation and Restoration from FCT-UNL (Ion beam microanalysis – medieval glazed tiles, Lisbon Roman Theatre ware glass, Palácio da Pena stained glass).
- Isabel Tissot – Museu de Arqueologia, Portugal (Ion beam microanalysis – gold bracelets).
- Filomena Guerra - Centre de Recherche et de Restauration des Musées de France (Ion beam microanalysis - gold bracelets).
- Carlos Almeida – Aveiro University (Ion beam microanalysis - hybrid biocompatible materials).

**NAME: Luís Miguel Mota Ferreira**

**CATEGORY: Auxiliary Researcher**

**IST-ID: 5455**

## ACTIVITIES

Nº	Activity Description	R&D (%)
1	Application of ionizing radiation for a sustainable environment ( <i>Project ARIAS: RECI/AAG-TEC/0400/2012</i> )	30%
2	Preparation of polymeric materials catalytically actives on biodiesel production by vegetable oils methanolysis ( <i>Project Biodiesel: PTDC/CTM-POL/114579/2009</i> )	15%
3	Hybrid materials for biomedical applications ( <i>Project Biomedical Hybrids: PTDC/CTM/101115/2008</i> )	25%
4	Laboratory of Macromolecular Materials ( <i>LM3</i> )	14%
5	Laboratory for Assays in Biomaterials ( <i>LEB</i> )	14%
6	Preparation of macromolecular materials by ionizing radiation techniques and their characterization by thermal analysis (ERASMUS Training Program)	2%
<b>Total</b>		<b>100</b>

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<ul style="list-style-type: none"> <li>- Informatics re-equipment of staff (researchers and technicians) and analytical techniques associated to the project;</li> <li>- Acquisition of two scintillation detectors for PALS technique, assemble and test.</li> <li>- Acquisition and installation of a new FTIR spectrophotometer with ATR accessory for the Laboratory of Macromolecular Materials (<i>LM3</i>).</li> <li>- Acquisition of a CO2 chamber to install in the Laboratory for Assays in Biomaterials (<i>LEB</i>).</li> <li>- Internal process for acquisition of new equipment for thermal analysis (TGA and DSC).</li> </ul>
2	<ul style="list-style-type: none"> <li>- LDPE based copolymers prepared by gamma irradiation were prepared to be used as catalyst support in catalytic membrane reactors (CMR) for biodiesel production. The evaluation of materials structural stability based on its crystallinity evolution as a function of their respective grafting degree and radiation dose of preparation revealed an unknown ability of the high grafted films to partially recover their structural order. This process, attested by DSC and FTIR analysis, seems to result from radiation protective effect on copolymers matrix carried out by the grafted branches which give to LDPE backbone the ability to recover some of the lost structural order. This effect allows a new approach to mechanical functionalization of such materials.</li> <li>- Looking for efficient heterogeneous catalysts for methanolysis of vegetable oils, with the ability of being supported in polymeric membranes to be used at polymeric catalytic membrane reactors, mesoporous silicas (SBA-15 and KIT-6) with anchored guanidine (TBD) were prepared and tested in methanolysis of soybean oil, in batch reactor. It was evaluated the effects of the linking agents CPTMS</li> </ul>

	<p>chloropropyltrimethoxysilane) and GPTMS (3-glycidylpropyltrimethoxysilane) and the hydrophilic/hydrophobic balance on the catalysts' activity and stability.</p> <p>It was possible to anchor both linking agents and guanidine to the structure of mesoporous silicas. The support pore system was kept unchanged across the anchoring procedure. The prepared mesoporous silicas with anchored guanidines were found to be an effective catalyst for the methanolysis of soybean oil particularly in the case of TBD/CPTMS/KIT-6.</p> <p>KIT-6 supported guanidine showed higher activity than the SBA-15 counterparts, which is likely to be due to the higher accessibility of the KIT-6 pore network. A pseudo-homogeneous kinetic model was developed assuming catalyst deactivation during the catalytic test. The good fitting to the experimental data supports this hypothesis.</p> <p>These batch results are very promising in order to support such mesoporous silicas with anchored guanidines in polymeric catalytic membranes to be used at polymeric catalytic membrane reactors.</p>
3	<p>Development of PDMS/TEOS/PrZr hybrid materials with new compositions by incorporating elements that promotes the bioactive behaviour with the successful addition of Calcium and Strontium compounds to the precursors. Special attention was dedicated to the preparation and optimization of a novel hybrid material with calcium and strontium release capability where, for the first time, the incorporation of strontium in a PDMS-TEOS hybrid system was achieved and evaluated. PDMS-TEOS-CaO-TiO<sub>2</sub> hybrid materials were also prepared and characterized. The results of these studies are presented and discussed in the respective published papers. This FCT research project, carried out in collaboration with the Ceramics Engineering and Glass Department of the University of Aveiro, was successfully concluded and executed on the 31<sup>st</sup> of May 2013.</p>
4	<p>- Studies on the preparation of new polymeric and hybrid materials with improved properties using ionizing radiation were continued. Special attention was given to the optimization of the processing for tailored properties of materials (functionalization) designed for specific applications in industry (e.g. natural biodegradable packing films, catalysts supports) and biomedical field (polymeric and hybrid materials with improved bioactivity and biocompatibility).</p> <p>- Sludges from ink factories were submitted to gamma irradiation tests as an attempt to valorise them as raw material to prepare new products for building restoration and maintenance. As so, ink sludges from a Portuguese ink factory, with a valuable content in Si, Ca, Ti and Mg, agglomerated in an acrylic/methacrylic resin partially cross-linked were irradiated in order to evaluate the possibility to use the ionizing radiation to partially fragment the cross-linked network giving opportunity to reuse the inorganic and organic content as raw materials in a new formulation.</p> <p>Preliminary assays of irradiation showed a decrease in viscosity of the samples irradiated at relatively low dose (aprox. 10 kGy) which was attributed to polymeric network fragmentation according to FTIR analysis. Being these sludges from water based inks and with high remaining water content, this process of treatment takes advantage of the conjugated effect of the ionizing radiation and radiolysis processes. As so, first results seem promising in the valorisation of these sludges by ionizing radiation treatment.</p> <p>- LM3 technical capacities were reinforced with the installation of a new lab space for Thermal Analysis and IR spectroscopy and which includes new FTIR equipment. Two scintillation detectors were also acquired in order to finish the assembling of PALS technique.</p>
5	<p>The installation of a new laboratory for assays in biomaterials was initiated. This new laboratory aims to be a complement of the Laboratory of Macromolecular Materials (<i>LM3</i>), supplying essential analysis of the materials developed for biomedical applications, which have been ordered until now from exterior.</p> <p>This laboratory will combine two main areas: one for bioactivity assay of materials and other for cellular biocompatibility of materials.</p>
6	<p>- PDMS/TEOS hybrid materials with different ratio of precursors were prepared by gamma irradiation. In order to improve the bioactivity of these materials the introduction of calcium in its composition was investigated. Being an element that introduces a high disorder or</p>

