

## Microtextures in the MAC 88107 carbonaceous chondrite: Is this meteorite really a primary accretionary rock?

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MAC 88107 is an ungrouped carbonaceous chondrite having intermediate properties between the CM and CO groups [1]. Carbonaceous chondrites generally consist of chondrules and inclusions embedded in a fine-grained matrix, which constitutes >30 vol.% of the meteorites. In contrast, MAC 88107 virtually has no matrix and consists mainly of chondrules and inclusions surrounded by rims. The rims are thought to have formed by accretion of dust onto the surface of chondrules and inclusions while floating in the solar nebula [2]. Thus, meteorites like MAC 88107 are thought to be “primary accretionary rocks”, which formed directly from the solar nebular [2]. However, recent studies of chondrules/rims in the Mokoia CV chondrite show abundant evidence for rim formation within the meteorite parent body [3,4]. Based on the model proposed by [3, 4], the rims are remnants of former matrix adhering to chondrules and inclusions.

To reevaluate the formation processes of MAC 88107, we performed detailed observation and analyses of this meteorite using SEM-EDS, STEM-EDS, and SR-XRD.

The rims in MAC 88107 mainly consist of extremely fine-grained material (<1 $\mu$ m) with small fragments (1-10  $\mu$ m) of forsterite, enstatite, and magnetite-fayalite-hedenbergite aggregates. Our STEM observations and SR-XRD measurements reveal that the extremely fine-grained material consists mostly of an amorphous material with minor amounts of phyllosilicate, olivine, pyroxene, pentlandite, and magnetite.

Many rims in MAC 88107 contain characteristic veins (~10  $\mu$ m in width) consisting of coarse grains (1-15  $\mu$ m) of magnetite, fayalite, and hedenbergite. Krot et al. (2000) [1] suggested that these veins were formed during fluid-assisted oxidation of metal-sulfide nodules in chondrule peripheries. The oxidation was associated with a volume increase, induced high stresses in adjacent rims, and eventually broke to form fractures, which were subsequently filled with growing magnetite. However this model cannot explain the presence of veins in rims around CAIs which have no opaque nodules. If the veins were originated from cracks formed by brecciation of the present meteorite lithology, there should have been veins penetrating multiple chondrules/rims. However such vein is absent. These facts suggest that the veins were formed from cracks that resulted from brecciation of a precursor lithology of the chondrules/rims.

Characteristic layers, 5-30  $\mu$ m in width, occur between neighboring rims. These layers consist of relatively coarse-grained magnetite, fayalite, and hedenbergite. Krot et al. (2000) [1] termed them “inter-rim layers”. The mineralogy and texture of inter-rim layers resemble to those of veins in the rims.

We found several clasts which contain multiple chondrules in MAC 88107. These clasts are 150-500  $\mu$ m in diameter and have round shapes. They contact with adjacent chondrules or rims directly or through inter-rim layers. The chondrules in the clasts have no rims. The matrices of the clasts have mineralogy and texture similar to the chondrule rims in the outside of the clasts. These observations suggest that the chondrules/rims are actually clasts that resulted from brecciation of a precursor lithology and subsequent transportation and abrasion.

From these results, we suggest that MAC 88107 was formed through the following processes: (1) formation of chondrule/rim clasts by brecciation of a precursor lithology, (2) transportation and abrasion, and (3) accumulation and lithification of those clasts.

### References:

[1] Krot et al. (2000) MAPS 35, 1365?1386. [2] Metzler et al. (1992), GCA 56, 2873?2897. [3] Tomeoka and Ohnishi (2010), GCA 74, 4438?4453. [4] Tomeoka and Ohnishi (2014), GCA 137, 18?34.

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