Precise Density Measurements of Refractory Liquid Metals over 3000 K by Using Electrostatic Levitation

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Containerless methods combined with the UV illumination imaging technique have offered many technological and scientific advantages for measuring the density of high temperature materials. However, accurate liquid density measurement of refractory metals over 3000 K is still very challenging mainly due to two reasons; one is the shape deformation caused by sample motion, and the other is the gradually blurred sample edge in the captured image caused by strong sample radiation. This significantly affects thermal expansion coefficients

In the present work, we quantitatively study the impact of shape deformation by sample motion and background-sample contrast on the density measurement accuracy. We find that the combination of sample rotation and precession causes significant uncertain density values. Also the pixel size of an image is dependent on contrast, which is almost constant when the contrast is larger than a certain limit. In addition, lower contrast of a sample image results in smaller density values and larger data scattering. We further determine the minimum contrast limit for ensuring high quality density measurements. In short, by enhancing the intensity of UV background light and controlling the sample motion with the carefully aligned heating lasers and electrode set, we successfully measure the density of four refractory liquids (tungsten, rhenium, osmium, and tantalum) with significantly improved accuracy.