Nuclear Instruments and Methods

João B. Manteigas

The strategy of the group involves activities in the following lines:

1. Modelling of radiation fields, calculation of neutron physic parameters, measurement of neutron cross-sections;
2. Modelling and applications of gas discharges;
3. Development of software for control and data analysis;
4. Design of electronic instrumentation for nuclear applications;
5. Instrumentation and technical assistance;
6. Co-operation with other institutions.

Modelling of radiation fields, calculation of neutron physic parameters

Monte Carlo calculations have been carried in the framework of the n_TOF Collaboration (ITN participation on the n_TOF-Ph2 experiment at CERN).

Measurement of neutron cross-sections

The analysis of the data for cross-section measurement, taken in the TOF spectrometer installed at the CERN, was carried out.

Modelling and application of gas discharges

1. The study of methane conversion by a non-thermal plasma produced by a dielectric barrier discharge system (DBD) to obtain Syngas and other hydrocarbons has continued with (a) study of the influence on rectangular voltage pulses on conversion and selectivity, (b) the study of the electron kinetics in methane/carbon dioxide/helium mixtures and, (c) development of theoretical models to explain the variation of i) the breakdown voltage with rare gas concentration and, ii) the conversion fractions with the specific input energy.
2. The study of a dielectric barrier discharge system for processing of polymers by a non-thermal plasma for industrial applications.
3. The construction of a RF-plasma needle with application in biology and medicine.

Development of software for control and data analysis in nuclear spectrometry

The development of free software has continued with the support of EPICS-based gamma spectrometry equipment on the *PyMCA* software for X-ray analysis.

Instrumentation and technical assistance

1. The main objectives are the development of equipment for ITN groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.
2. The technical assistance takes mainly the forms of specialised consultant engineering advice, installation of nuclear gauges, including calibration maintenance and repair and recharging of gauges with imported radioactive sources.
3. The group started providing maintenance and repairing services of HPGe detectors as well as technical advice in the installation of gamma spectrometry equipment.

Co-operation with other institutions

1. Plasma Physics Centre / Gas Electronics Group, IST;
2. ISEL, Dept. of Automation and Electrotechnical Engineering;
3. Comenius Univ., Dept. of Experimental Physics, Bratislava, Slovakia;
4. Leibniz Institute for Plasma Science and Technology, Greifswald, Germany;
5. Research Institute for Solid State Physics and Optics, Budapest, Hungary;
6. n_TOF collaboration, a consortium of several laboratories in Europe, USA and Japan.

Research Team

Researchers

J. MANTEIGAS, Aux., Group Leader
C. CRUZ, Aux. (20%);
I. F. GONÇALVES, Aux.
J. NEVES, Aux.
N. PINHÃO, Aux.

Students

C.M.CARRAPIÇO, Ph.D. Student, IST (IG)
R. SARMENTO, Ph.D. Student, IST (IG)
R.P.F. MENDES, Collaborator (NP, 15%)
A. JANECO, Ph.D. Student (NP)
S. BARROS, Ph.D. Student (IG)

Technical Personnel

T. JESUS
N. INÁCIO
M. CABAÇA

Collaborators

GABRIEL SILVA (10%)

Technical Assistance in the Field of Engineering Applications of Radiation and Radioisotopes

J. Manteigas, J. Neves, N. Pinhão

Objectives

The main objectives are the development of equipment for internal groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.

Results

A summary of the more relevant work carried out is:

(i) Collaboration in corrective and preventive maintenance of the "Ion Beam Laboratory" – TANDEM 3 MV" at the Physics Unit.

(ii) Optimization of the electronic device "Photo-multiplier Divider" for the BaF_2 calorimeter under the project n_TOF-Ph2 experiment at CERN.

(iii) Services in nuclear spectrometry;

(iv) Development and maintenance of electronic equipment to UFA, UPSR, URSN, UCQR and UTR.

Summary of the more relevant Services/Equipment rendered in 2011

Activity	Qty	Client
Electronic Equipment Laboratory equipment for the determination of radioactive element traces by electrodeposition	4	NATS (Qatar)
	1	Dr. Henry Ben (Polónia)
Electronic Equipment Technical Assistance to Nuclear Equipment	21	EMA21 – Portucel/Soporcel (Cacia/Portugal)
	20	EMA21 – Portucel/Soporcel (Cacia/Portugal)
	6	SIDERURGIA NACIONAL (Seixal/Portugal)
	1	ENDRESS+HAUSER (Portugal)
	8	ITN (URSN, UCQR, UPSR) (Portugal)
Prices including TAX (VAT)		**Total Amount: 20 747,66 €**

