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

A. TONOTANI1, K. BAJO1, S. ITOSE2, M. ISHIHARA3, K. UCHINO4, AND H. YURIMOTO1.

1 Natural History Sciences, Isotope Imaging Laboratory, Hokkaido University, Sapporo, Japan.
2 JEOL Ltd., Musashino, Akishima, Tokyo, Japan.
3 Department of Physics, Osaka University, Toyonaka, Osaka, Japan.
4 Graduate School of Engineering Sciences, Kyushu University, Kasuga, Fukuoka, Japan.

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 $5 \times 10^{-3}$ in the linear mode, and $2 \times 10^{-3}$ 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.