Quantitative parameterization and formulation of crystallization process of amorphous silicates

Keisuke Murata[1]; Takashi Takakura[1]; Hiroki Chihara[2]; Chiyoe Koike[3]; Akira Tsuchiyama[1]

[1] Earth and Space Sci., Osaka Univ.; [2] Dept. of Earth and Space Sci., Osaka Univ.; [3] kyoto Pharmaceutical Univ.

The author performed heating experiments of amorphous silicate with the CI chondritic composition for analogue of a cosmic dust in circumstellar environment around oxygen-rich young stars. Two kinds of the starting amorphous silicate samples were synthesized by the Sol-Gel method; one contains all iron as divalent (Fe/Si = 0.90) and the other contains iron (Fe/Si = 0.39), where the rest of iron forms FeS and not included in the amorphous silicate. The amorphous samples were heated to investigate temperature and time dependences of crystallization. In the IR spectra, the absorption peaks of olivine grew gradually with increasing heating duration at a constant temperature or increasing temperature for a constant duration. The amorphous silicate with the lower iron content crystallized more rapidly than that with the higher iron content.

The author performed an IR spectral fit of the heated samples and estimated the degree of crystallization quantitatively. Using this parameter, crystallization process could be formulated using the Johnson-Mehl–Avrami equation. It was suggested that nucleation, which could not be detected by either of infrared spectroscopy or synchrotron X-ray diffraction, had already finished when the amorphous silicate was prepared.