Novel Optical Spectroscopy System to Enhance VCU Advanced Materials Research and Education

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ABSTRACT:

The Virginia Commonwealth University (VCU) Departments of Mechanical and Nuclear Engineering, Chemistry, and Physics will strengthen their academic and research capabilities in the core area of material characterization and analysis for nuclear fuel cycle and waste management of advanced nuclear technology. This strengthening will be through adding capabilities to measure dynamic physical properties and speciation, supplementing the current Radiochemistry, Laser Spectroscopy, and Nano-nuclear & Radiation Processing, and Materials and Manufacturing Research Center at VCU. The proposed novel optical spectroscopy system (NOSS, $225,163 in total)—comprising a tunable laser module, a spectrometer, and high resistance optical fiber assemblies—will be integrated to the existing Neodymium Yttrium Aluminum Garnet (Nd:YAG) Q-Smart 45 laser currently available to the project team. This project will aid Office of Nuclear Energy supported training and research including VCU's 2023 integrated university project establishing a research, education, and training Center of Excellence for nuclear fuel cycle and waste management of advanced reactors.

The NOSS will allow VCU to include advanced characterization and analyses of special nuclear materials in our research and educational capabilities. These analyses will be related to research & education in areas of interest to the Department of Energy (DOE), such as Materials for Advanced Reactor Technologies, Salt Behavior in Molten Salt Reactors, and Material Recovery and Waste Form Development. The NOSS will improve and open up research and teaching opportunities in nuclear fuel cycle technology, material science, and nuclear chemical physics. The proposed objectives for the addition of NOSS are:

(1) To enhance the measurements of material dynamic properties (e.g., self-diffusion, etc.) for various alloys (e.g., ferritic martensitic steels, high molybdenum alloys exposure to light water reactor conditions) and materials for advanced reactors (e.g., advanced ceramic cladding, molten halide salts) – applicable to the current on-going NEUP and DOE National Laboratory funded projects;
(2) To improve detection of short-lived transient species in the optically excited region on timescales of ps-ns in addition to bulk measurements on timescales of ms-mins. This identification is critical in the corrosion and nucleation processes that can improve the design of advanced reactors, plant-life extension evaluations; and
(3) To enhance the nuclear education mission at VCU by training students in MNE, Chemistry and Physics—by adding a laboratory module on NOSS use & data analysis for (i) material science, (ii) instrumental analysis, and (iii) nuclear detection & measurement courses.

The NOSS will strategically enhance both the research & teaching capabilities at VCU. The proposed NOSS will be utilized by at least 50 students per year and increase the employment chances of undergraduate and graduate students. As part of VCU's overarching mission as a Minority Serving Institution, a large focus will be on impacting students from underrepresented minority and underserved backgrounds.