# Experimental reproduction of voids in chondrules and their three-dimensional size distributions

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Chondrules are quenched silicate droplets and characteristically included in condrites. It is widely accepted that chondrules were formed by heating and melting of solid precursors. However, the heating process of chondrule formation is still in controversy. In recent years, their 3-D structures have been examined by X-ray computed tomography (CT). It was proposed that voids are commonly present in chondrules although their amounts are small (up to 3 vol.%) [1]. This shows that voids are another important constituents of chondrules as well as silicates, Fe-Ni metal and Fe sulfides.

In the present study, experimental reproduction of voids in chondrules was performed to examined the condition for void generation during chondrule formation. An FeO-rich chondrule analog composition with a low liquidus temperature was used as a starting material in the present experiments (FeO ~ 50 wt. % [2]) because the maximum working temperature of a furnace is about 1500oC. The starting materials were prepared from a mixture of mineral grains of olivine (Fa100 : 67.8 wt.%), orthopyroxene (En39.2 : 17.5 wt.%), clinopyroxene (Di93.3 : 3.3 wt.%) and plagioclase (An75.0 : 11.4 wt.%). 30 mg of such mixture was pressed into pellets (up to 50 um size) and attached to a Pt wire loop. The pellets were heated in a 1 atm H2/CO2 gas-mixing furnace at constant temperature (1120-1240oC) for different durations (up to 1 hr) at oxygen fugacity of 0.5 log unit below the Iron-Wustite buffer curve. After heating, the charges were quenched into water. 3-D structures of the charges were obtained with an X-ray CT (Nittetsu ELEX: ELESCAN). The minimum size of pixel of the CT image is 3.516x3.516 um2, and the slice thickness is 5.625 um. The charges were finally mounted in epoxy, sliced and polished, and observed under an SEM-EDS ( JEOL: JSM-5510LV +JED-2300 ) to identify their phase and to compare CT images with the SEM images.

The porosities, connectivities ([3]) and the size distribution of voids were obtained by image analysis, such as binarization of the 3-D CT images. For a constant heating duration (20 min), the porosity decreases (from about 30 to 0 vol. %) and the number of voids decreases too, while the connectivity increases with increasing temperature. The size of the voids increases first, reaches the maximum and decreases with increasing temperature. Analytical results of the size distribution of voids and experimental results for different heating durations at a constant temperature will be also reportd.

So far, the features of voids in natural chondrules were not reproduced by the present 1atm experiments. Low pressure experiments will be also preformed near feature as well as 1 atm experiments at different conditions to elucidate void formation conditions in chondrules.

[1] Tsuchiyama et al. (2003) LPSC, XXXIV, 1271. [2] Connolly et al. (1998) Geochim. Cosmochim. Acta., 55, 2943-2950. [3] Ikeda et al. (2000) Mineral. Magazine, 64(5), 945-956.