Experimental reproduction of voids in chondrules under low pressure like primitive solar nebula

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Chondrules are silicate objects which are about 1mm diameter and characteristically included in primitive meteorites, chondrites. It is widely accepted that chondrules were formed by heating and melting of solid precursors, because they are igneous and include glasses. And they would have important information about the evolution of the solar system, because their sizes are between interstellar dust and planetesimals. However the heating mechanism of chondrule formation is controversial. Tsuchiyama et al. [1] found that voids are present in chondrules although their amounts are small (up to 3 vol.%). They would have important information on the process of chondrule formation. Nakashima et al. [2] performed experimental reproduction of voids in chondrules with dust ball of mineral grains in 1 atm environment for the investigation of the origin, but they couldn't reproduce low polocities of natural chondrules. One of the most probable reasons of this difference would originate from the difference of surrounding pressure between the experiments and chondrule formation.

In this study, we performed new heating experiments at lower pressure like primitive solar nebula to reproduce voids in chondrules for the investigation of the origin of voids in natural chondrules.

We assumed the precursor material of chondrules as dust ball of mineral grains as [2]. An FeO-rich analog composition with a low liquidus temperature compared to that of natural chondrules was used as a starting material(FeO˜50Wt%). They were prepared from a mixture of mineral grains of olivine, clinopyroxene, orthopyroxene, and plagioclase (3mm diameter). We heated them at 1040-1400^{o}C for 30s-40min at 10^{-3}atm(mixing gas of H_2 and CO_2). We observed run products with using X-ray CT, and obtained their three-dimensional structures. The result of image analysis showed that large voids were present in run products formed even at low pressure. Those voids were constantly present even if we removed water and volatile materials from the starting material. We will discuss the origin of the voids in the experiments.

[1] Tsuchiyama et al. 2003, LPSC, abst#1271

[2] Nakashima et al. (2005), 2005 Fall Meeting of the Japanese Society for Planetary Sciences, pp.104