Petrographic study of a compact type A CAIs with partial melting process

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Compact type A CAIs (CTAs) are expected to be formed in the earliest stage of solar nebula and experienced a partial melting at least once (e.g., [1]). The indicator of partial melting is necessary to discuss the formation of oxygen isotope disequilibrium within CAI minerals and the formation of the entire CAIs. However, there are only a few studies that referring to the formation processes of CTAs from the perspective of crystal growth in partial melting states (e.g., [2]). Generally, spinel in CTAs are poikilitically enclosed by melilite or fassaite, and estimated to be first crystallized mineral from CAI melt [3]. Namely, spinel in CTAs is expected to preserve valuable information of the thermal histories such as partial melting processes. Therefore, we focus on the petrological and mineralogical feature of spinel grains in CTAs. The CTA (KU-N) is included in a polished thin section of North West Africa 7865 reduced CV3 carbonaceous chondrite. The preliminary study concluded that they experienced multiple partial melting from the KU-N CAI. We have undertaken petrographic and mineralogical investigations of the CTA (KU-N-02) focusing on micro-textures resulting from partial melting (local compositional zoning, grain morphology and relationships of crystallographic orientation), using a polarizing microscope, scanning electron microscope (SEM) and electron back scatter diffraction (EBSD).

In the KU-N-02 CTA, spinel crystals are enclosed by melilite or fassaite. The former (up to 50 μm in size) is substantially euhedral but the edges are rounded, while the latter (about 10 - 100 μm in size) are almost euhedral with sharp edges.

In interior KU-N-02 CAI, single crystal melilite with spinel inclusions show a remarkable compositional zoning, for core-to-rim normal zoning, with decreasing Al. In the melilite single crystal, the area of about 10 μm wide around the spinel surfaces has Åk-rich composition in comparison. By EBSD analysis, Åk-rich melilite crystal orientation and Åk-poor melilite crystal orientation is same. Therefore, Åk-rich melilite part (~10μm) surrounding spinel are crystallized after Åk-poor melilite. Because of these results, it is difficult to explain how Åk-rich part surrounding spinel in a melilite crystal crystallized by a single stage cooling. This texture indicates that the boundary area between spinel and melilite had eutectically melted at high temperature by some heating process, and then Mg/Al contents had been redistributed to melilite and spinel during rapid cooling. Accordingly, this partial melting probably resulted in the unique morphology and the crystallographic orientation relationship of the spinel enclosed by melilite and Local composition zoning of the melilite.

[1] Simon et al., 1999 *GCA.*, 63, 1233-1248 [2] Kawasaki et al., 2017 *GCA.*, 201, 83-102 [3] Stolper, 1982 *GCA.*, 46, 2159-2180.