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Density measurements of liquid FeS at high pressure using X-ray absorption image

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Introduction

Iron sulfide (FeS) has been thought to be one of the major constituents of the cores of terrestrial planets. Thus, density of liquid FeS at high pressure is fundamental to evaluate the internal structure of planets and their satellites. Chen et al.[1] measured the density of liquid FeS at 4.2 GPa and 1300 °C using X-ray absorption method from the radiography image [1]. Here we report new experimental results on density of liquid FeS at 7 GPa using X-ray absorption image based on [1].

Experimental

Pressure was generated by the KAWAI-type 6–8 double stage system using the high-pressure apparatus, MAX-III installed at beamline BL14C2, KEK-PF. Starting material was FeS powder. The radiography system consists of a YAG:Ce crystal as a fluorescent screen and a cooled CCD camera (BITRAN BS-40L). The energy of the monochromatic X-ray beam was 30 - 40 keV. This radiography image is based on the intensity of the transmitted X-rays. The contrast of the image depends on the difference of absorption between the sample and assembly parts. Based on the linear conversion from X-ray intensity to image brightness and the Beer-Lambert law, the image Brightness B(z) in the sample area is expressed as

$$B(z) = I_0 K \exp\{(-\mu\rho t)_{FeS} + (-\mu\rho t)_{Al_2O_3} + (-\mu\rho t)_{environment}\}$$

where I_0 is the intensity of the incident X-ray, K the coefficient of X-ray intensity to radiograph brightness conversion, μ and ρ the mass absorption coefficient and density. Therefore, the sample density can be obtained by fitting above equation. The image was integrated 10 pixels in a horizontal direction to obtain the brightness. The X-ray mass absorption coefficient was calibrated experimentally at 700 °C using equation of state for solid FeS (NiAs type) [2] and obtained X-ray absorption profile.

Results and Discussion

The variation of the density of FeS with temperature at constant load (450 ton) is shown Fig. 1. The density variation derived the capsule position is within 2 %. This error is most likely due to capsule deformation. As shown in Fig. 1, pressure was decreased with increasing temperature. The density depression between 1400 °C and 1500 °C indicates melting of FeS. The present density of liquid FeS is consistent with [1] and [3] (Fig. 2).

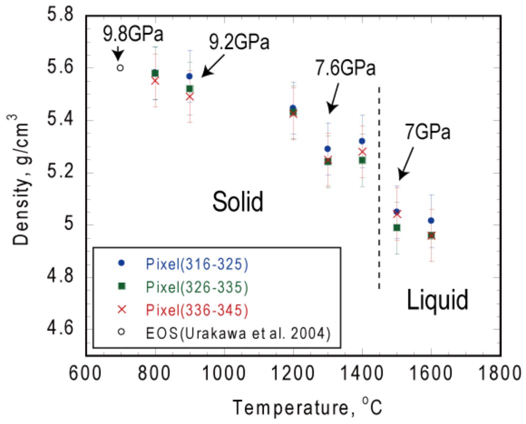

Fig. 1 Density of FeS as a function of temperature at constant load (450 ton).Pixel numbers represent the capsule position in X-ray absorption image.

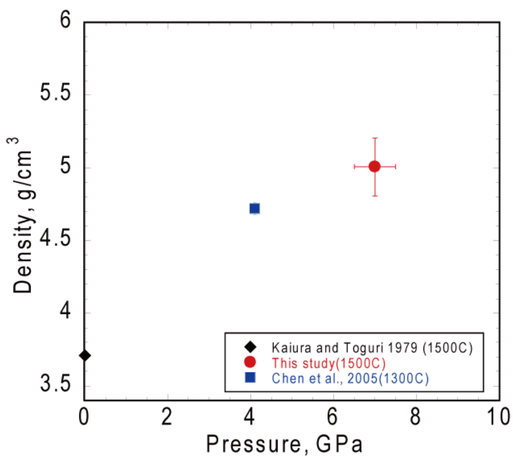

Fig. 2 Pressure dependence of liquid FeS.

References

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