Evaluation for multi-turn time of flight mass spectrum of laser ionization mass nanoscope

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Laser ionization mass nanoscope (LIMAS) was developed for measuring trace amounts of noble gas isotopes in samples such as returned materials (Hayabusa and Genesis missions) from micro-area [1, 2]. We have improved the mass spectrometer equipped on LIMAS, which consists of multi-turn time-of-flight mass spectrometer (TOF-MS) called MULTUM II and an ion injection optics. We characterize mass resolution and ion transmittance for the LIMAS

Mass-resolving power had not increased after TOF of 1,000 μs (200 multi-turn cycles) in the simple accumulation mode, owing to the TOF modulation of ion packets. We developed a correction method for mass calibration. As a result, mass-resolving power of 620,000 was achieved at TOF of 5 ms (1,000 multi-turn cycles corresponding to flight path length of 1,312 m).

Ion transmittance of LIMAS was limited by the divergent trajectories of post-ionized ions before 20 multi-turn cycles of MULTUM II, and by the collisions with residual gas in MULTUM II after 20 multi-turn cycles. The transmittance per multi-turn cycle of 99.96% was achieved.

Under these conditions, the useful yields for Si were 5×10^{-3} in the linear mode, and 2×10^{-3} at 1,000 multi-turn cycles with mass resolution of 620,000.

We conclude that LIMAS is an instrument with satisfactory high mass-resolving power and a high useful yield for microanalysis.

References: [1] Ebata et al. (2012) Surface Interface Analysis, 44, 635-640. [2] Bajo et al. (2015), Geochem. J., 49, 559-566.