In-situ X-ray diffraction studies of hydrous phases up to ~50 GPa

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Recent experimental and theoretical studies suggest the high-pressure forms of hydrous minerals, phase H and delta-AlOOH, play important roles in transportation of water into the deep Earth’s interior via subduction of oceanic slabs. Phase H forms a solid solution with delta-AlOOH by the substitutions of Mg^{2+} + Si^{4+} <-> $2Al^{3+}$ because of their similar crystal structure and volume. Since epsilon-FeOOH is also istostructural to $MgSiO_4H_2$ phase H and delta-AlOOH, delta-AlOOH likely form partial solid solutions with epsilon-FeOOH. However, experimental study shows that FeOOH component in delta-AlOOH is limited (~20 mol%) because of the much larger unit-cell volume of epsilon-FeOOH, in contrast to the complete solid solution between phase H and delta-AlOOH. On the other hand, spin transition of Fe in epsilon-FeOOH at ~50 GPa likely reduce its volume significantly, which may cause the compositional change of hydrous phase in the lower mantle. Thus, the unit-cell volume of hydrous phases at high pressures is important to understand the chemical composition of hydrous phase in the mantle.
Here, we report new experimental results on the X-ray diffraction studies of Phase H, delta-AlOOH, epsilon-FeOOH, and their solid solutions up to 50 GPa. In-situ X-ray diffraction measurements were performed using a multianvil apparatus (SPEED-Mk.II) at BL04B1, SPring-8. The unit-cell volume of $MgSiO_4H_2$ phase H is ~3% larger than those of pure delta-AlOOH and ~15% smaller than those of epsilon-FeOOH up to 50 GPa. However, the large volume reduction of epsilon FeOOH due to the spin transition of Fe was observed above ~50 GPa, resulting in the similar unit-cell volume with delta-AlOOH and phase H. Based on these experimental results, the chemical composition of hydrous phase in the lower mantle will be discussed.

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