Mechanical and Elastic Properties of Advanced Nuclear Fuels

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Abstract

The Office of Nuclear Energy work at LANL currently focuses on the investigation of novel ceramic nuclear fuel concepts under the Advanced Fuels Campaign program. One of the material properties targeted for improved performance of nuclear fuels is fracture toughness. New materials or composite fuel architectures that offer greater resistance to cracking under the extreme environments encountered during nuclear reactor service would provide significant improvements to steady state (e.g. heat transfer, fuel redistribution) and transient (e.g. radionucleide release at elevated temperatures) conditions. Options currently under investigation include 'nontraditional' nuclear fuels designated around high uranium density. These include uranium silicides, uranium borides, and composite fuel materials constructed of these and uranium nitride or uranium dioxide. Preliminary screening of the thermophysical and thermodynamic properties of these concepts has provided confidence in their soundness, but evaluation of their mechanical properties at relevant temperatures must be executed in order to support further study.

Nanoindentation and Resonant Ultrasound Spectroscopy (RUS) has seen limited use for evaluation of the mechanical properties of nuclear fuel materials. The mechanical properties of nuclear fuels, and ceramics in particular, can be challenging to assess through conventional mechanical testing methods. Nontraditional fuels exhibit a range of attractive material properties for nuclear fuel applications, but little is known regarding their mechanical behavior.

At the Fuel Research Laboratory at LANL we have a unique set up of equipment for the characterization of nuclear fuel materials. In this seminar I will present the capabilities we have in our lab and the mechanical properties characterization by nanoindentation and RUS for these fuels in the unirradiated state.

Bio

Dr. Ursula Carvajal-Nunez received her B.S. in 2007 in Chemistry, a M.S. in 2009 in Material Engineering from University Complutense of Madrid (Spain) and Ph.D. degree in 2014 from the Delft University of Technology (Netherlands) in Applied Science. The Ph.D. experimental research was performed at the Institute of Transuranics Elements in Germany. For her dissertation, Ursula worked on the synthesis and characterization of advanced nuclear fuels forms such as plutonium nitrides and carbides. Ursula moved to the U.S. in 2015 and spent one year as a postdoctoral researcher in the Center for Integrated Nanotechnologies at LANL working on determination of mechanical properties of nuclear fuels.

Currently Ursula is a postdoctoral researcher in the Nuclear Fuel Research Laboratory group which is part of the Materials Science and Technology division at LANL. Her current work focuses on thermophysical and mechanical properties of advanced nuclear fuels, ceramics and alloys.