

Three dimensional shapes and internal structure of chondrules from Allende CV3 chondrite

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Origin of chondrules in meteorite is still controversial issue. Miura and Nakamoto have developed a shock-wave heating model for chondrule formation in a series of papers (Miura et al., 2002, 2005, 2008). According to the model, systematic relation would be expected between 3D shapes and internal structure of chondrules. Using X-ray CT at SPring-8 synchrotron, Tsuchiyama et al. (2003) measured 3D shapes and internal structure of 47 chondrules separated from Allende CV3 meteorite. They found that 4 out of 20 chondrules show prolate-shape (like a rugby-ball) and others show near spherical shapes. The prolate-shape could be explained by high-rotation during the shock wave heating episode, while the shock wave heating model predicts oblate-shape (like a pancake) chondrules without rotation. However, oblate-shaped chondrules were not observed in Tsuchiyama et al's study, most probably due to small number of samples analyzed.

In order to clarify 3D shapes and internal structure of chondrules, we have separated 180 chondrule grains from the Allende meteorite by a freeze-thaw method and hand picking. The internal structure of chondrules was investigated using the X-ray CT apparatus (Scan Xmate-D180RSS270) recently installed at the Museum of Natural History, Tohoku University. The 3D shape of chondrules was examined by an optical device newly developed (Nishida et al. JPGU 2013).

As presented in Fig. 1, the 3D shapes of chondrules show wide distribution consisting of true spheres, prolate-spheres and oblate-spheres. Note that 25 chondrules with nearly spherical shapes were not examined for X-ray CT to save time. About 60% of the measured chondrule grains were omitted in Fig. 1 because of imperfect shapes due to destruction or presence of matrix. Chondrules with porphyritic texture distribute in all shape categories. Chondrules with granular texture (lower melting degree than porphyritic) also show nearly homogeneous distribution. Chondrules with barred olivine texture (quenched from superheated melt) show a distribution between true sphere and oblate-shape. Implication of the 3D shapes and internal texture of chondrules will be discussed from the shock-wave heating model.

Keywords: Allende, Chondrule, X-ray CT, Three-dimensional shape, Shock-wave heating model

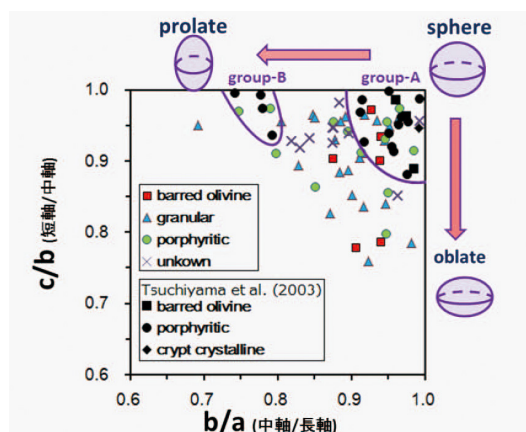


Fig.1 3D shape and internal texture of chondrules in Allende CV3 chondrite