Using Lasers to Characterize Structure and Properties of Materials used in the Energy Industry

In this presentation I will discuss recent efforts to characterize both material microstructure and materials properties using laser ultrasonics and laser-based thermal wave imaging. Three examples will be given that are germane to the energy industry. The first involves using laser resonant ultrasound to perform in-situ characterization of grain restructuring in nuclear fuel surrogates. The second example involves using picosecond ultrasonics to character subsurface grain structure in model fuel cell materials. The third example involves using laser-based thermal wave imaging to characterize the influence of individual microstructural features on thermal transport in ion irradiated oxide fuel surrogates. This discussion will be followed by a brief discussion of plans to implement similar experiments to characterize nuclear fuel under neutron irradiation inside test reactors run by the Department of Energy.

Hurley Bio:

David Hurley received a Ph.D. in Materials Science and Engineering from Johns Hopkins University and is currently a Directorate Fellow at Idaho National Laboratory (INL). Since coming to INL, he has focused on characterizing material behavior in extreme environments. Dr. Hurley's research background and expertise encompass elements of physics, mechanical engineering and materials science. This middle ground between science and engineering has given him a unique perspective on many materials issues facing the nuclear industry. Connecting microstructure to mechanical properties of nuclear fuel provides an important example of this perspective. As part of this effort his group at INL contributed significantly to the foundation of a new field of mechanical characterization termed laser resonant ultrasonic spectroscopy. On the science side he served as experimental coordinator and executive board member for the Center for Materials Science of Nuclear Fuel. This Energy Frontier Research Center was focused on development of a first-principles understanding of the effect of irradiation-induced defects on thermal transport in oxide nuclear fuels. One of his more notable accomplishments within the CMSNF was leading a team that isolated thermal transport signatures of specific microstructural features. Examples include the first measurement of the Kapitza resistance of a bicrystal boundary and the identification of a cooperative effect between oxygen vacancies and grain boundaries in oxide fuel.

Currently, Dr. Hurley is the director of the Center for Thermal Energy Transport under Irradiation. The mission of this $11.5M Energy Frontier Research Center is to provide the foundational work necessary to accurately model and ultimately control electron- and phonon-mediated thermal transport in 5f electron materials in extreme irradiation environments. Dr. Hurley is also the Deputy Technical Director of the In-pile Instrumentation program, which is charged with developing unique instruments to characterize the behavior of fuels and materials during irradiation tests conducted at the Nuclear Science User Facility Reactors.