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New insights into the thermophysical properties of materials using electrostatic levitation

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Electrostatic Levitation (ESL) allows non-contact measurement of the thermophysical properties of materials in both the solid and liquid states, from over 3500C to deep in the undercooled liquid, for a wide range of materials including metals, ceramics, and semiconductors. The combination of ESL with synchrotron x-ray structural measurements allows unprecedented insight into the relation between structure and properties in reactive and undercooled materials. Of the many different thermophysical and thermomechanical properties that have been measured using levitation techniques, four will be discussed. The density of the sample is calculated from the shape of the free surface in video images and the known mass. The surface tension and viscosity are determined from the natural frequency and damping, respectively, of free surface oscillations. Creep is measured by observing the changes in free surface shape due to centrifugal acceleration in a rapidly rotating drop. Combined with the x-ray structure measurements, these mechanical measurements can reveal the development of texture and strain-induced phase transformations. Any of these measurements may be performed on the same sample, in the same environment, at the same time as the x-ray structural measurements, allowing direct observation of the effect of changes in the structure of the sample on the thermophysical properties.