The effect of possible contamination from sample holders on samples returned by Hayabusa2

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Introduction: For technical developments in handling, transfer and analysis of samples returned by the Hayabusa2 spacecraft, special team (Phase 2 curation team) was organized by Extraterrestrial Sample Curation Center of Japan Aerospace Exploration Agency. A sample transfer container among facilities and sample holders which are applicable to multiple analytical instruments such as SR-CT, SEM, TEM, STXM and NanoSIMS were newly developed, and Antarctic micrometeorites were successfully analyzed by using the transfer container and holders minimizing sample lost and sample damages [1]. As sample holder comes into contact with samples, it could cause contamination of metallic elements, organic materials, volatile species such as water and noble gasses. In this study, two materials (gecko tape made by carbon nanotubes, and polyimide film) which were used as the new sample holders were analyzed by instrumental neutron activation analysis (INAA) and/or instrumental photon activation analysis (IPAA). Besides these materials, quartz plate was also analyzed. Quartz plate was used for the preservation and transfer of Hayabusa-returned samples [2]. Based on the elemental abundances of these three materials, any contamination from these three materials was evaluated.

Sample and methods: Gecko tape samples were developed by Nitto Denko Corporation and Osaka University. Quartz plate (7 mmϕ x 1 mm) and polyimide film were provided from Fujiwara Scientific Co. Ltd and Protein Wave Co. Ltd, respectively. Before analysis, quartz plate was treated by both full-cource and acid-alkali cleanings [3]. Polyimide film was washed by ethanol at an ultrasonic bath. INAA and IPAA were performed at Kyoto University Research Reactor Institute (KURRI). For INAA, the three materials were irradiated for 10s and 4 hrs at the pn-3 and pn-2 of KURRI, respectively. Gecko tape and quartz plate were analyzed by IPAA. The irradiation was carried out using the linear accelerator at KURRI operated at 30 MeV electron beam energy and 102 μA current for 36 hrs.

Results and Discussion: Ten elements (Na, Al, Cr, Mn, Fe, Ni, Eu, W, Au and Th), fourteen elements (Na, Mg, Cl, K, Cr, Mn, Fe, Co, Ni, Y, Zr, Sb, Hf and Au) and fourteen elements (Na, Al, K, Sc, Ti, Cr, Zn, Ga, Br, Sb, La, Eu, Ir, Au) could be determined for gecko tape, quartz plate and polyimide film, respectively. Europium, W, Au and Th contents for gecko tape, and Ti for polyimide film are higher than those for carbonaceous chondrites. Other elements abundances for these three materials are about tem times lower than those for carbonaceous chondrites. Assuming that 1% of contamination (in mass) from these three materials to carbonaceous chondrites, elemental contributions are estimated to be 1.5% for Cl, 7% for Ti, 8% for Eu, 4% for W, 7% for Au and 35% for Th. Elemental contributions of other elements were less than 1% for carbonaceous chondrites, indicating that contaminations of these three materials could be negligible for other elements.

Groups of carbonaceous chondrites can be distinguished from each other based on elemental ratios for refractory elements to moderately volatile and/or volatile elements (e.g., Zn/Cr). In order to define the effect for contamination from sample holders (gecko tape, quartz plate and polyimide film), elemental ratios (Mn/Cr, Zn/Cr, Ga/Cr, Sb/Cr, Ir/Cr and Au/Ir) of CM chondrite as an analogue of Hayabusa2-returned sample contaminated from sample holders were estimated. In the case of quartz plate and polyimide film, 100% by mass contamination could not affect elemental ratios of CM chondrite. In contrast, more than 0.3% by mass contamination from gecko tape may affect Au/Cr ratio of CM chondrite, implying that careful attention is required when the Au/Cr ratio is used for discussion. Although more than 20% by mass contamination from gecko tape could affect elemental ratios (Mn/Cr, Zn/Cr, Ga/Cr, Sb/Cr and Ir/Cr), such contamination is not highly likely and could be optically detected.

References

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