Development of TOF-MS for planetary exploration

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In-situ material measurement in planetary exploration is important in understanding origin and evolution of the planets. For the purpose of performing in-situ elemental analysis, mass spectrometers are installed, for example, on NASA’s Curiosity rover and the ESA’s Rosetta spacecraft. However, researchers in Japan still do not have a mass spectrometer that is suitable for the future planetary exploration. Therefore, we have decided to develop a Time-Of-Flight Mass Spectrometer (TOF-MS) aiming at using for the future planetary exploration. Among different applications for our mass spectrometer is in-situ Potassium-Argon (K-Ar) isochron dating. In situ Potassium-Argon (K-Ar) isochron dating is the combination of a laser-induced breakdown spectroscopy (LIBS) for the K concentration measurement and a mass spectrometer for the Ar isotopic measurement. Considering that the instrument should be installed on a planetary lander, there exists limitation on the weight, size and power, it is necessary to design a small size mass spectrometer which has a mass resolution capable of the Ar isotopic measurements. In order to minimize the variation of the initial position and initial energy of the ionized ions for maximizing the mass resolution, we adopted a single-stage reflectron with two-stage acceleration part. We have analytically optimized the design parameters of the TOF-MS. By using SIMION field and charged particle trajectory simulation software we have confirmed that mass resolution of our TOF-MS is high enough for Ar isotopic measurements. We will report the current status of our TOF-MS development. In addition, we will report the status of the multi-reflector type TOF-MS which has the potential to increase mass resolution under the size constraint.

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