Establishment of Noncontact AC Calorimetry of High-Temperature Melts using Solid Platinum Spheres as a Reference

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Wunderlich and Fecht have developed the ac calorimetry, which has been applied to electromagnetically levitated metallic melts. The molar heat capacity and hemispherical total emissivity were determined at elevated temperatures. In principle, the thermal conductivity would be also determined from the analysis of the phase difference between heating power and temperature response. However, surface convections existing on the droplets make it difficult to measure the intrinsic thermal conductivity. In the meantime, Yasuda et al. have reported that an electromagnetically levitated droplet behaves as a hard sphere in a static magnetic field. The motion of the droplet and convections on the surface were effectively suppressed due to the Lorentz force acting on the droplet caused by interaction with the static magnetic field.

The present authors have come up with a new idea, which is the noncontact ac calorimetry incorporating static magnetic field to realize the measurement of the intrinsic thermal conductivity of molten silicon. An electromagnetic levitator was equipped in a superconducting magnet. The silicon droplet was periodically heated by a laser irradiation on the top of the melt. The temperature response was measured from the bottom of the melt using a two-color pyrometer. The details of the measurements on molten silicon will be separately reported in this symposium by the present authors.

In the present study, in order to establish the experimental method of the above-mentioned new ac calorimetry, the thermal transport properties of solid platinum have been determined as a reference. The solid platinum sphere was heated by a modulated laser. The thermal transport properties such as molar heat capacity, total hemispherical emissivity and thermal conductivity of the platinum sample have been successfully measured at elevated temperatures.

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