even severe damages in hybrid structures, different approaches/formulations for calcium introduction in the hybrid matrix were attempted.

Results show that the introduction of calcium, up to 0,5% in content, through aqueous acid medium, leads to the best results although resulting in samples not so much homogeneous once it was detected the formation of few small calcium clusters within the hybrid matrix. Results obtained will be discussed in a forthcoming paper.

Note: Optimization studies of this parameter, including other bioactive elements, still go on associated to the research in hybrid materials running in LM3.

- Preliminary assays on new formulations and irradiation methods for the preparation of methylcellulose based biodegradable polymers, were done with very good results. Even though with excellent mechanical strength, transparency and flexibility, the fast kinetic solubility of the films when in direct contact with water reveals one of the hardest problems to resolve. Results obtained will be discussed in a forthcoming paper.

Note: This training program was framed within the research in natural polymers modified by ionizing radiation on going in LM3.

## PUBLICATIONS

- M.H. Casimiro, M.C. Corvo, A.M. Ramos, E.J. Cabrita, A.M. Ramos, L.M. Ferreira, Synthesis and characterization of gamma-induced porous HEMA-IL composites, *Materials Chemistry and Physics*, 138, 11-16 (2013), doi: 10.1016/j.radphyschem.2012.01.036.
- L.M. Ferreira, J.P. Leal, M.H. Casimiro, C. Cruz, J.J.H. Lancastre, A.N. Falcão, Evidence of Structural Order Recovery in LDPE Based Copolymers Prepared by Gamma Irradiation, *Radiation Physics and Chemistry*, 94, 31-35 (2014), doi: 10.1016/j.radphyschem.2013.06.031.\*
- M.H. Casimiro, A.G. Silva, R. Alvarez, L.M. Ferreira, A.M. Ramos, J. Vital, PVA supported catalytic membranes obtained by gamma-irradiation for biodiesel production, *Radiation Physics and Chemistry*, 94, 31-35 (2014), doi: 10.1016/j.radphyschem.2013.05.058.\*
- J.C. Almeida, A.G.B. Castro, J.J.H. Lancastre, I.M. Miranda Salvado, F.M.A. Margaça, M.H.V. Fernandes, L.M. Ferreira, M.H. Casimiro, Structural characterization of PDMS-TEOS-CaO-TiO<sub>2</sub> hybrid materials obtained by sol-gel, *Materials Chemistry and Physics*, 143, 557-563 (2014), doi: 10.1016/j.matchemphys.2013.09.032.\*

*\*The final versions of these three papers (yellow highlighted) were published online in 2013 although the physical publication only came out to public in January 2014.*

## COMMUNICATIONS

- *Valorization of sludges from ink factories by ionizing radiation treatment*, J.J.H. Lancastre, L.M. Ferreira, R. Melo, M.H. Casimiro, L.C. Alves, F.M.A. Margaça, A.M.T. Aguiar, *WASTES 2013: Solutions, Treatments and Opportunities - 2nd International Conference, Braga, Portugal, Sep 11-13 (2013)*, Poster.
- *Mesoporous silicas with anchored guanidines as catalysts of methanolysis of soybean oil*, R.N. dos Santos, A.G. Silva, L.M. Ferreira, M.H. Casimiro, A.M. Ramos, J. Vital, *11th European Congress on Catalysis – EuropaCat XI-2013, Lyon, France, Sep 1-6 (2013)*.