Participation of ITN in the n_TOF-Ph2 experiment at CERN (5th year)

I. F. Gonçalves, P. Vaz, C. Cruz, J. Neves, C. Carrapiço, R. Sarmento, S. Barros

This project is the continuation of the involvement of ITN in the activities of the n_TOF Collaboration. Since February 2011 the ITN continued the analysis of the data recorded from 2004 till 2010, in collaboration with INFN-Bari and CEA-Saclay, as well as the feasibility studies associated to the construction of the second experimental area. The ITN team participated in several data taken shifts at CERN and is strongly involved in collaboration with Bari and Saclay, in the following areas: Monte Carlo simulation - full and detailed simulation of the geometry of the new experimental area with the usage of Monte Carlo codes MCNPX and GEANT-4; data analysis of the data on neutron capture on U-233 and the analysis of the resonances data on neutron-induced fission on U-236 and Am-241, Am-243 e Cm-245, taken during 2004 using the FIC ("Fast Ionization Chambers") detectors; data analysis of the Fe isotopes (of relevance for innovative technological systems and for Nuclear Astrophysics).

Conversion of methane by a non-thermal plasma using rare-gas/CH_4/O_2 and rare-gas/CH_4/CO_2 mixtures on a dielectric barrier discharge system

J. Branco, N. R. Pinhão, A. Janeco, A. Ferreira, L. Redondo

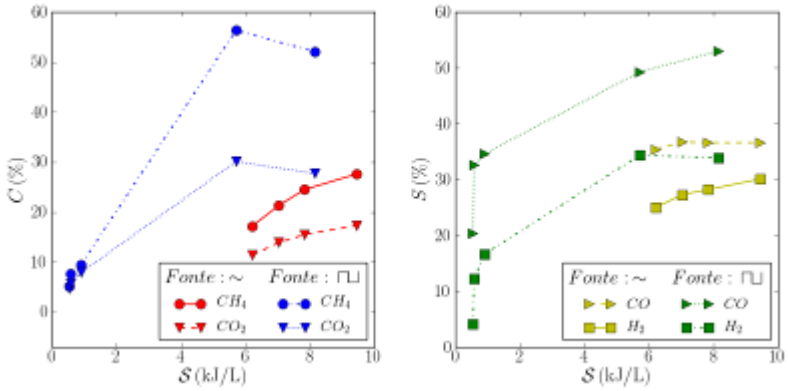

Fig 1- Dependency of conversion, C, for CH_4 and CO_2 and selectivity, S, for CO and H_2 with the specific energy with the voltage pulse shape (sinusoidal or rectangular).

The direct conversion of methane into *Syngas* and other hydrocarbons by a non-thermal plasma is an interesting alternative to the established production process. The study of the conversion of CH_4/CO_2 mixtures in a non-thermal plasma has continued with (i) the study of the influence of the voltage pulse shape of a DBD (dielectric barrier discharge) on conversion and selectivity; (ii) the study of the electron kinetics and, (iii) the development of models for the discharge breakdown. The theoretical model developed is able to explain the results obtained for the breakdown voltage.

Development of software for control and data analysis in nuclear spectrometry

R.P.F. Mendes, N.R. Pinhão

The development of Free Software for gamma and X-ray spectrometry has continued with the extension of the *PyMCA* software (for analysis of X-ray spectra) to support gamma spectrometry and online acquisition from remote equipment based on the EPICS libraries for distributed control of scientific equipment.

***Development of atmospheric non-thermal plasma sources for applications in material and biological* sciences**

N.R. Pinhão, J. Neves

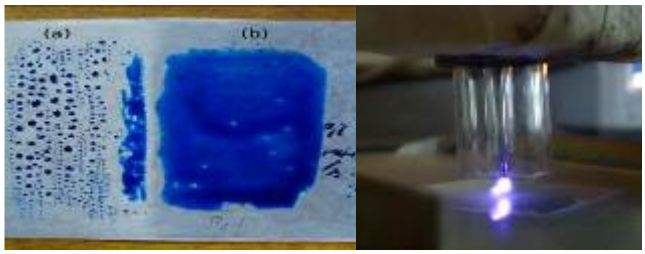

Fig 1 - A - Results on the wettability of a polyvinyl acetate: (a) untreated, (b) treated with a corona discharge. B – Plasma needle discharge at 3 W.

The treatment of surfaces at atmospheric pressure with non-thermal plasmas is an increasingly important field.

The development of two different plasma sources has started: a corona/dielectric barrier discharge system for processing of polymers and a RF-frequency plasma needle for biological and medical applications.