Measurements using ERDA technique in Pelletron Laboratory

The ERDA technique is very efficient to identify and quantify implanted (or evaporated) substances on surfaces of large samples[1,2,3]. This technique is specially indicated for samples consisted of thin films of light Z elements (mainly under Ne) on substrates of heavy Z elements, a mass region where another techniques (like RBS - Rutherford BackScattering) have a low efficiency.

In the first proposal, we showed that we were able to perform measurements using an experimental setup based in the mass identification of the scattered particle using the time of flight technique. The signals for this measurements were generated by a surface barrier detector set at 40 degrees in the laboratory frame (start) and the Pelletron bunching beam system reference (stop).

Because we experienced some problems with the RF amplifiers used in the bunching system, we decided to perform measurements using a ΔE-E technique to identify the elements, identifying the ejectiles by their Z number. Data were taken using an ionization chamber mounted at 40^{o} in relation of beam direction in the scattering chamber of 30B beam line. Samples were mounted with a 60^{o} in relation of beam direction. Analysis of the two dimensional spectrum shows a clear identification of the isotopes, specially for the Z under 17.

In the years we have done ERDA measurements in about 100 samples from different research groups. Typical samples were: B and N in DLC (IEAv), N in steel (Instituto de Física - Unicamp), N on Mo (INPE) and elemental analysis of bovine teeth treated with several clarifying agents.

In order to show the quality of data obtained with our experimental configuration we present below a two-dimensional spectrum ΔE-E from our participation in a “robin round” experiment to analyze Al N O films on Si substrate with width ranging form 10 to 1000 A. Samples were generated by Dr Numo Barradas in Sacavem (Portugal). Statiscal analysis comparing results of several laboratories showed that our results were consistent with most of other laboratories and that we were part of the few able to distinguish the N contribution in the thinner films.

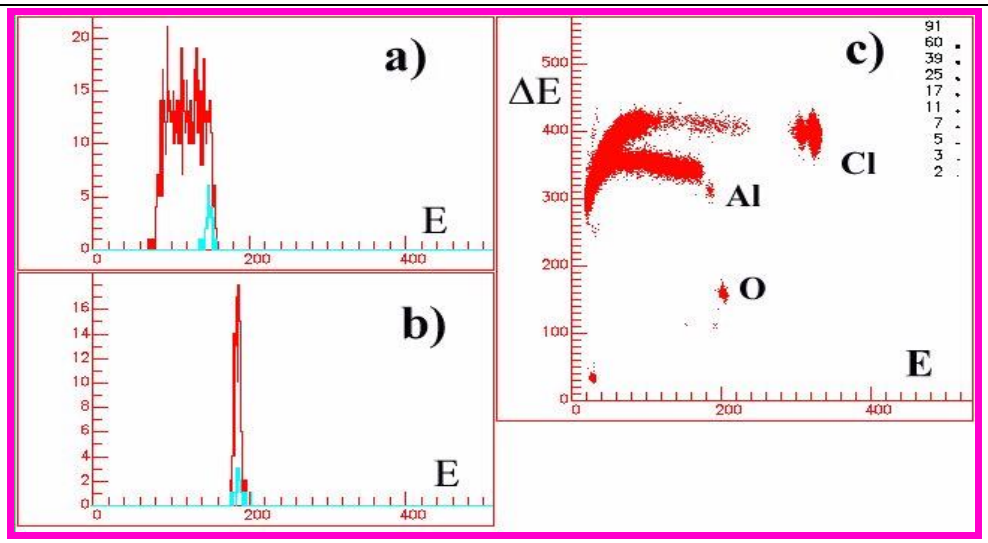

Figura 1: a) Energy spectrum obtained for Al recoils from samples (ITN - Portugal), nominally 1000 and 10 A; b) Energy spectrum obtained for Al recoils from samples (ITN - Portugal), nominally 10 and 100 A; c) Two Dimensional spectrum DE x E obtained for sample S3.

