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Development of novel mass spectrometer to analyze solar wind noble gases

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Solar-gas-rich regolith breccia from asteroids has been studied [e.g., 1, 2], which were irradiated by solar wind (SW) on the parent body surface. Regolith breccia was lithified by compaction process from regolith soils. The compaction processes which were recorded in the breccias should reveal a migration, deposition, SW irradiation of the soil. To figure out the SW distribution in the breccia high spatial resolution is required because SW implanted layer is less than 100 nm [2].

LIMAS (Laser Ionization Mass nanoScope) [3] is a time-of-flight sputtered neutral mass spectrometer (TOF-SNMS) with non-resonant laser post-ionization system which can observe in-situ distributions of all elements in solid materials down to tens nm level. LIMAS is mainly composed of Ga focused ion beam (FIB) for sputtering, femtosecond laser for post-ionization of sputtered particles, and multi-turn mass spectrometer (MULTUM II [4]).

An n-type Si wafer, which was irradiated by 30 keV ^{4}He of 2 x 10^{16} ions/cm^2 was used to evaluate and confirm sensitivity for He. The sputtering crater was 6.4 x 15.2 um^2 and measurement area is 2.1 x 4.1 um^2 of the center. The detection limit of ^{4}He for the system is about 10^{18} ions/cm^3 for ^{4}He The performance of LIMAS should be improved towards higher sensitivity and lower background noises because bulk concentrations of solar-He in gas-rich meteorite is 10^{-2}-10^{-4} cm^{3}STP/g [e.g., 1] which can be translated into 10^{16}-10^{18} atoms/cm^2 for rocky material (density ~ 3 g/cm^3).

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