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Radiation hardness limits for semi-insulating GaAs detectors irradiated by 5MeV electrons

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Recent progress in the field of high energy physics and in space applications brings detector utilization in a radiation harsh environment where also high-energy electrons play an important role, like radiation belts of planets or the electron-positron collider foreseen as the ILC. We have been studying the radiation hardness of developed Schottky barrier semi-insulating (SI) GaAs detectors against 5 MeV electrons for a couple of years. The influence of cumulative dose up to 200 kGy on detection and electrical properties of detectors was published in [1, 2], were degradation of charge collection efficiency (CCE), energy resolution (FWHM) with decrease of breakdown voltage and reverse current were observed. However, the ability of SI GaAs detectors to measure spectra and distinguish energies was preserved. The investigated detectors were irradiated in 25 steps by now and a limit of their functionality was reviled to be 1000 kGy. The influence of cumulative absorbed dose on detection properties (CCE, FWHM, peak to valley ratio and detection efficiency) was analysed, with relation to detector applied voltage. The CCE has dropped down to 20%, the peak to valley ratio reached almost 1 and the FWHM increased to 40% at maximum applied dose. The spectrometric properties of detectors were determined from gamma ray spectra of 241-Am and 133-Ba depending on the detector reverse voltage. The electrical properties, the breakdown voltage and the reverse current were obtained from measured current-voltage characteristics of detectors. The breakdown voltage of detectors decreased to 60% of its original value and the reverse current was slightly lower also with decreased value of dynamic resistance. The investigated detectors were made of a bulk VGF (Vertical Gradient Freeze) SI GaAs grade of 230 μm thickness with the circular Schottky electrode made of Ti/Pt/Au (10/35/90 nm) multilayer on the top and a whole area quasi-ohmic metal electrode from Ni/AuGe/Au (30/50/90 nm) multilayer on the back side of the substrate.

REFERENCES

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