

RADIATION DAMAGE

(CONVENER'S REPORT)

STEFANIA BACCARO

Italian National Agency for New Technology, Energy and the Environment, Advanced Physics Technologies, Via Anguillarese 301, 00060 S. Maria di Galeria (Roma), Italy

E-mail: stefania.baccaro@casaccia.enea.it

The importance of radiation damage effects for many physics experiments is evident in many applications and regards different kind of materials. However most of the attention is devoted to improve electronic components for space or accelerator experiments and materials for detectors in irradiation environment

To take into account these two aspects the session has been split in two parts: the first one was devoted to radiation effects in electronic components and the second one to the effects induced by radiation in materials for detectors, like scintillators or new dosimeters. The reports on radiation damage of diamond, polymers or other materials used for special applications (like medical devices) have been inserted into dedicated sessions of the Conference.

To introduce the radiation effects on the electronic components, M. Bruzzi gave a large overview of the major changes in the operational parameters due to radiation damage in silicon detectors. Her contribution described the microscopic damage in silicon, macroscopic damage in micro-strip detectors as well as the radiation hardening technologies to meet the goals requested in particular by High Energy Physics Experiments at LHC.

The contribution by A. Seidman put in evidence the results obtained in the study of the influence of neutron irradiation on the optical properties of silicon detectors; while the talk presented by V. Re, reported a study of 0.18 μm CMOS process devices under γ irradiation, in view of applications to high density mixed-signal front-end systems and the results showed the tolerance to γ -ray confirming the intrinsic radiation hardness of these components.

Many authors work on the electronic components for spatial applications, in particular for experiments in Low Earth Orbit (LEO) Space Payloads. An extensive survey on current technologies to obtain commercial off-the-shelf components (COTS) to be used in this field, was given by M. Menichelli. Several discrete, analog and digital components have been tested at 0.3 kGy total dose, according the ESA/SSC 22900 specifications with the aim to use COTS in the construction of the

power supply system of the AMS experiment. The results obtained on 42 different COTS indicate the possibility to use these components in space especially in LEO payloads.

C. Leroy reported the behavior under neutron and γ irradiation in liquid argon of some materials and equipment to be part of the ATLAS liquid argon calorimeters at LHC. In the hard conditions used for the tests, the results showed that no significant pollution was evident with respect to the outgassing and electrical or mechanical stability of these devices.

J.J. Velthuis reported the results obtained by the ZEUS collaboration at the HERA accelerator after the installation of a new silicon strip vertex detector (MVD): the Helix 3.0 chip (not designed to be radiation resistant) was exposed to γ radiation up to 0.5 kGy and the results put in evidence the possibility by suitable method, to partially compensate the radiation damage.

Last contribution of radiation damage session regarding the electronic components, was presented by G. Vitale.

It is very important to conclude this session dedicated to electronic components under irradiation with the realization of the power supply systems proposed by CAEN, able to guarantee safe and reliable operation, in particular for LHC experiments. As a matter of fact, a study of radiation and magnetic field tolerance of CAEN HV and LV boards has been performed and the results showed that the boards successfully passed the restrictions requested by LHC experiments.

M. Nikl introduced the second part of the session regarding the effects on materials for special applications. The aim of his talk was to compare the optical performances of NaPO_3 - GdPO_4 -based glasses doped with Tb^{3+} for the detection of X or γ rays and neutrons, under ionizing and laser irradiation at room temperature. The investigation seemed necessary to optimize the glass matrix with respect to unwanted energy losses during the scintillation conversion. Also a detailed understanding of the processes of energy storage and of the nature of related color centers was described.

A good example of a material that could be proposed as a possible candidate for radiation detectors was given by R.M. Montekali. Starting from the well-known fact that lithium fluoride (LiF) crystals are good dosimeter materials, she underwent an optical characterization of gamma irradiated polycrystalline LiF films. These films were deposited on radiation hard substrate irradiated up to 10^6 Gy in air and luminescence spectra were measured. Gamma irradiation of LiF induced stable formation of F centers which emit efficient red and green photoluminescence; the trend of luminescence versus absorbed dose results sub-linear. These preliminary results are encouraging and LiF films can be used as sensors and dosimeters for gamma irradiation. Further studies could indicate that LiF films are suitable also for neutrons or other ionizing sources detectors.

The following contribution given by A. Ziegler showed interesting results about the in-situ measurements of radiation damage in the new ZEUS luminosity

monitoring system at HERA accelerator. Optical properties of scintillating fibers (of the SCSF or BCF type) were measured under irradiation with X-ray, ^{137}Cs and ^{60}Co sources, also as a function of temperature, giving important indications about their radiation resistance.

M. Korzhik summarized in the last contribution of this session, the results of R&D PWO program performed by the CMS Collaboration at CERN. The lead tungstate PbWO_4 (PWO) crystals will be used to build the Electromagnetic Calorimeter of CMS and the Photon Detector of Alice experiment at LHC as well as to construct ECAL of BTeV experiment at Fermi National Laboratory. A large overview of the results obtained with PWO about radiation damage, recovery, scintillation and their influence on the calorimeter performance in irradiation environment was discussed. The model of the fast and slow recovery of PWO radiation damage has been also proposed.

In conclusion, radiation damage appears to be a crucial point in many experiments and from different points of view, because of the induced modifications in the behavior of material and components, representing often the weak point of the very complex apparatuses.

The reports collected in this section are therefore a few significant examples of the many possible problems (or solutions) that scientists meet when their experiments take place in a radiation environment.