4H-Silicon Carbide as Field Deployable Sensor for Trace Actinide Detection

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Abstract:

The rapid and accurate characterization of field samples in the event of nuclear incidents has long provided important information corresponding to the scale of the event and its impact on the environment (Fukushima Dai-Ichi, Chernobyl, etc.). However, the delay caused by off-site sample processing results in the loss of critical time that can be used to treat or contain the event. Current radiation detectors commonly used in laboratories are not readily deployable due to the external equipment required to provide accurate results and environmental factors that influence spectrum collection due to a narrow band gap. It is also known that a sensor alone cannot be solely relied on for sample identification, so the sensor is often coupled with another form of chemical identification to distinguish elements and/or isotopes in a sample. Differential pulse voltammetry (DPV) provides an option for small form factor elemental identification which can be coupled with a radiation detector for isotope identification in field samples. 4H-Silicon Carbide (SiC) is a semiconductor material whose characteristics of high radiation tolerance, wide band gap, low leakage current, and high breakdown voltage make it a strong candidate for a field deployable sensor. 4H-SiC Schottky barrier diodes (SBD) are characterized through alpha spectroscopy analysis of electrodeposited ^{241}Am and uranium actinide sources. In addition, 4H-SiC diode behavior is monitored throughout the electrodeposition and stripping processes (current-voltage and capacitance voltage measurements), and lastly, important detector parameters such as lower-limit of detection (LLD) and mu-tau product are quantified.