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# Energy-resolved Neutron Imaging of Materials for Nuclear Energy

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Nuclear energy technologies are used to produce a significant portion of the world's electricity, and this will continue to be true as numerous countries build or expand their nuclear power plant fleets. The continued use and growth of nuclear energy globally, however, faces significant materials science and engineering challenges. These include the development of advanced nuclear fuel materials with accident-tolerant properties, structural materials with high corrosion resistances, and waste forms appropriate for geological disposition. Energy-resolved neutron imaging techniques such as neutron energy resonance imaging and Bragg edge imaging offer the capability to nondestructively characterize, understand, and explore materials for nuclear energy. Development of these techniques has grown exponentially as pulsed neutron sources and neutron detectors continue to advance. Information that can be obtained and spatially resolved includes isotopic composition, temperature, strain, and stress, as well as crystallographic phase and orientation. Efforts are underway at Oak Ridge National Laboratory to develop neutron imaging capabilities to study materials for nuclear energy. This discussion will focus on the recent progress to develop and leverage energy-resolved neutron imaging techniques to study materials with applications in the nuclear energy sector and will include recent experimental results. For example, we have mapped the three-dimensional spatial distribution of uranium and gadolinium in UO3-Gd2O3 spheres using neutron energy resonance imaging to understand the chemical process used to produce them. Neutrons in the epithermal energy region (roughly 0.1 eV to 1 keV) were used. Results from preliminary studies using Bragg edge imaging to understand the conversion of spherical uranium-containing kernels from oxide to either carbide or nitride, which are of interest for use in several proposed advanced nuclear fuel forms, will also be addressed.

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