Validation of Thermal Conductivity Technique for Low Conductivity Oxides at Extreme Temperatures

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The modelling and experimental measurements of thermal properties of materials at extreme temperatures is an increasing challenge. For many modern techniques a semi-infinite assumption is used to simplify calculations. However, this assumption is invalidated in systems emitting large amounts of thermal radiation. In the finite calculation, we face challenges from geometrical changes in material structure and nonlinearity that is induced with radiative boundaries causing an increased dependence on spatially and temporally varying properties.

Using a newly designed method to measure thermal conductivity at high temperatures utilizing laser-based heating we seek to remedy these issues by only considering small changes in temperature in these regions. In our experiment a continuous wave beam is applied to heat the sample surface to a steady state temperature followed by a small pulse to increase the sample surface to a second steady state temperature. The temperature at the surface is measured through radiative pyrometry as a function of perturbed laser power to give us a function of change in laser power and change in temperature. In this work we further confirm the validity of this technique utilizing both analytical and finite numerical solutions to back out the temperature dependent conductivities of UO_2 and other low conductivity oxides in the 1800 K+ regions.