RELATIVELY COARSE-GRAINED CHONDRULE RIMS IN TYPE 3 CHONDRITES. Alan E. Rubin, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024, USA.

Several different types of rims occur around chondrules and inclusions in type 3 carbonaceous and ordinary chondrites. For example, many CAIs possess rims that may have formed by alteration of melilite in the CAIs by a nebular gas phase (1). Fine-grained, iron-rich, opaque silicate matrix material (2,3), containing varying amounts of sulfide and metallic Fe,Ni, forms discrete rims around many chondrules in type 3 ordinary and carbonaceous chondrites. I have found a largely undescribed type of rim that surrounds ∿50 %, ∿5 % and <1 %, respectively, of chondrules in CV3, H-L-LL3 and CO3 chondrites, but only very rare CAIs. This type of rim surrounds all types of chondrules (including those with abundant glass) and compound chondrules. The rims are coarse-grained relative to opaque matrix; average grain sizes range from ∿4 μm in H-L-LL3 chondrites to ∿10 μm in CV3 chondrites. Rim thickness average ∿150 μm and ∿400 μm in H-L-LL3 and CV3 chondrites, respectively.

Relatively coarse-grained rims are composed predominantly of FeO-rich olivine and low-Ca pyroxene. Plagioclase is present in a few of the coarser rims: bytownite in Allende and oligoclase in Semarkona. Nepheline and sodalite occur in many rims in CV3 chondrites. Sulfide and metallic Fe,Ni occur in most rims as spherical blebs and/or continuous or discontinuous rings; the dominant sulfides are troilite in H-L-LL3 chondrites and pentlandite plus (troilite or pyrrhotite) in CV3 chondrites. Olivines within the relatively coarse-grained rims are generally more ferroan than those within the chondrules they surround. Some of the finest-grained of these rims in Allende have olivine grains identical in composition to those within the opaque matrix (Fa50) (4). One very coarse-grained Allende rim possesses olivines (Fa11) that are much less ferroan than average (Fa 30), approaching in composition olivine phenocrysts (Fa6) in the enclosed chondrule.

In texture, appearance, grain size, mineral abundance, mineral composition and bulk composition, relatively coarse-grained rims in H-L-LL3 chondrites resemble "dark-zoned chondrules" (5). Recrystallized matrix material (2) also appears to be related to these rims. The relatively coarse-grained rims are similar in composition to opaque matrix, exhibiting similar interelement abundances and fractionations relative to CI chondrites. However, the CV rims are depleted in Fe, Ni, P and S and enriched in Ti, Na and K relative to the matrix, and the H-L-LL rims are depleted in Fe, Ni, P, S, Na and K and enriched in Ti relative to the matrix. Not all CV rims are of the same composition: the relatively coarse-grained rim around one large compound chondrule in Allende is enriched in Cr and Na and greatly enriched in Mn relative to opaque matrix and bulk CV chondrites (6).

The dark-zoned chondrules and relatively coarse-grained rims were formed by heating clumps of opaque matrix material to subsolidus to sub-liquidus temperatures in the solar nebula. This may have been accompanied by reduction of some FeO to metallic Fe (perhaps by C in the matrix) and loss of some Fe, Ni and S either as a liquid or through sub-solidus migration. Phosphorus in the rims may either have been partially volatilized or partially reduced (forming phosphides which may have been lost with metallic Fe). The absence of relatively coarse-grained rims around the vast majority of CAIs in CV chondrites indicates that the chondrules acquired their rims shortly after chondrule formation, not during chondrite agglomeration. The most likely source of the heat which formed the rims and dark-zoned chondrules is the mechanism responsible for chondrule formation. This mechanism completely melted some materials (to form chondrules) and only sintered other materials (to form the relatively coarse-grained rims), suggestive of a steep thermal gradient. Lightning (7,8) and reconnecting magnetic field lines (9) seem the most plausible energy sources.

CV chondrites may have formed in a region of the nebula where the chondrule formation mechanism was less efficient, most likely at greater solar distances than ordinary chondrites. The lesser efficiency of heating might be responsible for the greater abundance of relatively coarse-grained chondrule rims in the CV chondrites. Alternatively, CV chondrules may have suffered fewer particle collisions prior to chondrite agglomeration.

Clumps of opaque matrix were completely melted in some instances to form chondrules. One such chondrule, TI-21 from Tieschitz (10,11), has an igneous texture and a bulk composition exactly the same as that of opaque matrix. However, most chondrules have lower Al/Ca and higher Mg/Si ratios than matrix material, suggesting that chondrules formed from more than one solid precursor.

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