**DYNAMIC CRYSTALLIZATION EXPERIMENTS ON LEW97008: EXPERIMENTAL REPRODUCTION OF CHONDROID TEXTURES.** J. W. Nettles[1], L. Le[2], G. E. Lofgren[3], and H.Y. McSween, Jr.[1] [1] Department of Geological Sciences, University of Tennessee, Knoxville, TN, 37996 (jnettle1@utk.edu) ,[2]Lockheed-Martin, Houston, TX 77058, [3] SN-2, NASA Johnson Space Center, Houston, TX, 77058.

**Introduction:** Dynamic crystallization experiments were conducted using LEW97008 (L3.4) as starting material. Experiments were melted at temperatures well below its liquidus (1250-1450°C) in order to document the textural and compositional changes that occur in UOC material with modest amounts of partial melting and subsequent crystallization. The textures of the experimental products compare very well to natural chondroids (partially melted nebular particles that would become chondrules if more completely melted). Thus it is possible to use the textures in these experiments as a guide to unraveling the melting and cooling histories of natural chondroids.

The Antarctic meteorite LEW97008 was chosen as the starting material for our experiments. As an L3.4 it is slightly more metamorphosed than would ordinarily be preferred, but this meteorite is unusually fresh for an Antarctic meteorite, which made it attractive.

**Experimental techniques:** A matrix of 12 experiments were performed on 75 mg. aliquots of LEW97008 that were ground to a fine powder with an average grain size of approximately 100 μm; this is coarse enough to ensure that relict crystals can survive melting. The aliquots were pressed into pellets and placed in a furnace with a $CO/CO_2$ ratio-controlled oxygen fugacity that was one half a log unit below the iron-wustite buffer curve. The time-temperature matrix has melt temperatures of 1250, 1350, and 1450 °C and cooling rates of 1000, 100, and 10 °C/hr or quenched. Two experiments were melted at 1370 instead of 1350°C; these experiments will be repeated. The experimental charges were mounted in epoxy and cut into slices approximately 500 μm thick for study. Backscatter electron (BSE) images were collected and quantitative analyses were completed with the JSC Cameca electron microprobe at an acceleration potential of 15 kV and a beam current of 20 nA.

**Results:** The results of the experimental results are described below, grouped by their maximum heating temperatures.

***1250 °C***. The most noticeable feature in these charges is the these relict material. In the quenched experiments, several fragments of barred olivine chondrules remain, as well as more euhedral olivine relicts. Several crystals are very rounded while some are euhedral. With decreasing cooling rate, there are fewer relicts and less chemical zoning. In these samples, particularly the quench experiment, there are several crystals that are noticeably larger than the others. Olivine cores average approximately 14 wt% FeO and approximately 45wt% MgO, and this does not change much with cooling rate. Metal blebs have become rounded and are usually localized to specific parts of the sample. These samples are very heterogeneous in grain size and crystal shape and composition.

***1350 & 1370°C***. At these maximum temperatures, most of the crystals are more euhedral (or at least more angular) than those heated to 1250°C. While there is considerable variation in grain size, it is less than the variation in the 1250 °C experiments. Zoning is prominent in almost all of the crystals except for the experiment with the slowest cooling rate. Olivine cores have MgO and FeO concentrations similar to the 1250°C experiments.

***1450 °C.*** These experiments were heated to the highest melting temperature. Most notable features in these charges are the more extensive melting and growth of new euhedral crystals. There is also more development of mesostasis that shows varying degrees of crystallization. At 1000 °C/hr. the mesostasis contains small acicular crystals. At 100 and 10°C/hr there are fewer acicular crystals. Overgrowths on pre-existing crystals are more common.

