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Development on the post-ionization SNMS and application for the isotopic measurement of Presolar SiC grains

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Isotopic composition of the individual presolar grains in primitive meteorites provide us the information on nucleosynthesis in Asymptotic Giant Branch stars (AGB stars) or supernova explosion that had occurred prior to the formation of the Solar system. So far, isotopic measurement of individual presolar grains often has been carried out by using Secondary Ion Mass Spectrometry (SIMS). However, since secondary ion yield of SIMS is less than 1 %, precise analysis of minor elements in individual grains has been difficult. That is, improvement of sensitivity is highly desired for better understanding of the nucleosynthesis.

Here, we report on the development on the post-ionization Sputtered Neutral Mass Spectrometry (SNMS) and an application for the isotopic measurement of presolar silicon carbide grains (SiCs). In this analytical system, the neutrals particles sputtered by Ga ion beam of which diameter is 40nm˜2 μm was post-ionized by femt-second laser, and separated by the multi-turn time-of-flight mass spectrometer 'MULTUM' depending on their masses. Last year, we has achieved the about 1000 times higher secondary ion yield for Pb signals with high mass resolution (Nakabayashi et al. 2014).

Based on the preliminary Si isotope analysis using SNMS, we confirmed that current SNMS system shows good reproducibility of terrestrial Si isotopic ratios and figured out that the instrumental mass fractionation is -150˜200 ‰/amu. Moreover, we successfully separate ^{28}Si (=27.977 amu) and ^{29}Si (=28.976 amu) peaks from interference peaks such as N_2 (=28.006 amu), CO (=27.995 amu) and ^{28}SiH (=28.985 amu) by using MULTUM. Finally, we also confirm the heavy isotopic anomaly of Si isotopes (δ^{30}Si/^{28}Si=100˜200 ‰ ,δ^{29}Si/^{28}Si=130˜200 ‰) of presolar SiC candidates extracted from Murchison meteorite, which are consistent with those of previous studies.

Keywords: SIMS, presolar grain, in-situ analysis, isotope anomaly, nuclear synthesis, meteorite