

Non-Contact Electromagnetic Induction Calorimetry for Metallic Specimen at High Temperatures

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Calorimetry of high-temperature metallic alloys in the liquid phase with conventional thermoanalytic equipment is complicated by the ubiquitous presence of container wall reactions. Similar considerations hold for the undercooled liquid phase where the contact between the specimen and container causes heterogeneous nucleation limiting the accessibility of the undercooled liquid phase for thermoanalytical measurements. Non-contact calorimetry in an electromagnetic (em) levitation device was conceived to alleviate these problems. A specimen is levitated in a radio-frequency em-field and the heating power input to the specimen is modulated. From the temperature response measured with a pyrometer and knowing the amplitude of the modulated heating power input, the heat capacity of the specimen can be calculated if the modulation frequency has been properly chosen. This far the method has been applied in the regime of low Biot numbers, $Bi < 0.02$, where the time scale of internal heat transport is much faster than that of external heat loss. In this case an adiabatic or isothermal modulation frequency can be found where the effects of the finite thermal conductivity and radiative and convective heat losses can be neglected. This may no longer be possible for high temperature alloys of technological interest. We describe a coupled reservoir model consisting of an inductively and a conductively heated volume part which allows to extend the previous analysis to the case of higher Biot numbers. It is demonstrated that when the temperature variation and the phase shift between heating power modulation and temperature response are measured at each reservoir as a function of the modulation frequency the specific heat capacity and thermal transport coefficients can be obtained also in the case of larger Biot numbers.