LABORATÓRIO ABERTO

DE FÍSICA NUCLEAR

N°

Proposta de Experimento

Período :

Título: Irradiation with ion beams
Responsável: Nemitala Added
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Participantes: N. Added, M.A. Rizzuto, M.H. Tabacniks, N.H. Medina, M.A.G. Silveira, A.O. Delgado, G.F. Trindade, bolsistas de IC

Porta Voz: Nemitala Added
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Número de dias solicitados: 1+1+1+1+1+1+1+1+1+1 (10 no total)
Datas preferidas:
Datas realmente impossíveis:
Canalização: 30B / 0 graus

Feixe	Est. Carga	$I_{mínima}$ (alvo)	V_{min}	V_{max}	Pulsado?
Vários feixes	Depende	10 na	7	8	Não importa

Alvos: amostras fornecidas pelo pesquisador.
Pastilhas: TiH2 (ou composto mais conveniente)
Características de Feixe Pulsado:
Continuação da Experiência já Aprovada N°: 43
Outras informações: Interessante se dias de máquina pudessem ser distribuídos durante os seis meses, para evitar espera excessiva do usuários.

Irradiation with ion beams

The interaction between charged particles with matter can be used for produce new materials, radioactive materials or also to destroy some cancerous cells in radiotherapy. The main goal of this project is to provide experimental setups that attend specifications of each particular irradiation. In particular, to attend the irradiation of samples that can´t be mounted in a low pressure chamber, we have developed a external beam setup. One of the characteristics of this setup is to allow the simultaneous irradiation of several small samples (5 x 5 mm^2) with the same dose. The total dose in samples can be evaluated by a surface barrier detector used as a monitor facing the Al foil exit window.

In the last years we have performed measurements in collaboration with different groups:

- Irradiation of proton in DNA samples - evaluation of number and size of fragments (Collaboration with Depto Física Experimental - IFUSP, IPEN, Universidade de Havana) Tese de Mestrado.
- Proton dosimetry - investigation of new materials for proton dosimetry motivated by its use in radiotherapy (Collaboration with Emico Okuno's group - DFN-IFUSP). Amostras de Eduardo .
- New technology for tiristors construction - defects generation in a given piece of device induced by proton irradiation.
- Irradiation of plastic foils (polymers) to create ion tracks. These irradiations were used in pos-graduation works in our group (GFAA), studying the characteristics of these ion tracks for several configurations of ion/energies and using these ions tracks for generating micropores eventually used to build micro structured devices.

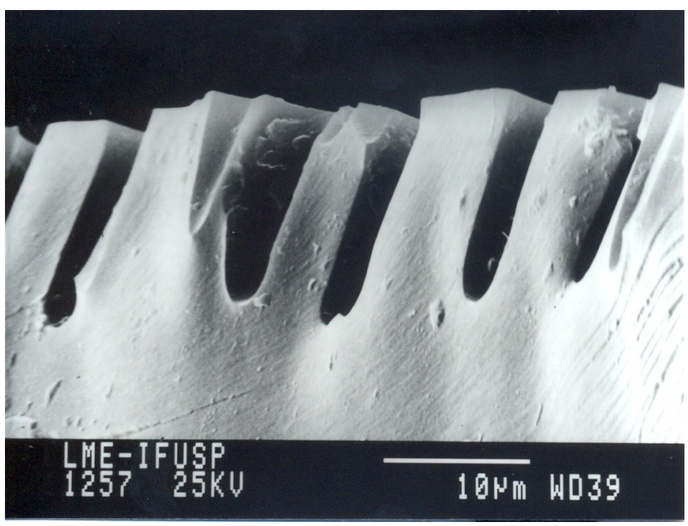


Figure 1: Pores generated by chemical etching of ion tracks from ^{16}O (24 MeV) ion beam in CR39

For this new period our group (GFAA) intends to use our irradiation setups to probe several materials, some in collaboration with other groups:

