

## REPRODUCTION OF TYPE I CHONDRULES AND THE IMPLICATIONS.

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**Introduction:** Chondrules with quasi-solar compositions but volatiles depleted are tiny igneous spherical objects, ~0.1-1 mm in diameter [1,2]. They formed from rapid cooling after some transient heating of chondritic precursor materials plausibly in the solar nebula at the earliest solar system dated on ~4565-4567 Ma [e.g., 3], which are main constituents with fine-grained matrices of unequilibrated chondrites. The heat source for the melting event is still in debate. Chondrules mainly consist of olivines, pyroxenes, Fe-Ni metals, and sulfides, which are compositionally divided into two types: type I (MgO-rich) and type-II (FeO-rich) [1]. Type II chondrules have been successfully reproduced [e.g. 4], but not enough for type I. Type I is much more abundant than type II in carbonaceous chondrites. In the present study, type I chondrules were recently synthesized using a newly constructed H<sub>2</sub> gas mixing furnace controlled under medium vacuum [5]. New analytical preliminary data on isotopes would be included. The original idea has been presented at the poster session in the NIPR symposium on Antarctic Meteorites [6].

**Experimental syntheses:** The experimental conditions were as follows: (1) Starting materials were mainly of chondritic sintered pellets, (2) Controlled total pressure using Baratron diaphragm was at P(H<sub>2</sub>) = 0.001 bar, with peak temperature of 1450°C, cooling rate 100°C/h, oxygen fugacity of IW-2 to IW-3.8 log unit, and molybdenum wire loop for charge holding, in Knudsen-type cell of alumina, (3) The interior of the Knudsen cell was buffered by silica and iron powder, or non-buffered. The run products were similar to type I chondrules. Especially, non-buffered case to porphyritic olivine (PO) chondrules and silica buffered case to porphyritic pyroxene (PP) chondrules. This was formed via evaporation of iron oxide components from the charge. In the case of silica buffer, SiO<sub>2</sub> condensation helped the crystallization of low-Ca pyroxenes, resulting in the syntheses of PP chondrules.

**Implications:** (1) Silicate liquid is unstable under the condition of low pressure and the solar abundance gas [7,8]. The ratio of the other gas species to H<sub>2</sub> in the capsule is consistent with dust-enriched system by [7,8], where silicate melt is stable at high temperature. This condition does not require the high pressure to produce chondrule melt, but low pressure 0.001 bar is acceptable for chondrule formation pressure. (2) Isotopes of major elements (magnesium, iron, and silicon) in chondrules do not show any significant fractionations, magnesium and iron for [9,10], and silicon for [10,11]. No significant isotopic fractionations for these elements are expected from the present experimental system using the Knudsen-type cell [e.g., 12]. This is because the capsule with small orifice may suppress the mass dependent isotopic fractionations. Thus the present experimental condition should reproduce the natural chondrule formation environments. The isotopic measurement for synthesized chondrules would support the idea and was planned carried out using SHRIMP II recently installed at NIPR. (3) The present experiments showed that the evaporation of iron oxide components from chondritic precursors played important role in forming type I chondrules. This experimental evidence suggests that precursors were dust aggregates and planetesimals but not simply recycling of chondrules. The idea is consistent with the complementally feature between chondrules and matrices [e.g., 13]. We do not prefer collisional heat source since the present experiments do not need high pressure as be suggested by [14]. The heat source to melt the precursors in order to form chondrules might be transient and intense solar flare accompanying shock [15, 16].

**Acknowledgements:** The study is supported by the grant of KAKENHI (23340165 and 17K05721).

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