THE REPRODUCTION OF CHONDRULE RIMS: A PRELIMINARY REPORT.

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INTRODUCTION Chondrule textures have been experimentally duplicated (1-3) but the relationship between chondrules and rims is still controversial (4,5). Preliminary experiments have produced rims on chondrules and may provide some constraints on models of chondrule evolution. Present experiments are analogous to the interaction of hot rocks in a dusty nebula.

EXPERIMENTAL TECHNIQUE Experiments were performed on a DT-31-VT-OS vertical muffle tube furnace at 1 atm with a controlled fO_2 of 0.5 log units below the Fe-FeO buffer curve. Charges were produced from Type II chondrule composition (6), heated from 1566-1526°C for 30 min. and cooled at 500°C/hr. Dust of Type II composition or powdered fayalite slag was introduced into the furnace as the charge's core was finishing its crystallization in attempts to form rims. Dust was emplaced using a "puffer", a ceramic tube (D=1mm) with a plastic tube and rubber bulb attached to one end. Dust is placed in the rod and inserted into the furnace at the desired temperature, then puffed onto a charge. The puffer aims dust directly at the charge, and produces a small dust cloud in the muffle tube. Rim experiments were performed in pairs. The first charge was quenched and thin sectioned as control. Before the second charge was quenched, various "puffs" of rim dust were applied.

EXPERIMENTS Experiments were carried out to simulate (a) the mixture of hot chondrules into a dusty nebula and (b) the reaction of host chondrules with a hot chondrule matrix. (a) The first series of four experiments used a glass of average Type II chondrule composition as rim dust. In experiments that prooduced both barred olivine (BO) and porphyritic olivine (PO) textures in the control charges, no rims were produced. These experiments involved puffing dust onto the charges at 930-1194°C with either single or multiple puffs. Puffing air alone onto a charge had no effect.

The second series of experiments used less refractory powdered fayalite slag as the rim dust. Charge 415 (Fig. 1) was cooled from 1577°C to 1176°C. The charge was then puffed 22 times at 1176°C and quenched 14.5 hrs. later. The charge has a PO texture and a rim, aproximately 200μm thick containing euhedral Fa crystals, dendrites, and glass. Some exchange of Fe and Mg between the charge and the rim occured (Fig.1). Charge 417 was cooled 1529°C to 1043°C and puffed with a smaller amount of dust. The charge was quenched 2 min. later. The charge has a transitional BO/PO texture with a rim, 50μm thick containing Fa_{100} anhedral grains, small euhedral Fa_{100} crystals and glass, with no reaction between rim and chondrule. A few Fa_{100} grains have actually been incorporated into the charge (Fig. 2).

(b) Preliminary sintering experiments were conducted to determine the extent of reaction between chondrules and chondrite-like host. Mixtures of fayalite slag and San Carlos olivine sinter readily in a crucible, without Fe-Mg exchange, forming a rock-like aggregate unlike the thin surface coatings seen as chondrule rims. Charges of various compositions were placed in a bucket and covered with chondrite-like matrix dust and heated at 1008°C for two days. No rims were produced on the charges.

DISCUSSION Rims were not observed in experiments performed with glassy Type II chondrule dust, either because this dust did not stick or because the charge and rim have the same composition and therefore cannot be distinguished. Experiments performed with fayalite slag dust produced distinct rims. Based on the preliminary experiments, rim thickness depends primarily on the amount of dust puffed. With higher temperatures (Fig.1) the rim shows more extensive melting (more glass and dendrites, more and larger euhedral grains, and fewer anhedral grains). With shorter times (Fig.2) at the same temperature there is no reaction between rim and charge, suggesting that rim formation in nature requires fairly slow continuous cooling of chondrules. These experiments are analogous to the mixing of slowly cooling chondrules into a dusty region of the nebula containing dust that is less refractory than the chondrules. Chondrules can, therefore, acquire rims during transport from hot regions of the nebula to cooler, more volatile rich regions. Further experiments using more magnesian rim dust closer to natural chondrule rims will determine upper and lower temperature limits of rim sintering, establish whether coarsening of rim grains can occur without Fe-Mg exchange between sphere and rim, investigate the role of partial melting in rim formation, and the relation between rim thickness and quantity of dust.

