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Phase relation in Fe2O3-Al2O3 system under high PT determined by in-situ X-ray diffraction and quench experiments

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We carried out in-situ X-ray diffraction and quench experiments in Fe2O3 and FeAlO3 at pressure of 15-35 GPa and at temperature of 300-1800 K to determine phase relation in Fe2O3-Al2O3 system. In situ X-ray diffraction measurements of alpha-Fe2O3 (Hematite) were performed using a Kawai-type apparatus, SPEED-1500, installed in BL04B1, SPring-8, Japan. Starting material was a mixture of Fe2O3, KCl, and Au which was used as a pressure marker. We observed transformations from hematite to Rh2O3(II)-type structure (forward transition) and those from Rh 2O3(II)-type structure to hematite (reverse transition), separately. Pressure and temperature conditions of the forward transition were different from those of the reverse transition below 1100 K, because of the slow reaction kinetics. In contrast, at a temperature of 1200 K, we observed forward and reverse transitions at the same pressure and temperature conditions. Therefore, we determined the equilibrium phase boundary between hematite and Rh2O3(II)-type structure above 1200 K. We also performed in situ X-ray diffraction and quench experiments of FeAlO3 at pressures between 17 and 35 GPa and at a temperature of 1673 K. Starting material was FeAlO3 with FeGaO3-type structure. We observed decomposition of FeAlO3 into Fe-bearing Al2O3 and Al-bearing Fe2O3 at all the experimental conditions. Results of in-situ X-ray diffraction experiments show that Al-bearing hematite transforms into Rh2O3(II)-type structure above 24.5 GPa indicating that the Al incorporation increases the transition pressure. Chemical compositions of recovered samples were measured using SEM-EDS. The results revealed that the Al2O3 component incorporates about 10 mol% Fe2O3 whereas the Fe2O3 component incorporates about 5 mol% Al2O3 and that the amount of the mutual substitution is insensitive to pressure. Using the experimental data obtained in the present study, we propose a phase diagram in Fe2O3-Al2O3 system with pressure at a temperature of 1673 K.

Keywords: hematite, FeAlO3, phase relation, in-situ X-ray diffraction experiment, Rh2O3(II)-type structure