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# Characterization of Interface States & Radiation Damage Effects in Duo-lateral PSDs Using SEM Microscopy and UV Beam Profiling Techniques

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**Abstract:**

There has been an increase in the use of duo-lateral position sensitive detectors in practically every radiation and beam detection application. These devices unlike other light detection system utilize the effect of the lateral division of the generated photocurrent to measure the position of the integral focus of an incoming light signal. The performance of a PSD is impaired or strengthened by a number of events caused by parameters such as interface states and recombination introduced during the fabrication of the detector and/or its absorption of ionizing particles. This thesis show the results from the successful implementation of alternative characterization methods of these effects and parameters using scanning electron microscopy and UV beam profiling techniques on duo-lateral position sensitive detectors (PSDs).

To help create the groundwork for the research content of this thesis, different technical reviews of previous studies on interface states, surface recombination velocity and radiation damage due to continuous absorption of ionizing particles on detectors are investigated. The thesis also examines published theoretical and measurement techniques used to characterize these surface/interface phenomena.

The PSDs used in this research were developed using silicon technology and the various methodologies put into the fabrication of the detectors (n+p and p+n doped) were fashioned after the simulated models. The various steps associated with the cleanroom fabrication and the prior simulation steps are highlighted in the content of the thesis. Also discussed are the measurement techniques used in characterizing the fixed oxide charge, surface recombination and the position deviation error of the PSDs in a high vacuum environment of a scanning electron microscope SEM chamber. Using this method, the effects of interface states and surface recombination velocity on the responsivity of differently doped PSDs were investigated. By lithographically patterning grid-like structures on n+p doped PSD and using sweeping electrons from the SEM microscope, a very high linearity over the two-dimensions of the PSD total active area was observed. The lithographically patterned grids helped eliminate further external measurement errors and uncertainties from the use of other typical movable measurement devices such as actuators and two-dimensional adjusters which would normally be difficult to install in a remote vacuum chamber.

In a similar vein, field plate and field rings were patterned around an array of the PSDs used as pixel detector(s). By studying the interpixel resistance and breakdown characteristics, the most effective structural arrangement of the field plate and field rings used to curb induced inversion channel between the n+ doped regions of the pixel-detector is observed.

Finally, by using UV beam profiling after the irradiation of UV (193 nm or 253 nm) beam on n+p and p+n doped PSDs, the degree of radiation damage was also investigated. The results obtained help to illustrate how prolonged UV radiation can impact on the linearity and the position deviation/error of UV detectors.