

Study of thermophysical properties of melts at very high temperature by aerodynamic levitation



Abstract: Density, surface tension, and viscosity of melts play a key role in material processes such as metallurgy, fusion casting of ceramics, glass production... It is needed to quantify, understand, and model the effects of the temperature, the atmosphere, the pressure, and the composition of the melts on these thermophysical properties at high temperature. This knowledge is essential both at the fundamental level for a better knowledge of the basic mechanisms and at the technological level to improve the performance of processes which are conducted at temperatures ever increasing.

Measuring accurately thermophysical properties at high temperature is very difficult, because of the high temperature conditions and the high chemical reactivity. In addition, numerical simulations allow to get around the experimental difficulties. However, the models are valid only in limited ranges of compositions and temperature due to complicated non-linear relationships.

The laboratory CEMHTI has developed an original device to measure density, surface tension and viscosity at high temperature, up to 2800 K, based on aerodynamic levitation combined with acoustic excitation. The levitator includes a convergent-divergent nozzle that channels a regulated gas flow below a spherical sample (typically 1-4 mm in diameter) placed in the upper cone of the nozzle. The heating is performed using two CO₂ lasers focused onto the sample using

References:

- E. de Bilbao et al. "Corrosion of high alumina refractories by Al₂O₃-CaO slag: thermodynamic and kinetic approaches." *Metall. Res. Technol.* 112(6): 607 (2015)
- L. Henet et al., "Aerodynamic levitation and laser heating. Applications at synchrotron and neutron sources." *Eur. Phys. J. Special Topics*, 196 151–165 (2011)

spherical mirrors from the top and from the bottom through the hole inside the nozzle. The temperature is measured using optical pyrometers and video cameras are used to monitor the sample during the levitation process.

To understand the behaviour of the studied melts, the measurements will be completed by other characterization techniques such as high-temp. XRD, high-temp. NMR, SEM-EDS...

Main objectives of this study:

- To measure the thermophysical properties of melts based on Al₂O₃-CaO-SiO₂-MgO oxides at high temperature.
- To compare the experimental results with ones calculated from models.
- To study the effect of Oxygen partial pressure and total pressure.

Keywords: viscosity, tension surface, density, high temperature, levitation.

Background of the applicant:

Materials science, applied physics.

Location: Laboratory CEMHTI, CNRS UPR3079 1D, avenue de la Recherche Scientifique CS 90055, 45071 Orléans cedex 2

Funding: 3-year contract (Univ. of Orléans) – ~1450 €/month net.

Starting date: October or November, 2019

Contact: Dr. Emmanuel de Bilbao
emmanuel.debilbao@univ-orleans.fr
 Phone: +33 (0)238 255 696