Thermophysical Properties of Nickel-Based Superalloys

Twentieth Symposium on Thermophysical Properties
Boulder, CO
June 24-29, 2019

Michael P. SanSoucie (NASA MSFC)
Jan R. Rogers (NASA MSFC)
Jannatun Nawer (Tufts University)
Molly Pleskus (Tufts University)
Douglas M. Matson (Tufts University)

The NASA Marshall Space Flight Center (MSFC) electrostatic levitation (ESL) laboratory has a long history of providing materials research and thermophysical property data. The lab can measure thermophysical properties such as density, surface tension, and viscosity of liquid materials, including elements, alloys, glasses, ceramics, and oxides.

Nickel-based superalloys (e.g. Inconel, Hastelloy, and Waspaloy) have many high performance applications, including turbine engines for aerospace. Superalloy parts are typically manufactured by casting and forging. These processes generate both polycrystalline and monocrystalline parts. A relatively new method of fabrication of turbine disk materials is additive manufacturing, which is typically done for aerospace parts by powder-bed methods such as selective laser melting (SLM).

Accurate modeling of casting and forging, as well as additively manufacturing processes, require thermophysical properties (density, surface tension, and viscosity).

The thermophysical properties of liquid nickel-based superalloys, both conventional and additively manufactured, were measured at several temperatures in both undercooled and superheated condition. Surface tension and viscosity was measured using the oscillating drop method and density and thermal expansion was measured using edge detection methods.