In-situ viscosity measurement of $NaAlSi_3O_8$(albite) melt at high pressure

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1. Introduction

Pressure-induced viscosity changes of silicate melts have been measured at low pressures (2 GPa) (e.g., Kushiro, 1976). Based on these studies, viscosity of silica-rich silicate melts decreases with increasing pressure. This is contrast to normal liquids. In order to fully understand the rheological behavior of silicate melts at the Earth's mantle conditions, viscosity change should be measured at much higher pressure. However, traditional "quench" falling sphere technique would not be applied for low viscosity melts. In order to measure low viscosity melts, we have developed "in-situ falling sphere technique" (Kanzaki et al., 1987). In this study, we have applied this technique to measure viscosity coefficient of albite ($NaAlSi_3O_8$) melt up to 6 GPa.

2. Experimental

SPEED1500 multi-anvil apparatus is used for pressure generation. We adopted in-situ falling sphere technique for viscosity measurement. In this method, a falling metal sphere in silicate melt is observed using X-ray radiography. Direct X-ray beam, passed through the anvil gaps of SPEED1500 and sample under pressure, is observed with an X-ray camera. Real time images from the camera are stored on hard disk in PC, and are analyzed after experiments.

We used common 8/14 mm anvil truncation-pressure medium size system. Pressure medium is made of AlSiMag ceramics. Our preliminary experiment reveals that even platinum capsule with 0.1mm wall thickness can be used for radiography, however, contrast would be low. Therefore, graphite capsule is used in the present study. Pressure is determined from equation of state of MgO, which is used as an insulation sleeve between heater and sample capsule. Albite glass is used as starting material. A platinum sphere with diameter of about 200 μm is embedded in the sample.

3. Results and Discussion

Although this was first high-pressure radiography experiment at SPring-8, we could observed falling platinum spheres in albite melts in six experiments. Images from one of experiments (~ 5GPa and 1620 °C) is shown in Fig. 1. The lower image is taken 5 seconds after upper image is captured. Settling of platinum sphere is clearly visible in these images. In this case, viscosity of albite melt at this condition is calculated from settling velocity to be 2 Pa·s.

Although viscosities of albite melts at six P-T conditions have been determined, inspection of experimental products after the beam time revealed that albite melts are contaminated by MgO in several experiments. The MgO came from the insulation sleeve placed between heater and sample capsule. We are currently improving high-pressure cell design to avoid MgO contamination and blow out which occurred in several early experiments.

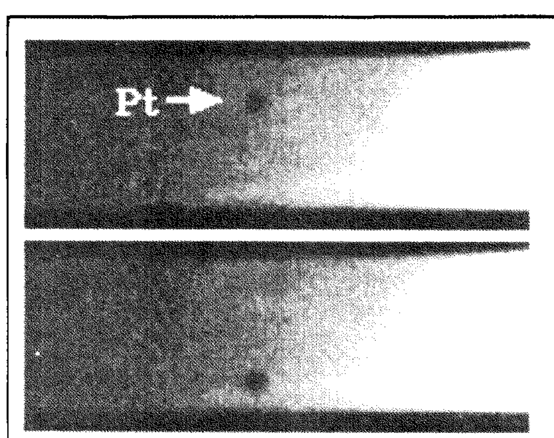

Fig. 1. Falling Pt sphere in albite melt at ~ 5 GPa and 1620 °C.