Development of multiscale tomography by Synchrotron radiation for future sample return missions.

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Introduction: X-ray computed tomography (CT) is one of the important methods for the analyses of extraterrestrial samples. We can observe precious extraterrestrial samples without breaking them physically and three dimensionally [e.g. 1-2]. We can determine the volume, shape, weight and internal structure of the sample, and also analyze the composition of the samples using X-ray linear attenuation coefficient (LAC) [3-5]. Those features are suitable for the first observation of a sequential analysis of the returned samples. Actually, synchrotron radiation tomography (SR-CT) was applied to the samples obtained by past sample return missions such as Stardust and Hayabusa, as the first observation of sequential analyses [2,6].

However, several issues should be solved before the analyses of the retuned samples of future missions. Previously, samples were fixed on the tip of a fiber by resin or bond, and exposed to the terrestrial atmosphere and dust inside the experimental hutch directly during the scanning. In addition, because of the limitation of FOV, samples should be broken into smaller size than the FOV for the high resolution analysis.

In this presentation, we introduce improvements of the experimental environment of SR-CT. We developed new sample holders for the analyses with N2 purged environment and without adhesive materials. In addition, we introduce a new detector systems for the mutiscale tomography.

Experiments and Results: Three X-ray detectors, a large FOV high-speed detector for the XRD-CT [5], a large FOV detector for low magnification tomography and a high resolution detector for high magnification tomography, were fixed on a moving stage together with, just behind the rotating stage of the sample. Each detector was moved into X-ray pass by stepping pulse motors with enough repeatability of the relative position of their FOV. The sample, a chip of Murchison (CM2) meteorite with 3 mm along the largest axis, was fixed on a rotation stage with CNT Gecko tape which can hold the sample during the long CT scan, and was covered with a polyimide tube to prevent the dust and atmosphere of the experimental hutch.

We could obtain whole sample shape with 3.2 μm of voxel size and precise texture of chondrules with 0.37 μm of voxel size. In addition, we could obtain distribution of minerals inside the sample by XRD-CT with the same setup. Though the system is still under the development, we can provide important option for the future analyses of the returned samples.

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