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「きぼう」搭載用静電浮遊炉を利用した宇宙実験状況

Status of Space Experiments Using the Electrostatic Levitation Furnace onboard the ISS-KIBO.

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Investigations of molten materials at temperatures exceeding 2000°C are highly challenging, primarily due to chemical reactions between the molten samples and their containers. To address this issue, containerless techniques such as electrostatic[1)], electromagnetic[2)] and aerodynamic[3)] levitations have been developed. Among them, our group has developed electrostatic levitation method, which utilizes the Coulomb force between a charged sample and surrounding electrodes. While it is possible to levitate sample on the ground, huge electric field is required to counteract gravity. This brings limitations to ground experiments. First, levitating oxide samples is hard due to low surface charge. Second, preventing electric discharge among electrodes is unfeasible in an inert gas environment. However, these issues find simple solutions in microgravity. Oxide samples can be easily levitated and melted, while metals and alloys can be processed in inert gas to prevent evaporation.

The ISS-ELF[4)] was transported to the ISS in 2015. Then, it was installed to the MSPR (Multi-Purpose Small Payload Rack) in KIBO in the following year. Since then, a variety of oxide and metal samples have been levitated and melted in the facility[5-9)]. The ISS-ELF has a capability to measure thermophysical property of extremely high temperature melts. Density, surface tension, and viscosity can be measured by this facility. Additionally, with the installation of a high-speed camera in 2023, it has become possible to observe rapid solidification process such as crystal growth of molten Zr (Figure 1). Status of thermophysical property measurements will be briefly described in this presentation.

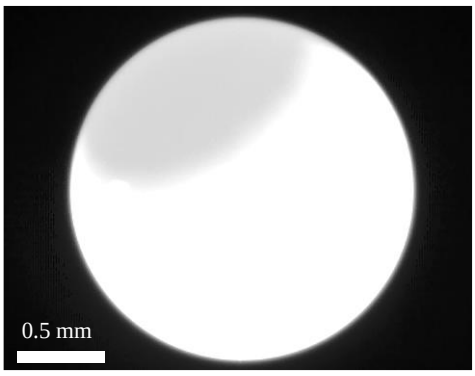

Figure 1. An example of high speed camera image captured at 4000 fps during solidification of molten Zr. Darker and brighter regions indicate liquid and solid states, respectively.

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