Orthopyroxene and protopyroxene in H3 and L3 chondrite

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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. In diopside (Di)-hedenbergite (Hd)-enstatite (En)-ferrosilite (Fs) pyroxene quadrilateral, pyroxene with high Ca content is augite, low-Ca pyroxene is pigeonite and Ca-free pyroxene is orthopyroxene. In Ca-free and Mg-rich composition in pyroxene quadrilateral, it has been known Ppx is a stable phase instead of Opx at high temperature (1000-1500 C). Ppx changes to Cpx with polysynthetic twin while quenching. Because Ppx and Opx have a coexistence narrow area in the temperature-composition relations, there are few reports for this coexistence. In this study, we found the coexistence of Opx and Cpx with polysynthetic twin.

It is used for two kind of chondrites; H3 chondrite (ALH-78084) and L3 chondrite (Y-793375) in this study. These chondrites are so-called Ordinary chondrites. Some pyroxenes in chondrules have been examined with polarization-microscope SEM-EDS, and EBSD (electron back-scattered diffraction technique) to confirm the presence of Opx and Cpx. It is observed Cpx and Opx by polarization-microscope. Opx shows the straight extinction under crossed-polarized. Cpx shows polysynthetic twin under crossed-polarized; this feature is caused by transformed from Ppx to Cpx. This feature is indicated Ppx. EBSD patterns of Opx were obviously different from and could be identified clearly. It is determined chemical compositions by SEM-EDS.

For H3 chondrite, under the microscope, it is confirmed that Cpx shows polysynthetic twin; this feature is caused by transformed from protopyroxene (Ppx) to Cpx while quenching. Thus, this Cpx is originally Ppx, when it was crystallized. Opx shows straight extinction under crossed-polarized. Opx and Cpx have Aug rim. Besides, Opx is in contact with Cpx showing polysynthetic twin. Two pyroxenes are examined by EBSD because each phase is identified. Chemical compositions are as follows. Cpx is Wo1-2 Fs14-18. Opx is Wo1-2 Fs13-16, and each rim is Wo30-33, Fs11-19. As a result, chemical compositions are similarity, between Cpx and Opx.

For L3 chondrite, under the microscope, it is confirmed that Cpx shows polysynthetic twin. Thus, this Cpx is originally Ppx, when it was crystallized. Opx shows straight extinction under crossed-polarized. Opx and Cpx have Aug rim. Besides, Opx is by Cpx side. Two pyroxenes are examined by EBSD because each phase is identified. Chemical compositions are as follows. Cpx is Wo1-2 Fs9-16. Opx is Wo1-2 Fs12-18, and each rim is Wo28-39, Fs8-13. As a result, chemical compositions are similarity, between Cpx and Opx.

In Mg-end composition, Opx transformed to Ppx around 1000C. Huebner (1980) reported that this transition temperature increased as increasing Fe component. Using in En-Fs phase diagram by Huebner (1980), each chondrules temperature of crystallization is 1200-1300C (H3), 1200-1300C (L3). This result suggested that it is found Ca-poor Opx coexists within Ppx in high temperature (1200-1300C).