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Phase relationship of sulfur up to 8GPa

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Introduction

We reported three high-pressure phases (HPPs) of sulfur in our previous study [1]. Their stable pressure ranges were 3-8GPa, 8-15GPa and higher than 15GPa, respectively. All HPPs were formed at high-temperature condition and were unquenchable at ambient condition.

On the other hand, Geller (1966) [2] reported a quenchable high-pressure phase synthesized at 4GPa and high-temperature condition, which was in the stable region of the HPP1 in our study. Geller reported that the quenchable phase could be obtained only by through crystallization from liquid under high-pressure condition.

The aims of the present study are to observe high-pressure and high-temperature behavior of sulfur carefully, and to demonstrate phase relationship of sulfur up to 8GPa.

Experiment

In-situ X-ray observation of sulfur was carried out by the energy-dispersive type X-ray powder diffraction method with the MAX80 system at PF-AR-NE5C. The details were described in our report [1,3].

Result and discussion

Figure 1 shows typical X-ray diffraction patterns of sulfur in the high-pressure and high-temperature process referring Geller's report [2]. Starting material of sulfur has a complicated crystal structure, which consists of 16 crown-shape S_8 molecules, *i.e.* Z=128 (Fig. 1-a). The material was compressed up to 4GPa and elevating temperature to 500°C. Liquid state was stable in the P-T condition (Fig. 1-b). Crystallization was observed by dropping temperature to 300°C (Fig. 1-c). This diffraction pattern could be explained by our HPP1 with a hexagonal cell [3]. The HPP1 was quenchable to room temperature at high-pressure condition. The HPP1 was observed in the pressure range below 0.5GPa in the decompression process. However, the HPP1 was unquenchable at ambient condition. It converted to Geller's phase (Fig. 1-d).

The present result shows that Geller's phase is not the high-pressure phase but a metastable phase. It is consistent with our previous study, in which all HPPs were unquenchable at ambient condition.

The compression behavior of the HPP1 is summarized in Fig. 2. The *a*-axis of the hexagonal cell was slightly compressive than the *c*-axis. The compression behavior of the HPP1 is contrastive to that of the HPP2 with another hexagonal cell.

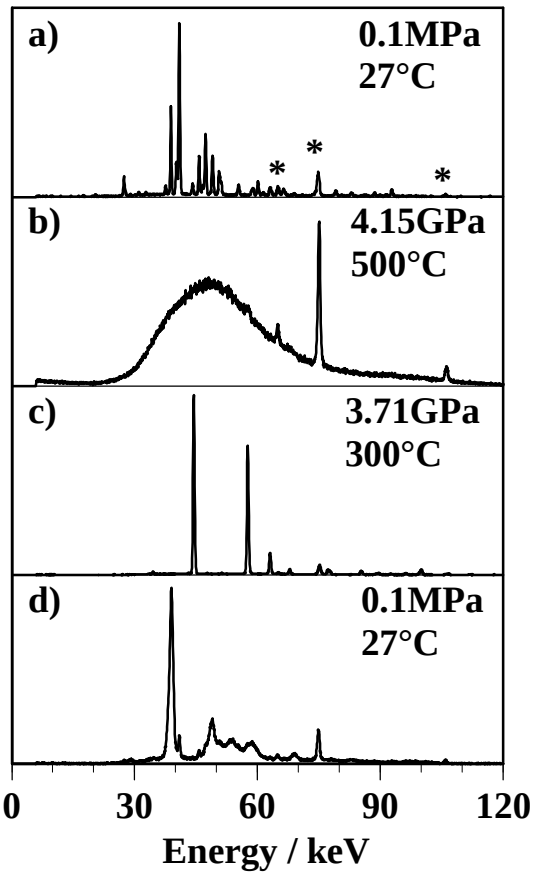

Fig. 1 X-ray diffraction patterns of sulfur with MgO, of which diffraction lines are indicated by asterisks.

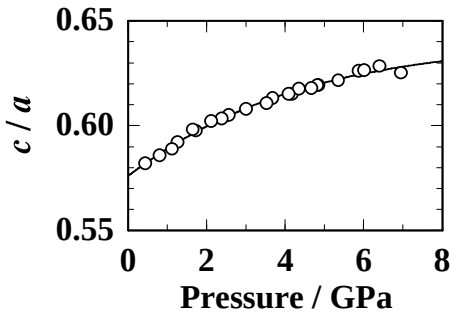

Fig. 2 Anisotropic compression behaviors of the HPP1.

Reference

[1] K. Kusaba *et al*., PF Act. Rep., **B17**, 228 (2000).
[2] S. Geller, Science **152**, 644 (1966).
[3] K. Kusaba *et al*., PF Act. Rep., **B18**, 200 (2001).

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