TEM observation of carbonaceous particles in Hayabusa-returned samples.

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Introduction: Preliminary examination of carbonaceous materials of Hayabusa-returned samples, classified as category 3, were processed for 1 year, and we obtained information of their origin. Texture and chemical composition of them obtained by scanning electron microscopy with energy dispersive X-ray spectrometry (SEM-EDS) analysis indicate that those particles would have several origins, and then some of them might be terrestrial contamination.

Ito et al. [1] analyzed three category 3 particles by NanoSIMS and did not found any exotic isotopic anomalies. However, they noticed that it is difficult to conclude their origin as terrestrial, and further investigation about their molecular structure, microstructure and chemical compositions are important for the determination of their precise origin.

In this presentation, we report results of transmission electron microscopy (TEM) observation of category 3 particles and potential contaminants such as fluoro rubber and silicon rubber, those used in clean chamber and clean room. We compared their microstructure and discuss the origin of category 3 particles including possibility of their extraterrestrial origin.

Experiment: All category 3 particles were fixed by pressing on gold (Au) or indium (In) plates using sapphire glass. We can observe the sample through the sapphire glass during pressing and thus reduce the accidental loss of the samples. Ultra-thin sections (UTSs) were extracted from the pressed samples by focused ion beam (FIB) after the application of SIMS analysis, FT-IR and Raman spectroscopy.

Fluoro rubber and silicon rubber were also pressed on In plate, and a particle corrected from a contamination coupon exposed to clean room of Hayabusa 2 construction was pressed on Au plate. Their UTSs were also extracted by same procedure of category 3 particles.

After the analysis of Extended x-ray absorption fine structure (EXAFS) , we observed the UTSs by TEM/STEM (JEOL FEM-2800 and JEM-2100F).

Results: We found Si and N distribution in RB-QD04-0047-02 and RA-QD02-0120 in TEM-EDS analysis [2]. Although Si distribution is apparent in Si rubber, it did not include N. In addition, Si rubber we observed contains amount of Ti-oxide inclusions which would be doped for coloring of the rubber. Such inclusions were not observed in category 3 particles. We also found several inclusions such as Mg or Zn in fluoro rubber. Thus, artificial rubbers contain remarkable inclusions, and we can distinguish them from other materials.

On the other hand, we found similar Si and N distribution in UTS of a contamination coupon particle of Hayabusa2 construction clean room. The particle shows uniform N distribution and heterogeneous distribution of Si, which is closely resemble to the category 3 particles. Based on these results, we will be able to make further discussions for the origin of the category 3 particles.

References: [1] Ito et al. 2014. *Earth Planets. Space* 66:91. [2] Uesugi et al., 2014 *Earth Planets. Space* in press