# X-ray Diffraction System to Enhance VCU Nuclear Materials Research and Education

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**Program**:  Infrastructure

**ABSTRACT:**
The Department of Mechanical and Nuclear Engineering (MNE) at Virginia Commonwealth University (VCU) proposes to strengthen its academic and research capabilities in the core area of nuclear material characterization and detection technology. The main focus of this enhancement will be on obtaining the benchtop X-ray diffraction (XRD) system in advancing material science and analysis in a controlled environment operating in the range of room temperature up to 500□C, supplementing the current capabilities at VCU. This proposed sophisticated system will allow VCU-MNE to incorporate crystal structure analyses of special nuclear materials relating to research and 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 XRD will strategically improve and open up research and teaching opportunities in material science, nuclear fuel cycle technology, and nuclear forensics. The proposed objectives of the above instrumentation are:

(1) To enhance the characterization of crystalline materials and surface chemistry of various alloys (e.g., ferritic martensitic steels, high molybdenum alloys exposure to light water reactors) and materials for advanced reactors (e.g., advanced ceramic cladding, molten halide salts) – applicable to the current ongoing NEUP and National Laboratory funded projects;
(2) To understand the effect of mechanical stress on the corrosion behavior by studying the phase composition of solid materials under extreme environments. The identification of phase composition is critical for an understanding of corrosion processes which helps to design advanced reactors and decide the plant-life extension;
(3) To enhance the nuclear education mission at VCU by training undergraduate and graduate students in MNE—by adding a laboratory module on the use of XRD and data analysis to (i) material science, (ii) nuclear security, safety and safeguards, and (iii) nuclear detection and measurement courses; and
(4) To enhance VCU-MNE research capabilities across multiple areas of nuclear science, engineering, and technology.

This instrument will strategically enhance both the teaching and research domains at VCU-MNE. The proposed implementation will be utilized by at least 50 students per year. In addition, it will bring new research capabilities to the program in the areas of nuclear materials characterization, detection, and accountability.