Demonstration and characterization of high-resolution 4H-SiC Schottky diode alpha particle detectors at high temperatures

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Abstract:

Silicon carbide as a wide bandgap semiconducting material for the fabrication of radiation sensing and spectroscopy devices is nearing maturity. In this study the sensing limits of 4H-SiC is being explored. At elevated temperatures radiation detectors fabricated on semiconducting materials will show a change in signal-to-noise ratio, which ultimately limits the resolution. Devices fabricated on ordinary semiconductors, such as silicon, signal-to-noise ratio rapidly decreases as temperature increases, and hence show poorer resolution. Due to the wider bandgap of 3.11 eV of 4H-SiC, the noise level is maintained up to a higher temperature while the excitation energy decreases, producing a greater signal. Schottky diode radiation detectors were fabricated on high purity 4H-SiC epitaxial wafers. The fabricated detectors were characterized, and their spectroscopy performance quantified at room temperature up to 500 °C. Parameters of the radiation detectors such as charge collection efficiency and charge carrier excitation energy are extracted with respect to temperature. Finally, resolution of the detectors is compared at increasing temperatures and acquired spectra are shown to be capable of distinguishing alpha particles from various sources.