High Temperature Nanoindentation of Advanced Accident Tolerant Fuels

D. Frazer[a], J.T. White[a], T.A Saleh[a]

[a] Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, USA

The Fukushima accident prompted a significant amount of work on developing advanced accident tolerant fuels for light water reactors. One of the properties that these advanced fuel forms are trying to improve is the thermal conductivity in the fuel. Thorough these campaigns a variety of different fuel forms have been developed and proposed such as UN, U_3Si_2, and UO_2 with additives. While the processing and thermophysical properties are important in understanding the fuel performance, there is a need for mechanical properties of these advanced fuel forms to evaluate phenomenon like the pellet clad mechanical interaction during operation. Important material properties that are needed for modeling the pellet clad mechanical interactions of these advanced accident tolerant fuel forms are the elastic modulus, fracture properties and creep of the fuel at the operating temperature. A technique that can measure the mechanical properties of small batches of developmental fuel at operating temperature is elevated temperature nanoindentation. However, a main challenge with performing elevated temperature nanoindentation on these uranium based compounds is their sensitivity to oxygen. This difficulty makes the mechanical property data of these uranium based compounds scare at elevated temperatures. A Hyistron Triboindenter has been modified to perform high temperature nanoindentation in an inert or reducing environment to measure the mechanical properties of uranium based compounds at elevated temperatures. These mechanical properties can then be feed into models to evaluate the pellet clad mechanical interactions of this new advanced accident tolerant fuel forms. In this work we perform elevated temperature nanoindentation of UN, U_3Si_2 and other accident tolerant fuel forms to evaluate their mechanical properties over temperature.