LABORATÓRIO ABERTO
DE FÍSICA NUCLEAR

N°

Proposta de Experimento

Período :

Título: External PIXE and PIGE measurements in Pelletron Laboratory
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Número de dias solicitados: 1+1+1+1+1+1 (6 no total)
Datas preferidas:
Datas realmente impossíveis:
Canalização: 30B / 0 graus

Feixe	Est. Carga	$I_{mínima}$ (alvo)	V_{min}	V_{max}	Pulsado?
H	1 +	10 na	7	8	Sim/não
Diversos feixes	Depende	10 na	5	8	Sim/não

Alvos: amostras fornecidas pelo pesquisador.
Pastilhas: TiH2 para proton (ou composto mais conveniente)
Características de Feixe Pulsado:
Continuação da Experiência já Aprovada N°: 23
Outras informações: Interessante se dias de máquina pudessem ser distribuídos durante os seis meses, para evitar espera excessiva do usuários. Se o feixe pulsado estiver operacional, pode-se utilizá-lo para algumas amostras.

External PIXE and PIGE measurements in Pelletron Laboratory

One of the most used techniques to identify elements in a sample is PIXE (Particle Induced X-ray Emission) technique. The identification of characteristic X-ray leads to a very precise identification especially for high Z elements. It's well known that PIXE has a better efficiency to identify high Z elements. A complementary technique to identify low Z elements is PIGE technique, which discriminate the elements analyzing the particle induced gamma-ray emissions. By applying both PIXE and PIGE methods a very good overall picture of the elemental composition of a sample may be obtained. The important additional advantage of an external beam combined with these techniques is that heat dissipation from the surface of sample is effective and samples may be cooled easily.

Another characteristic of this combination is related with the possibility of analyzing samples that can't fit or be under low pressure. This is the case of some archaeological artifacts (porosity) or biological samples (liquid solutions).

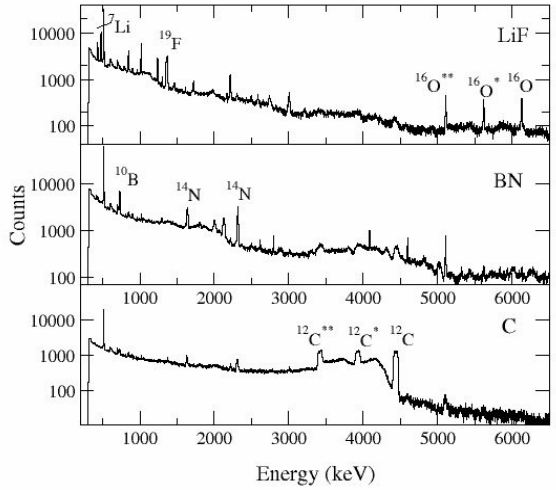

Figure 1. Energy spectra obtained for some of the simple compounds analyzed in the experiment. Peaks used for identification of elements are pointed out in figure. Stars on C and O indicate single and double escape processes for these energies.

The experimental setup used for measurements uses a 0.5 mm Al exit window after a 3mm Tantalum collimator. Detection system consists of a HPGe detector (from gamma group) for gamma rays and a Si(Li) detector for X rays. This setup was used to perform measurements to evaluate the traces elements composition in three different species: human, bovine and suine teeth. This work was a collaboration between our group and the Faculdade de Odontologia da USP. Results show a clear difference in the trace elements composition in these species.

Initially, the experimental setup was mounted in the 45B beam line, where we faced problems measuring simultaneously both techniques due to the difficulty to control the low intensity beam and the high level background generated by beam. Due to the superconducting solenoid

installation in the 45B beam line, we mounted a modified configuration of our setup in 30B beam line. First measurements indicate that will be easier to control the low intensity beam in this setup. In the last period we performed measurements to improve our experimental setup in order to be possible the simultaneous PIXE and PIGE measurements. Results indicated we must reduce and control the contribution from the interaction of beam particles with collimators and exit window.

In the next period we plan to adapt our setup to use the zero degrees beam line, that it was built to reduce the intensity of the probing beam without losing intensity in the control area of accelerator.