## EDUCATION

- Scientific supervisor, ERASMUS Training Programs, *Preparation of macromolecular materials by ionizing radiation techniques and their characterization by thermal analysis*, MsC. Olga Opuchovic, Vilnius University – Lithuania, Jun to August 2013.
- Co-supervisor of a MsC young researcher (Joana Lancastre) within the project PTDC/CTM/101115/2008 – *Hybrid Materials for Biomedical Applications* (until May 2013).
- Co-supervisor of a MsC young researcher (Joana Lancastre) within the project RECI/AAG-TEC/0400/2012 - *Application of Ionizing Radiation for a Sustainable Environment* (from June 2013).

- Supervisor of a Post-Doc researcher (Pedro Santos) within the project RECI/AAG-TEC/0400/2012 - *Application of Ionizing Radiation for a Sustainable Environment* (from June 2013).

## PROJECTS

- *Preparation of Polymeric Materials Catalytically Actives on Biodiesel Production, by Vegetable Oils Methanolysis*, PTDC/CTM-POL/114579/2009. Leading Institution: Fundação da Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa. IST/CTN/C<sup>2</sup>TN coordinator: L.M. Ferreira (15%).
- *Biodegradable Polymer Matrices Obtained by Ionizing Radiation for Skin Scaffolds*, IAEA Research Contract No: 18202/RO, Leading Institution: IST/CTN/C<sup>2</sup>TN. IST/CTN/C<sup>2</sup>TN Coordinator: L.M. Ferreira (40%).

## COLLABORATIONS

- Maria Helena Casimiro, REQUINTE/CQFB, Departamento de Química, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Caparica, Portugal, Weekly visits for work and scientific discussions on the aim of macromolecular materials research.
- Ana Maria Ramos, Prof. Doutora, REQUINTE/CQFB, Departamento de Química, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, occasional regular visits for scientific discussions on the aim of common projects running (polymeric membranes).
- Joaquim Vital, Prof. Doutor, REQUINTE/CQFB, Departamento de Química, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, occasional visits for scientific discussions on the aim of common projects running (polymeric membranes).
- I.M. Miranda Salvado, Dept. Glass and Ceramics Eng., CICECO, University of Aveiro, Portugal, monthly visit, Collaboration research on hybrid materials for biomedical applications.
- J.C. Almeida, Dept. Glass and Ceramics Eng., CICECO, University of Aveiro, Portugal, every other month visit, to discuss results obtained in sol-gel prepared hybrid materials for biomedical applications.

**NAME: Maria Teresa Pinheiro**

CATEGORY: Auxiliary Researcher

IST-ID: 5083

## ACTIVITIES

Nº	Activity Description	R&D (%)
1	Research	70
2	Teaching	30
Total		100

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>Major research areas focused:</p> <p><b>1) Clinical research:</b></p> <p>a) Studying the role of new and specific markers for coronary artery disease, which may provide information on inflammatory, oxidative and apoptosis processes associated with the atherosclerotic plaque burden and disease evolution. Hospital de Santa Marta-CHLC/CEDOC, Univ. Nova de Lisboa/Instituto Medicina Molecular collaboration; b) Studying the role of iron and ferritin in chronic skin inflammation. Instituto Medicina Molecular/INSERM, Amiens/Univ. Paris/CMAM, Univ. Autonoma Madrid collaboration.</p>

	<p><b>2) Interaction between air pollution and health</b> Study of fugitive emissions in Setúbal harbour. Collaboration with LEN, CTN</p> <p><b>3) Environmental metal toxicity</b> In vivo and in vitro studies to assess metal toxicity in marine environments: a) intracellular distribution of trace elements in marine phytoplankton exposed to metal pollution; b) metal distribution in organs of animals and plants inhabiting contaminated aquatic environments. Collaboration with Instituto Português do Mar e da Atmosfera (IPMA).</p> <p><b>4) Toxicity of nanoparticles</b> Study of TiO<sub>2</sub> nanoparticles (TiO<sub>2</sub>-NP) distribution in organs and tissues including eggs of <i>Daphnia magna</i> which was used as a model. Collaboration with Laboratório Nacional de Energia e Geologia.</p> <p>These research projects involve a variety of techniques, such as, proton microscopy, inductively coupled plasma mass spectrometry, flow cytometry, biochemical methods, magnetic resonance imaging, and radiofrequency-based techniques.</p>
2	Professor in charge of the semestrial Biophysics course, Physics Dept., IST

## PUBLICATIONS

### Book Chapter

- C. Ramos, Napoleão P, Cruz Ferreira R, Fondinho C, Selas M, Mota Carmo M, Crespo AM, Pinheiro T. Relationship between ox-LDL, immune cells, atheroma dimensions and angiographic measurements assessed by coronary angiography and intravascular ultrasound. In: *Coronary Angiography: WHAT SHOULD WE KNOW ABOUT PREVENTED, DIAGNOSTIC, AND INTERVENTIONAL THERAPY IN CORONARY ARTERY DISEASE*, Branislav Baskot (Ed.) (ISBN 980-953-307-720-3). InTech (2013). URL <http://dx.doi.org/10.5772/45953>

