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DYNAMICS OF CORE - SHELL DROPLET FOR INTERFACIAL TENSION MEASUREMENT BY USING ELECTROSTATIC LEVITATION

Abstract

In the processing of steel products, molten iron - slag interface occurs. When considering the quality of steel products, there is a concern that the quality of the material may decrease due to gathering of fine particles and bubbles on interface. It is required to understand the interfacial phenomena to solve this issue, and the interfacial tension value is deeply related to this phenomenon. Therefore, it is important to measure the value of interfacial tension.

In conventional measurement technique, the interfacial tension is measured by placing the target substance in a container. Such a measurement method cannot be used for materials with high melting points or high reactivity. Recent years, containerless processing is paid attention for measuring the interfacial tension on high temperature melt. Accordingly, the interfacial tension measurement of molten steel covered with oxide materials, which mimics the molten iron – slag systems, is performed by the electrostatic levitation furnace (ELF) in the International Space Station (ISS). The interfacial tension between core and shell liquids is estimated by the equation introduced by Saffren et al. that the oscillation behaviors of outer droplet is used. However, there is little experimental verification because direct observation of core droplet on the metal and oxide melts is difficult. Thus, we carried out the experiment using electrostatic levitation method on the ground to confirm the relationship between the interfacial tension measurement and the dynamics of core and shell droplet.

A double layered concentrically spherical droplet of silicone oil and water as transparent working fluid is levitated between electrodes by electrical force. The oscillatory motion on levitated droplet is induced by external electric force with certain frequency. The time variation of the vertical length of the droplet was measured, and the resonance frequency was obtained by FFT. By substituting the obtained resonance frequencies into the equation derived by Saffren et al. the interfacial tension value can be estimated.

It was found that the estimated interfacial tension depends on radius ratio of core and shell spheres experimentally. When radius ratio is large, the shell surface oscillation is dominant, while when radius ratio is small, the oscillation of interface between core and shell is dominant. Therefore, it is considered that differences in the estimated interfacial tension value occur because the detected peak frequencies change.