

## Thermal degradation experiments of cometary N-rich organics analogs.

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**Introduction:** Organic matter in carbonaceous chondrites and stratospheric IDPs formed from chemical processes involving mostly carbon, hydrogen and oxygen. Nitrogen is a minor element in bulk samples (< 1 wt%), but can reach much higher abundance in tiny area a few micrometer across (> 10 wt%). The high N/C ratio reported there suggests the presence of the so-called HCN polymer, which could be formed in cometary ices by polymerization of HCN [1]. The astronomical observations of cometary atmospheres point out distributed CN sources, which could be the result of secondary thermal degradation of refractory cometary grains [2]. In order to understand the molecular carrier of the distributed sources, thermal degradation processes of N-rich analogs must be studied along with the characterization of N-bearing species in cosmomaterials [3]. These studies also report on possible heating processes which possibly occurred in the solar nebula.

We have an experimental set-up dedicated to such simulations. N-rich analogs (HCN polymer, tholins) were studied in the 25-550 °C temperature range under secondary vacuum. The chemical and structural evolution of such samples was monitored by micro-IR and Raman spectroscopies.

**Experimental:** *In situ* micro-infrared experiments were performed with a HYPERION 3000 and a home-made cell maintained under secondary vacuum (10<sup>-5</sup> mbars). *In situ* micro-Raman experiments were performed with a LabRam Jobin-Yvon micro-spectrometer and a commercial heating cell, under an inert (Ar) atmosphere. Long time duration experiments were performed with a brass cell followed by *ex situ* analysis. A single experiment in aqueous alteration was performed.

**Results:** Experiments were carried out on a SA90 tholins [4]. The chemical transformation was monitored in the infrared spectra by the bands relevant to the terminating groups – NH<sub>2</sub>, –CH<sub>2</sub>/CH<sub>3</sub>, –CN and the position of the band at 1650-1600 cm<sup>-1</sup> attributed to double bonded C=C or C=N.

In each experiment for T > 250 °C, the sample got darker and the peak initially at

~1650 cm<sup>-1</sup> shifted towards low wavenumber. This observation is consistent with N loss and an aromatization process. The cyanide chemical group is more labile than the amines and alkyls. The cyanide band at ~2200 cm<sup>-1</sup> became narrower, evidencing that only non conjugated cyanides remain in the sample. Last but not least, the experiment in water points out an increase of the NH<sub>2</sub> bands along with the decrease of the –CN, consistently with a hydrolysis process. Carbon oxidation (-OH) is supported by the appearance of a feature at ~ 1090 cm<sup>-1</sup>.

Short-time/high temperature (t<10 days - T<500 °C) tholins exposure lead in all cases to significant N loss, the chemical transformation of tholins samples but no significant increase of order in the carbon structure (assessed by Raman spectroscopy). Thermally processed N-rich analogs like HCN-polymer could be present in stratospheric IDPs or pristine chondrites. Further experiments and analysis are under way in order to more extensively constraint the nature and extent of the chemical transformation, and to analyze the gaseous component expelled during the process.

### References:

- [1] Aléon J. et al. (2003) GCA, 67,3773–3783.
- [2] Fray and Cottin (2008) SSRv 138, 179
- [3] Quirico et al. (2008) Proc. IAU251
- [4] Quirico et al. (2008) Icarus 198, 218



**Figure 1: The micro-IR HYPERION and the heating environmental cell used for *in situ* experiment.**