The characteristics of Hayabusa returned samples and their distributions for NASA and international announcement of opportunity (AO).

T. Yada[1,2], M. Abe[2,1], T. Okada[2,1], M. Uesugi[1], Y. Karouji[1], Y. Ishibashi[1], S. Yakame[3], K. Shirai[1], T. Nakamura[4], T. Noguchi[5], R. Okazaki[6], M. Fujimoto[2,1] and M. Yoshikawa[2,1], [1]Lunar Planet. Explor. Program Group, JAXA, [2]Insti. Space Astronautical Sci., JAXA, [3]Depart. Earth Planet. Sci., Grad. Sch. Sci., Univ. Tokyo, [4]Depart. Earth Planet. Sci., Grad. Sch. Sci., Tohoku Univ., [5]Depart. Sci., College Sci., Ibaraki Univ., [6]Depart. Earth Planet. Sci., Faculty Sci., Kyushu Univ.

Introductions:

Hayabusa spacecraft returned its reentry capsule to the Earth in June 2010 [1]. After a series of processes in the Planetary Material Sample Curation Facility (PMSCF) in JAXA [2, 3], some parts of samples were distributed to initial analyses, which clarified that they must be particles recovered from the surface of S-type asteroid Itokawa [4-8]. As we continued to describe particles recovered from a sample catcher of Hayabusa, we have obtained more than three hundred particles. Some parts of them have been distributed to initial analyses, NASA and international AO research. Here we mention the nature of the particles, review the first distribution of NASA and international AO, and refer to future plan including the second ones.

Methods:

The sample catcher of Hayabusa is a cylinder of 48mm in diameter and 57mm in height, and divided into three rooms; A, B and a rotational cylinder [3]. Most of the recovered particles from the catcher were picked up from quartz glass disks, which had been once set to the openings of room A and B to receive falling particles in the room due to vibrating the catcher. Particles on the disk were picked up with an electrostatically controlled micromanipulation system equipped in a clean chamber filled with nitrogen gas.

Handpicked particles are then analyzed by a field emission scanning electron microscope (FESEM) equipped with energy dispersive X-ray spectrometer (EDS) for initial description of the particles. They are processed without exposure to air and conductive coating using a special sample holder to seal the samples and low vacuum mode of the FESEM. After the FESEM analyses, they are sent back to the clean chamber and put on each of grids of quartz glass slides one by one for preservation.

Results:

Categories of Hayabusa returned samples

In total, the particles recovered from the quartz disks reach more than 340 so far. Among them, almost 70% were recovered from room A and the rest from room B. They are divided into four categories based on their chemical compositions obtained from FESEM-EDS (Fig. 1). Category 1 particles consist mainly of silicate mineral, such as olivine, pyroxene and plagioclase (Fig. 1a). They sometimes contain minor mineral such as K-feldspar, chromite and phosphate. Category 2 particles are basically composed of same minerals as category 1, but they contain Fe-Ni metals or Fe-sulfide (Fig. 1b). Particles of these categories were distributed to initial analyses to be approved as Itokawa particles as mentioned before. Category 3 particles mainly consist of carbon, oxygen and nitrogen, presumed to be organic materials. Category 4 particles are chips of artificial materials, such as aluminum, quartz glass, stainless steel and etc.

A size distribution of Itokawa particles

The size distribution of category 1 and 2 particles, those are Itokawa particles, are shown in Fig. 2. It has bimodal peaks in 30-40 µm and 50-60 µm size bins. This is because those from room A have a peak in 50-60 µm and room B have a peak in 30-40 µm. It is suggested that an achievement rate of pickup for the room B quartz disk is higher than that of room A one, because a number of particles on the room B one is less than that on the room A one.

Mineral ratios of Itokawa particles

The constituent minerals of Itokawa particles are estimated based on their EDS spectra. We have no information for a mineral ratio for each particle, thus we assume the main constituent mineral of the particle as its only constituent mineral. And we calculated areas of minerals by squaring major axes of particles. Based on this assumption, we estimated mineral ratios of category 1 and 2 particles. Fig. 3 shows mineral ratios of category 1 and 2 particles from room A and B. Olivine is enriched in room A particles whereas less olivine and more plagioclase in room B ones. This might be due to the difference of mineral ratios between two touchdown positions on the surface of the asteroid Itokawa.

Sample distributions:

1st NASA sample distribution

Before the launch of Hayabusa, JAXA and NASA agreed with a Memorandum of Understanding (MOU) that some part of samples returned by Hayabusa should be distributed to NASA. Based on the MOU, the first NASA sample distribution was held in last December. Fifteen category 1 and 2 particles were set in dimples of quartz glass slides, enclosed into the stainless steel flange containers [9], and given to NASA.

1st international AO sample distribution

The first international AO was in public last January and closed in last March. Submitted proposals were reviewed by the international AO committee during three months, seventeen of them have been selected for sample distributions. So far, most of them have been already distributed to the selected researchers.

Future plans for sample descriptions and distributions:

We continue to describe particles obtained from the sample catcher. At present, we are recovering samples from the cover of the catcher room B. We will then recover particles from the rotational cylinder in next year. We will tap the catcher again to fall particles onto quartz glass disks as far as possible, and then disassemble the catcher to recover particles as much as we can to figure out whole particles in the catcher at least in these three years.

