High Spatial Resolution Distributed Fiber-Optic Sensor Networks for Reactors and Fuel Cycle Systems

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Collaborators: Westinghouse Electric Company LLC
Corning Incorporated

Program: NEET- 2.6 Advanced Measurement Sensor Technology

ABSTRACT:

The safe and efficient operation of nuclear reactors and various fuel cycle processes demand gathering multitude information with high spatial resolution. In this NEET program, a team led by the University of Pittsburgh proposes to develop multi-functional, remotely activated, distributed fiber optical sensor networks to monitor a number of parameters critical to the safety of nuclear power systems. These sensor networks will have high sensitivity, high accuracy, and high spatial resolutions.

Researchers from the University of Pittsburgh will work with scientists in Corning Incorporated, a world-leading optical fiber company, to develop radiation-hard, application-specific air-hole microstructural fibers for multi-parameter measurements of temperature, pressure, and hydrogen concentration. Through ingenious fiber structure designs and the integration of nano-composite coating, this research program aims to enhance functionalities of distributed fiber sensing schemes way beyond their traditional uses for temperature and strain measurements.

As passive elements, distributed fiber sensors' performance and applications have been limited by their total passivity. Passive sensor elements cannot actively adapt to a changing environment to maintain their performance. This proposal will develop an active distributed fiber sensing technology powered by in-fiber light. This will allow distributed fiber sensors to actively adjust its sensitivity and functionality on-the-fly while achieving high spatial resolution sensing for nuclear power systems. The fiber sensors will be tested in Westinghouse Electric Company's radiation laboratory to evaluate their performance in both normal and post-accident scenarios.

The new distributed fiber sensing capabilities and new radiation-hard microstructural fibers developed by this program will address critical technology gaps for monitoring advanced reactors and fuel cycle systems under both normal operation and in post-accident scenarios.

The proposed research efforts have the potential to fundamentally transform distributed fiber sensing technology by expanding its functionality; improving its sensitivity; and enhancing its adaptability over wide operational environments. For the first time to our best knowledge, radiation-resistant features will be integrated into air-hole microstructural fiber design and fabrication specific to nuclear energy applications. The program will change the landscape of radiation-hard fibers.