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CONCLUSION Rims like those on chondrules can be formed by bombarding crystallizing synthetic chondrules with fayalite dust at temperatures above their solidus. This technique has enormous potential for the study of chondrule thermal history and the dust content of the solar nebula.

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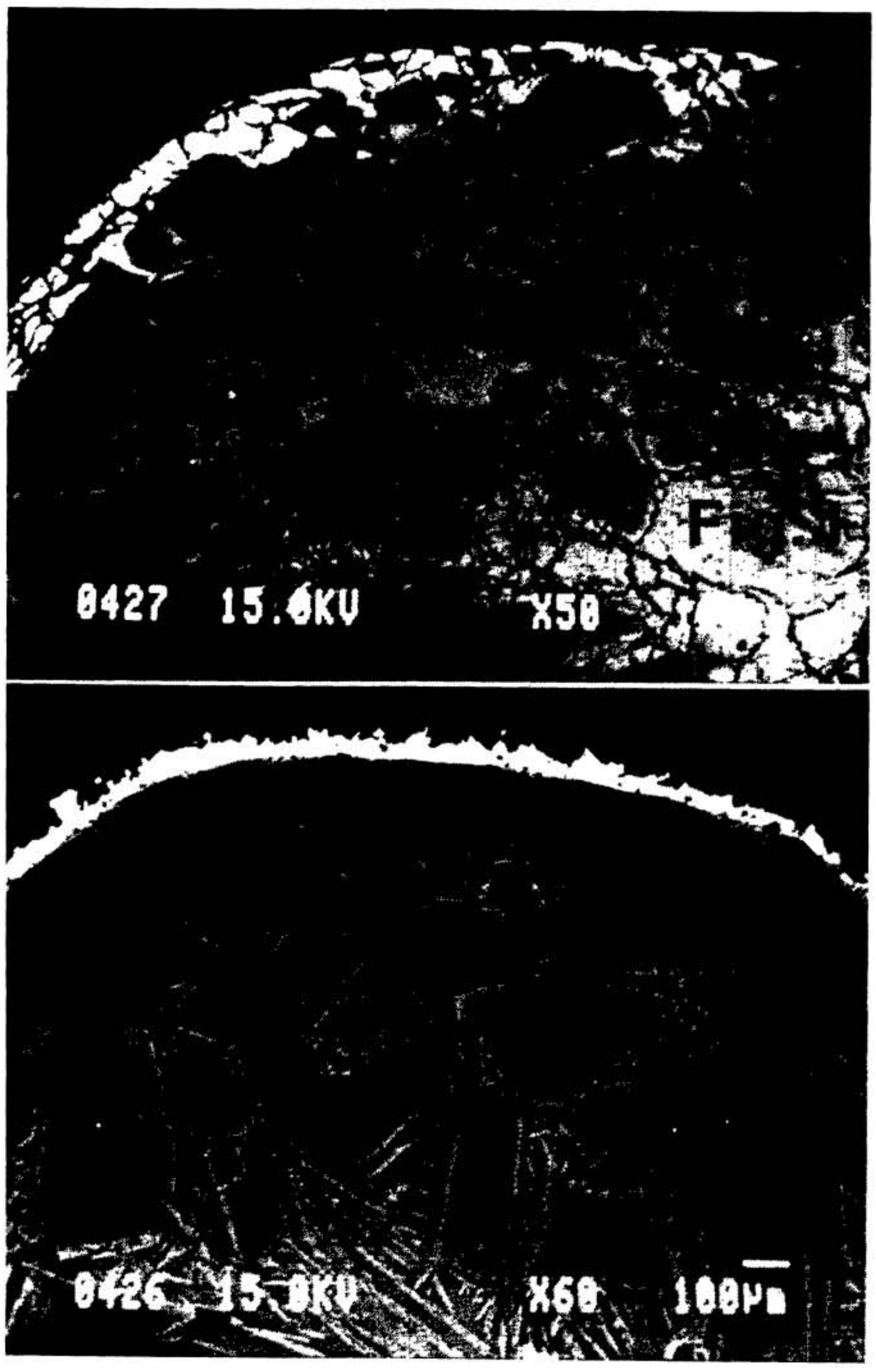

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