### Papers

- P.M. Félix, C. Franco, M.A. Barreiros, B. Batista, S. Bernardes, S.M. Garcia, A.B. Almeida, S.M. Almeida, H.Th. Wolterbeek, T. Pinheiro (2012). Biomarkers of exposure to metal dust in exhaled breath condensate: methodology optimization. *Archives of Environmental and Occupational Health*. 2013; 68(2):72-79. <http://dx.doi.org/10.1080/19338244.2011.638951>.
- P.M. Félix, S.M. Almeida, T. Pinheiro, J. Sousa, C. Franco, H.Th. Wolterbeek. Assessment of exposure to metals in lead processing industries. *Int J Environm Health*. 2013; 216:17–24.
- M.A. Barreiros, Pinheiro T, Felix PM, Franco C, Santos M, Araújo F, Freitas MC, Almeida SM. Exhaled Breath Condensate as a biomonitor for metal exposure: A new analytical challenge. *J. Radional Nucl Chem*. 2013; 297-377-382.
- S.M. Almeida, M.C. Freitas, M. Reis, T. Pinheiro, P.M. Felix, C.A. Pio. Fifteen Years of Nuclear Techniques Application to Suspended Particulate Matter Studies, *The Journal of Radioanalytical and Nuclear Chemistry*. 2013; 297(3):347-356. <http://dx.doi.org/10.1007/s10967-012-2354-1>.
- P. Napoleão, M. Selas, C. Freixo, M. MotaCarmo, A.M. Viegas-Crespo, R. Cruz Ferreira, T. Pinheiro. T lymphocytes alterations are associated with oxidized LDL, troponin T, white blood cells and C-reactive protein during acute myocardial infarction. *Clinical Hemorheology and Microcirculation* 2013; 55:349-358.
- T. Pinheiro, L. Moita, L. Silva, E. Mendonça, A. Picado. Nuclear microscopy as a tool in TiO<sub>2</sub> nanoparticles bioaccumulation studies in aquatic species. *Nucl Instrum Methods B* 2013; 306:117-120. DOI: 10.1016/j.nimb.2012.12.049.
- R.M. Godinho, J. Raimundo, C. Vale, B. Anes, P. Brito, L.C. Alves, T. Pinheiro. Micro-scale elemental partition in tissues of the aquatic plant *Lemna minor* L. exposed to highway drainage water. *Nucl Instrum Methods B* 2013; 306: 150-152. 152. DOI: 10.1016/j.nimb.2012.10.032.
- R.M Godinho, C. Vale, M. Caetano, L.C. Alves, T. Pinheiro. Microdistribution of major to trace elements between roots of *Halimione portulacoides* and host sediments (Tagus estuary marsh, Portugal). *Plant and Soil* 2013 (online). DOI 10.1007/s11104-013-1935-2.

- T. Pinheiro, 13th International Conference on Microprobe Technology and Applications (ICNMTA2012) 2013-07. DOI: [http://dx.doi.org/10.1016/S0168-583X\(13\)00525-9](http://dx.doi.org/10.1016/S0168-583X(13)00525-9).

#### Conference Proceedings

- T. Pinheiro, C. Ramos, P. Napoleão, C. Mendonça, C. Fondinho, M. Selas, M. Mota Carmo and R. Cruz Ferreira, Plaque vulnerability phenotype in patients with coronary artery disease: An intravascular ultrasound radiofrequency analysis: CARDIOTECHNIX 2013, Proceedings of the International Congress on Cardiovascular Technologies 2013; pp:84-89 <http://www.scopus.com/inward/record.url?eid=2-s2.0-84887231168&partnerID=MN8TOARS>.
- C. Ramos, P. Napoleão, C. Fondinho, M. Selas, M. Mota Carmo, R. Cruz Ferreira and T. Pinheiro, Expansive growth of atherosclerotic plaques assessed by VH-IVUS: Association with TNF- $\alpha$  and OX-LDL levels in circulation: CARDIOTECHNIX 2013, Proceedings of the International Congress on Cardiovascular Technologies 2013; pp:90-94. <http://www.scopus.com/inward/record.url?eid=2-s2.0-84887247956&partnerID=MN8TOARS>.

#### COMMUNICATIONS

- T. Pinheiro, Seminar “Poluição, Nanopartículas e Sistema Respiratório”, *Biologia Humana e Ambiente* Master degree, Faculdade de Ciências, Universidade de Lisboa, February 2013.

#### EDUCATION

- T. Pinheiro, Biophysics Course, Semestrial, Physics and Biomedical Engineering master degrees, Physics Department, IST.
- T. Pinheiro, External evaluator for position as Senior Lecturer in Applied Nuclear Physics, Engineering Faculty of Lund University, January 2013.
- T. Pinheiro, Co-supervisor of Post-Doc researcher Rita Godinho (FCT funding SFRH/BPD/41898/2007).

#### CONFERENCE ORGANIZATION

- T. Pinheiro, Symposium chair: Symposim Visualcardio2013 - how to visualize cardiovascular function, Cardiotechnix 2013 (<http://www.cardiotechnix.org/Symposia.aspx?y=2013#VisualCardio>).