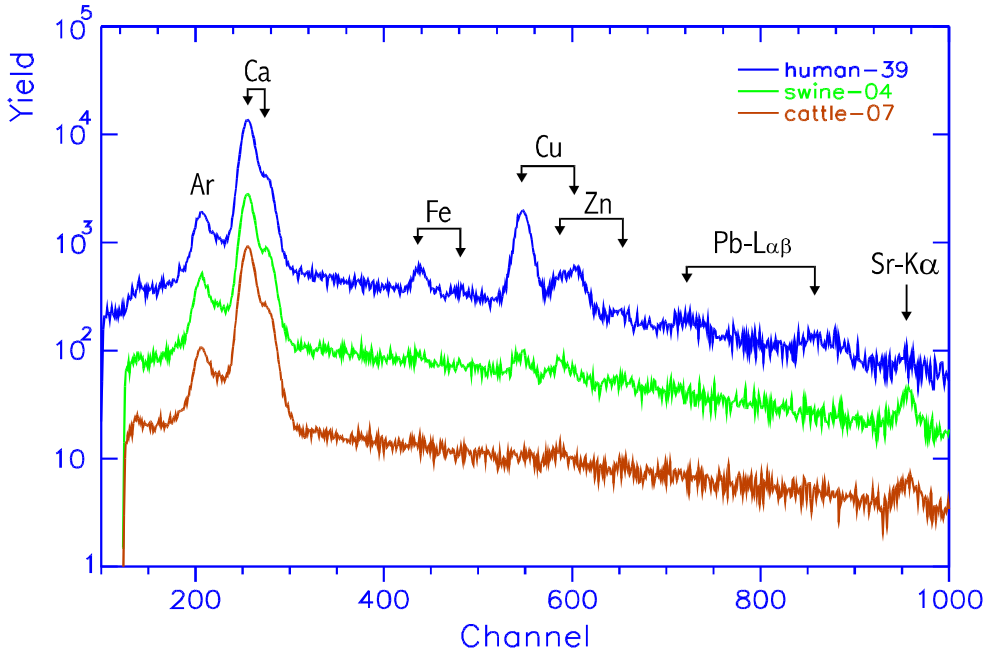

Figura 1: X ray spectra obtained using the external beam setup at Pelletron Laboratory

Future measurements were based in the following lines:

Influence of nitrogen content on the surface in the ductility of ancient swords: In collaboration with Diogo Emiliano. The project aims to correlate ductility of ancient swords obtained measuring mechanical properties with the nitrogen contribution on the steel surface. As it is well known, the nitriding of metallic pieces change their mechanical properties. Using $^{15}N(p,\alpha\gamma)^{12}C$ reaction, it is possible to evaluate the nitrogen content as well as its depth profile for the swords. This information can be analyzed together with crystalline structure of these compounds to understand their correlation with ductility.

Study of the Sr/Ca relation in bones as a temperature sensor: That is an ongoing project of our group. Bones are basically formed by Ca compounds, highlighting hidroxyapatite. In biological systems, Ca atoms

are replaced by Sr atoms, depending on the offer of Sr and the temperature of environment. In this project, we will measure Sr/Ca relation in bones from several species to investigate the correlation with body temperature. As the most of biological samples, these measurements should be done using external beam setup.

Analysis of ceramic samples: in collaboration with UEL researchers (Carlos Appoloni). Ceramic samples can be classified in relation to several properties: clay used, treatment of external or internal surface or functionality. Many times it is necessary to use energetic proton beams (or heavier) to be able to pass the external surface to excited the atoms in the clay region. The range of a 15 MeV proton beam is around 1,4 mm in a Si piece, allowing the analysis of the internal region of ceramic pieces.

Analysis of corrosion in metallic surfaces: That is an ongoing project of our group in collaboration with several groups, highlighting the MAE group. As in the case of ceramics, sometimes the thickness of corrosion films on metallic surfaces demands a more energetic beam in order to investigate the internal region of metallic sample. The information of the composition of the internal region is fundamental to understand the corrosion processes and help indicating the best way to treat the problem.

We estimate in next year we will need about 2 days for optimazing the new setup and another 4 days for analyzing samples. So we request a total of 6 days for next year.

Bibliography

1) J. Räisänen, A. Antilla **NIM196** (1982) 489
2) E.T. Williams **NIM B3** (1984) 211
3) J. Räisänen **NIM B17** (1986) 344