INVESTIGATION FOR SOLAR WIND HELIUM DISTRIBUTION ON ITOKAWA PARTICLES.

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Introduction: Depth profile of solar wind helium from Itokawa particles have measured by a sputtered neutral mass spectrometry (SNMS) [1]. They used tunneling ionization by using fs-laser to detect He sputtered neutrals from ~1 μm^2 area on the surface. Nagao et al. [2] determined isotopic compositions of noble gases from asteroid Itokawa particles of JAXA Hayabusa mission. They inferred He depletion from the particles due to higher mobility of He compared to the other noble gasses. Noguchi et al. [3] demonstrated that surface layers of Itokawa particles have been damaged for about ~50 nm in depth probably by solar wind irradiations. In this study, we measured microdistribution of solar wind He from Itokawa particles by using the SNMS technique.

Experimental: Itokawa particles on Si-wafwer and a San Carlos olivine irradiated by $^{4}He^{+}$ of 4 keV were used in this study. The particles were handled by Axis Pro manipulator (Micro Support Co., Ltd.). These samples were set on the stainless steel sample holder with carbon-tape. The He distribution in the Itokawa particles was measured by using depth profiling method with SNMS instrument called LIMAS [4]. The primary beam of ~1 μm in diameter was rastered on the sample with a square pattern with a step of 600 nm interval. Positive ions, which were ionized by fs-laser, were introduced into a multi-turn time-of-flight mass spectrometer. These pulses of fs-laser and mass spectrometer were synchronized with the primary ion pulses in 1 kHz repetition rate. We measured $^{4}He^{+}$, $^{12}C^{3+}$, $^{16}O^{+}$, $^{24}Mg^{2+}$, $^{28}Si^{4+, 3+, 2+, +}$, and $^{56}Fe^{2+}$. A mass resolving power for each ion was 8000 at 10% valley. A supputtering rate and He concentration for the Itokawa particles was estimated by that of He-implanted San Calros olivine. The He concentration at a given point was calcurated from $^{4}He^{+}/^{28}Si^{4+}$ ratio, which was higher reproducibility than the other combination [5].

Results and discussion: The depth distribution for RA-QD02-0169 is shown in figure 1, of which scale is x = 8 μm, y = 12 μm, and z = 500 nm. As can be seen the peak concentrations and the peak depth are variable within micrometer scales on surface. A peak concentration of He was ~2 × 10^{20} cm^{-3} at 20-40 nm in depth. This He distribution might indicate that He escaped from the particles and heterogeneous distribution in particle surfaces was caused by mechanical erosion. Microdistribution of solar wind Ne is key isotope in order to reveal the variable concentration of solar wind He because $^{4}He/^{20}Ne$ ratio is sensitive parameter for He escape. Recently, Matsumoto et al. [6] demonstarated some morphological properties of Itokawa particles, which were thermal metamorphism, fractuation, abrasion, and space-weathering. If we compare He distribution with the morphological properties, the heterogeneous distribution of solar wind He can be explained.

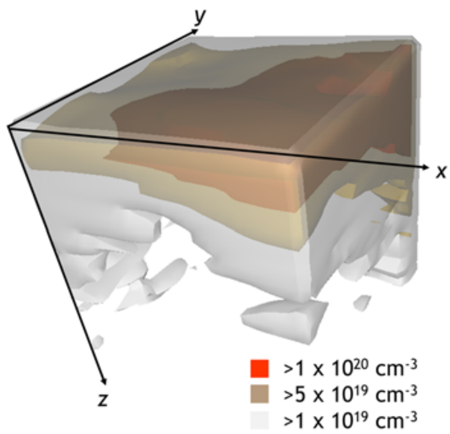

Figure 1. Three dimensional distribution of solar wind ^{4}He. The colors represent ^{4}He concentrations from high concentration (red) to low one (gray).

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