

Modeling of Semiconductor Detectors Made of Defect-Engineered Silicon: The Effective Space Charge Density

A. Saadoune, S. J. Moloi, K. Bekhouche, L. Dehimi, M. McPherson, N. Sengouga, and B. K. Jones

Abstract—

The effective space charge density N_{eff} is the average density of carriers over the depletion layer in a semiconductor diode and is measured from the capacitance–voltage curve extrapolated to full depletion V_d . Full semiconductor modeling has been performed for PIN diodes made of materials with a large density of generation–recombination (g–r) centers, such as irradiated or semi-insulating semiconductors. The results show that this extrapolation method can give incorrect values for the introduction rate of charged traps and g–r centers with large irradiation fluence. This is because the introduction of midgap g–r centers moves the Fermi level toward midgap which allows existing traps to change their ionization state. We propose an alternative approach to evaluate the effective density from the C–V characteristics without the need to evaluate the depletion voltage.

Index Terms—Diode, modeling, radiation damage, semiconductor, semi-insulating.