Viscosity measurement with an X-ray radiography falling sphere method using Diamond/SiC composite anvils in the Kawai-type high-pressure apparatus

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Abstract

Using diamond/SiC composites anvils prepared with hot isostatic pressing, we have been attempting their practical application to high-pressure anvils addressing their transparent properties to X rays. Cubes of the composites with 14 mm edge length were fabricated and used as the second stage anvils in a Kawai-type high-pressure apparatus. Because the diamond/SiC composites are transparent to X rays, the present anvils are applicable not only to energy dispersive diffraction experiments but also to angle dispersive diffraction experiments and radiographic studies that need a larger window for X-ray passes. In the present study, we measured the melting temperatures and the viscosities of KCl and NaCl under high pressure by an X-ray radiography falling sphere method using synchrotron radiation and the diamond/SiC composites anvils,

High-pressure and high-temperature falling sphere viscometry experiments were attempted in the SPEED-MkII system. Because the present diamond/SiC composite is an insulator, we used the hybrid anvil system with four diamond/SiC and four WC 14 mm cube anvils for heating. Electric power is supplied via WC anvils to furnaces in a high-pressure cell. Pressure generation for anvils with a truncation edge length of 3.0 mm was examined. A high-pressure cell assemblage developed for viscosity measurements was used with minor modifications according to the feedback from each run. We used TiB2 and LaCrO3 cylindrical heater. The pressure-transmitting medium was semi-sintered MgO and the gasket material was pyrophillite. KCl and NaCl powder together with Mo and W spheres was charged in an Al2O3 sample capsule. By using the two spheres with different density, we also attempted density measurements of these liquids. We used a newly developed high-speed radiography system that makes it possible to capture images at an interval of about 4 msec/picsel.

The obtained viscosity of liquid KCl as a function of pressure shows non-linear increase around 2 GPa and this may indicate a local structure change corresponding to the B1-B2 transition that occurs in the solid phase at the same pressure range. Due to the mechanical strength of our diamond/SiC composites anvils, the maximum pressure in the present study was limited to about 17 GPa. The viscosity of NaCl shows gradual increase in the present pressure range.

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