Mesoscale Modeling and Experiments for Predicting the Thermal Conductivity of UZr Fuels

F. Badry[1], M. Gomaa Abdoelatef [1], Moiz Butt[1], Sean McDeavitt[1], Mitch Meyer[2], Karim Ahmed[1]

[1] Nuclear Engineering Department, Texas A&M University, TX, USA.
[2] Idaho National Laboratory, ID, USA.

Uranium-Zirconium fuel is the leading nuclear fuel candidate for fast reactors. The thermal conductivity of the nuclear fuel is of paramount importance for both the safety and performance of nuclear reactors. The effective thermal conductivity of nuclear fuels strongly depends on the underlying microstructure. We conducted a combined experimental and computational work to investigate this relationship in UZr fuel pellets. A combined phase-field and finite-element model was developed to simulate effective thermal conductivity of these pellets. The model accounts for the thermal resistance of the interfaces and able to predict the effective conductivity of the fuel for different fuel compositions, microstructures, and temperatures. The model has been implemented in the MOOSE framework. A companion experimental work was also conducted to correlate the effective thermal conductivity of U-10Zr pellets measured using the laser flash method and the underlying microstructure quantified via 3D X-ray tomography. The model was validated against the experimental data. The model results agree well with the experimental data obtained in this work and from literature.