AOGS 2006

Research to Improve the Mass Resolution of an LEF-TOF Ion Mass Analyzer (IMA)

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There are few in-situ heavy ion observations from lunar soil or tenuous alkali atmosphere. It is commonly thought that these heavy ions around the Moon are mainly produced by ion-induced desorption (sputtering) or photon-stimulated desorption from the lunar surface and by the photoionization from the atmosphere. Once ions are produced, they are picked up and accelerated by the motional solar wind electric field E =−V x B, where V is the plasma bulk velocity and B the magnetic field. In this case most of them will escape from lunar orbit, because the gyroradius is much greater than the lunar radius. IMA (Ion Mass Analyzer) on board the SELENE satellite will measure these picked-up ions around the Moon in order to investigate the production mechanisms and make the global surface compositional map of the Moon. IMA adopts foil-based LEF (Linear Electric Field) TOF (Time Of Flight) technique for mass analysis in order to discriminate heavy ions up to mass number 60. Thin carbon-foils are placed at the entrance part of IMA in order to generate start electrons when ions enter the analyzer. If incident ions exit the carbon foil as positive ions have the smaller kinetic energy than the reflection potential, they are reflected by the LEF. When reflected ions impact the top part of the analyzer, secondary electrons are emitted, and they are detected as the stop signals. The advantage of LEF TOF method is that, the flight time of reflected positive ions is not affected by the energy degradation nor angular scattering caused by the carbon foil. At the upper part of the analyzer, a secondary electron emitter plate is installed to generate TOF stop signal efficiently. Though we have empirically found that using MgO-coated metal plate enhances stop electron generation, the quantitative analysis for the efficiency was insufficient. In this study we compared the efficiency of electron emitter plates through experiment with different base plate materials; CuBe and Al and with different MgO thickness; 20nm, 500nm and 1000nm. We also changed the surface roughness of these base plates. Our experimental results showed the thicker MgO coating emits secondary electrons efficiently. We confirmed the efficient electron emission from the plate also improve the mass resolution of IMA especially when measuring heavy ions.