STUDY OF CHARGE TRANSPORT IN SEMICONDUCTORS BY ION BEAM INDUCED CHARGE (IBIC) MICROSCOPY

G. PROVATAS, M. JAKŠIĆ, D. COSIC, A. CRNJAC, M.R. RAMOS, M. VIĆENTIJEVIĆ

Laboratory for Ion Beam Interactions, Ruđer Bošković Institute, Zagreb, Croatia

The ion beam induced charge (IBIC) technique is a well-established, powerful experimental tool for the study of charge transport properties in semiconductor materials, providing the unique advantage of individual charge pulse measurement, produced while fast ion interacts with the sample material. The information about the electronic transport of semiconductors measured by IBIC is obtained down to the micrometer level by modulating the analytical depth, using ions of different energies, and with the use of a focused ion beam which is scanned over the surface of the samples.

In the Laboratory for Ion Beam Interactions of the Ruđer Bošković Institute (RBI), two microbeam end stations are installed and the group has a long experience in the characterization of electronic materials and devices by means of all variations of the IBIC technique. In this presentation we highlight examples of the recent IBIC applications, done on a variety of samples and carried out within the RBI and with collaborators from different research fields, in the framework of the EU projects RADIATE, AIDA2020 and EUROfusion, IAEA CRP project G42008 - Facilitating Experiments with Ion Beam Accelerators and CERIC-ERIC analytical infrastructure network.

The presented applications will cover the exploration of the charge transport properties in detectors with three-dimensional structure, used in the development of high radiation tolerance detector devices. The study of the electronic properties of single-crystal diamond (scCVD) detectors operated at extreme temperature environments, from cryogenic temperatures (~20 K) up to 700 K, will be described too, while the IBIC study of the deterioration of the charge collection efficiency in diamond due to the trapping of charge carriers, will be discussed to stress limitations of the detector's spectroscopic properties. Furthermore, by aiming in developing a single-ion deterministic implantation technique for applications in quantum information processing devices, IBIC studies of diamond detector signals to several low penetrating ions will be discussed. Finally, an experimental methodology for the characterization of the electronic features of silicon power diodes, based on polychromatic angle resolved IBIC analysis, will be presented.