SURFACE MORPHOLOGIES AND THEIR ORIGINS OF ITOKAWA REGOLITH PARTICLES.

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Introduction: External 3D shapes and surface morphology of the regolith particles can provide information about formation and evolution history of regolith particles in relation to asteroidal surface processes. 3D shapes of Itokawa regolith particles were obtained using microtomography and it was found that some particles are abraded [1,2]. The surface nano-miromorpholgy of Itokawa particles were observed using FE-SEM [3]. However, the number of particles was limited and genial feature on the surface morphology has not been understood. In this study, the surface morphology of Itokawa regolith particles was systematically investigated together with their 3D structures.

Experiments: Eleven and nine particles picked up from Rooms-A and –B of the sample catcher, respectively, which were allocated by the initial analysis, AO-1 and AO-2, were used. They were examined by analytical dual-energy microtomography [4] with the voxel size of about 100 nm at BL47XU of SPring-8 for 3D structures and by FE-SEM (JEOL JSM-7001F, JSM-7800F, Hitachi S-5500, SU-8220) for micro-nanaomorphology. In the SEM analysis, the samples were not coated with any conducting materials to avoid possible decoration by the coating. To avoid charge up by electron irradiation, observation was made at a low accelerating voltage (1 or 2 kV) in vacuum.

Results and discussion: Based on the SEM observation, the regolith surfaces can be classified into three-types. Type 1 surfaces are represented by nearly parallel and sometimes branched steps. They are regarded as fractured or cleaved surfaces by comparing with fractured and cleaved surfaces of terrestrial olivine and pyroxene grains. These surfaces were formed by impact on the Itokawa surface. Type 2 surfaces are represented by parallel and/or concentric steps with polygonal shapes. Type 3 surfaces are covered with many micron-submicron mineral grains, which are connected to the substrates based on the CT observation. These grains usually have facets and show euhedral shapes. Type-2 and -3 surfaces resemble to products in vapor condensation experiments of olivine [5], and thus can be regarded as condensates from vapor. Particles having these surface types are porous in the CT images. They should be walls of closed cavities or "microdruses", which were formed from originally porous aggregates of fine materials such as matrix or fine regolith breccia at high temperatures during thermal metamorphism or post-shock heating.

The surfaces can be also categorized into two different types regardless of Types 1-3; one corresponds to surfaces with sharp steps and edges and the other corresponds to surfaces with fainted steps and/or rounded edges, which were formed by abrasion [1,2]. A single grain sometimes has the both surface types.

Blister structures, which were formed by solar wind implantation as a part of space-weathering rims, were also observed irrespective of the surface types. Details are reported and discussed in [6].

References: [1] Tsuchiyama A. et al. 2011. *Science,* 333:1125-1128. [2] Tsuchiyama A. et al. 2014. *Meteoritics & Planetary Science,* 49:172-187. [3] Nakamura E. *Proc. Nat. Acad. Sci*. 109:E624-E629. [4] Tsuchiyama A. et al. 2013. *Geochimica et Cosmochimica Acta*, **116**, 5-16. [5] Kobatake, H. et al., 2008, Icarus, 198:208–217. [6] Matsumoto et al. 2014. This symposium.