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Simulation, Measurement and Analysis of the Response of Electron- and Position Sensitive Detector

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Abstract:

Different methods exist in probing and investigating the physical and structural composition of materials especially detectors whose usage have become an integral part of radiation detection. The use of scanning electron microscopy is just one of such exploratory methods. This technique uses a focused beam of high-energy electrons to generate a variety of signals at the surface of the device under investigation.

This thesis presents results derived from signals from electron beam-sample interactions revealing information about the different cleanroom fabricated electron detectors used. These information include the detector's external morphology and texture, surface recombination, fixed oxide charge and the behavioral characteristic in the form of its position detection accuracy and linearity.

An electron detector with high ionization factor having a 10nm Silicon Oxide passivating layer was fabricated. Results from using the scanning electron microscopy showed that its maximum responsivity was approximately 0.25 A/W from a possible 0.27 A/W. In conjunction with simulations, results also showed the significance of the effect of the minority carriers surface recombination velocity on the responsivity of the detectors. In addition, measurements were done to ascertain the performance variance of these electron detectors with respect to their surface recombination velocity and fixed oxide charge when the doping profile is altered.
By incorporating special features on a fabricated duo-lateral position sensitive detector (PSD), a position sensing resolution of the PSD using the electron microscopic method was also evaluated. The evaluation showed a very high linearity over two-dimensions of 77% of the PSD's active area.

The results in this thesis offer a significant improvement in electron detectors in applications like gas chromatography detection of trace amounts of chemical compounds in a sample as well as applications involving position sensitive detection.