Properties of submicron craters on Itokawa regolith particles

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Introduction: The Hayabusa spacecraft recovered surface regolith particles from S-type asteroid Itokawa. Micrometeoroid impacts are considered to be among the important agents for surface modification processes on Itokawa such as dynamic regolith mixing/convection and space weathering. In previous studies, submicron sized craters have been reported on Itokawa particles [1, 2, 3]. The craters are expected to have been formed through the impacts of secondary ejecta created by primary impacts on Itokawa [2, 3]. Since only 24 craters have been reported on Itokawa particles so far [1, 2, 3], statistical analysis of the craters is limited. In this study, we performed extensive investigations of submicron craters on Itokawa particles. The purpose of this work is the detailed characterization of abundance, areal and size distributions, and morphologies of submicron craters.

Experiment: We investigated 34 Itokawa regolith particles from approximately 10 μm up to 200 μm in size. We observed the surface morphology of the Itokawa particles using a scanning electron microscope (SEM; Hitachi SU6600). Secondary electron (SE) imaging was conducted at an accelerating voltage of 2 kV in high vacuum.

Results and Discussion : We found 8 Itokawa particles over 80 μm in size, with surfaces with numerous submicron craters. Such crater-rich particles account for approximately 40 % of Itokawa particles over 80 μm in size observed in this study. In this study, we identified craters ranging from approximately 10 nm to 700 nm in diameter. The morphologies of the craters are similar to those of microcraters on lunar regolith [4]. From the size distribution and areal density of more than 400 craters on 3 Itokawa particles, we estimated the flux of impactors that formed submicron craters. We assumed that the craters accumulated during direct exposure to space for 10^3 years from the common appearance of blisters on the surface. We compared impactor flux on Itokawa regolith with impactor flux on the lunar surface [4] and interplanetary dust flux models [5]. The comparison revealed that the flux on Itokawa particles is up to two orders of magnitude higher than the interplanetary dust flux and is also comparable to the case of the Moon. Higher lunar and Itokawa surface flux over interplanetary flux can be explained by high-speed secondary ejecta impacts and not by primary meteoroid impacts [10]. Secondary impacts will have significant effects for submicron-scale cratering on airless bodies of various sizes in the solar system.

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