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Quenched Nitrogen-included Carbonaceous Composite (QNCC): A powerful candidate of the carriers of the UIR bands in classical novae

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Abstract. We have succeeded in synthesizing organics, 'Quenched Nitrogen-included Carbonaceous Composite (QNCC)', via plasma chemical vapor deposition (CVD) method, whose infrared spectral properties reproduce the characteristics of the unidentified infrared (UIR) bands observed around classical novae. Past studies have shown that the UIR bands observed around novae appear somewhat differently from those observed in other astrophysical environment and are predominantly characterized by the presence of a broad 8μm feature. The remarkable similarity between the infrared properties of QNCC and the UIR bands in novae indicates that QNCC should be considered as a strong candidate of the carriers of the UIR bands in novae. Finally, we have started a space exposure experiment of QNCC aiming to explore the evolutional link between the QNCC and the insoluble organic molecule (IOM) in carbonaceous condrite and, thus, to infer the origins of organics in our solar system.

Keywords. (ISM:) dust, extinction, ISM: lines and bands, infrared: ISM

1. Quenched Nitrogen-included Carbonaceous Composite (QNCC)

The unidentified infrared (UIR) bands have been ubiquitously observed in various astrophysical environments. Many studies have been conducted to identify the band carriers based on combined approaches among infrared observations, theoretical calculations and laboratory experiments. Polycyclic aromatic hydrocarbon (PAH) hypothesis (Allamandola *et al.* 1989) has been commonly used to interpret the nature of the UIR bands. However, the true nature of the carriers has not been fully understood so far. Recently, mixed aromatic aliphatic organic nanoparticles (MAON: Kwok & Zhang 2011), which contain hetero atoms in addition to hydrocarbon models, have been proposed as a more realistic interpretation of the band carriers. Further experimental approaches to examine the influence of nitrogen inclusion into hydrocarbons are crucial for the better understanding of the band carriers. Quenched Nitrogen-included Carbonaceous

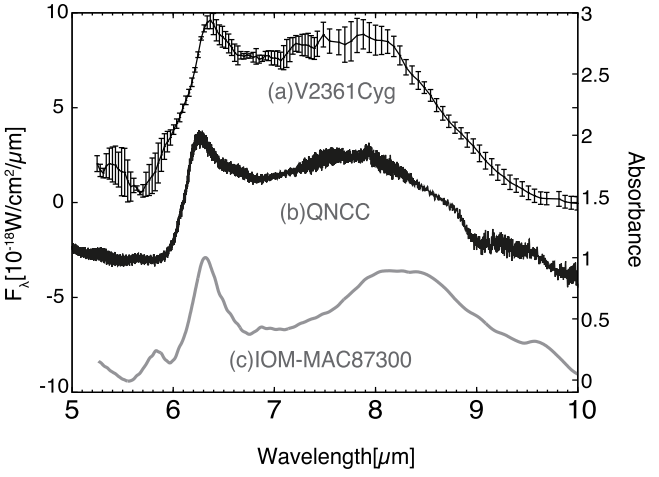

Figure 1. Comparison of (a)the UIR band observed in classical nova V2361Cyg at 116 days after outburst (Helton *et al.* 2011) with the infrared absorption spectra of (b)QNCC and (c)Insoluble organic matter (IOM) MAC87300 (Kebukawa *et al.* 2011)

Composite (QNCC: Endo *et al.* 2018), whose infrared properties can reproduce the UIR bands observed in classical novae is synthesized by condensation of plasma produced from nitrogen gas and hydrocarbon dust (e.g. QCC; Sakata *et al.* 1983, PAHs; Allamandola *et al.* 1989) via 2.45GHz microwave discharge (Figure 1). The synthesis method of QNCC simulates the circumstellar conditions of novae, where nitrogen-rich nova wind hit the existing circumstellar hydrocarbon dust. We have found that N/C ratio of QNCC is 3-5% based on the measurement with elemental analyzer/isotope ratio mass spectrometer (EA/IRMS). We also have found that the amine structures are contained in QNCC and are responsible for the broad 8μm feature observed in the infrared spectrum of dusty classical novae based on the X-ray Absorption Near Edge Structure (XANES) measurement. This result suggests that, in addition to the classical hydrocarbon models, nitrogen inclusion should be the key for the better understanding of the carriers of the UIR bands.

2. Space exposure experiment of QNCC

We have initiated a space exposure experiment of QNCC using the exposure experiment module 'ExHAM' on the Japanese Experiment Module 'Kibo' of the International Space Station (ISS). We have recognized some similarities between the properties of QNCC and those of insoluble organic matter (IOM) in carbonaceous chondrite. Firstly, the broad band feature around 8μm seen in infrared absorption spectra of QNCC is also seen in those of IOM. Secondary, N/C ratio of QNCC is comparable to that of IOM (2-5%). We plan to compare the infrared and X-ray properties of QNCC retrieved from the space exposure experiment with those of IOM. This experiment aims to test the hypothesis that the organics formed in the circumstellar space of evolved stars are delivered as a part of the primitive organics to the solar system.

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