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Characteristics and Total Ionizing Dose Compensation of Double Silicon-on-Insulator Integration Type Sensor

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We are developing monolithic pixel sensors based on Lapis 0.2 μm fully-depleted Silicon-on-Insulator (SOI) technology. The SOI pixel sensors have properties such as low leakage current, fast response, and single event effects immunity. For use in hard radiation environments as in HEP experiments, the total ionizing dose (TID) effect is the major issue since the rather thick (200 nm) buried oxide layer affects the readout circuit operation after irradiation.
To compensate for TID damage, we have introduced a Double SOI structure which has a Middle Silicon layer (SOI2 layer) underneath the buried oxide layer in addition. The effects due to irradiation-induced holes trapped in oxide layers are to be cancelled by applying a negative voltage to the SOI2 layer.
We studied the recovery of an integration-type Double SOI sensor from TID damage induced by ^{60}Co gammas. The sensors irradiated to 100 kGy recovered the pixel functionality by applying a negative voltage to the SOI2 layer, and showed a response for IR laser as expected for non-irradiated sensors. Other characteristics such as cross-talk, signal shape and response to beta-rays were evaluated.
The sensors are operated with full depletion as a feature of our SOI devices, allowing fast signal collection and uniform response across. We conclude that the Double SOI sensor is radiation hard enough to be used in HEP experiments in harsh radiation environments such as at Bell II or ILC.

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