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「きぼう」静電浮遊炉を利用した宇宙実験

Space experiment utilizing the Electrostatic Levitation Furnace in Kibo.

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1. Overview

The electrostatic levitation method which was developed by Rhim et al.[1)] uses Coulomb force between a charged sample and the surrounding electrodes to control the sample position. The JAXA has developed the electrostatic levitation furnace for the ISS (ISS-ELF) as shown Fig. 1. The ISS-ELF measures thermophysical properties of the molten samples with high melting temperature without a container. The samples can be heated over 3000 K in air or Ar at maximum pressure of 2 atm. Moreover after heating, the samples are supercooled and can be changed into high-functional glasses resulting from suppression of heterogeneous crystallization at the interface.

Figure 1. The electrostatic levitation furnace in ISS-Kibo.

2. Thermophysical properties measurement

2.1. Density

The ISS-ELF can measure densities of the molten samples with high melting temperature. The sample is levitated and melted by the semiconductor lasers. It is cooled by turning off the lasers and solidified. The sample volume is measured from analyzing images which are captured during melting. Densities are calculated after remeasurement of the sample weight on ground.

Among the various oxides, lanthanoid sesquioxides (Ln_2O_3) have extremely high melting temperatures on

the order of 2700 K. Due to their high melting temperatures, the thermophysical properties of these compounds have rarely been assessed. In contrast the properties of Gd_2O_3, Tb_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, and Lu_2O_3 were measured successfully by the ISS-ELF [2-5].

2.2. Surface tension and viscosity

The ISS-ELF also can measure surface tensions and viscosities of the samples with high melting temperature by using droplet oscillation method. Capability of the drop oscillation method evaluated using Al_2O_3 [6]. This technique was then applied to molten terbium oxide (Tb_2O_3) whose surface tension and viscosity have not been reported. Good oscillation wave forms were obtained with Tb_2O_3, as shown in Fig.2, from which the surface tension and the viscosity were successfully measured [6].

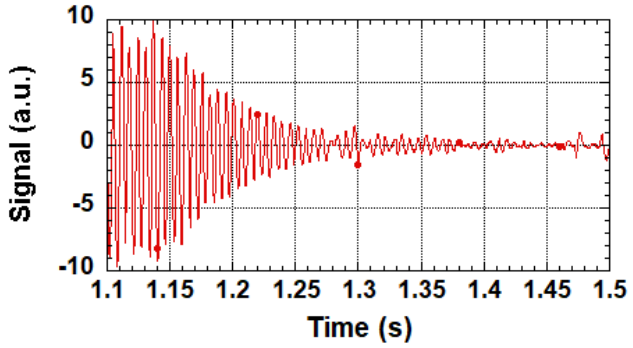

Figure 2. Tb_2O_3 oscillation signal obtained in the ISS-ELF.

3. Utilization program of the ELF

The JAXA provides three utilization programs of the ISS-ELF, that are 1. Basic-research utilization program (Joint research, Free of charged), 2. Private enterprise utilization program (Commissioned research, Charged), and 3. International partnership program. The first program is intended for Japanese universities and public institutes, in which the eight research themes are proceeded. The second program is intended for Japanese private institution and corporation, in which we promote utilization of the ISS-ELF and the ground-ELF, that is in Tsukuba space center. The third program is named as Japan-United States open platform partnership program (JP-USOP3), that is established to enlarge utilization and outcome on the ISS and to encourage the JAXA and the NASA to utilize their experimental equipment mutually. In the third program, four research themes have finished or been proceeded.

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