Experimentally Validated Mesoscale Modeling of Thermal Conductivity of a UO_2-BeO Composite Nuclear Fuel

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ABSTRACT

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 UO_2-BeO fuel composites. A combined phase-field and finite-element model was developed to simulate effective thermal conductivity of UO_2-BeO fuel composites. The model accounts for the thermal resistance of the UO_2-BeO interface 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. The model predicts higher effective thermal conductivity of UO_2-BeO fuel for microstructures with continuous distribution of second phase than microstructures with dispersed second phase particles for the same volume fraction and temperature. The model results agree well with the experimental data obtained in this work and from literature.