Comparison between ultra-micro CT and FE-SEM images on cometary dust grains

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Dust from comet 81P/Wild2 has been successfully recovered in the Stardust mission. For these very precious samples, we need to consider analytical sequence, from non-destructive to destructive, to obtain information from the samples as much as possible. As non-destructive analyses, microtomography, XRD and XRF using synchrotron radiation (SR) are extremely useful since Stardust particles are very tiny (about 10 microns). Based on the above view point, our group are performing research on Stardust samples by the following analytical sequence [1,2]; (1) Mineral compositions are determined by SR-XRD. (2) Three-dimensional structures of samples selected from the results of (1) are determined by SR-microtomography. (3) Samples selected by (1) and (2) are cut by using an ultra-microtome, their potted putts are observed by FE-SEM, isotopes are analyzed by SIMS, and the ultra-thin sections are observed by TEM as destructive analyses.

XRD measurement was made at BL3A of PF and BL37XU of SPring-8 [1]. Ultra-microtomography experiments using an imaging CT system was performed at BL47XU of SPring-8 at 7.13 keV with the voxel size of 76.5 nm, which gives the effective spatial resolution of few hundreds nm [1]. We can obtain 3-dimensional distribution of qualitative linear absorption coefficient (LAC) as CT images. After these experiments, the sample particles were embedded in an epoxy and sliced by an ultra-microtome. Their potted butts were observed under an FE-SEM (JEOL 7000F) at Tokyo University [2].

In this paper, we compared CT and FE-SEM images with the aid of XRD data to confirm textures and mineral compositions estimated from CT images. A cross section of CT image as close as corresponding FE-SEM image was obtained by image processing technique. By comparing these images, sub-micron mineral grains and glass, which were estimated by CT images, were confirmed by FE-SEM images. In addition, it is known that the values of Mg# of olivine estimated from LAC values in CT images are correct within the error of 0.05. As described above, it is demonstrated that we can obtain accurate three-dimensional textures and mineral compositions from the CT images with the aid of XRD data.

[1] Nakamura et al. (2007) MAPS, in press.

[2] Nakamura et al. (2008) 39th. LPSC, abstract.