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Phase transition of $MgFe_2O_4$

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Iron is one of the major components of mantle. Fe^{2+} is contained mostly in perovskite and magnesiowustite in the lower mantle, and in wadsleyite and ringwoodite in the transition zone. Although a part of iron contained in a mantle may exist as Fe^{3+}, possible host phases of Fe^{3+} are not fully clarified. For this reason, it is meaningful to investigate behavior of the phases containing Fe^{3+} under high temperature and high pressure. $MgFe_2O_4$ (magnesioferrite) is considered as one of the possible end member of candidate phases containing Fe^{3+}. Andrault and Bolfan-Casanova (2001) reported that $MgFe_2O_4$ transforms to $CaMn_2O_4$-type structure at high temperature and high pressure. However stability field of this phase and phase relationship with other high-pressure phases have not yet been examined. In this study, high-pressure phase transition experiments of $MgFe_2O_4$ were conducted under the temperatures and pressures corresponding to the transition zone and the lower mantle.

The 6-8 type multi-anvil press apparatus at Gakushuin University with WC anvils were used for the high temperature and high pressure experiments. Starting material was a mixture of MgO and Fe_2O_3 in composition of $MgFe_2O_4$. The starting material was put into a sintered MgO capsule or a Pt capsule in order to prevent reduction of Fe^{3+} during the experiment. A semi-sintered MgO octahedron was used as the pressure medium. Pt-Pt13%Rh thermocouple was used for measurement of temperature. The high-temperature high-pressure experiments were conducted at pressures of 18-27 GPa and temperatures of 1473-1873 K. After pressurizing to the target pressure, the sample was heated for 1-2 hours. After quenching, the sample was decompressed and was recovered. The phases in the recovered sample were identified using powder X-ray diffraction techniques. Compositions of some samples were investigated by SEM-EDS.

The samples synthesized at 18-21 GPa show a different X-ray diffraction pattern from spinel structure and $CaMn_2O_4$-type structure that Andrault and Bolfan-Casanova (2001) reported. The samples synthesized at 21-27 GPa show a similar X-ray diffraction pattern to $CaMn_2O_4$-type structure. The lattice parameters were refined by the least-squares method, assuming that this phase had orthorhombic symmetry like $CaMn_2O_4$. As a result, almost all diffraction peaks were successfully assigned, and lattice parameters were determined as a= 3.262(2) A, b=9.766(4) A and c= 10.137 (3) A. Andrault and Bolfan-Casanova (2001) reported the cell parameters of $CaMn_2O_4$-type $MgFe_2O_4$ as a= 2.7392(5) A, b=9.200(2) A and c= 9.285(2) A at 37.3GPa. The samples synthesized in this study had a/c=0.322 and b/c=0.963. This phase had a/c ratio larger than and smaller than those of $CaMn_2O_4$-type structure. Therefore, this phase synthesized in this study may have a structure that is different form, but similar to the $CaMn_2O_4$-type. Now, structures of two phase synthesized in this study are under investigation.