# Thermal Expansion and Density Measurement of Metals by an Electromagnetic Levitation Melting Technique

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A containerless and contamination-free measurement method using electromagnetic levitation techniques has been developed to accurately determine thermal expansion and density of metals in solid and liquid states. The paper provides details of the electromagnetic levitation instrument as well as theoretical background and numerical simulation of the experimental apparatus and technique. A computer model for predicting levitating force, absorption power and heating temperature has been developed and experimentally validated. The paper also discusses a number of design issues with respect to a single levitation and heating coil. Several challenges in the technique are discussed: (1) how to increase levitating force when the experiment is under 1 g environment; (2) how to control levitated droplet position and temperature range by using a single induction coil to maximize the efficacy of the optical techniques; and (3) how to accurately detect the edge of a droplet in the image process. After getting a stable and good position (the sample image is minimally blocked by the inductive coil) of samples and within a desirable temperature range, two "good" view images (one from a side view and another from the top view) are then used to determine the volume of the sample. A new edge detection method has been developed, which reduces the error by about 30% as compared to the maximum intensity gradient method, a conventional edge detection method often used. Optical measurement errors are also considered and corrected. Finally, thermal expansion and density data for representative solid and liquid metals and alloys are shown in the paper.