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Fluence dependent barrier capacitance and compensation effects in neutron irradiated Si pin diodes

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The high resistivity particle Si pin-detectors, operating at full depletion regime, are commonly employed for detection of the ionizing radiation. Radiation induced defects acting as carrier trapping, generation and compensation centers affect the operational parameters of diodes by the increase of leakage current, by reduction of charge collection efficiency and signal to noise ratio. Commonly, these characteristics are examined by employing current-voltage (I-V), capacitance-voltage (C-V), deep level transient spectroscopy (DLTS) techniques, etc. However, at high irradiation fluences (>10ˆ14 cm-2), the mentioned techniques are unacceptable, as C-V characteristics are distorted by generation current leading to misinterpretation of doping effects, while DLTS technique is only applicable if trap density is significantly less than that of dopants. Therefore, techniques capable to separate trapping, generation and compensation effects are needed.
In this work, a technique, based on analysis of transients of barrier capacitance charging current induced by linearly increasing voltage pulse, is presented. To extract barrier parameters, the transients for reverse and forward biasing are examined. Fluence dependent variations of barrier capacitance, of space charge generation current and doping compensation effects in neutron irradiated diodes are discussed. It has been shown that generation current, caused by radiation induced traps of high density, distorts capacitance measurements in irradiated devices, while there is no sign inversion effect, however, heavily irradiated detectors become fully depleted in equilibrium.

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