Pressure generation of 120 GPa and stability of bridgemanite

*Daisuke Yamazaki[1]

1. IPM, Okayama University

Physical and chemical properties and structure of materials are strongly depend on the pressure and temperature. $MgSiO_3$ bridgemanite, which is the most abundant mineral in the lower mantle, undergoes the phase transition to post-perovskite structure ($CaIrO_3$, Cmcm) at pressure and temperature corresponding to the D” layer conditions, discovered by diamond anvil cell high pressure experiments (Murakami et al., 2004). This phase transition is considered to a key to understand the mantle dynamics and therefore precise determination of the phase boundary is important, for example, effect of the other elements (e.g., Fe, Al and Fe^{2+}/Fe^{3+}). In this study, we developed the high pressure generation technique in a Kawai-type multianvil apparatus, which enables us to obtain large volume sample (~0.1 mm^3) with stable heating and homogeneous high temperature distribution in the sample, and tried to determine the phase boundary between bridgemanite and post-perovskite.
We conducted pressure generation test by using a Kawai-type large volume press (SPEED mk.II) at SPring-8 synchrotron facility. For the cell assembly, we used Cr-doped MgO as pressure medium, $BN+TiB_2$ as heater because of high transparency for X-ray and soft fired pyrophyllite as gasket. Temperature was monitored by $W_{97\%}Re_{3\%}$-$W_{75\%}Re_{25\%}$ thermocouple whose junction was located in the heater. Before experiment, we prepared the sintered starting material of the mixture of $Mg_{0.9}Fe_{0.1}SiO_3$+5wt % Al_2O_3 bridgemanite and gold which was used as the standard to estimate the pressure (Tsuchiya, 2003) in the ration of 1/6 in weight. During compression in the experiments, we frequently pre-heated the sample to 800-1100 K at every 5-10 GPa for the relaxation of stress stored in the cell assembly to reduce the probability of “blow out”.
We finally succeeded to generate pressure to 120 GPa with press load of 13 MN at an ambient temperature after pre-heating at 800K. Then we again heated up sample to 1673 K to observe the phase transition from bridgemanite to post-perovskite at 105 GPa because a large pressure drop occurred down to 105 GPa at higher temperature than 800 K during heating up. The obtained diffraction pattern was completely indexed as bridgemanite, indicating the stability field of bridgemanite with the composition of $Mg_{0.9}Fe_{0.1}SiO_3$+5wt % Al_2O_3. The present result is consistent with previous study in $MgSiO_3$ (Tateno et. al., 2009). They reported the phase boundary to be 110 GPa at ~1673 K. As a conclusion, the effect of 10 mol % of iron component and 5 wt % of Al_2O_3 is less than 5 GPa on phase boundary shift in pressure.

