X-ray CT observation of compound chondrules and the constraints on chondrule formation.

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Formation process of compound chondrules in the early solar nebula is one of the most important issues of the study of chondrule formation. If the compound chondrules were formed by mutual collisions between the chondrules which already solidified (primary) and still molten (secondary), their existence would indicate that there was a considerable difference of melting degree between the chondrules in a very close distance at the time of chondrule formation. The collisional formation would also indicate that the number density of chondrules in the chondrule formation region would be very high. Thus, the structure of compound chondrules indicates several constraints on chondrule formation [1-2].

There are three possibilities for the origin of the difference of the melting degree between the chondrules; (1) difference of liquidus temperature, (2) difference of cooling rate (difference of radius) and (3) difference of formation region. If the difference of liquidus temperature is responsible for the difference of the melting degree, the secondary chondrule should have lower liquidus temperature than that of primary chondrule. However, Uesugi and Sekiya [3] indicates that the secondary chondrules have higher liquidus temperature for around 50% of the compound chondrules. Thus, difference of liquidus temperature would not be responsible for the difference of melting degree.

Uesugi and Uesugi [4-5] have developed high resolution X-ray CT method for the observation of meteorite chips. This method enables the observation of chondrule texture and the boundary of compound chondrules, that were impossible to observe by previous method, by synchrotron radiation X-ray CT.

Using this method, we observed compound chondrules inside 4 meteorite chips (4x4x4mm, LL3.1, H3) by X-ray CT and obtained the three dimensional structure of compound chondrules. The results of the observation show that the most of primary chondrules have larger radius than secondary chondrules. If the difference of the cooling rate between the chondrules dominates the structure of compound, the radius of primary chondrule should be much smaller than secondary. Our results indicate that the cooling rate origin of the difference of melting degree would be small.

In the future works, the development of the method for preparing thin sections of small meteorite chips with arbitrary cutting surface is needed for the precise analysis of chemical compositions.

[1]Wasson J. T. et al. (1995) GCA, 59, 1847
[2] Akaki T. and Nakamura T. (2005) GCA, 69, 2967
[3] Uesugi M. and Sekiya M. (2005) Antarctic Meteorites XXIX, 90.
[4] Uesugi M. and Uesugi K. (2006) Antarctic Meteorites XXX, 119.
[5] Uesugi M. and Uesugi K. (2007) Antarctic Meteorites XXXI, 101.