DEVELOPMENT OF A NEW X-RAY CT FOR THE OBSERVATION OF METEORITES AND RETURNED SAMPLES OF FUTURE MISSIONS. M. Uesugi[1], K. Uesugi[2], A. Takeuchi[2], Y. Suzuki[2], M. Hoshino[2], and A. Tsuchiyama[3], [1]JAXA Space Exploration Center, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 252-5210, Japan, [2]Japan Synchrotron Radiation Research Institute (JASRI) 1-1-1 Kouto, Sayo-cho, Sayo-gun, Hyogo 679-5198, Japan, [3]Department of Earth and Space Science, 1-1 Machikaneyama, Toyonaka, Osaka 560-0043, Japan

Introduction: Synchrotron Radiation X-ray CT is one of the important tools of the observation and analysis of meteorites and materials obtained by sample return missions. We can observe the three-dimensional structure of the samples non-destructively, and also deduce the chemical composition of the internal materials by comparing calculated values of Linear Attenuation Coefficient (LAC) of X-ray and observed LAC values those expressed as contrasts of the slice images [1-4]. Because the chemical composition of meteorites, especially Fe content of silicates changes largely by meteorite class, we can deduce the class or type of meteorites without breaking them. However, we could not make strict determination of the mineral phases in the slice images of the meteorites only by the LAC. So destructive analysis after the CT observation is required for further detailed analysis. Hayabusa2 is a subsequent mission of Hayabusa, which successfully recovered samples from asteroid Itokawa. The target of Hayabusa2 mission is 1999 JU3, a C-type asteroid which thought as a parent body of carbonaceous chondrite. Non-destructive observation will become more important in the initial analysis of the Hayabusa2, in order to protect the samples from contaminations.

Here, we show a new method for the identifying mineral phases and shapes in meteorites. Tsuchiyama et al. [4] showed that analytical dual-energy CT method for the determination of mineral phases in CT images. However, the sample size available for the method is limited to smaller than 100µm. XRD-CT, combination of X-ray diffraction method and X-ray CT method, is another solution for the determination of mineral phases in CT image. We show the result of the application of the XRD-CT method to the meteorite samples, and discuss further development in the future works.

Results and Discussions: The experiment was carried out at experimental hutch2 of BL20XU. The experimental set-up of XRD-CT was simple as projection type CT. The image detector was changed to large field type. The beam size was 12um x 12um formed by a cross slit. A first generation CT method, translate-rotate type was applied for the XRD-CT, however, the rotating came first to obtain diffraction spots. The step size of translation and rotation were 5um and 1deg, respectively. The exposure time of one shot was 1 s. The total scan time for a slice was about 10 hours per 1 slice. Of course it depends on the sample size and can be reduced using higher flux X-ray.

Figure 1 shows the slice images of general absorption X-ray CT and distribution of serpentine of the same slice obtained by XRD-CT. We can clearly observe the hetarogenous distribution of serpentine in the fine grained matrix. We could observe the distribution of other minerals in CM2 chondrite, such as tochilinite and pentlandite, by the XRD-CT.

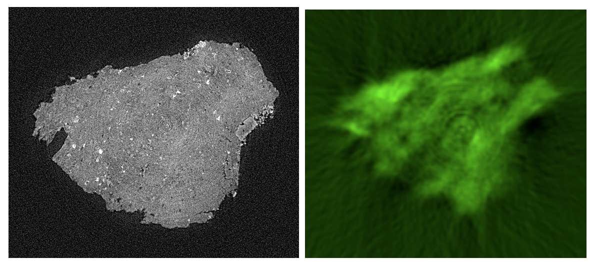

Figure 1 Absroption X-ray CT image (left) and serpentine distribution image (XRD-CT, right).

Although this method is useful and effective for the non-destructive observation of meteorites, there is still several problems. As we noticed, average experimental time is 10 hours per 1 slice. It is too long to obtain three dimensional CT data, and we can obtain only a few number of two dimensional slice images for a sample. In addition, spatial resolution of the method depends on spot size and step size of the translation. If we increase the step number (decrease the step size), experimental time increases. We must increase the speed of the acquisition. Efficiency of the detecter and step speed of translation should be both increased.

Final goal of our development is three-dimensional XRD-CT. Analysis of three-dimensional mineral distribution, mode composition, and average chemical compositions of the minerals by combining the LAC analysis will be possible by the XRD-CT. These methods are truly non-destructive, and will be important for the future sample return missions.

References: [1] Tsuchiyama A. et al. 2005. *American mineralogist* 90:132-142. [2] Uesugi M. et al. 2010. *Earth and Planetary Science Letters* 299:359-367. [3] Tsuchiyama A. et al. 2011. Abstract #1777. 42th Lunar & Planetary Science Conference. [4] Tsuchiyama et al. 2012. submitted to *Geochimica Comochimica Acta.*