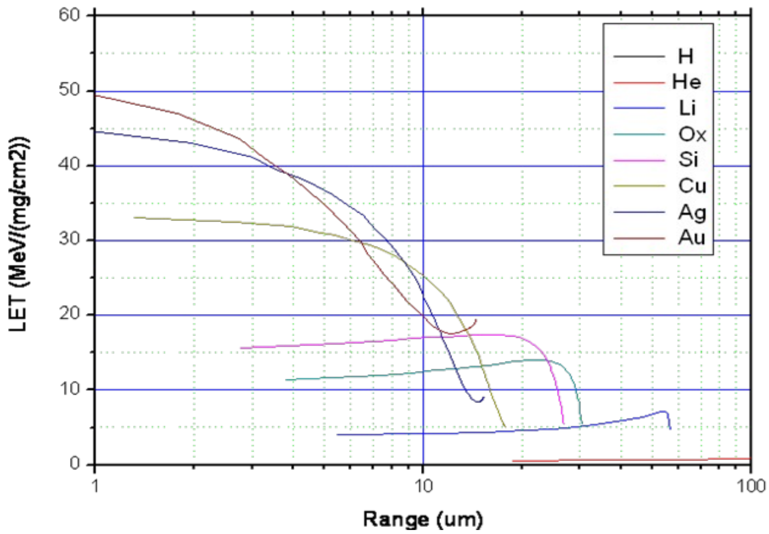
Irradiation of polymers: In these works our group intends to study the relationship between tracks created by radiation damage of each single projectile and characteristics of pores that can be generated by chemical etching. For that we will irradiate several samples varying the ion/energy configuration trying to generate different types of damage in the ion tracks.

1) M.E. Brandan, I. Gamboa-de-Buen, M. Rodriguez Villafuerte - Private communication
2) B. Jayant Baliga, E. Sun - IEEE Transactions on electron devices ED-24 (1977)

Irradiation of eletronic devices for aeroespacial application: In collaboration with FEI (K. Cline, R.B.B. Santos, S. Gimenez) and CTI (J.A. de Lima, L. E. Seixas Junior, W. Melo) researchers. The study of ionizing radiation effects on materials used in electronic devices is of great relevance for the progress of global technological development and, particularly, it is a necessity in some strategic areas in Brazil [1]. Electronic circuits are strongly influenced by radiation and the need for IC´s featuring radiation hardness is largely growing to meet the stringent environment in space electronics. On the other hand, aerospace agencies are encouraging both scientific community and semiconductors industry to develop hardened-by-design components using standard manufacturing processes to achieve maximum performance, while significantly reducing costs. To understand the physical phenomena responsible for changes in devices exposed to ionizing radiation several kinds of radiation should then be considered, among them heavy ions, alpha particles, protons, gamma and X-rays. Radiation effects on the integrated circuits are usually divided into two categories: Total Ionizing Dose (TID), a cumulative dose that shifts the threshold voltage and increases transistor's off-state current; Single Events Effects (SEE), a transient effect which can deposit charge directly into the device and disturb the properties of electronic circuits [2]. TID is one of the most common effects and may generate degradation in some parameters of the CMOS electronic devices, such as the threshold voltage oscillation, increase of the sub-threshold slope and increase of the off-state current. The effects of ionizing radiation are the creation of electron-hole pairs in the oxide layer changing operation mode parameters of the electronic device. Indirectly, there will be also changes in the device due to the formation of secondary electrons from the interaction of electromagnetic radiation with the material, since the charge carriers can be trapped both in the oxide layer and in the interface with the oxide. In this work we will investigate the behavior of MOSFET devices fabricated with different geometries, using heavy ion and proton beams. First tests were done using the 1.7 MV 5SDH tandem Pelletron accelerator of the USP Physics Institute with a proton beam of 2.6 MeV. Nevertheless, it is necessary to use heavy ion beams such as ^{28}Si, ^{37}Cl and ^{107,109}Ag in the energies produced by the Tandem 8MV Pelletron accelerator and the new Linear Accelerator (under construction) to achieve the high values of Linear Energy Transfer specified in standards used to characterize the electronic devices. For next year we plan to investigate Single Event Effects in the eletronic devices varying the LET, using for that different projectiles like ^{28}Si, ^{35}Cl, ^{107}Ag, ^{197}Au.

LET simulation

Ion beams in Si
(Maximum energy in Pelletron)



Ion	Energy (MeV)
Li	32
O	70
Si	90
Cl	100
Cu	100
Ag	100
Au	100

Figure 2: LET simulation (TRIM code) for projectiles using typical conditions in Pelletron accelerator.

[1] Duzellier, S., "Radiation Effects on Electronic Devices in Space", Aerospace Science and Technology 9, pag. 93-99, 2005.
[2] Barnaby, H.J., "Total-Ionization-Dose Effects in Modern CMOS Technologies", IEEE Transactions on Nuclear Science, vol. 53, n° 6, 2006.