Investigation of Oxide Systems by Aero-Acoustic Levitation

F. GREFFRATH

Institute of Mineral Engineering (GHI), RWTH Aachen, Germany

ABSTRACT

Since early 2011, the Institute of Mineral Engineering (GHI) of RWTH Aachen University operates the worldwide unique fully automatic aero-acoustic levitator for the containerless melting of non-metallic materials at temperatures up to 3000° *C*.

This unique method allows for the synthesis of metastable phases and disequilibria in matter and provides insight into the thermodynamics and kinetics of their formation as well as their influence on material characteristics.

The device is equipped with two CO_2-Lasers with 240 W power each as well as high speed camera and pyrometer systems, allowing for the documentation of melting and solidification processes accompanied by synchronous temperature measurement on the kilohertz scale.

Within this device, sample materials will be prepared into spherical shapes of 2–3 mm diameter, levitated by means of a Bernoulli nozzle and heated up beyond their melting point. By cooling down with variable rates, undercooling to solidification can be documented. Glass formation and crystallization can be observed in real time with the camera.

This includes observation of dynamic effects like convection as well as localization of nucleation and dissolution for subsequent SEM analyses of the relevant parts of the sample, which is an integral step of the experimental procedure.

The objective of the current presentation is to give an introduction into the apparatus and show some results that have been derived from the investigations of the ternary Al_2O_3-SiO_2-ZrO_2 system.

The method of measuring the melting point temperature with help of the recalescence, i.e. the release of latent heat upon recrystallization, is exemplified by a high-speed camera

capture and a temperature plot of the single Al_2O_3 phase. Using this method the liquidus line for the binary SiO_2-ZrO_2 system has been determined.

Special attention has been payed to the 2-liq miscibility gap and its metastable extension. Primary crystallization, the meta-stable differentiation of the droplets and the confirmed immiscibility of the liquids are documented by SEM and TEM micrographs. Finally, further experimental potential and limitations of the test rig are discussed.