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Study of High-dose X-ray Radiation Damage of Silicon Sensors

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The high intensity and high repetition rate of XFEL, the European X-Ray Free-Electron Laser presently under construction in Hamburg, results in X-ray doses of up to 1 GGy in pixel sensors for 3 years of operation. Within the AGIPD Collaboration the Hamburg group has systematically studied X-ray damage using test structures and segmented sensors fabricated on high-ohmic n-type silicon. MOS Capacitors and Gate Controlled Diodes from 4 vendors with different crystal orientations and different technological parameters, as well as strip sensors have been irradiated in the dose range between 10 kGy and 1 GGy. Current-Voltage, Capacitance/Conductance-Voltage and Thermal Dielectric Relaxation Current measurements were used to extract oxide-charge densities, interface-trap densities and surface-current densities as function of dose and annealing conditions. The results have been implemented into TCAD simulations, and the radiation performance of strip sensors and guard ring structures simulated and compared to the experimental results. Finally, with the help of detailed TCAD simulations, the layout and technological parameters of the AGIPD pixel sensor has been optimized. It is found that the optimization for sensor exposed to high X-ray doses is significantly different than of non-irradiated sensors and that the specifications of the AGIPD sensor can be met.

quote your primary experiment

European XFEL

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