

SECTION A. Project Title: Multipurpose, Radiation- and Temperature-Resistant Semiconductor Radiation Detectors for Advanced Process Monitoring and Nuclear Safeguards – University of South Carolina**SECTION B. Project Description**

The University of South Carolina, in collaboration with Brookhaven National Laboratory, Fisk University, and Westinghouse Electric Company, proposes to develop an innovative multi-purpose complete radiation detection system based on highly resistive n-type 4H-SiC epitaxial layers for nuclear material control and accounting in nuclear fuel storage and reprocessing facilities to enhance nuclear safeguards. The proposed detection system will be capable of monitoring neutrons, gamma-rays, x-rays, and alpha particles at very high temperature and extreme radiation conditions. The specific scopes of the program are:

- Demonstrate innovative 4H-SiC p-n diode solid-state neutron detectors using an enriched boron (^{10}B) diffused neutron converter layer with thin Ni-B contact layer a-top.
- Demonstrate high barrier M-S-M Schottky diodes (SBD) based on 4H-SiC epitaxial layers with passivated guard rings for alpha, x-ray and gamma-ray detection.
- Large area pixilated detector arrays (both p-n diodes and SBDs); the number, position and size of the pixilated detector elements within the array structure will be evaluated for optimal performance.
- Identify the origin and nature of the performance-limiting defects within the devices, and establish steps to reduce their concentrations through modification in 4H-SiC epitaxial layer growth and detector fabrication procedures for high resolution devices.
- Identify key issues for sustainable long-term operation in harsh environment, such as innovative contacts, detector encapsulation, and electronic packaging.
- Investigate front-end readout electronics (preamplifiers and application-specific integrated circuits ASICs) that are capable of operating in the same harsh environments.

SECTION C. Environmental Aspects / Potential Sources of Impact

Radioactive Material Use - At University of South Carolina, sealed and low-dose radioactive sources such as ^{137}Cs (5 μCi) and ^{241}Am (0.1 μCi) will be used in a confined storage box located in an isolated and dedicated laboratory for nuclear radiation detection testing. This laboratory facility and the sources are regularly monitored and certified by Environment Health and Safety (EHS) department of University of South Carolina. The experiments will be carried out by trained personal.

At Brookhaven National Laboratory (BNL), sealed radioactive sources such as ^{137}Cs , ^{133}Ba , and ^{241}Am with activities of $<8 \mu\text{Ci}$, will be used in a dedicated laboratory areas for nuclear radiation detection testing by a trained and qualified personal. All measurement will be conducted in Bldg. 815, Lab D6 in compliance to ESR#181 (Experimental Safety Review), approved by the Department Non-proliferation and National Security, which applies to all existing or proposed experimental activities conducted under BNL control. This laboratory facility and the sources are regularly monitored and controlled by the Sealed Radioactive Source Accountability and Control Program at BNL.

At Westinghouse facilities at Pittsburgh, PA, sealed radioactive sources such as ^{137}Cs and ^{60}Co gamma, ^{241}Am -Be and ^{252}Cf neutron, and low-intensity alpha sources will be used in dedicated radioactive laboratory. The facility has a state PADEP license for the radioactive materials. The license number is PA-0198 and it does include the full scope of their work.

There will be no generation of any radioactive waste material at any of the aforementioned facilities.

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.

DOE-ID NEPA CX DETERMINATION

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). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial development.

Justification: The activity consists of university-scale research aimed at developing a radiation detection system.

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

Approved by Jason Sturm, DOE-ID NEPA Compliance Officer on 08/03/2017