**Surface morphology of Itokawa regolith particles related to space weathering on Itokawa.**

T. Matsumoto[1], A. Tsuchiyama[2], A. Miyake[2], K. Yasuda[3], N. Watanabe[4], A. Kouchi[4], A. Takigawa[2], T. Noguchi[5],Y. Nakata[3], T. Nakamura[6], J. Matsuno[2], A. Shimada[1], [1]Osaka Univ., [2]Kyoto Univ., [3]The Wakasa Wan energy research center, [4]Hokkaido Univ., [5]Ibaraki Univ., [6]Tohoku Univ. (tmatsumoto@kueps.kyoto-u.ac.jp)

**Introduction:** Surface morphology of Itokawa regolith particles has important information on interactions between space environments and solid mineral surfaces on the asteroid [1]. In preliminary examinations, solar wind He implantation to Itokawa particles are confirmed by noble gas isotope analysis [2]. Space weathering rims were also found on the particle surfaces within 100 nm in depth by TEM/STEM, wchich may be primarily caused by solar wind H and He irradiation [3, 4]. Especially, vesicles and hillorocks (blister structures) on the space weathering rims [4] indicate that space weathering modified surface nano-morphologies of the particles. In this study, in order to examine the surface nano-morphology related to space weathering, the surfaces of Itokawa particles were observed by FE-SEM and TEM/STEM. $He^+$ irradiation experiments were also performed to compare the Itoakawa particles.

**Experiments:** Surfaces of nineteen Itokawa particles, which have been already examined by microtomography [1], were observed using an FE-SEM (JSM-7001F). After FE-SEM observations, one Itokawa particle (RB-QD04-0043) was sectioned by FIB (Quanta 200 3DS) and were observed by TEM/STEM (JEM-2100F). $He^+$ ions of 4-50 keV were irradiated on olivine fragments ($Fa_{30}$) at the Wakasa Wan Energy Research Center and Institute of Low Temperature Science (Hokkaido University) [5]. The irradiated sample surfaces were also observed by FE-SEM and TEM/STEM.

**Results and Discussion:** Numerous convex blister structures of several tens nm in size were observed by FE-SEM on most Itokawa particle surfaces. We observed FIB sections of these blister structures with TEM/STEM and found that there are vesicular rims similar to the space weathering rims observed by [4]. Twelve of nineteen Itokawa particles have the blister structures, which indicates that space weathering has been commonly occurred on Itokawa particles. The blister structures are distributed heterogeneously on each Itokawa particle, suggesting that the degree of space weathering varies with location on a single grain surface. Roundness of grain edges, which indicates grain abrasion [6], does not correlate with the blister distribution.

Vesicles and blister structures were also observed on the surfaces of the $He^+$ irradiated olivine samples. The irradiation duration for the blister formation (~500 and ~5000 years) seems to be consistent with solar wind irradiation duration of vesicular rims (the order of $10^3$ years) estimated by solar flare track density [4]. Effects of ion flux difference between cosmic environments and the experiments should be understood for further quantitative evaluation for space weathering.

**References:** [1] Tsuchiyama A. et al. 2013. This volume. [2] Nagao K. et al. 2011. *Science* 333:1128-1131. [3] Noguchi T. et al. 2011. *Science* 333:1121-1125. [4] Noguchi T. et al. 2013. *Met. & Planet. Sci.* in print. [5] Matsumoto T. et al. 2013. *LPSC* XLIV:1441. [6] Tsuchiyama A. et al. 2011. *Science*, 333:1125-1128.