外熱式ダイヤモンドアンビルセルを用いた液体ガリウムの密度測定
Density measurement of liquid gallium using externally heated diamond anvil cell

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Density of a liquid metal at high pressure and high temperature is fundamental information to determine its equation of state (EOS). Gallium (Ga) which has a low melting temperature at ambient pressure has been reported to have complex liquid structures. The densities of Ga at high pressures have been reported based on the measurement of volume changes (Lyapin et al. 2008), that of liquid structures (Yu et al. 2012), and that of sound velocity (Ayrinhac et al. 2015). However, these densities were not consistent each other. In this study, we measured densities of liquid Ga at high pressure using an X-ray absorption method with an externally heated diamond anvil cell (EHDAC).

Ga sample and reference materials (KBr, RbBr) were loaded into each hole drilled on a pre-indented Re gasket. The reference materials were used for estimation of sample thickness and for determination of experimental pressures (Takubo et al. 2018). The Re gasket was coated with Al_2O_3 to avoid a reaction between the Ga sample and the gasket. High pressure was generated using a symmetric DAC with a lever-arm frame. The culet size of the diamond anvils used was 600 μm. High temperature was generated using external heaters composed of Pt-Rh wires with a ZrO_2 insulator. X-ray absorption measurements were conducted with monochromatic X-ray of 30 keV at BL10XU and BL22XU beamlines in SPring-8. Intensities of incident and transmitted X-rays were detected using a photo-diode or ion chambers. Experimental pressures were determined based on EOSs of KBr and RbBr using their volumes from XRD patterns collected using a flat panel detector.

The densities of liquid Ga were measured up to 9.4 GPa and 500 K. The densities of liquid Ga obtained at 4–9 GPa range 6.53(7)–7.25(14) g/cm^3. The measured density at 4 GPa is consistent with the density calculated from sound velocity data reported by Ayrinhac et al. (2015).

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