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DYNAMIC CRYSTALLIZATION CHARACTERISTICS OF ENSTATITE CHONDRITE CHONDRULES; Gary E. Lofgren, John M. DeHart, SN-2, NASA Johnson Space Center, Houston, TX 77058 A.B. Lanier, C23, Lockheed ESC, 2400 NASA Rd. 1, Houston, TX 77058.

Although the chemical properties of enstatite and ordinary chondrites are distinctly different (1), they both contain chondrules with a similar array of textures. This similarity suggests like origins. Textural studies using chondrule compositions from ordinary chondrites suggest that these chondrules have an igneous origin: either by crystallization from melts or from partial melts of crystalline material, probably nebular dust. In contrast, the cathodoluminescence (CL) properties of the enstatite from enstatite chondrites have been interpreted to mean that mechanical aggregation played an important part in their formation (2). An alternative interpretation of these CL properties, however, suggests that variations in the minor element content of the enstatite, a probable result of igneous fractionation processes, could also produce different CL colors (3). We will attempt to evaluate the two models by performing dynamic crystallization experiments on an average enstatite chondrule composition and by looking at the resultant CL.

The crystallization characteristics of this E-chondrite chondrule composition are broadly similar to the pyroxene rich (radial pyroxene) composition studied previously (4). The liquidus phase is olivine which is in a peritectic relationship with enstatite. Thus, depending on the nucleation conditions, the resulting crystalline material may or may not have olivine as a significant phase. There are several typical textures for both olivine and pyroxene. For olivine, the barred dendrite is common for melts which experienced temperatures above the liquidus. These textures are not like the barred dendrite in the olivine rich compositions which dominate the entire charge, but sparse dendrites enclosed in a matrix of enstatite, usually spherulitic or dendritic. At melt temperatures at or just below the liquidus, skeletal or hopper olivine microphenocrysts and/or large phenocrysts prevail. These olivines can be quite large and grow beyond nominal modal proportions of the melt. Pyroxene textures dominate if pyroxene nuclei are present in near liquidus or subliquidus melt runs because enstatite will crystallize readily. Slightly skeletal enstatite which encloses rounded olivine, whose growth preceded the enstatite, dominate at the slower cooling rates (5-50°C/hr). At the faster cooling rates the enstatite is dendritic and/or barred and may also contain barred olivine dendrites. If large numbers of nuclei are present, the texture becomes granular and the crystals decrease in size in proportion to the increase in the number of nuclei. Olivine crystals are mixed with the enstatite if the melting occurs reasonably close to the liquidus.

The CL of the experimentally grown enstatite is mostly red to purplish red with blue intermixed in a striated pattern. The CL color was determined under the electron microprobe beam at a potential of 15KeV and a current of 300na. The bluish areas have slightly lower Cr and Mn contents. The Cr in the bluish enstatite is approximately .15 wt % as opposed to >0.2 for the red. The Mn is typically 0.05 wt. % in the blue and 0.1 in the red enstatite. There is overlap in these values, but they do correspond to the approximate values reported for naturally occurring red and blue enstatite (2,3). The close association of the red and blue enstatite must be a growth phenomena. It has the superficial appearance of exsolution lamellae or an intergrowth of ortho (blue) and clinoenstatite (red), but the only compositional differences are in the minor elements.

The textures grown experimentally crystallized E-chondrite melts confirm that formational processes are similar to those for the ordinary chondrites with the obvious exception of the oxidation state. A first look at the CL of these enstatites suggests that mixed blue and red CL colors in a single chondrule or grain could result from growth processes.

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