



SERESSA 2014

International School on the Effects of Radiation on Embedded Systems for Space Applications

A FACILITY FOR THE STUDY OF SINGLE EVENT EFFECTS IN THE TANDAR ACCELERATOR

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Solar cells and other semiconductor devices used in space applications suffer permanent degradation due to the space radiation environment, which affects both electric and electronic parameters, reducing eventually the in-orbit lifetime. The most important effects of radiation on electronic components are: TID (Total Ionising Dose) caused by electrons and protons present in the radiation belts, SEE (Single Event Effects) due to cosmic rays and heavy ions from solar flares, and DD (Displacement Damage) which is a cumulative effect on TID induced by protons from solar flares.

To test and characterize the response of electronic devices to radiation exposure we used a beam line of our tandem Van de Graaff heavy ion accelerator (TANDAR). A test chamber able to simulate the space radiation environment was installed in a beam line, allowing variable-energy proton irradiations. Emulation of the space proton spectrum was used to assess TID effects and to estimate the comparative behavior of devices under test in a space-like ionising environment. To evaluate SEE effects we designed and built a system of tantalum filters allowing in-beam determination of the response of devices subjected to consecutive exposures under controlled conditions.

BEAM LINE E.D.R.A

(ENSAYOS DE DAÑO POR RADIACIÓN Y AMBIENTE)

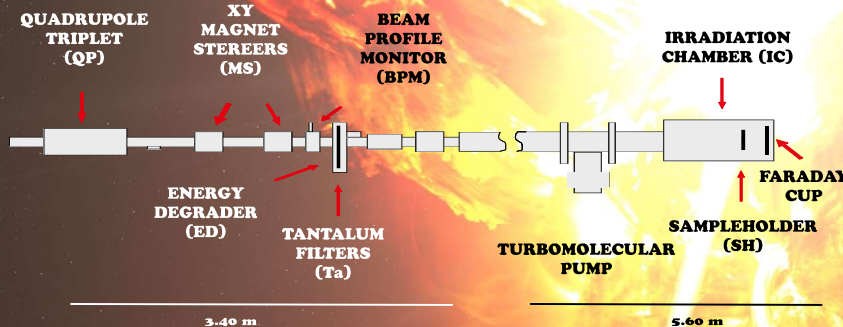


Figure 1. Beam line E.D.R.A

TANTALUM FILTERS

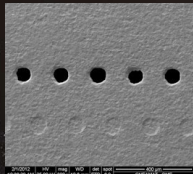


Figure 2. Electron microscopy photograph of etching tantalum sheet.



Figure 3. Ta1 filter

	Ta1 Filter	Ta2 Filter	Ta3 Filter
Perforation number	31	73	31
Average diameter	100 μm	130 μm	70 μm

Table 1. Characteristics of the tantalum filters.

With the aim of achieving the necessary conditions to evaluate in real time the device's response in a SEE experiment we design a tantalum filter that allow to decrease the current beam of our heavy ion accelerator (TANDAR) and achieve variable flux from a few 100 part./cm²seg to 10⁶ part./cm²seg.

To evaluate the design of the tantalum filters we built a prototype with different techniques. Photolithography with selective chemical etching with a mix of acid (HF and HNO₃) was chosen to obtain a perforation pattern on a tantalum sheet.

Three filters were built and install in the beam line E.D.R.A (Figure 1). Each one with different perforation number and diameters (Table 1) and a copper foil of 1 μm thickness.

BEAM CHARACTERIZATION

In order to characterize the beam in the irradiation chamber, after pass through the system of tantalum filters with a copper foil, we used insulator polymer sheet. The ion beam irradiation produces molecular structure modifications in the polymer due to the high energy density, deposited through electronic and nuclear interactions. To analyze the tracks distribution (damage region) we use chemical etching technique. The tracks were revealed and observed with an optical microscope (Figure 5). Spatial statistic was applied to analyzed the track pattern in 2D and prove the beam homogeneity.

To test the three filters 50 MeV oxygen and 83 MeV iodine were used (Table 2). An ion beam irradiation were performed using a tantalum filter without the copper foil (Figure 6).

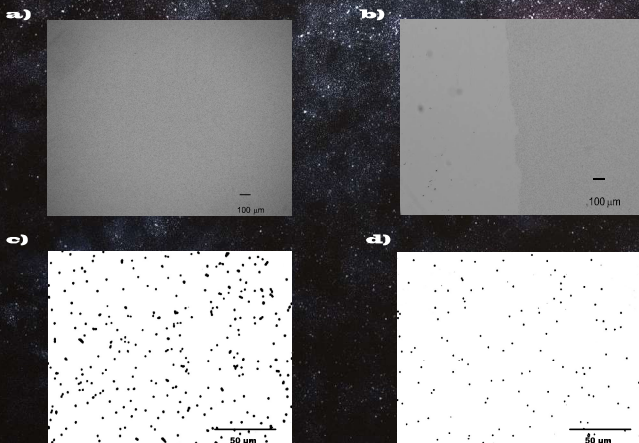


Figure 5. Optical microscopy of tracks in Lexan a) center and b) edge of the polymer, c) Iodine 83 MeV-Ta1, d) Oxygen 50 MeV-Ta1.

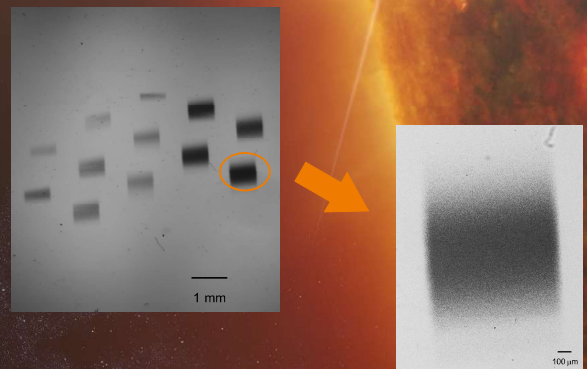


Figure 6. Lexan polymer irradiated with Ta3 filter without copper foil.

	Ta1		Ta2		Ta3
Ion beam	O	I	O	I	I
Energy (MeV)	50	83	50	83	83
Initial current beam (nA)	0,25	4,5	0,3	1,2	6
Final current beam (nA)	0,2	3,5	0,28	1,2	4,5
Detector counts (p/cm ² seg)	534	447	3777	730	273
Irradiation time (seg)	600	2107	252	1380	3000
Number of tracks (p/cm ² seg)	625	406	365	679	169

Table 2. Experimental irradiations condition of Lexan sheet.