Experimental Demonstration of Ga_2O_3 as a Radiation Sensor and Its High Temperature Resistance

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Abstract:

The desire to place radiation sensors in extreme environments have led to the motivation to use ultra-wide bandgap semiconductors. β phase Ga_2O_3 is being explored in this study for its ability to withstand and operate at high-temperatures. The objective of this project is to fabricate Ga_2O_3 Schottky barrier diodes to be used as alpha particle detectors that will be deployed in high-temperature radiation environments such as in molten salt reactors or pyro-processing facility. The devices are formed from $6 \times 10^{15}\ cm^{-3}$ doped Ga_2O_3 homoepitaxial layer 20 µm thick. Schottky contacts are formed by Ni on the epilayer face and Ohmic contacts by a Ti/Au stack on the bulk face. All of the device fabrication is performed in a clean room facility at The Ohio State University. With the intent to operate the devices in high-temperature environments design decisions are made accordingly, such as the choice of contact material, pre-deposition surface treatment, and annealing condition. Room temperature and high-temperature electrical characterization is presented. The high-temperature electrical measurements were performed using a Signatone high-temperature water cooled hot chuck. The hot chuck is capable of heating samples to 500°C. Sensitivity to alpha particles from Am-241 has been demonstrated by pulse shape from preamplifier and the collected energy spectrum. The acquired spectra are supported by theoretical energy deposition calculation and SRIM/TRIM simulation.