**NAME: Sandra Isabel Silva Damas Cabo Verde**

CATEGORY: Auxiliary Research (Ciência 2008)

IST-ID: 5470

#### ACTIVITIES

Nº	Activity Description	R&D (%)
1	"Ionization radiation treatment of fruits and vegetables for immuno-compromised patients – feasibility study”, IAEA Research Contract No. 16281 (2011-2014)	20
2	“Survival and Inactivation Patterns of Viral Threat Agents in the Environment: Assessment of Ionizing Radiation as Decontamination Tool”, IAEA Research Contract No. 17474 (2012-2015)	20
3	“Characterization and conservation of cultural heritage: neutrons and ionizing radiation in artwork” – RADIART”. FCT project PTDC/HIS-HEC/101756/2008 (2009-2013)	5
4	“Application of Ionizing Radiation on the Cork Wastewater Treatment”, IAEA Research Contract No. 16513 (2011-2014)	10
5	“Modelo de Monitorização da Eficiência Funcional de Infraestruturas de Unidades de Saúde” – EFICARE; QREN 30399/2013 (2013-2015)	10



6	“Application of Ionizing Radiation for a Sustainable Environment” – ARIAS; RECI/AAG-TEC/0400/2012 (2013-2015)	20
7	Services on Radiation Sterilization/Decontamination	5
8	Services on Microbiological criteria for Indoor Air Quality	5
9	Services on Neomycin Sulfate assay for pharmaceutical product release	5
<b>Total</b>		<b>100</b>

## WORK SUMMARY

Nº	Work Summary and Main Achievements
1	<p>The research developed has focused on the evaluation of the irradiation effects on fruits and the potential extension of shelf-life. The analysed fruits were blackberries and sweet cherries. Samples of packed fruits were irradiated at a Co-60 source at dose range of 0.5 up to 4 kGy (depending on the type of product). Microbiological, physico-chemical and sensorial parameters were assessed after irradiation and during storage time (4°C). Generally, the obtained results indicated a limited microbial inactivation (<math>\leq 1</math> log reduction) for the applied gamma radiation doses and during storage time. The characterization of fruits microbiota point out to a surviving population predominantly composed by filamentous fungi and/or yeasts. Regarding fruits physico-chemical properties, irradiation caused a decrease in firmness compared with non-irradiated fruit, indicating the texture as the critical parameter for fruit irradiation. Although, it was observed that irradiated fruits preserves higher antioxidant activity compared with non-irradiated samples. In general, it was verified similar acceptability among irradiated and non-irradiated fruits along storage. Studies aiming to assess the impact of ionization radiation on mycotoxins are being performed. With that purpose, solutions with the same initial mycotoxin concentration (aflatoxin B1, aflatoxin B2, aflatoxin G1 and aflatoxin, ochatoxin A and zearalenone) were exposed to gamma radiation doses ranging from 0.5 up to 10.0 kGy, at distinct moisture level – dehydrated, in water, and in methanol:water solution. The results showed degradation of mycotoxins with doses above 3.0 kGy, but only when irradiated in aqueous environment. With dehydrated samples, no significant reduction was observed.</p> <p>Supervision of Duarte Guerreiro on the study of the effects of gamma radiation on cherry tomatoes microbiota; discipline of Introduction to Research I of Applied Microbiology Master degree, Faculdade de Ciências da Universidade de Lisboa.</p> <p>Supervision of Marina Oliveira MSc thesis “Evaluation of potential of gamma radiation as a conservation treatment for blackberry fruits”; Master degree Food Engineering, Escola Superior Agrária de Santarém.</p>
2	<p>The developed work was based on the optimization and validation of the methods to assess the virucidal effect of gamma radiation. Human Norovirus (HNoV) is considered the leading cause of gastroenteritis worldwide, however this human virus cannot be replicated in cell culture, as so it was used a Murine Norovirus as surrogate model of HNoV. Knowledge of NoV inactivation is crucial to ensure public safety, and measures for the prevention and control of NoV spread include a proper disinfection treatment of environmental matrices. The prevalence of viruses on different food surfaces has been linked to their high stability in the environment, being aware of this in the validation of the methodologies it was used a surface test where the virus was in a dried surface biofilm to mimic an environmental hard condition. Regarding to MNV-1 propagation on RAW cells unforeseen results were found. The early infection of RAW cells and harvesting the virus after 1 day post-infection point out to be an improved method to produced higher yield MNV stocks. Additionally, the data obtained suggested that MOI and cell stage have an effect on MNV propagation and as result higher titers were obtained after early cell infection with low MOIs (0.05 and 0.1). Concerning the MNV-1 inactivation studies the attained results indicated that gamma radiation presented a virucidal activity against MNV in the tested conditions. Furthermore to assess the virucidal effect of gamma radiation onto MNV-1 genome, a Reverse Transcriptase PCR (RT-PCR) method was performed on RNA extracted from non-irradiated and irradiated virus, using primers designed to amplify a conserved portion of the MNV-1 genome. The criterion normally set for virucidal efficacy is a 99.9% (3 log), 99.99% (4 log) or 99.999% (5 log). The data obtained, showed that MNV titer could be effectively reduced</p>

