

SECTION A. Project Title: Understanding irradiation behaviors of ultrawide bandgap Ga₂O₃ high temperature sensor materials for advanced nuclear reactor systems – North Carolina State University**SECTION B. Project Description**

North Carolina State University (NCSU) proposes to examine the fundamental irradiation behaviors of emerging ultrawide bandgap Ga₂O₃ high temperature sensor materials through a series of well-designed irradiation experiments and post-irradiation examination (PIE) tests. Due to its unique physical properties, especially intrinsic high radiation resistance and excellent temperature tolerance, Ga₂O₃ has been considered as a promising candidate material for several key nuclear sensing and radiation hardened electronics applications for nuclear instrumentation of next-generation nuclear reactor systems and strategic fuel cycle technologies. The proposed work fully leverages the expertise of NCSU in nuclear sensor materials development, the NCSU Nuclear Reactor Program (a Nuclear Science User Facilities (NSUF) User Facility) neutron irradiation and positron measurements capabilities, and the post irradiation examination capabilities of Idaho National Laboratory (INL) and Center for Advanced Energy Studies (CAES). The proposed research will focus on two key parts to achieve the proposed project objective: (1) performing systematic neutron irradiation and positron annihilation lifetime spectroscopy (PALS) and Doppler broadening spectroscopy (DBS) analysis at NCSU's PULSTAR Nuclear Reactor; and (2) conducting targeted post irradiation examination (PIE) at CAES to measure the changes of microstructures, compositions and functional properties of Ga₂O₃ sensor materials. Special emphasis will be put on the evaluation of the impact of irradiation and temperature on Ga₂O₃, i.e., clarifying the neutron influence-rate dependence of Ga₂O₃ performance at different working temperatures.

SECTION C. Environmental Aspects / Potential Sources of Impact

The proposed work in this project involves the irradiation of Ga₂O₃ sensor materials at NCSU's PULSTAR reactor and post irradiation examination at CAES. After the irradiation, the samples will be radioactive. The researchers plan to irradiate 12 sample sets (total 24 samples) (each sample has a size of 5.0mmx5.0mmx0.5mm). The NCSU PULSTAR reactor and the CAES are two DOE NSUF Partner Facilities and perform irradiation and post irradiation examination on a routine basis to serve the users. Both facilities have already established standard procedures to handle and ship radioactive materials. Small amounts of low-level radioactive waste will be generated, handled, and disposed of following routine facility procedures.

SECTION D. Determine the Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 CFR 1021, Appendix B, give the appropriate justification, and the approval date.

Note: For Categorical Exclusions (CXs) the proposed action must not: 1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, including requirements of DOE orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) adversely affect environmentally sensitive resources. In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not "connected" nor "related" (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

References: B3.6 Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). For purposes of this category, "demonstration actions" means actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment. Demonstration actions frequently follow research and development and pilot projects that are directed at establishing proof of concept.

Justification: The activity consists of an investigation of the deployment of innovative Ga₂O₃ sensors in advanced nuclear energy systems.

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) Yes No

Approved by Jason Anderson, DOE-ID NEPA Compliance Officer, on 08/31/2021.