THREE-DIMENSIONAL EXTERNAL SHAPE AND INTERNAL STRUCTURE OF CHONDRULES IN ALLENDE CV3 CHONDRITE.

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Introduction: Chondrules are considered to be formed through some melting events. Corresponding heating mechanism has not been clearly identified yet, and various heating mechanisms are proposed, including shock waves in the nebula gas [1]. Proposed mechanisms can be categorized into two groups: ones in which chondrules are exposed to a gas flow, and the others. If molten chondrules are exposed to a gas flow, they are expected to be deformed depending on the ram pressure and the surface tension, as is the case of completely molten cosmic spherules [2] that are heated and melted when they enter the Earth's atmosphere and solidify again in the air. Thus, if we see the signature of gas flow exposure in the external shapes of chondrules, it would imply that chondrules were heated and formed by events related to the gas flow.

In this study, we measure the external shape of chondrules in Allende CV3 chondrite to look for the gas flow signature. We also observe the internal structure and the 3D distribution of metallic iron nuggets in chondrules to see the degree of melting and to infer the melting process.

Sample and Measurement: Using the freeze-thaw method, we disassembled a piece of Allende chondrite, which was about 11 g, into chondrules, CAIs, and other matrix components, and we picked up about 180 chondrules. Then, we measured some of them using the X-ray CT apparatuses (Scan Xmate-D180RSS270, Scan Xmate-D160TSS105/11000) in the Museum of Natural History, Tohoku University.

Results and Discussion: We measured the external shape of chondrules approximating them as triaxial ellipsoids, and found that barred-olivine and glassy chondrules (they are molten once completely) have various shapes such as spherical, oblate, prolate, and triaxial. The degree of the difference from the sphere was also quantitatively obtained. These results are broadly consistent with expectations of the shock-wave heating theory [2, 3].

We also found that metallic iron nuggets in porphyritic chondrules gather depending on the degree of melting. This may indicate that chondrule forming events heat precursor particles with various degrees; some of precursor particles are heated incompletely so that they form porphyritic chondrules including some iron aggregates, and some of them are heated well and form barred-olivine and glassy chondrules. In the latter chondrules, iron aggregates are likely to be ejected from molten chondrules when they have a deceleration motion, which is the case of the shock-wave heating mechanism. This may also imply that the iron-silicate separation is generated via the chondrule formation process, not by the constituent of precursor material.

References: [1] e.g., Iida A. et al. 2001. *Icarus* 153: 430-450. Desch S. J. and Connolly H. C., Jr. 2002. *Meteoritics & Planetary Science* 37: 183-207. Ciesla F. J. and Hood L. L. 2002. *Icarus* 158: 281-293. [2] Doi M. and Nakamoto T. 2011. Abstract #2761. 42nd Lunar & Planetary Science Conference. [3] e.g., Miura H. et al. 2008. *Icarus* 197: 269-281.