Crystallization of amorphous $MgSiO_3$ by shock compression

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Structural change of synthesized amorphous $MgSiO_3$ by shock compression up to 22.2 GPa has been investigated using XRD and IR analyses. The obtained result provides information for elucidating of the collision behavior of $MgSiO_3$ contained in cosmic dust.

Amorphous $MgSiO_3$ sample was prepared by an aqueous solution of TEOS, Magnesium Nitrate Hexahydrate, and ethanol with ammonia as a catalyst. As-prepared sample was heated at 700 C˚ to dehydrate excess water. TG curve of this sample indicated that the sample contained about 8.8 wt% of water molecules and hydroxyl groups.

A powdered heated (original) sample was put in an aluminum tubes and pressed at 20 kN for 10 minutes to obtain samples for shock compression experiment. These samples were compressed at 13.6, 17.2, and 22.2 GPa using a single-stage propellant gun at Kumamoto University.

XRD pattern of the pressed sample showed no crystalline peak as same as the original sample. However, the XRD pattern of thesample compressed at 13.6 GPa showed the weak crystalline peaks at around 2θ = 28, 31, 35-36˚. These peaks became intense with increasing shock pressure. Crystalline peaks observed in the XRD pattern for the sample of 22.2 GPa were attributed to those of enstatite. However, some peaks was due to the formation of Mg_2SiO_4. IR spectra for the compressed samples showed the similar trend as the result of XRD analysis. But IR analysis indicated that the sample contains water molecules even after the shock compression at 22.2 GPa. Water molecules probably present in the remaining amorphous part. Crystallization of sample by shock compression has not been reported in shock experiments for other crystalline and non-crystalline silicates. The crystallization of our samples at low pressure may be due to the simple chain structure of enstatite. Also, high shock temperature which generated by friction due to the porosity of the sample may promote this crystallization.

Keywords: MgSiO3, amorphous , shock compression, enstatite