	<p>(3 log; virucidal efficacy of 99.9%) by a gamma radiation dose of 10 kGy, but the viral genome or a fragment of it was still detectable by RT-PCR. The discrepancy observed between the detection of viral genomic copies and infectivity after gamma radiation treatment involves that the presence of genomic copies is not necessarily associated with infectious virus particles. This approach cannot inform as to whether the signals detected represent infectious virus that poses a threat, or remnants from inactivated virus that are harmless. Based on this, the plaque assay method will be used further on to evaluate the viral inactivation by gamma radiation.</p>
3	<p>The ceramic tile panel “The Great View of Lisbon”, in exhibition at the National Tile Museum, is a unique masterpiece of Portuguese tiles which depicts the city before the tragic earthquake of 1755. The tile panel presents visible colored alterations (e.g. green spots) in the glaze of many tiles that were assigned to microbial growth, based on a preliminary analysis by conservators. The main goal of this study was to identify the agent of the green spots pathology present in the ceramic tiles from the panel “The Great View of Lisbon”, as a critical step for a further definition of a process of preservation and conservation. Previous results based on an integrated microbiological and instrumental analysis methodology could not demonstrate the presence of biodeteriogenic microorganisms and thus other causes should be considered for the conservative purposes. Raman spectroscopy was employed, since is a technique that can be sensitive to organic and inorganic compounds and able to identify key spectral markers in a mixture of biological and geological components. Raman spectroscopy point out to be an efficient tool for the characterization of various biomarkers (especially pigments) that can produced by microbial colonies as part of their survival strategy.</p>
4	<p>Biodegradation is considered as a sustainable process of wastewater treatment which, under appropriate conditions, can promote an efficient reduction of the organic matter content with minimal energy requirements and low costs. The aim of this work was to find out if ionizing radiation treatment could increase the biodegradability of recalcitrant compounds present in cork wastewater using a microbial consortium and a mixed solution of four phenolic acids as a model. Chemical and microbiological analyses were performed in non-irradiated (0 kGy) and irradiated (100 kGy) mixed phenolic acids cultures during incubation time. A preliminary HPLC and GC-MS analysis were performed to detect the major phenolic compounds in cork wastewater samples. Results indicated the presence of gallic, protocatechuic, vanillic and syringic acids in cork boiling water and gallic, protocatechuic and vanillic acids in sediment tank samples. The Total Phenolic content (TP) of mixed phenolic acids cultures during incubation time indicated a decrease of 38% for 100 kGy irradiated samples. The HPLC analysis suggested that the radiolytic products of syringic and vanillic acids are protocatechuic and gallic acids. The CFU counts pointed out to a decreasing tendency along the incubation time for phenolic acids cultures (0 kGy and 100 kGy) suggesting a non-degradation trend. The selected microbial consortium was not able to metabolize the phenolic compounds solutions at the used conditions. This could be due to the detected radiolytic degradation dynamics of the phenolic acids considering the antimicrobial activity of these compounds.</p> <p>Supervision of Célia Lima MSc thesis “Biodegradation studies in cork wastewater”; Master Degree in Applied Microbiology, Faculdade de Ciências da Universidade de Lisboa.</p>
5	<p>EFICARE is a joint project coordinated by the Portuguese private enterprise Integridade in cooperation with IST, ISQ, Quadrante and Centro Hospitalar de Setúbal. The objective of this project is to integrate and optimize the energy efficiency, the indoor air quality (IAQ) and the management of the maintenance in Health Units.</p> <p>In 2013, IST/CTN assessed the IAQ in Setúbal Hospital: chemical and comfort parameters were measured; airborne microorganisms were collected; airborne isolates were characterized and identified; the perceived IAQ and the related symptoms were assessed by means of a questionnaire survey among the workers; and an evaluation of the design, performance and maintenance of the ventilation systems was carried out.</p> <p>Results showed that particle concentrations were higher in the emergency services due to the large circulation of people that promotes the re-suspension of dust. PM10 levels exceeded the limit values established by the WHO. VOC concentrations presented higher values in the operating theatres, increasing at the beginning of the surgery during the disinfection of the</p>

