

Chemical structure analysis of laboratory-synthesized organic dust analogue by using high-temperature vacuum TPD

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Unidentified Infrared Bands, a series of emission bands in infrared wavelength range, have been widely observed in the circumstellar environment of stars at various evolutionary stages and the ISM. The carrier of the features is believed to be organic matter and their compositional and chemical identification should be crucial for the understanding of the lifecycle of organic matter in the Universe. However, its detailed chemical structure has not yet been identified. So far, our research group has synthesized a cosmic organic dust analogue named Quenched Nitrogen-included Carbonaceous Composite (QNCC), a material formed by quenching a plasma gas made from solid hydrocarbons and nitrogen gas, that exhibits IR spectra similar to the unidentified IR bands seen around novae (Endo et al. 2021). The unidentified infrared band around novae is characterized by the presence of a broad feature around 8 μm and Endo et al. (2021) suggest that the inclusion of amine structures in the carriers would be responsible for the presence of the feature.

In this study, to investigate the chemical structure of QNCC in more detail, we have carried out the high-temperature vacuum TPD analysis of QNCC and, for comparison, filmy QCC (Quenched Carbonaceous Composite; Sakata et al. 1984). A combination of High-temperature vacuum TPD developed by Dr. Yoshii at Tohoku University and X-ray photoelectron spectroscopy (XPS) should provide us powerful tool to investigate the detailed chemical structure of organic samples composed of C, H, and N.

The results showed that filmy QCC has more H-terminated structures and fewer alkyl groups, and is an sp³-C-rich material; QNCC also has more H-terminated structures and fewer alkyl groups, more sp²-C than filmy QCC, and the presence of pyridinic-N and/or amine similar to those contained in amine-modified nanodiamonds in addition to pyrrolic-N.

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