FINDING OF HIGH-TEMPERATURE ORTHOPYROXENE IN A CHONDRITE

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Introduction: Texture and chemical composition of pyroxene, one of the main constituents of chondrules, have been studied extensively, because they give information about the formation conditions of chondrules. On the other hand, for thirty years there has been controversy about the phase relations of the $Mg_2Si_2O_6$–$CaMgSi_2O_6$ system [e.g., 1-4]. The contentious point is that although Ca-bearing orthopyroxene (Ca-Opx) and orthoenstatite (Oen) have the same space group (*Pbca*), they occupy distinctly separate positions in a phase diagram [1, 4]. Recently, we report an isosymmetric phase transition of Ca-Opx from low-temperature form (LT-Opx) to high-temperature form (HT-Opx) at around 1170 °C, identified in in-situ high-temperature synchrotron X-ray powder diffraction experiments (Ohi et al., submitted). The study provides direct evidence that HT-Opx is thermodynamically distinct from Oen. The P-T condition of the stability field of HT-Opx suggests the possible origin of the pyroxene in chondrules in unequlibrated chondrites. Here we report the finding of HT-Opx in a chondrule of Y-86751 (CV3).

Results and Discussion: A chondrule in Y-86751 (CV3) includes HT-Opx (70 μm × 20 μm). The chondrule is porphilitic and includes olivine, pyroxene and troilite grains among interstitial glass. The crystal system of the pyroxenes was determined under an optical microscope and EBSD of a SEM. The compositions of minerals were obtained by EDX analysis of a SEM.

Two grains of pyroxene in the chondrule consist of three different polymorphs as the zoning from the core of clinoenstatite to the rim of diopside through Ca-bearing Opx. Clinoenstatite has the average composition of $En_{98}Fs_1Wo_1$ and shows the polysynthetic twining, indicating that the transformation from protoenstatite during cooling. Diopside in the rim has the average composition of $En_{64}Fs_1Wo_{35}$. Ca-bearing Opx in the mantle of the grains has the space group of Pbca and the average composition of $En_{95}Fs_1Wo_4$. This result indicates that Ca-bearing Opx grew as HT-Opx and transformed to LT-Opx during cooling. Coexistence of protoentatite and HT-Opx suggests the temperature about 1400 ± 30 °C by phase diagram in En–Di system [4].

Noguchi (1989) [5] reported that the four kinds of pyroxenes in chondrules; protoenstatite (Wo < 2), orthopyroxene (Wo 2–5), pigeonite (Wo 5–15) and augite (Wo > 25) based on only the composition, although the orthopyroxene has not been identified as Ca-bearing Opx. The orthopyroxene is considered to be Ca-bearing Opx, implying the common occurrence of the pyroxene in chondrules.

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