Development of a Secondary Neutral Mass Spectrometer for submicron Imaging mass spectrometry

Y. Kawai[1,2], K. Terada[1,2], T. Hondo[1], J. Aoki[2], M. Ishihara[1,2], M. Toyoda[2], and R. Nakamura[3]

[1]Graduate School of Science, Osaka University, Osaka 560-0043, Japan
[2]Project Research Center for Fundamental Sciences, Graduate School of Science, Osaka University, Osaka 560-0043, Japan
[3]Science & Technology Entrepreneurship Laboratory, Osaka University, Osaka 565-0871, Japan

Isotopic compositions in extraterrestrial materials provide us an important clue to decipher the origin and evolution of the solar system. *In-situ* high-spatial resolution analysis with a Secondary Ionization Mass Spectrometer (SIMS) has been widely used for isotopic measurements of individual minerals and presolar materials in meteorites. In the SIMS analysis, the sample surface is irradiated by a primary ion beam, and among the sputtered materials, secondary ions are analyzed by the mass spectrometer. By scanning the primary ion beam, two-dimensional isotope distribution of the sample are obtained, which led to the discovery of the presolar silicates in the interplanetary dust and primitive meteorite [1, 2].

The disadvantage of the SIMS is the low secondary ionization yield. Most of the samples are sputtered as neutrals and lost. The analytical sensitivity is determined by the spot diameter of the primary ion beam under the same ionization yield. As a result, the spatial resolution of the SIMS measurement is limited by the low ionization efficiency. To overcome this disadvantage, we have been developing Secondary Neutral Mass Spectrometer (SNMS), which post-ionizes sputtered neutrals with an intense pulsed laser [3]. By irradiating the high power laser above 10^{15} W/cm^2, 100% of the sputtered atoms and molecules can be ionized in the non-resonant ionization regime. As the primary ion source, the focused ion beam system with liquid metal Ga ion source was applied. The beam diameter of this system is attained less than 40 nm. The produced ions are analyzed by the multi-turn time-of-flight mass spectrometer (MULTUM) with mass resolving power of greater than 30,000 [4]. By rastering the focused ion beam, we can obtain the isotope imaging of the sample surface with submicron scale spatial resolution.

In this presentation, we will report the current status of this instrument.

[1] S. Messenger *et al.*, *Science* (2003). [2] A. N. Nguyen and E. Zinner, *Science* (2004). [3] K. Terada *et al.*, JPS Conf. Proc. (2017). [4] M. Toyoda *et al.*, J. Mass Spectrom. (2003).