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Surface-state induced inter-electrode isolation of n-on-p devices in mixed-field and ☒-irradiation environments

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Surface damage caused by ionizing radiation in SiO_2-passivated silicon particle detectors consists mainly of the accumulation of a positively charged layer along with trapped-oxide-charge and interface traps inside the oxide and close to the Si/SiO_2-interface. High density positive interface net charge can be detrimental to the operation of a multi-channel n-on-p sensor since the inversion layer generated under the Si/SiO_2-interface can cause loss of position resolution by creating a conduction channel between the electrodes, which is typically addressed by including additional isolation implants (p-stop, p-spray) between n^+-electrodes. In the investigation of the radiation-induced accumulation of oxide charge and interface traps, a capacitance-voltage characterization study of n/γ (mixed field)- and γ-irradiated Metal-Oxide-Semiconductor (MOS) capacitors showed that close agreement between measurement and simulation was possible when oxide charge density was complemented by both acceptor- and donor-type deep interface traps (N_{it}) with densities comparable to the oxide charges. Tuned densities show substantially higher introduction rates of N_{it} in mixed-field environment than for γ-irradiations. Corresponding inter-electrode resistance (R_{int}) simulations of an n-on-p sensor with tuned oxide-charge and interface-trap parameters show considerably higher R_{int}-levels for mixed-field irradiation as a result of the higher introduction rates of N_{it}, that additionally make the isolation performance independent of the presence of an isolation implant between the electrodes. The beneficial impact of radiation-induced accumulation of deep interface traps on inter-electrode isolation indicates that position sensitive n-on-p sensors without isolation implants may be feasible in the future HEP-experiments with mixed field/particle dominated radiation environment.

Collaboration

HGCAL

Role of Submitter

I am the presenter

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