Development of Laser Post-Ionization SNMS for In-Situ U-Pb chronology

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In space and planetary sciences, Secondary Ion Mass Spectrometer (SIMS) has been widely used for isotopic analyses at the micron scale. In the SIMS analysis, the surface of a sample is irradiated by a primary ion beam, and secondary ions of the sputtered materials are introduced into the mass spectrometer. However, the secondary ion yield of SIMS is very low (less than a few %). As a result, a large amount of material is wasted as neutral particles. In order to improve this disadvantage, we have been developing a Sputtered Neutral Mass Spectrometer (SNMS) with a femto-second laser.
The instrument consists of a focused ion beam system with a liquid metal gallium ion source (Ga-FIB) to attain an ultrahigh lateral resolution less than 1 μm. After a sputtering by Ga-FIB, the sputtered secondary particles are ionized by irradiating the femto-second laser. The post-ionized ions are introduced into the multi-turn ToF analyzer (MULTUM) which achieves ultrahigh mass resolving power of 20000. In addition, we introduced a new detection method, ion counting system, to improve the detection sensitivity. As a result of measurement of a standard sample in U-Pb chronology, 91500 zircon (concentration of uranium is about 100 ppm), the signal peaks of uranium and uranium oxides could be detected, so we have confirmed that the detection limit of the present system is 100 ppm.
In this study, we measured cyrtolite which contains a high concentration of uranium (2 wt.%) and 91500 zircon to confirm whether SNMS can be applied to in-situ U-Pb chronology. As a result of measuring two samples, uranium, uranium oxides and lead signal peaks were detected. In addition, signal peaks of interfering ions, for example, hafnium oxides and gallium clusters, were separated from the peaks of lead by increasing the number of cycles in MULTUM. After the measurement, the diameter of the sputtered area was about 1 μm. In this presentation, we will report the present performance of SNMS in in-situ U-Pb chronology.

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