Some of these projects are summarized below:

Thickness and composition of CN films: In collaboration with LACIFID group (J.F. Chubaci, M. Matsuoka). In order to investigate hardness of CN films, samples are produced using different methods. Recently, the group has implemented the IBAD technique that allow the production of thin films with a high purity. Results of measurements combined with mechanical properties of the films indicate which method is the most efficient to achieve the expected behavior.

Y. Andoh, Y. Suzuki, K. Matsuda, M. Satou, F. Fujimoto, Nuclear Instruments and Methods in Physics Research B 6(1985)111-115.

F. Fujimoto, Vacuum 42(1991)67-72.

K. Ogata, Y. Andoh, E. Kamijo, Nuclear Instruments and Methods in Physics Research B 33(1988)685-688.

J. F. D. Chubaci, et al., Nuclear Instruments and Methods in Physics Research B 80/81(1993)463-466

Measurement of B in Si samples: In collaboration with IPT researchers (J.B. Ferreira Neto). One of the problems in the development of silicon technology for solar cells is to evaluate the contamination of impurities in the metallurgical process. Several methods can be used, but none is as efficient as ERDA to measure the depth profile of boron in Si, especially if this contribution is in the ppm region. Using ΔE-E ERDA technique, it will be possible to access this information.

Measurement of hydrogen in steel samples: In collaboration with Centro Tecnológico da Marinha researchers (D.Y. Kobayashi). The stress failure of steel (350 type) has been related to hydrogen contamination during the fast oxidation process. ΔE-E ERDA technique it will be used to identify H contribution in the oxidized film. Samples prepared in controlled environment will be probed to evaluate the sensitivity of measurements.

Considering that some of collaborations are still ongoing (some new collaborations always starts) and evaluating that we will be able to perform measurements in about 20 samples/day we request 5 days of beam time for the next year.

1)E. Arai, H. Funaki, M. Katayama et al NIM **B64** (1992) 296
2)S.C. Gujrathi, D. Poitras et al. NIM **B188** (1996) 560
3)N. Dytlewski, P.J. Evans, et al. NIM **B188** (1996) 278
4) H. Timmers, R. R. Ophel, R. G. Elliman, NIM B 161-163(2000)19-28.
5) R. G. Elliman, et al., NIM B 161-163(2000)231-234.
6) N. Added, J. F. D. Chubaci, M. Matsuoka, R. A. Castro, M. Radtke, E. Alonso, R. Liguori Neto, M. A. Rizzutto, M. H. Tabacniks, R. D. Mansano, NIM B 175-177(2001)787-790.

Previous Information on Project

Proposal approved	N 15d
Period of beam time (date)	14 – 15 /04/2014
Results or problems: Measurements on nitrided steel samples + LiF samples Problems: propane instead P10 was used in the gas system. Results: Data used in a project of Ufscar (Sorocaba site) related with modification of surfaces of steels by different nitretation processes.	
Proposal approved	N
Period of beam time (date)	
Results or problems:	

LABORATÓRIO ABERTO DE FÍSICA NUCLEAR
PAC 2016

Proposal	N° 15 (cont)
Title: **Measurements using ERDA technique in Pelletron Laboratory**	
Responsable: **Nemitala Added**	e-mail: **nemitala@if.usp.br**
Participants **N. Added, M.A. Rizzuto, M.H. Tabacniks, J.F. Chubaci**	
Spokeperson: **Nemitala Added**	e-mail: **nemitala@if.usp.br**
Telephone: 3091-6824	Skype:
Number of days for experiment:	1 + 1+ 1 + 1+ 1
Period planned for the experiment (are the setup ready for beam time?): Experiment can be used in next month	

Technical information

Ion source			Accelerator			Experimental Area	
Beam	Cathode	$I_{mínima}$	V_{min}	V_{max}	Bunched beam?	Beam line	Target
35Cl		300 nA	6,5	7,5	n	0, 30B	several

Other relevant/needed information:
One day each two months