Development of XRD combined CT for the observation of mm-sized meteorites.

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X-ray computed tomography (CT) has been applied for the observation of extraterrestrial samples, such as meteorites, cosmic dusts and samples retrieved by spacecraft in recent studies [e.g. 1-3]. Because of small amount of such precious samples provided for the scientific studies, non-destructive feature of CT is important for the initial analysis of the samples.

However, characteristics of internal component of the samples, such as mineral phases and chemical compositions of them, could not be investigated in detail, because CT enables us to obtain only x-ray attenuation. We could roughly deduce the materials if we had knowledge about the internal components, by calculating x-ray attenuation and comparing it with the observed value. Even in those cases, however, it was difficult to determine materials uniquely, if composition of a material were heterogeneous.

In this paper, we show a new protocol of synchrotron radiation CT (SR-CT) combined with x-ray diffraction (XRD), which can add crystallographic information of materials to SR-CT. The sample was scanned by x-ray probe with 30 keV, focused into 1μm by Fresnel zone plate, horizontally to obtain 2D-intensity distribution map of XRD, called XRD-CT [e.g. 3,4]. Comparing the images of XRD-CT and absorption CT, distribution of mineral grains in the texture can be obtained.

Result of observation of carbonaceous chondrite samples with 5mm diameter showed that distributions of tochilinite inclusions, carbonates and Fe rich silicates, those are difficult to separate by the x-ray attenuation. Although it is difficult to obtain 3D data of XRD-CT because of its long experimental duration, 8 hours per 1 horizontal slice, we can investigate vertical distribution of minerals in the sample from powder diffraction pattern, by vertical scanning of the x-ray probe with rotating the sample.

The new analytical protocol developed in this study will provide important base for the observation of samples of future sample return missions, such as Hayabusa2 and OSIRIS-REx.

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