Precise Density Measurement for Electromagnetically Levitated Liquid Combined with the Surface Oscillation Analysis

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Electromagnetic levitation (EML) technique is useful method for measurement of thermophysical properties of liquid state of metals and semiconductors at high temperature. Because, the EML technique has big advantages for easily keeping large undercoolings and for keeping high purity of measurement samples due to containerless environments. When we measure using this technique the density of liquid metals or molten semiconductors, the volume of levitated droplet-samples must be precisely observed from their shapes. In conventional methods, volume of the droplets obtained by averaging of few hundred images taken by high-speed camera, but large error values appear in temperature dependence data due to the asymmetry of surface oscillation of electromagnetically levitated liquid droplets [1]. The strong electromagnetic force in order to levitate the samples enhances the surface oscillation, so that error values for the volume make large. Therefore, we propose new method to obtain accurate density of high temperature liquid by using the analytical technique of surface oscillations. Since this method is based on the analysis of surface oscillation of levitated droplets, it is easy to increase of accuracy of density measurements with the conventional EML system. Another approach to reduce the error value in the density measurement on the ground conditions is to suppress the surface oscillation of levitated liquid droplets by applying a static magnetic field [2]. Since the magnetic field generates the Lorentz force by interaction with the electrical current in the levitated samples, the Lorentz force suppresses the flow motion in the liquid samples. Combining above two methods, we confirmed the reduction of density distribution of molten Si at temperature range 1500 K to 1900 K to one order magnitude rather than the previous reported data [3]. Using this new method, we succeeded to measure the density of molten SiGe and stainless steel (SUS304) with the various compositions in the wide temperature range.

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