Experimental Determination of Phase-Equilibria and Thermo-Physical Properties at Temperatures up to 3000°C by Aerodynamic-Acoustic Levitation

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ABSTRACT

The aerodynamic-acoustic levitation is a very unique experimental technique for the determination of thermo-physical properties like melting points, liquidus and phase-transition temperatures, thermal expansion, density, surface tension and viscosities at temperatures up to 3000°C and also in the undercooled liquid state.

Samples of 3-5mm diameter are levitated in a heated gas stream (air, N_2, O_2, Ar …), stabilized by a 3-dimensional ultrasonic sound field (~22 kHz) and surface-heated by two CO_2-lasers.

For in-situ characterization of the samples a high-speed and -resolution pyrometer is combined with a digital high-speed video camera system, that allows the direct observation and correlation of thermal effects in the temperature-time curve like melting, recalescence, phase transitions with the recorded microstructural changes in the sample.

This method enables direct access to high temperature phase-equilibria at temperatures above 2000°C and the experimental data will be used as input for the optimization of the adjustable parameters of the Gibbs energy functions according the CALPHAD method.

Additionally it is possible to control the aero-acoustic levitation forces along single or all three acoustic axis of the acoustic system to induce and measure dynamic oscillations in liquids at very high temperatures and also in the highly undercooled state, from which liquid surface tension and viscosity values can be obtained.

By amplitude modulation of the acoustic forces and measuring the resonant frequencies and the decay of oscillation surface tension and viscosity values can be determined, that provide the basis for modeling of these thermo-physical properties over wider composition ranges.