	<p>patient. In the emergency service and in the infirmary, CO<sub>2</sub> concentrations exceeded the limit values established by national and international standards due to the poor ventilation. Fungal concentrations presented very high values in the emergency service, whereas bacteria presented higher concentrations in the emergency service and in the infirmary. Airborne microorganisms were collected by impaction method using a Microbial Air Monitoring Equipment (MAS100). After sampling, processing and culturing (culture solid media) of the samples, quantitative (colony forming units counting) and qualitative (phenotypes) results were obtained, with characterization and identification of airborne isolates. Whenever possible, filamentous fungi were identified to the species level, since adverse health effects vary according to fungal species. Identification of filamentous fungi were carried out on material mounted in lactophenol blue and achieved through morphological characteristics listed in illustrated literature. Yeasts were identified through biochemical API test. The bacterial isolates were phenotypically characterized (macro and microscopic morphology, Gram staining, biochemical tests) and the most frequent isolates and potential relevant species were identified by miniaturized biochemical test systems.</p>
6	<p>The objective of ARIAS project is to consolidate the competences and resources on Radiation Technologies applications. The main activities developed focused the supervision of: 1) one Post-doc student Rita Melo, on the radiation treatment of wastewater for reuse with particular focus on wastewaters containing organic pollutants; 2) one Master student Joana Madureira, on the extraction natural antioxidants such as phenolic compounds from cork wastewater by adsorption onto activated carbon in order to valorise the wastewater from cork industry; and 3) one Master student Telma Silva, on the development of the overall exigencies of quality in ionizing radiation processing (e.g.: food preservation, healthcare products sterilization, wastewater treatment) in order to guarantee the safety and efficiency of the processes and products.</p>
7	<p>Radiation processing has been widely accepted for use in many areas of the global economy. Sterilization, polymer cross-linking, tire component curing, irradiation of food items are well established technologies. Ionizing radiation is being used more frequently as a useful and effective means of sterilization or decontamination. Being aware of this, several entities had requested services to study the effects of gamma radiation on products, namely:  Instituto Politécnico de Bragança – Ionizing radiation an alternative treatment for preservation of chestnut fruits (CHESTNUTSRAD - QREN n° 13198/2010)  Lusomedicamenta – Substantiation of 25 kGy as the Sterilization Dose (D<sub>min</sub>) for pharmaceutical tubes.  Universidade do Minho – Irradiation of dextrin hydrogels for maximum dose (D<sub>max</sub>) assessment.  Hovione – Study of the resistance/degradation of API compounds to gamma radiation – Determination of the maximum dose (D<sub>max</sub>) for one API product.  Laboratórios Edol - Study of resistance/degradation of ophthalmic ointments to gamma radiation for maximum dose (D<sub>max</sub>) assessment.</p>
8	<p>In Portugal exists a legislation (Decreto-Lei n.º79/2006) that establish limit values for microbiological contamination in the indoor air environment. To guarantee this legal compliance, two companies EFACEC and Tradelabor, requested the assessment of the indoor concentration of airborne bacteria and fungi in several public buildings (Contract IST-EFACEC) and clean room areas (Contract IST-Tradelabor). The concentrations of airborne bacteria and fungi were determined by impaction using the MAS-100 portable air sampler and microbial culture media.</p>
9	<p>The activity of antibiotics could be tested in vitro by microbiological assay methods. Based on a previous methodological validation performed the Iberfar pharmaceutical industry requested for batch release purposes the determination of the potency of Neomycin Sulfate in several batches of the Nodryl product using the microbiological agar diffusion assay.</p>

## PUBLICATIONS

- M. Oliveira, J. Pereira, S. Cabo Verde, M.G. Lima, P. Pinto, P.B. de Oliveira, C. Junqueira, H. Marcos, T. Silva, R. Melo, C.N. Santos, M.L. Botelho. Evaluation of potential of gamma radiation as a conservation treatment for blackberry fruits. *Journal of Berry Research* 3 (2013) 93-112 DOI:10.3233/JBR-130050.
- I. Nunes, N. Mesquita, S. Cabo Verde, M.M. Carolino, A. Portugal, M.L. Botelho. Bioburden assessment and gamma radiation inactivation patterns in parchment documents. *Radiation Physics and Chemistry*, (2013) 88: 82–89, doi: 10.1016/j.radphyschem.2013.03.031i
- S. Cabo Verde, M.J. Trigo, M.B. Sousa, A. Ferreira, A.C. Ramos, I. Nunes, C. Junqueira, R. Melo, P.M.P. Santos, M.L. Botelho. Effects of Gamma Radiation on Raspberries: Safety and Quality Issues, *Journal of Toxicology and Environmental Health, Part A: Current Issues* (2013) 76 (4-5): 291-303, doi: 10.1080/15287394.2013.757256
- I. Nunes, N. Mesquita, S. Cabo Verde, A.M.L. Bandeira, M.M. Carolino, A. Portugal, M.L. Botelho. Characterization of an airborne microbial community: A case study in the archive of the University of Coimbra, Portugal. *International Biodeterioration & Biodegradation* (2013) 79: 36-41, doi: 10.1016/j.ibiod.2013.01.013
- A.L. Antonio; M. Caroch; P. Santos; S. Cabo Verde; A. Bento; M. L. Botelho; B. Quintana. Dosimetric Characterization of a Multipurpose Experimental Gamma Chamber, 26-29 May 2012 Kyiv, Ukraine, *NeeFood-2013* (2013) pp. 302.

