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Development of TOF-MS for in-situ K-Ar dating

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In-situ age determination of planetary surface is quite important in understanding the evolution of planets. We are now developing a new instrument for in-situ Potassium-Argon (K-Ar) dating. The K-Ar dating is a radiometric dating method based on the measurement of ^{40}Ar that is produced from the radioactive decay of ^{40}K. This instrument is the combination of laser-induced breakdown spectroscopy (LIBS) and time-of-flight mass spectrometer (TOF-MS). K is measured using LIBS and Ar is measured using TOF-MS. In this presentation, we report the current development status of the TOF-MS.

In order to install the instrument on a rover, it is necessary to design the TOF-MS as small as possible due to the severe restrictions on the mass and power. To increase mass resolution while keeping the size of TOF-MS small, we have adopted a dual-stage reflectron that has two-stage reflector with two different electric field intensity. We have analytically optimized the size and electric field of the reflectron for achieving highest possible mass resolution. We have confirmed that the mass resolution of the designed reflectron is high enough for K-Ar dating.

We also need to measure a small amount of ^{36}Ar for the Ar isotope measurement. We have found that the ion detection rate should be more than 10 percent and the repetition frequency of the ion pulse acceleration should be a few kHz in order to keep good counting statistics estimating from the amount of the ions generated by LIBS. To improve the efficiency of ion detection, we simultaneously accelerated the ions within a finite area. We have confirmed that ion detection rate is more than 10 percent by numerical simulation. Furthermore, for improving the pulse repetition frequency, we have designed the drift tube to be negatively biased. Since the ion pulse acceleration voltage can be reduced, it is possible to increase the pulse repetition frequency to a few kHz.

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