**Discussion:** Since all of the experiments were partially melted, many of the textural features in the resulting products develop from the reaction between the relict crystals and the surrounding

melt during the melting event and subsequent cooling. Compositional zoning in crystals is most pronounced in runs with high cooling rates and least evident when the cooling rate is slowest. Acicular crystals tend to develop out of melts at modest to high cooling rates, as do overgrowths on relict crystals. In all the experiments the primary crystals are euhedral to subrounded. Barred olivine or radiating pyroxene crystals are largely absent (except as relicts). The experiments reproduced textures found in many natural chondroids. Figure 1 shows the similarity between one experiment (see caption for details) and a chondroid found in Semarkona. Figure 2 compares another Semarkona chondroid to an experiment that was melted to a lower temperature (1250 °C). Aside from expected differences in the amount of mesostasis and grain sizes, the two images are virtually indistinguishable.

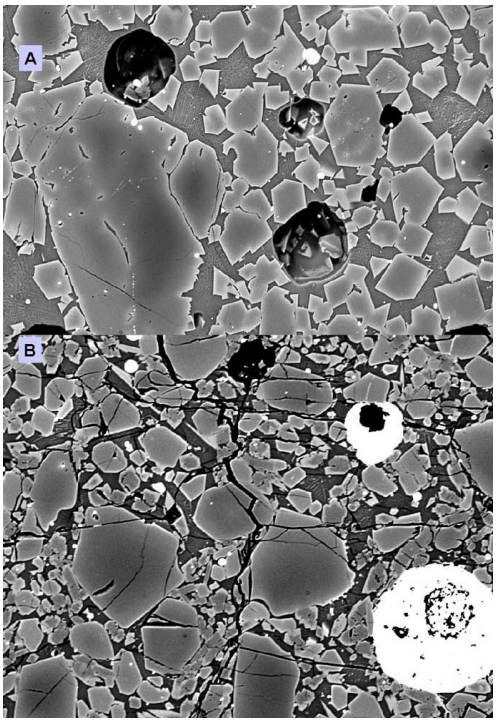


**Figure 1.** Experimental results (A) have similar textures to natural chondroids. A) Experiment Que-278, melted at 1350 °C for 1 hour and cooled at 1000 °C/hr. B) Natural chondroid sample in Semarkona (width of both images is 500 µm).

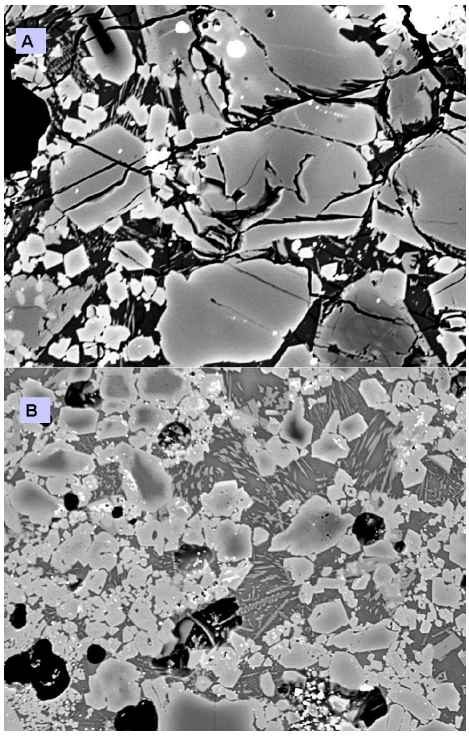


**Figure 2.** A) Semarkona chondroid (width of image 300 µm). B) Experiment QUE-287, melted for 1hr. at 1250 °C and cooled at 100 °C/hr (width of image 500 µm). As in Figure 1, the textures are very similar.

**Conclusions:** In each of these experiments the samples were heated to temperatures well below their melting temperatures. The resulting textures are very much like those found in porphyritic chondrules, which supports the hypothesis that partial melting is an important part of the chondrule-forming process. Previous dynamic crystallization experiments [1 & 2] conducted at higher temperatures from 1450 to 1600°C demonstrated that mostly or totally melted chondrules could be separated from chondroids (partially melted chondrules) based on textures. These lower temperature experiments provide the basis for discrimination between modestly and minimally melted chondroids. By matching textures in natural chondroids to results of experiments such as these, one can approximately determine the amount of melting the natural chondroid suffered.

**References:** [1] Lofgren, G.E. and Russell, W.J., *GCA, 50*, 1715 – 1726. [2] Lofgren, G.E., *GCA, 53*, 461-470.