CHONDRULES BORN IN PLASMA: LABORATORY SIMULATIONS OF CIRCUMSTELLAR PROCESSES.

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Introduction: Most chondrules appear to have been heated to 1500–1600 ºC, followed by a rapid cooling of usually between 10 to 1000 ºC/h [1]. The exact process is still not known - common scenarios are formation in a protoplanetary nebular environment: e.g. X-wind model [2] or nebular shock fronts, where precursor grains are heated by collisions with gas [3].

In this part of our study about the formation of chondrules by shock processes, we try to simulate the formation of chondrules by gas-grain collisions in a nebular environment. To achieve this, we heated precursor materials (silicates, sulfides etc.) in hot plasmas created by an RF electric arc [also compare 4,5].

Techniques: A basic atmospheric pressure RF arc discharge was adapted fro this work. The arc was generated between copper electrodes separated by 15 mm using a low voltage solid state switching circuit to drive a Tesla coil (natural frequency ~ 325 kHz).

The gas temperature in the arc column has been determined in an earlier experiment through fitting of modeled rotational structure of emission spectra: at 25W power input, the gas temperature is in the region of 2500 +/- 100 K.

Material (mixture of fine grained labradorite, forsterite, sulphide and metal) was dropped vertically through the arc plume. The resulting 'processed particles' were recovered, embedded in resin, polished and analyzed for their chemical composition using SEM/EDX.

Results: SEM images of particulate matter formed in the experiments show that a high abundance of spherules or 'chondrules' were produced, many in the size range 0.1-1 mm. Various phases are visible. There are compound 'chondrules' consisting of several spherules, in addition to relict grains.

EDX analysis of the polished samples shows large forsterite and labradorite grains embedded in a groundmass. While many of the former are probably relict, unmelted grains, bubbles in others indicate that these phases at least underwent melting. The chemistry of the embedded forsterite grains is unchanged compared with the starting material, but that of the feldspars shows some variations. This could indicate some mixing during melting. The groundmass shows abundant bubbles – its chemistry is a mixture of the starting materials.

Conclusions: The results of the first round of experiments were promising. The next series will focus on grains held together by organics, to simulate dust aggregates as starting materials.

References: [1] Zanda B. (2004) *ESPL* 224:1-24. [2] Shu et al. (2001) *The Astrophysical Journal* 548: 1029-1050. [3] Desch and Connolly Jr. (2002) *Meteoritics & Planetary Science* 37:183-208. [4] Hewins et al. (2000) *LPSC* XXXI, abstract #1675 [5] Guettler et al. (2008) *Icarus* 195: 5094-510.