DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-17-081

SECTION A. Project Title: Radiation Effects on Optical Fiber Sensor Fused Smart Alloy Parts with Graded Alloy Composition Manufactured by Additive Manufacturing Processes – The University of Pittsburgh

SECTION B. Project Description

The University of Pittsburgh, in collaboration with Westinghouse Radiation Laboratories, Corning Inc., and the Massachusetts Institute of Technology (MIT), proposes to develop robust fiber optical sensors and their packages for high spatial resolution measurements in nuclear reactor cores. This will be accomplished by:

Scope I: The research team will use advanced laser fabrication schemes such as femtosecond ultrafast laser processing and chemical regenerative processes to produce fiber Bragg grating point sensors that are temperature-stable up to 900^{o}C in radiation-harden silica fibers. The project will also develop various temperature-stable sensors in sapphire fibers including fiber Fabry-Perot (FP) sensors fabricated on the tip of sapphire fibers and fiber Bragg grating sensor. Systematic in-core testing and PIE will be performed.
Scope II: Using advanced laser manufacturing techniques and through specialty fiber dopants, the project will seek to drastically improve the temperature stability of distributed fiber sensors from the room temperature operation to high-temperature applications up to 900^{o}C using distributed fiber sensing schemes such as Rayleigh backscattering optical frequency domain reflectometry (R-OFDR). The project seeks to demonstrate in-core fiber sensors that can perform high spatial resolution measurements with 1-cm spatial resolution up to 900^{o}C in radiation environments across the active regions of the MITR reactor core (24 inch).
Scope III: Using additive manufacturing as a versatile fiber packaging tool, the project seeks to study and to explore how protective fiber packages can improve the survivability and longevity of fiber sensors. Both ceramic and metal parts will be used to embed silica and sapphire fiber sensors to improve their mechanic and radiation survivability. Metal with low neutron activation such as Ti and those with high neutron activation (e.g. Ni:Fe alloy) will be compared. Through these studies, the project aims to shed light on how silica or sapphire fibers interact with their surrounding matrices in highly radioactive environments.
Scope IV: In addition to lead-out experiments, irradiated fiber samples embedded in metal and ceramic matrices to will be sent to the Westinghouse MCOE in Pittsburgh for PIE. The irradiated section of fiber will be analyzed and retained at the MCOE. These include both sapphire and silica fiber.

SECTION C. Environmental Aspects / Potential Sources of Impact

Chemical Use/Storage – Methanol-base cleaning solution, HF and KOH solution for glass etching, metal plating solutions (Ni, Cu, Fe, etc.), and other small quantity organic and in-organic chemicals will be used.

Chemical Waste Disposal – The project will generate chemical waste. The University of Pittsburgh has a well-established chemical waste disposal procedure, managed through the Environmental Health and Safety Department. All university students and faculty involved in handling chemical will go through chemical hygiene training and other relevant training. Chemical waste will be properly stored, removed, and disposed according to University, PA state government, and federal regulations.

Industrial Waste - The project will generate small quantity of industry waste such as scrapped metal pieces (Ni alloy, Fe-alloy, etc). These industry wastes are not toxic. The waste will be disposed properly under the supervision of the University of EHS department.

Radioactive Material Use/Radioactive Waste Generation – At the Westinghouse facility, two Co-60 gamma sources will be utilized in a hot cell to irradiate samples prior to sending to the MIT reactor. After irradiation in the MIT reactor, samples will be returned to Westinghouse for PIE within the hot cell. Both MIT and Westinghouse have well-established procedures to handle radioactive materials and dispose of radioactive waste. No radiological work will be performed at the University of Pittsburgh.

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). 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 the use of additive manufacturing to develop fiber optical sensors.

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 09/06/2017