IR EVOLUTION OF CONDENSING SILICATE NANOPARTICLES: EFFECTS OF IRON ON THE 10 μm BAND AND CRYSTALLIZATION

Shinnosuke Ishizuka[1, 2], Yuki Kimura[2], Itsuki Sakon[3]

[1]Departments of Earth Science, Tohoku University, Japan, [2]Institute of Low Temperature Science, Hokkaido University, Japan, [3]Department of Astronomy, University of Tokyo, Japan

Silicate dust is observed ubiquitously in the universe, and, therefore, the IR evolution of silicate is the key for understanding of life cycle of dust. Though the great majority of silicate is composed of amorphous, crystalline is also found at the several astronomical environments e.g. dust shell around evolved stars [1], disk around young stars [2], and comets [3]. Interestingly, crystalline silicate, which is a higher temperature products, has been observed in a dust shell at relatively lower temperature (< 300 K) around oxygen-rich stars. The formation scenario of crystalline silicate is still unknown [1, 4]. In contrast to amorphous silicate, crystalline silicate shows a sharp IR feature depending on the chemical composition [5, 6], crystallinity, shapes [7, 8], size and temperature [9] of dust. However, no one has succeeded in reproducing astronomical observation completely and in revealing the formation process of crystalline silicate in oxygen-rich shell. During the nucleation from the hot gas and subsequent growth around oxygen-rich stars, dust particles contain inhomogeneous structure and high surface/volume ratio due to its nanosize, which will show different spectra from simply calculated spectra using optical constants of bulk. Therefore, we considered it is valuable to measure IR spectra during nucleation and growth of nano particle *in-situ*, which have never been measured. Recently, we developed an original IR measurement system named Free-flying *In-situ* infrared measurement of Nucleating nanoparticles Experimental (FINE) system, which enables *in-situ* IR measurement of directly condensed silicate from hot vapor. IR spectra obtained by the FINE system can be compared directly with that of astronomical observation. Applying FINE system, we succeeded to measure the IR evolution accompaning with the nucleation and growth of Mg bearing silicate analogue particles of cosmic dust.

FINE system revealed quite different crystallizatioin scequence of nanoparticles from that we assumed previously. Silicate nucleates as a droplet and crystallizes ~500 K lower than the crystallization temperature of bulk material [10]. Futhermore, 10 μm band had different peak wavelengths and FWHM from that obtained by the KBr embedding method [5] or calculation [7]. Peak positions of 10 μm band has been considered as an indicator of iron content. Therefore, we focus on the dependence of the 10 μm band structure on the concentration of iron in silicate particles. Two peaks in the 10 μm band shifted toward longer wavelength from 9.7 to 10.0, 10.8 to 11.2 μm relatively as iron content increase. We will give a new discussion on chemical composition of circumsteller silicate based on 10 μm band obtained by FINE system.

References: [1] Waters, L. B. F. M., et al., 1996, A&A, 315, L361. [2] Bouwman, J., et al., 2001, A&A, 375, 950. [3] Diane, H. W., et al., 1999, ApJ, 517, 1034. [4] Molster, F. J., et al., 1999, Nature, 401, 563. [5] Koike, C., et al., 1993, Astron. Soc, 264, 654. [6] Jäger, C., et al., 1998, A&A, 339, 904. [7] Fabian, D., et al. 2001, A&A, 378, 228. [8] Koike, C., et al. 2010, ApJ, 709, 983. [9] Chihara, H., et al., 2001, Astron. Soc, 53, 243. [10] Ishizuka, S., et al. 2014, ApJ, submitted.