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Experimental confirmation of ringwoodite crystallization from shock-induced melts

MUTOU, Daiki[1] ; SEKINE, Toshimori[1*] ; KOBAYASHI, Takamichi[2] ; MASHIMO, Tsutomu[3] ; OHFUJI, Hiroaki[4]

[1]Hiroshima University, [2]NIMS, [3]Kumamoto University, [4]Ehime University

Many high-pressure phases have been identified in meteorites that experienced heavy collisions. The presence of high-pressure phase may provide an estimate of pressure condition. However, the dynamic formation conditions may not be equal to those at static pressures and there is no firm experimental report to indicate the ringwoodite formation at dynamic pressures, although there are Hugoniot data and trials to synthesize ringwoodite by shock compressions. We tried to confirm the ringwoodite formation by hypervelocity impacts from two powdered mixtures of biotite and cristobalite (sample A) and phlogopite and cristobalite (sample B) for Fe-rich and Mg-rich ringwoodites, respectively. When we used stainless steel containers for recovery, the container had reacted with the biotite melt to form chromite spinels. No spinel phase was observed in sample B. When we used copper containers for sample A, X-ray diffraction data on the recovered samples indicated a spinel phase (a =0.8257 nm). Because the lattice constant is greater than that of Fe2SiO4 (ahrensite) and significantly less than those of magnesioferrite and magnetite, the composition can be a Fe-rich ringwoodite. However, detailed scanning electron microscopy indicated no obvious crystals on the polished surface where there were many spherical voids. Finally the Raman spectroscopy investigations detected spectra similar to Fe-rich ringwoodite in the voids. We will try to investigate the spinel phase using analytical transmission electron microscopy.

The present experimental results confirm the formation of ringwoodite from shock-induced melts. Further studies need to provide Mg-rich ringwoodite formation and the minimum dynamic pressures required to the formation. If such experiments are extended to the other high-pressure phases present in meteorites, the shock pressure estimation will be more powerful and helpful than the present.

Keywords: ringwoodite, shock-induced melt, crystallization, recovery shots