Phase relations of $MgSiO_3$-$FeSiO_3$ system up to about 60 GPa and 2300K using multianvil apparatus with sintered diamond anvils

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$MgSiO_3$ bridgmanite is the most abundant mineral in the Earth’ s lower mantle, which can accommodate certain amount of $FeSiO_3$ under the P-T conditions of the lower mantle. Because of geophysical importance of $FeSiO_3$-bearing bridgmanite, phase relations of MgO-FeO-SiO_2 system have been investigated using both laser-heated diamond anvil cell (LHDAC) and Kawai-type multi-anvil apparatus (KMA), but there are some inconsistencies among their studies. Dorfman et al. (2013) made experiments up to 155 GPa and 3000 K using LHDAC, which reported a sharp increase of the solubility of the $FeSiO_3$ component in bridgmanite at 50-70 GPa. In contrast, Tateno et al. (2007) reported more continuous solubility of $FeSiO_3$ with pressure using similar techniques of LHDAC. On the other hand, Tange et al. (2009) precisely determined the phase relations in the system MgO-FeO-SiO_2 on the bases of KMA experiments using sintered diamond (SD) anvils, but the maximum pressure and temperature in this study were limited to 47 GPa at 1773 K.
Based on the newly developed high pressure and temperature techniques, we studied detailed phase relations in the system MgO-FeO-SiO_2 using KMA with SD anvils at pressures up to 61 GPa at a temperature of 2000 K. Synthetic pyroxene samples with chemical compositions of $(Mg_{0.4}Fe_{0.6})SiO_3$ and $FeSiO_3$ were used as the starting materials. Both quench experiments and in situ X-ray observations were adopted to constrain the phases present. Single-phase bridgmanite and an assemblage of wüstite + stishovite were formed in the $MgSiO_3$-rich and $FeSiO_3$-rich regions, respectively, under the present pressure and temperature conditions of up to ~60 GPa, which is generally consistent with the phase relations in the earlier studies. We found the solubility of $FeSiO_3$ in bridgmanite increases almost linearly with increasing pressure from Fe* (Fe/Fe+Mg) = 0.19 for 27 GPa to 0.38 mole for 60 GPa at 2000 K. The iron content in wüstite also significantly increases from Fe* = 0.68 for 27 GPa to 0.96 for 60 GPa.

Keywords: bridgmanite, high temperature generation, sintered diamond anvil

