Dependence of the defect introduction rate induced by MeV ions on the final degradation of the semiconductor detectors

Particles passing through matter lose energy by means of a variety of interactions and scattering processes, which results in two major effects: collision energy loss and atomic displacement. Displacement damage refers to the dislodging of atoms from their normal lattice sites in a target material by impinging energetic radiation. The resulting damage causes degradation of the electronic and optical properties of materials and devices. That degradation is generally due to the introduction of new energy levels in the semiconductor bandgap, which changes properties such as recombination lifetime. Due to the microscopic and macroscopic effects of ion radiation on semiconductor components, research in this regard is ongoing. The objective of this doctoral dissertation is to obtain the ability to model and simulate the interaction of ions with the matter, to experimentally determine the rate of damage caused by ion radiation on the performance of semiconductor components, and laboratory instrumentation to measure the induced current of ion beam using alpha source. In this study, in addition to C-V and I-V methods, the Ion Beam Induced Charge (IBIC) method will be used to measure the effects of vacancies. Complementary methods such as Positron Annihilation Spectroscopy (PAS) and X-Ray Diffraction (XRD) are used as needed for their unique ability to describe defect configurations and nanostructures in Si samples. To understand the response of Si crystals to ion beam radiation in different energy regimes and radiation conditions, simulation using existing codes will be used, which can create significant openings in the interpretation of experimental data.