A High Temperature-tolerant and Radiation-resistant In-core Neutron Sensor for Advanced Reactors

PI: Dr. Lei Cao, Dr. Don Miller – The Ohio State University

Collaborators: N/A

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ABSTRACT:

The objective of this proposal is to develop an understanding of the fundamental materials properties and electronic response of a gallium nitride (GaN) semiconductor device in an environment of high temperature and intense neutron field. Since the electronic properties of GaN are intertwined with as-grown defects, neutron-induced damage, and high temperature, an *in-situ* study scheme is the key. We propose: 1) an in-situ study of electronic properties of GaN device such as *I-V*, leakage current, and charge collection efficiency (CCE) in high temperature using an external neutron beam; 2) an in-core irradiation of GaN up to the highest yet fast neutron fluence and an off-line performance evaluation; and 3) a simulation for guiding the experiments and a validation of the model using experimental data. Based on the results of this study, a small and reliable GaN neutron sensor will be fabricated with the goals of withstanding high neutron fluence and high temperature (800 °C), isolating gamma background, and operating in a wide dynamic range. Such a device has broad applications in light water small modular reactors and high temperature reactors either as an in-core or an ex-core neutron flux detector.