## COMMUNICATIONS

- *Indoor air quality assessment in different hospital areas.* S. M. Almeida, S. Cabo Verde, C. Viegas, S. Viegas. *International Conference on Occupational & Environmental Toxicology - ICOETox 2013, Porto, Portugal, Sep. 16-17 (2013)*, Poster Presentation.
- *A biodegradation bench study of cork wastewater using ionizing radiation.* C. Lima, J. Madureira, R. Melo, S. Cabo Verde, M.M. Carolino, J.P. Noronha, F.M.A. Margaça, *WASTES: Solutions, Treatments and Opportunities, Braga, Portugal, Sep. 11-13 (2013)*, Poster Presentation.
- *Extraction of phenolic compounds from cork wastewater by adsorption onto activated carbon.* J. Madureira, R. Melo, S. Cabo Verde, C. Lima, I. Matos, J.P. Noronha, I.M. Fonseca, F.M.A. Margaça, *WASTES: Solutions, Treatments and Opportunities, Braga, Portugal, Sep. 11-13 (2013)*, Poster Presentation.
- *Ionization radiation treatment of fruits and vegetables for immuno-compromised patients: feasibility study,* S. Cabo Verde, A. António, P. Santos, R. Melo, T. Silva, J. Pereira, M. Oliveira, M. J. Trigo, T. Calado, A. Venâncio, M.L. Botelho, F. Margaça. *3rd RCM of The Development of Irradiated Foods for Immuno-Compromised Patients and other Potential Target Groups, Jeongseup, Republic of Korea, Sep. 9-13 (2013)*, Oral presentation.
- *Microbiological Contamination Assessment in Elderly Care Centers,* C. Viegas, M. Almeida-Silva, A. Gomes, S. Cabo Verde, S. Viegas, H.T. Wolterbeek, S.M. Almeida. *2 nd Encontro Ibero-Americano de Toxicologia e Saúde Ambiental - IBAMTOX 2013, Ribeiro Preto, Brasil, Jun 17-19 (2013)*, Poster Presentation.
- *Sterilization and decontamination of pharmaceutical products by ionizing radiation.* S. Cabo Verde, *Workshop: Applications of Ionizing Radiation to Pharmaceutical Industry, Hovione, Loures, Portugal, Jun 21 (2013)*, Invited Talk.
- *Effect of gamma radiation on mycotoxins solutions.* T. Calado, A.L. António, P. Rodrigues, S. Cabo Verde, L. Abrunhosa, A. Venâncio, *MycRed2013, Martina Franca, Italy, May 27-30 May (2013)*, Poster Presentation.
- *Applications of Ionizing Radiation.* S. Cabo Verde. *43º DQ Conference Cycle – Faculdade de Ciência e Tecnologia, Monte da Caparica, Portugal, Jan. 9 (2013)*, Invited Talk.

## EDUCATION

### *Lectures*

- Inactivation studies of the microbiota of medicinal plants by gamma radiation. Faculdade de Ciências da Universidade de Lisboa, 11-18 Dec. 2013, Theoretical and laboratory lessons in the scope of the discipline Microbial Biotechnology, Degree in Biology.
- Ionizing radiation applications. Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, 21th October 2013. Theoretical lesson in the scope of the Radiation Effects discipline, Master degree in Biochemistry.
- Ionizing radiation applications. Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, 15th April 2013. Theoretical lesson in the scope of the Radiation Effects discipline, Master degree in Biochemistry.
- Sterilization process by ionizing radiation. Faculdade de Farmácia da Universidade de Lisboa, 21th March 2013. Theoretical lesson in the scope of the Industrial Pharmacotechnics II discipline, Master degree in Pharmaceutical Engineering.
- Sistemas de Gestão de Qualidade – HACCP: Hazard Analysis and Critical Control Point. Faculdade de Ciências da Universidade de Lisboa, 8th May 2013. Theoretical lesson in the scope of Biotechnology discipline, Master degree in Applied Microbiology.

### *Training Course*

- Course Director of the *Regional Training Course on Microbiological Aspects of Sterilization Validation Process*, Lisbon, Portugal. 2-6 December 2013.

## PROJECTS

### *Running Projects*

- *Survival and Inactivation Patterns of Viral Threat Agents in the Environment: Assessment of Ionizing Radiation as Decontamination Tool*, IAEA Research Contract No. 17474. IST/CTN Coordinator: S. Cabo Verde (40%).
- *Ionization radiation treatment of fruits and vegetables for immuno-compromised patients – feasibility study*, IAEA Coordinate Research Project CRP D6-RC-1163.2 "Development of Irradiated Foods for Immuno-compromised Patients and Other Potential Target Groups", IAEA Research Contract No. 16281. IST/CTN Coordinator: S. Cabo Verde (30%).

### *Submitted Projects*

- Evaluation of food irradiation for immunocompromised patients, Investigator FCT. Not recommended for funding.
- Inactivation patterns of enteric virus by ionizing radiation. FCT, EXPL/DTP-SAP/2338/2013. Recommended for funding: 48.541,00 €.

## CONTRACTS

- Study of the resistance/degradation of ophthalmic ointments to gamma radiation for maximum dose (Dmax) assessment, Contract IST-Edol, Laboratórios Edol, ongoing, 1.2 k€.
- Microbiological analysis for Indoor Air Quality in the scope of the Energy Certification for Buildings, Contract IST-EFACEC, EFACEC, Apr. 2013- Apr. 2014, 2.7 k€.
- Microbiological analysis for Indoor Air Quality in clean rooms, Contract IST-Tradelabor, Tradelabor, Apr. 2013- Apr. 2014, 3.9 k€.
- Irradiation of dextrin hydrogels for maximum dose (Dmax) assessment, IST/CTN/N3800803, Universidade do Minho, Jul. 2013, 1.5 k€.
- Determination of Neomycin Sulfate for Nodryl product batches, IST/CTN/N381200008/N3800583/N3800584/N3800720/N3800721/N3800840, Iberfar-indústria Farmacêutica SA, Jan., Mar.-Apr. 2013, 6.7 k€.
- Study of the resistance/degradation of API compounds to gamma radiation for maximum dose (Dmax) assessment, IST/CTN/N3800580, Hovione, Jan.-Mar., 1.5 k€.

- Substantiation of 25 kGy for Sterilization Dose of Pharmaceutical Tubes, IST/CTN/N3800586, Lusomedicamenta - Sociedade Técnica Farmacêutica SA, Jan. – Feb. 2013, 2.5 k€.