Evaluation of GaN Schottky diodes for radiation detection and performance under high neutron fluence

Presenter: Jarod Remy

Advisor: L. Raymond Cao

The Ohio State University

remy.56@buckeymail.osu.edu

Abstract:

GaN is a wide bandgap semiconductor material with properties being explored for radiation detection and spectrometry. Due to the wide bandgap (3.45 eV) and radiation hardness property of GaN (displacement energy 19 eV), the material may prove to be an optimal candidate for sensing in extreme environments such as in advanced reactor designs and fuel cycle processes. The devices under consideration in this study are Schottky diodes comprised of 12 um n-GaN epitaxial layer deposited on 400 um GaN substrate. The carrier concertation in the epitaxial layer is 4-5 x 10^{14} cm^{-3} and the substrate has a doping concentration greater than 5 x 10^{18} cm^{-3}. The Schottky diode behavior was formed between the epitaxial GaN and Ni (60 nm) /Au (200 nm), respectively, and the Ohmic contact are Ti/Al/Ni/Au with a total thickness of 400 nm. After I-V and C-V characterization, an alpha spectrum from a 0.9 uCi Am-241 button source has been acquired, showing a well distinguished peak with the central channel number increasing with bias. Given the depleted depth is no more than 12 um GaN epitaxial layer, alpha particles only partially deposited their energies. The SRIM/TRIM simulation can help to correlate the experimentally acquired peak shift with the simulated energy deposition. Also, the results from X-ray irradiation will be shown for the detector's transient current response. Lastly, the radiation hardness of the devices was tested via near core irradiation up to 6.8 x 10^{17} n/cm^2 fluence performed at the 500-kW research reactor at the OSU Nuclear Reactor Laboratory and the results will be discussed.