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Nitrogen-included Carbonaceous Compounds (NCC): Laboratory-synthesized organics as the probable candidate for the carrier of the UIR bands observed in dusty classical novae

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Abstract. The unidentified infrared (UIR) bands have been ubiquitously observed in various astrophysical environments and consist of a series of emission features arising from aromatic and/or aliphatic C-C and C-H bonds (Allamandola *et al.* 1989). Therefore, their carriers are thought to be related to interstellar organics. However, our knowledge on the true carriers of the UIR bands is still limited. Recently Kwok & Zhang (2011) has proposed Mixed Aromatic Aliphatic Organic Nanoparticles, which contains hetero atoms in addition to conventional hydrocarbon models, as a more realistic interpretation of the band carriers. The challenges toward identifying the carriers of the UIR bands are still ongoing. Past studies have shown that the UIR bands observed around classical novae, which characterized by the presence of broad feature around 8μm (Helton *et al.* 2011), are somewhat different from those observed in other astrophysical environment. Here we report the success of experimentally synthesizing the organics called Nitrogen-included Carbonaceous Compounds (NCC; Sakon *et al.* 2015) whose infrared properties can reproduce the UIR bands observed in classical novae.

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

1. Experiment and Result

Nitrogen-included Carbonaceous Compounds (NCC) is synthesized by rapidly cooling the plasma gas 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 shows the comparison of the infrared absorption spectra of NCC and QCC with the UIR bands observed in dusty classical nova V2361 Cyg. The band profiles and the peak positions of features in the mid-infrared wavelength range are remarkably similar between the infrared absorption spectrum of NCC and the UIR bands in V2361 Cyg. The earlier

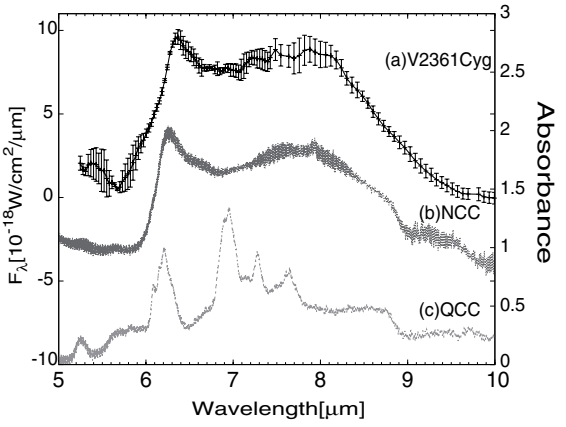

Figure 1. Comparison of (a)the UIR band observed in classical nova V2361Cyg at 116 days after outburst (Helton *et al.* 2011) with the infrared absorption spectra of (b)NCC and (c)QCC

works suggest that nitrogen inclusion into carbonaceous dust can naturally occur in the process of dust condensation in circumstellar environment (Hudgins *et al.* 2005) and that Nitrogen abundance in nova ejecta is higher than other circumstellar environment (e.g. Munari *et al.* 2008). Further more, the synthesis method of NCC simulates the circumstellar conditions of novae, where nitrogen-rich nova wind react with the existing circumstellar hydrocarbon dust. We, therefore, suggest that NCC be a powerful candidate of the carriers of the UIR bands in V2361 Cyg.

2. Properties of NCC

To investigate the chemical properties of NCC, we have carried out X-ray Absorption Near Edge Structure (XANES) measurements in the energy range of carbon (280-300eV) and nitrogen (395-415eV). From the results of the Nitrogen XANES (N-XANES) analysis, we have found that nitrogen atoms in NCC are contained in the form of imine (C=N) and amine (C-N) structures. In the infrared spectrum, the features arising from imine structures should appear around 6-7μm and are not clearly identified in the absorption spectrum of NCC mainly because of the blending with the 6.25μm feature arising from aromatic C-C. On the other hands, the feature arising from aromatic and aliphatic amine structure apear in 7.4-8.2μm and 8.2-9.8μm, respectively. We, therefore, concluded that the broad 8μm feature in the absorption spectrum of NCC is contributed by the amine structures. The present result suggest that nitrogen-inclution into conventional hydrocarbon model is significant for the better understanding of the carriers of the UIR bands.

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