RECENT PROGRESS IN HAYABUSA SAMPLE ANALYSIS ON 3D MICROSTRUCTURE AND SURFACE MORPHOLOGY: COMPARISON WITH LL CHONDRITE AND PROCESSES ON THE ASTEROID SURFACE.

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Introduction: The 3D structures of Itokawa regolith particles have been revealed by SXCT in 1st PE [1,2]. The mineral abundances and the 3D texture indicate that the particles represent LL chondrite materials. Their size and shape features and surface micromorphology suggest that meteoroid impacts on the asteroid surface primarily form the regolith particle, and that seismic-induced grain motion in the smooth terrain abrades them over time. In addition to 40 particles from Room A of the sample chamber examined by 1st PE, 8 and 12 particles were newly examined by 2nd PE and 1st AO, respectively (11 and 9 particles from Rooms A and B). Their surface nanomorphology were examined by FE-SEM as well as 3D structures by SXCT. The 3D texture was compared with that of LL5 and 6 chondrite fragments [3]. Here, we report the results of these investigations.

3D texture: comparison with LL chondrites: The mineral abundances, bulk density, porosity, and void and crack features are similar between the both samples, showing that the Itokawa particles are consistent with the LL chondrite materials in terms of not only elemental and isotopic composition of the minerals but also 3D microtexture [3]. There was not any significant difference between the particles collected from Rooms A and B.

Particle shape and size features: The shape distribution of the Itokawa particles is consistent with the results of mechanical disaggregation [3], primarily as a response to impacts [1]. The cumulative size distribution confirms the log slope of –2 [3], indicating lower abundance of the fine particles on Itokawa [1].

Surface micro/nanomorphology and space microerosion:

SXCT shows that some particles have rounded edges, which indicate grain abrasion as proposed by [1]. FE-SEM observation shows a variety of nanomorphologies; fractured structures (e.g., cleavage steps), convex and concave (pits) structures, which sometimes have concentric parallel steps probably due to thermal metamorphism, blisters by solar wind implantation [4], and melt splash by impacts. Particles with rounded edges do not have clear steps. They do not correlate with the degree of space weathering rim development observed by TEM/STEM [5]. The abrasion process has a longer time scale than the space weathering rim formation, and can be regarded as a different type of space weathering in a broad sense, called "space microerosion".

The present results and studies on space weathering [5] and noble gas [6] indicate the following surface processes: (1) regolith formation by meteoroid impacts, (2) formation of space weathering rim by solar wind implantation ($\sim 10^3$ yr.), (3) space microerosion by seismic-induced grain motion ($\sim > 10^3$ yr.), and final escape by impact after repeating (2) and (3) ($<< \sim 8 \times 10^6$ yr.).

References: [1] Tsuchiyama A. et al. 2011. *Science,* 333:1125-1128. [2] Tsuchiyama A. et al. 2013. *Geochimica et Cosmochimica Acta* 116:5-16. [3] Tsuchiyama A. et al. 2013. *Meteoritics & Planetary Science,* in print. [4] Matsumoto T. 2013. This volume. [5] Noguchi T. et al. 2013. *Meteoritics & Planetary Science* in print. [6] Nagao K. et al. 2011. *Science* 333:1128-1131.