Investigation of Lunar Volatile by a Triple-Reflection Compact Time-Of-Flight Mass Spectrometer TRITON

*Yoshifumi Saito[1], Naoki Yamamoto[1], Shoichiro Yokota[2], Satoshi Kasahara[3], Kazushi Asamura[1], Masaki N Nishino[1], Naoaki Saito[4], Yukio Fujiwara[4], Daiki Asakawa[4]

1. Department of Solar System Sciences, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 2. Graduate School of Science, Osaka University, 3. The University of Tokyo, 4. National Institute of Advanced Industrial Science and Technology

In order to investigate the presence and amount of water in the regolith 1 to 1.5 m below the lunar surface, a compact neutral particle mass spectrometer TRITON is under development. TRITON is a triple-reflection time-of-flight mass spectrometer which is designed to be installed on a lunar polar exploration (LUPEX) rover as one of the sub-systems of resource investigation water analyzer (REIWA). TRITON will perform mass analysis of neutral gas generated by lunar thermogravimetric analyzer (LTGA) that is another subsystem of REIWA. TRITON not only aims to measure water molecules included in the lunar regolith but also identify the atoms, molecules and their isotopes of other volatiles up to mass number 200 with mass resolution as high as 100.

A standard reflectron consists of an ion source, ion acceleration part, free flight part, ion reflection part and an ion detector. Ionized neutral particles are accelerated in a two-stage ion acceleration part by a pulsed high voltage whose pulse timing is used as a start signal. The accelerated ions enter into the free flight part and are reflected in a single-stage ion reflection part. Reflected ions again fly through the free flight part and are detected by a detector as a stop signal. Ion mass is determined by the time difference between the start and stop signal detection.

In order to increase the mass resolution as much as possible under the constraints of limited weight and volume, we have decided to modify the standard reflectron by adding a second reflector that enables triple reflections and doubles the flight length in designing TRITON. TRITON can be operated either as triple-reflection mode or single-reflection mode by changing the voltage applied to the analyzer. Since the triple-reflection reduces the detection efficiency while increasing the mass resolution, the single reflection mode is used as a complementary mode that is used when higher detection efficiency is necessary.

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