

A New High-Temperature Oscillating Cup Viscometer

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The values of the viscosities of liquid metals and alloys are important for scientific, as well as for technical, use. The determination of reliable viscosity values over a wide temperature range is essential, if the viscosity values are used as an input variable for scientific calculations, as, for example, in solidification simulations. For measuring viscosity values, several methods are known [1]. At high temperatures, the method of the oscillating cup is the most practicable one. Up to now, viscosity measurements below 1950 K were only possible. For high melting alloys, this temperature is not sufficient.

Based on experiments using several oscillating cup viscometers, a new one for temperatures up to 2500 K was constructed. This temperature is reached by employing a graphite tube furnace. Due to the special design of the heater, an excellent uniformity in the temperature distribution in the vertical and radial directions could be reached. The temperature is measured by a C-type thermocouple in the heater, and, above 1050 K, additionally by a pyrometer at the bottom of the crucible. Special care was taken to shield the torsion wire from heat conduction in the pendulum and hot gas. Measurements are carried out in an argon atmosphere at constant pressure. The sample is held in crucibles made from alumina, boron nitride, or graphite.

Torsional oscillations are excited, and the time dependent torsional angle is detected, using a laser and a position sensitive detector (PSD). The values of the oscillation period and the logarithmic decrement are calculated from an analytical function of damped oscillation, which is fitted to the measured pairs of time and torsional angle. From the measured values of the oscillation period and the logarithmic decrement, and the known diameter of the crucible, mass of the sample, and moment of inertia, the viscosity can be calculated. The analysis is based on the working formulas of either Roscoe [2] or Beckwith, Kestin, and Newell [3].

Test measurements were carried out successfully on several pure elements. The first results using high melting alloys will be presented.

[1] T. Iida and R.I.L. Guthrie, "The physical properties of liquid metals", Oxford: Clarendon Press, 1988.

[2] R. Roscoe, *Proc. Phys. Soc.* **72**, 576 (1958).

[3] J. Kestin, G.F. Newell, and Z. Angew, *Math. Phys.* **8**, 433 (1957).