The second sample distribution for NASA will be held in this December. From next January, the second international AO will be in public and the sample distributions for selected proposals will start in the middle of 2013.

References:

[1] Abe M. et al. (2011) *LPS XXXXII*, #1638. [2] Fujimura A. et al. (2011) *LPS XXXXII*, #1829. [3] Yada T. et al. (2012) *MAPS*, submitted. [4] Yurimoto Y. et al. (2011) *Science 333*, 1116-1119. [5] Ebihara M. et al. (2011) *Science 333*, 1119-1121. [6] Noguchi T. et al. (2011) *Science 333*, 1121-1125. [7] Tsuchiyama A. et al. (2011) *Science 333*, 1125-1128. [8] Nagao K. et al. (2011) *Science 333*, 1128-1131. [9] Ishibashi Y. et al. (2012) *LPS XXXXIII*, #2887.

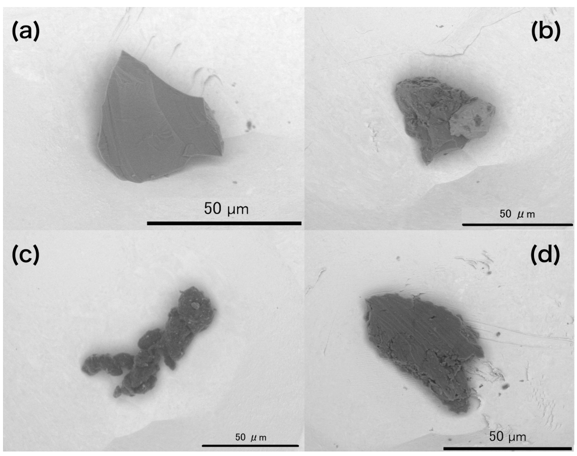

Fig. 1. Backscattered electron images of category 1 (a), 2 (b), 3 (c) and 4 (d) particles. Category 1 and 2 particles are mainly composed of olivine, pyroxene and/or plagioclase, although different in existence of iron metals or sulfide in category 2. Category 3 particles mainly consist of carbon and oxygen. Category 4 particles are artificial, such as aluminum flakes.

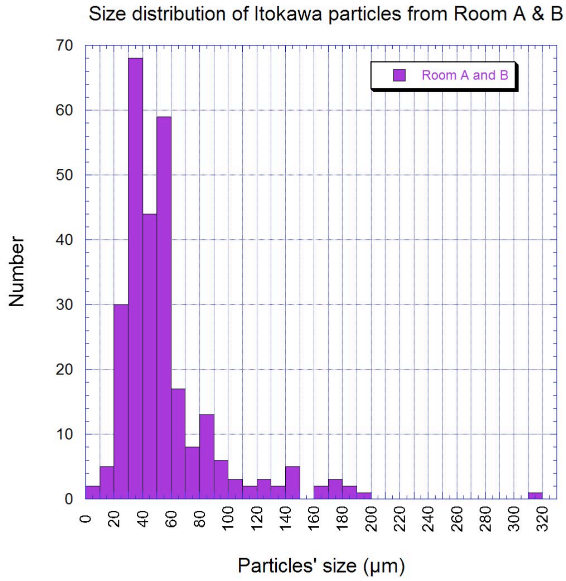

Fig. 2. A size distribution of the category 1 and 2 particles recovered from room A and B. It shows bimodal peaks in size bin of 30-40 μm and 50-60 μm.

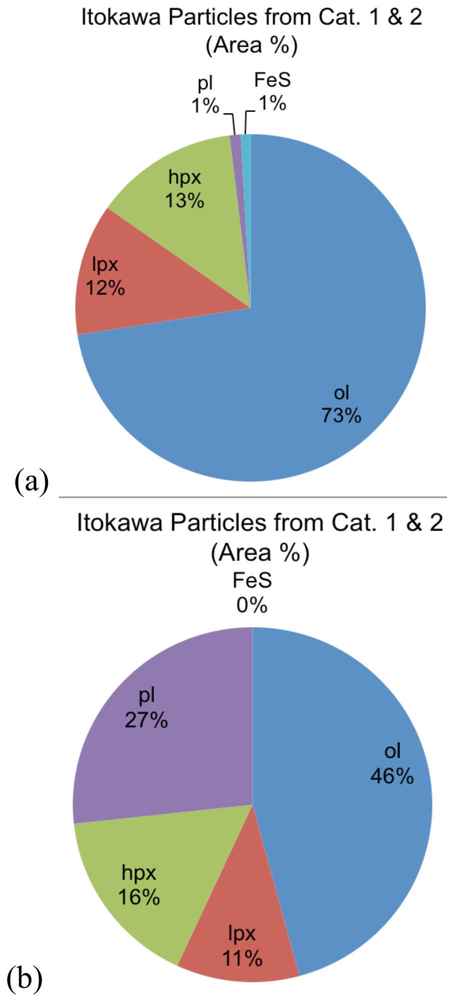

Fig. 3. Mineral ratios of category 1 and 2 particles recovered from room A (a) and B (b). These graphs indicate that olivine is enriched in room A whereas less olivine and more plagioclase in room B.