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Phase transition of (Mg,Fe)O under high pressure and temperature

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Introduction

Magnesiowüstite, (Mg,Fe)O, is one of the major components in the earth's lower mantle. High-pressure behaviors of two end-members of magnesuowüstite are quite different in the crystal structure and the electronic structure, although they can make a complete solid solution with a rock salt(B1) structure at ambient pressure [1]. Recent experimental results show also a possibility of decomposition of magnesiowüstite at high pressures and temperatures[2]. The purpose of this study is to clarify the high P-T phase of magnesiowüstite, which has a intermediate composition of FeO and MgO.

Experimental method

We conducted in-situ X-ray diffraction experiments for $Fe_{0.95}O$, ($Mg_{0.05}$, $Fe_{0.95}$)O, ($Mg_{0.1}$, $Fe_{0.9}$)O and ($Mg_{0.2}$, $Fe_{0.8}$)O at BL-13A using external-heated or laser-heated diamond anvil cell. Monochromatized X-ray of about 30 KeV was focused and collimated to 30 micron square beam. The diffracted pattern was detected by an imaging plate (Rigaku R-AXIS). The phase transitions of each sample was investigated up to about 100 GPa and 2000K.

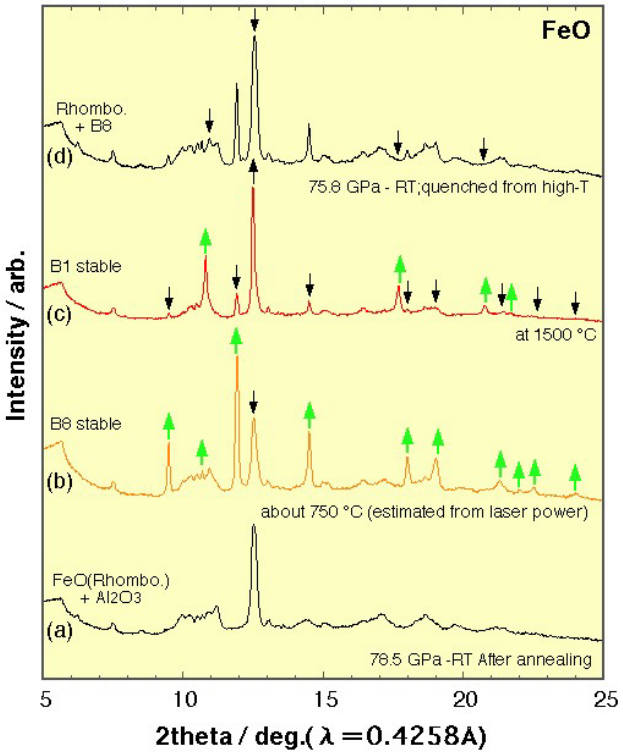

Figure 1. X-ray diffraction patterns of $Fe_{0.95}O$ under pressure and temperature.

Results and discussion

All samples exhibit a second order transition from a B1 structure to a rhombohedrally distorted phase at around 16 GPa at room temperature compression, which continue to over 100 GPa and was consistent with early studies. The B1 phase was observed again at high temperature above the stability field of the rhombohedral phase. The NiAs(B8) structured phase reported in the previous study[1] was observed between stability fields of the B1 and the rhombohedral phase only in $Fe_{0.95}O$ sample. The x-ray pattern of the B8 phase suggests not normal structure but inverse structure, indicating a electrically insulator state from theoretical studies[3-4]. Both B1 and B8 phase were unquenchable to temperature as shown in Fig.1 No decomposed phase was observed in the present experimental condition. Fig.2 shows the summary of the present study. Considering the experimental results and geothermal condition, magnesiowüstite in the lower mantle should have a B1 structure down to the bottom of the mantle even when free FeO phase exists in the lower mantle.

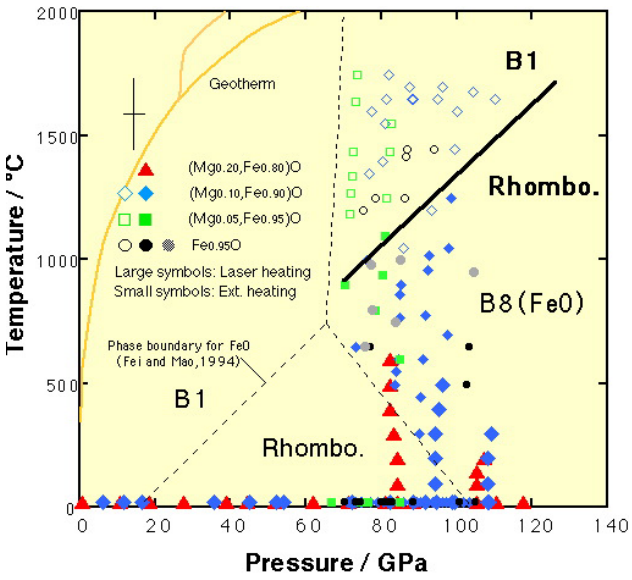

Figure 2. P-T phase diagram of (Mg,Fe)O.

References

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