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# Symmetry of majorite garnet in shocked chondrites revisited: A TEM study

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Majorite is a garnet-structured mineral with a composition on the join (Mg,Fe)$SiO_3$-$(Mg,Fe)_3Al_2Si_3O_{12}$, which contains Si in the octahedral sites. Al-free majorite samples synthesized by Kawai-type multianvil apparatus are known to have a tetragonal symmetry (space group $I4_1/a$) [1]. However, all of natural Al-free majorite samples found in shocked chondrites have been reported to be cubic ($Ia$-3$d$) [2]. Single-crystal X-ray study of a synthetic $MgSiO_3$ majorite clarified the tetragonal distortion of majorite is caused by Mg-Si ordering in the octahedral sites [3]. Subsequent microstructural observations of synthetic Al-free majorite by TEM concluded that the tetragonal phase is formed from the cubic phase through the cation ordering even upon rapid quenching ($10^3$ ℃/sec) and the symmetry reduction phase derives modulated and twinning structures [4]. On the contrary, cubic (Mg,Fe)$SiO_3$ majorite in shocked chondrites is inferred to have been preserved due to higher cooling rate than that in high-pressure synthesis where the cation ordering is inhibited.

Due to very small tetragonal distortion from the cubic phase ($c/a$ = 0.99) and very week extra reflections for the tetragonal phase, it is difficult to judge the symmetry of small amount of natural majorite samples by powder X-ray diffractometry. For the symmetry analyses of submicron-sized grains, single-crystal electron diffraction is a suitable method, since the intensities of weak reflections to diagnose the tetragonal symmetry are enhanced by the effect of dynamical diffraction. In this study, we revisit symmetries of majorite grains in shocked ordinary chondrites (Tenham; L6, Y-75100; H6) and also synthetic (Mg,Fe)$SiO_3$ majorite by TEM. The intensity of {101} reflections, which appears only for the $I4_1/a$ tetragonal phase, is under investigation by selected are electron diffraction.

References:

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