Three dimensional structures of aggregate-type Itokawa particles.

*T. Yada[1], M. Uesugi[1], K. Uesugi[2], Y. Karouji[1], Y. Suzuki[2], A. Takeuchi[2], and A. Tsuchiyama[3], T. Okada[1] and M. Abe[1], [1]Inst. Space Astronaut. Sci., Japan Aerosp. Explor. Agency, Japan. E-mail: yada@planeta.sci.isas.jaxa.jp, [2]Japan Synchrotron Radiation Res. Inst., Japan. [3]Div. Earth Planet. Sci., Grad. Sch. Sci., Kyoto Univ., Japan.

Introduction: Itokawa samples are the first asteroid regolith samples returned to the Earth [1]. They should retain information about physical and chemical conditions on asteroid Itokawa and its parent asteroid. Utilizing particles allocated for JAXA, we started studying aggregate-type Itokawa particles, which consist of smaller constituent particles (<10 μm) sticking each other. Aggregations of these consitituent particles should have occurred on the asteroid or the parent asteroid, so that they should preserve information about an environment of the particle formation.

Methods: We selected five aggregate-type Itokawa particles, RA-QD02-0184, -0236, RB-CV-0026, -0036, and -0044, whose sizes range from 55 to 128 μm. They were firstly analyzed by synchrotron X-ray computed tomography (CT). Because they might be fragile, they were placed inside tiny, upside-down pyramid-shaped sample holder made of SiN. They were irradiated in beam line (BL) 47XU of SPring-8 by photon light source of both 7keV and 8keV in energy and obtained their transmitted X-ray images. The obtained images were calibrated by computers, and their 3D structure could be reconstructed.

Mineral species in the particles could be estimated by the different X-ray adsorption factors of different energy X-ray in each of the minerals [2].

Results: Five aggregate-type particles are divided into three type based on their three-dimensional structures. The first one is a "sintered" type, RA-QD02-0184, in which its constituent particles are sintered to form necks between them. The second is "sticking" types, RB-CV-0026, -0036, and -0044, in which their constituent particles simply aggregate without neck. They are so fragile and one particle, RB-CV-0026, was divided into three pieces during manipulation. The third is a non-aggregate type, RA-QD02-0236, which is a particle enriched in cracks and has been misidentified as an aggregate type from its surface morphology.

Discussion and future plans: It is obvious that the sintered and the sticking type particles should have experienced different physical conditions in their aggregation processes. The sticking types are estimated to have aggregated because of electrostatic forces, which should have formed on the surface of asteroid Itokawa. On the other hand, the sintered type should have experienced higher temperature than the sticking types. Such a high temperature seems difficult to have been achieved in such a small body like asteroid Itokawa but possible in a larger body like a parent asteroid before Itokawa.

In order to confirm details of grain boundaries between their constituent particles, we are planning to slice the particles with a focused ion beam (FIB) technique to form their ultrathin sections, and observe them with a transmitted electron microscope (TEM). Additionally, we are also considering to analyze their fracture strengths utilizing a modified atomic force microscope technique [3].

References: [1] Fujimura A. et al. 2011. Abstract #1829. 42nd Lunar & Planetary Science Conference. [2] Tsuchiyama A. et al. 2013. *GCA* 116, 5. [3] Kuzumaki T. et al. 2012. *Diam. Relat. Mater.*, 25, 1.