Alteration of organic matter in carbonaceous chondrites and their analog compounds by ultraviolet irradiations and space exposures: Exploring chemical reactions on the surface of small bodies

*Kosuke Shimizu[1], Masashi Koga[1], Itsuki Sakon[3], Kensei Kobayashi[1], Hajime Mita[4], Hajime Yano[2], Yoko Kebukawa[1]

1. Yokohama National University, 2. JAXA, 3. The University of Tokyo, 4. Fukuoka Institute of Technology

One of the objectives of the astrobiology apace exposure experiment "Tanpopo2" on the International Space Station (ISS) was to investigate the effects of space exposures on organic matter in carbonaceous chondrites and its analogs to understand molecular structural changes in organic matter on the surface of small bodies. Tanpopo2 started its in-orbit exposure experiment on August 19, 2019 (JST) in Kibo's ExHAM1 and completed its 431-day space exposure on October 23, 2020 (JST). In this study, sample analysis of "Tanpopo2" were conducted and compared to laboratory UV irradiation experiments. Atomic oxygen irradiation experiments were also conducted to study the effects of space exposure on atomic oxygen. In Tanpopo2, humic acid, the Murchison meteorite, the Tagish Lake meteorite, insoluble organic matter (IOM) from the Murchison, and the synthesized IOM analog [1] were exposed to space environments. UV irradiation experiments were conducted on the synthesized IOM analog [1] and humic acid as analog materials of insoluble organic matter (IOM) in primitive carbonaceous chondrites. These samples were analyzed by attenuated total reflection infrared spectroscopy (ATR-FTIR) and Raman spectroscopy. ATR-FTIR spectra of UV-irradiated humic acid show a decrease in the peak height ratios of aliphatic C-H to C=C. Such trend was also observed in humic acid exposed to space in Tanpopo2. The D-band and G-band from Raman spectra of these samples were fitted with the L-BWF model to examine the ordering of aromatic structures and graphitization. The D-band and G-band FWHM (full width at half-maximum) of Tanpopo2 sample showed a tendency to increase by space exposure, which was the opposite of the direction of aromatization and aromatic skeletal ordering. This suggested that the aromatic skeleton itself might have been altered by space exposures. The results of atomic oxygen irradiation experiments will also be reported on the effects of atomic oxygen on space exposures.
[1] Y. Kebukawa et al. (2013) Astrophysical Journal, 771, 19

