DEPTH PROFILING ANALYSIS OF SOLAR WIND HELIUM IMPLANTED IN A NASA GENESIS SAMPLE AND IMPLICATIONS TO JAXA HAYABUSA SAMPLES.

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Introduction: A unique feature of NASA Genesis and JAXA Hayabusa samples are exposed intact surfaces to violent space environments. A noble gas mass spectrometry has measured implanted noble gasses of Solar wind from these return samples [1, 2]. A TEM study demonstrates that solar wind particles were implanted in the surface nm-layer of Itokawa particles [3]. However, in-situ distribution of solar noble gases has not been determined ever from natural samples. In order to reveal nano-scale distribution of solar wind noble gases in astromaterials, a novel mass spectrometer of sputtered neutral mass spectrometry (SNMS) using tunneling ionization has been developed. The development was started from 2004 at one year after launching of Hayabusa spacecraft [4]. Recently, we have newly developed new generation SNMS capable to detect tens ppma He from ~50 nm area on solid surface [5]. This project will be figured out how distribute He (and other noble gases and H) in the surface layer of Genesis and Itokawa samples with tens nm resolution. If such distribution is clarified, we can apply atomic mechanisms in solid established in metallic elements, such as diffusion, partitioning, etc., to conventional noble gas cosmochemistry. As a result, behavior of noble gas in minerals can be used to monitor changes of space environments in such a way as to use trace element behavior applying to terrestrial environmental research. Here we report the first results of depth profiling of solar wind ^{4}He implanted on a diamond like carbon target (DOS) of Genesis mission.

Experimental: A SNMS instrument called LIMAS was used. A Ga beam of 1-μm diameter with 30 keV was rastered on DOS with 5x5 μm^2. Sputtered atoms from the surface are post ionized by a strong field generated by a femto-second laser. The ions were introduced into time-of-flight mass spectrometer, and ions generated from the central area 2x2 μm^2 of the crater were used to determine depth profiling.

Results and Discussion: Depth profiles of solar wind ^{4}He on DOS were measured. The penetration range is about 20 nm and the peak concentration is about 2 $x10^{20}$ ^{4}He cm^{-3}. The fluence calculated by the profiles is about 8.5 $x10^{14}$ ^{4}He cm^{-2} consisting with the accumulated value during solar-wind irradiation-periods monitored by an on-flight apparatus on the Genesis space craft.

References: [1] Grimberg A et al. 2008, *GCA* 72: 626-645. [2] Nagao K et al. 2011, *Science* 333:1128–1131. [3] Noguchi T et al. 2011, *Science* 333:1121–1125. [4] Ishihara M et al. 2010, *Surf. Interface Anal.* 42: 1598-1602. [5] Ebata S et al. 2012, *Surf. Interface Anal.* 44: 635-640.