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Measurements and Simulations of Surface Radiation Damage Effects on IFX and HPK Test Structures

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Radiation damage effects at High Luminosity LHC expected fluences (2×10¹⁶ n/cm² 1 MeV) and total ionising doses (TID) (1 Grad) will impose very stringent constraints in terms of radiation resistance of solid-state detectors. The complex physical phenomena related to radiation damage effects can be addressed by means of TCAD tools aiming at evaluate the most suitable technological options to be adopted for the fabrication of radiation-resistant, long-term operating detectors. In particular, surface damage effects can be investigated with TCAD tools in order to study their macroscopic, device-level effects, e.g. the inter-electrode isolation and charge collection properties of different design options. Aiming at the generality of the approach, in this work, we address the effects of surface damage on detectors fabricated on p-type substrates by two different foundries. Actually, starting from standard test structure measurements the interface trap state density (NIT) and the oxide charge (QOX) can be extracted and used as input parameters to the simulation tools. Moreover, a detailed TCAD parametric analysis has been carried out, aiming at evaluating the effects of oxide charge density and interface trap density variation with the dose. The good agreement between simulation results and measurements would support the use of the model as a predictive tool to optimize the design and the operation of novel solid-state detectors in the HL-LHC scenario.

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