Ultra High Spatial Resolution Ion Imaging with a NanoSIMS Ion Microprobe: Applications to Astrobiology. M. Ito. Kochi Institute for Core Sample Research, JAMSTEC (B200 Monobe, Nankoku City, Kochi 783-8502 Japan).

Introduction: Ion imaging technique with secondary ion mass spectroscopy (SIMS) is a powerful tool to visualize the distributions of isotopes and/or elements in samples, and is becoming common to variety field of sciences including material science [1], cosmochemistry [2] and biology [3].

The CAMECA NanoSIMS 50L ion microprobe represents the *in-situ* microanalysis by SIMS, combining ultra high spatial resolution (minimum spot size of ~50 nm for Cs^+ and ~150 nm for O^-) with ultra-high sensitivity. Up to 7 elemental and/or isotopic images can be acquired simultaneously by 7 electron multipliers with sensitivity in the ppm. The capability for images of multiple elements and isotopes within a sample with per-mil precision and accuracy and nm scale spatial resolution is unique to the NanoSIMS. Because isotopic images can be acquired with extremely low primary beam currents (~ 1 pA), coordinated studies of morphological, structural, chemical and isotopic characteristics of materials at sub-μm scales by NanoSIMS, TEM, SEM, and FIB systems are becoming routine [4, 5].

Owing to these unique capabilities, the NanoSIMS has had a major impact in the field of cosmochemistry, leading to the discoveries of ancient silicate stardust and interstellar organic grains in meteorites and interplanetary dust [2, 6-8]. In both of these examples, the target materials are extremely small (0.2 - 1 μm), but have isotopic ratios in many elements that significantly differ (20-10,000 %) from materials formed in the Solar System. The NanoSIMS is particularly well suited to measuring large isotopic variations at small scales, and accordingly its use in cosmochemistry has been focused on the study of interstellar materials. More recently the NanoSIMS has been applied to high precision isotopic measurements that are required for many primitive Solar System materials (i.e., refractory inclusions in carbonaceous chondrites) that exhibit moderate isotopic variations (0.1-5 %) [9].

In last decade SIMS technique has been used to microbiology to match chemotaxonomic and phylogenetic signature of microbes [10]. Recently NanoSIMS ion imaging technique used to a stable isotope probing study (*i.e.*, ^{13}C, ^{15}N labeling) for a single cell to understand microbial metabolic activities, and combination with *in-situ* hybridization for phylogenetic identification [11-16].

Application to Astrobiology: The "Tanpopo Mission" is a space misstion on Japanese Experimental Module on the International Space Station for an interdisciplinary research of organic chemistry, microbiology and cosmochemistry [*i.e.,* 17] . The focuses of the mission are 1) to exam the survival of microbes and organic materials under space radiation and solar UV in space environment, 2) to capture organic materials and micrometeorites including interplanetary dust particles using an ultra low-density aerogel [17]. NanoSIMS ion imaging can be applied samples obtaind by Tanpopo mission; i.e., microbes under space radiation and solar UV to understand microbial metabolic activities and phylogenetic signature, organic materials and micrometeorites to investigate their origins and formation processes in the solar system based on H, C, N and O isotopic signatures.

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