Distribution of space weathered rims on Itokawa regolith particles and implication to space weathering of Asteroid Itokawa.

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Introduction: Asteroidal regolith particles have informations about surface evolusion porcesses of the asteroids. Analysis by TEM and STEM of regolith particles of S-type asteroid 25143 Itokawa revealed that space weathered rims including nano-phase iron surround the regolith particles, which were probably formed by micrometeoroid bombardment and solar wind irradiation [1, 2]. Previous study shows that space weathered rims with vesicles (blisters) on regolith particles can be identified non-destructively by observation of the particle surfaces with FE-SEM [3]. So far, distribution of space weathered rims on the particle surfaces have not been investigated. In this study, distributions of the space weathered rims were examined and discuss the evolution processes of the individual particle surfaces and space weathering processes of Itokawa.

Methods: Three-dimensional (3D) external shapes of twenty Itokawa regolith particles were analyzed by X-ray microtomography (μ-CT) at SPring-8, Japan. After μ-CT experiments, observations of surface micromorphologies of the Itokawa regolith particles were performed by FE-SEM at Kyoto University.

Results and discussions: Itokawa particle surfaces are composed of mainly two types: fractured surfaces formed by impact and surfaces of micro-druses, which were covered by subhedral to euhedral mineral grains formed by probably thermal metamorphism of fine materials or by vapor condensation. The surfaces of Itokawa particles can be also classified in two types; fresh surfaces having sharp edges, and matured surfaces having rounded edges. Previous study by μ-CT reported that the matured surfaces were considered to be formed from fresh surfaces by abrasion processes on Itokawa [4]. The fresh and matured surfaces were observed in both surfaces formed by impact and surfaces of micro-druses in this study.

Eleven out of twenty regolith particles have space weathered rims with blisters. These rims are heterogeneously distributed and the rims often present in opposite surfaces of the same particle, suggesting migration of regolith particles on Itokawa. In addition, the blister distribution and the roundness of the particle surface are not correlated, indicating that main mechanism of the abrasion process is not solar wind sputtering but mechanical abrasion.

The picture of space weathering processes of Asteroid Itokawa was speculated as follows. Space weathered rims were developed on local surfaces of individual regolith particles, which promotes the spectral change of Asteroid Itokawa. On the other hand, refreshment of the regolith surfaces occurred, which suppresses the spectral change, by mechanical abrasion due to grain migration and fragmentation due to impact.

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