P80 - Comparative study of the charge collection efficiency decrease on Si and SiC diodes after irradiation with high energy protons

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The study of radiation effects in semiconductor electronics and detectors is fundamental to evaluate the lifetime and performance deterioration of the semiconductor devices working in high radiation environments like nuclear reactors, particle accelerators and outer space.

In this work, we present a comparative study of the charge collection efficiency (CCE) degradation on a series of Si (n-type and p-type) and SiC (n-type) diodes after irradiation with high energy protons. The CCE was determined by the Ion Beam Induced Charge (IBIC) technique using 4 MeV protons. Moreover, the transient behavior of the collected carriers was analyzed at various reverse bias voltages.

The diodes were irradiated in our cyclotron with 17 MeV protons and fluences ranging from 3.3×10^{11} to 3×10^{14} p/cm2. At this energy the proton stopping power across the samples is practically constant, leading to a uniform vacancy profile with depth.

From the analysis of the IBIC results, using the simple drift-diffusion model, the change in the diffusion length of the minority carriers has been evaluated for different proton fluences. In addition, it has been observed an increase of the leakage current with ion dose, from which the damage coefficient of the samples has been calculated.

Keywords
Si diode, SiC diode, IBIC, proton irradiation, charge collection efficiency, transient analysis

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