**J246-022** **Room: Exibition hall 7 sub** **Time: May 17 12:17-12:30**

# Vapor-solid growth at extremely non-equilibrium environment in our solar nebula

# Hitoshi Miura[1]; Kyoko K. Tanaka[2]; Tetsuo Yamamoto[2]; Taishi Nakamoto[3]; Junya Yamada[4]; Katsuo Tsukamoto[5]; Jun Nozawa[6]

[1] Department of Earth Sciences, Tohoku University; [2] ILTS, Hokkaido Univ.; [3] Tokyo Tech; [4] Graduate School of Science,Tohoku Univ.; [5] Graduate School of Science, Tohoku University; [6] Geology, Sci., Tohoku Univ

Vapor-Solid (VS) growth was the main process for dust formation in early solar nebula, where the gas pressure was extremely low (~1 Pa). Actually, there are several lines of evidences in interplanetary dust particles (IDPs) and primitive meteorites that the dust condensed directly from the vapor phase; enstatite whiskers [1], um-sized ultra-fine particles [2] and micron-sized olivine crystals with various morphologies [3] in matrix of primitive meteorites. It was suggested that these fine silicate crystals of various morphologies form by a homogeneous nucleation and successive crystal growth in a highly supersaturated silicate vapor by some laboratory experiments [4, 5]. In order to generate such supersaturated silicate vapor, it is required that silicate dust particles evaporate at first, then the vapor cools very rapidly [6]. For example, it is estimated for enstatite whisker formation that the cooling rate should be larger than about 10-10000 K/sec [5]. This rate is about 3 order of magnitudes faster than the cooling rate for chondrule formation, which has been suggested the dynamic crystallization experiments [e.g., 7] and believed as the fastest dust processing events in our solar nebula.

As the formation site of these primitive condensates, we notice a local bow shock generation by small planet (km-size) with eccentric orbit (not circular around the Sun) [8]. When the bow shock passes through a certain region in the nebula, the nebula gas is abruptly accelerated, in contrast, the small dust particles keep their initial position, then the relative velocity between the gas and dust particles is generated. The relative velocity can heat the dust particles sufficiently to evaporate them. The shocked gas has higher temperature and pressure than ambient unshocked region, so they will expand outward. The adiabatic cooling associated this expansion will generate supersaturated silicate vapor.

We estimate the cooling timescale of the silicate vapor and consider the properties of condensates (condensation temperature, typical sizes of condensates) based on the classical nucleation theory. We obtain a simple formulation for the cooling rate of the shocked gas depending on the radius of small planet $R_p$; the cooling rate should be about 500 K/sec for $R_p$ = 1.0 km and 0.5 K/sec for $R_p$ = 1000 km. In such very rapid cooling environment, the condensation from the silicate vapor will take place at extremely high supercooling (about 1000 K). This shows a good agreement with the experimental conditions in which silicate crystals with various morphologies will form [4, 5]. Finally, we conclude that the planetesimal bow shock could generate the fine silicate crystals observed in the primitive materials in our early solar nebula.

References: [1] Bradley et al., Nature 301, 473 (1983). [2] Toriumi, EPSL 92, 265 (1989). [3] Nozawa et al., submitted to Icarus. [4] Kobatake et al., Icarus 198, 208 (2008). [5] Yamada, Master theses, Tohoku Univ., Japan (2009). [6] Yamamoto and Hasegawa, PThPh. 58, 816 (1977). [7] Jones and Lofgren, Meteoritics 28, 213 (1993). [8] Hood, MAPS 33, 97 (1998).