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Laboratory Experiments of Titan Tholins formed by Photochemistry of Cyanopolyynes

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Abstract

Tholins are complex organic materials produced by irradiation of several carbon and nitrogen rich atmosphere. It has been proposed that *Tholins* could have played an important role in the origin of life on Earth [1]. Here in, we investigate the formation of polymer (*Tholins*) from the photolysis of dicyanoacetylene.

1. Introduction

As of today, around 160 molecules have been identified in the interstellar Medium. Among the molecules detected in the ISM, the cyanopolyynes are very important since they are the essential constituents in building block amino acids. It is known that a rich organic chemistry takes place in and on grain mantles, essentially constituted of water, and contributes to the evolution of molecular diversity in the interstellar medium. Within the solar system, nitrile chemistry is particularly relevant to Titan. These cyanopolyynes are dominant atmospheric molecules on Titan. These compounds evolve through polymerization processes in aerosol particles, which grow by coagulation and rain down to the surface of Titan containing water ice.

2. Results

We present photochemical processes of larger cyanopolyyne formation from small precursor molecules submitted to long wavelength photons. Under UV irradiation cyanopolyynes are known to induce izomerization process (figure 1) [2] and formation of longer cyanopolyynes (Figure 2)[3].

We provide the photochemical processes of Titan *Tholins* formation (figure 3) from cyanopolyyne precursor molecules submitted to long wavelength photons. Such photons penetrate down into the stratosphere and troposphere. The photoreactivity of the cyanopolyynes with other Titan molecules are also presented. Laboratory experiments involving ultraviolet irradiation of dicyanoacetylene (C_4N_2) trapped in water ice have been conducted and monitored by infrared spectroscopy (FTIR). The irradiation of a C_4N_2/H_2O ice mixture at long wavelenghts has been found to be a possible source of $NH_4^+HCO_3^-$ (ammonium bicarbonate) and $NH_4^+HCOO^-$ (ammonium formate) [4].

3. Figures

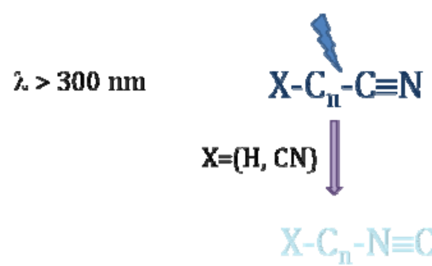

Figure 1: Izomerisation process of cyanopolyynes

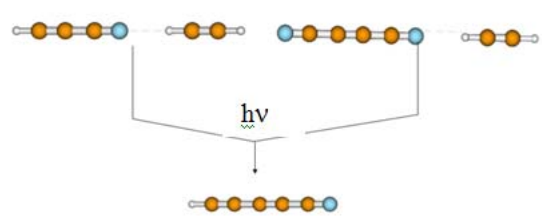

Figure 2: Formation of HC_5N under UV photolysis of C_4N_2:C_2H_2 and HC_3N:C_2H_2 mixtures

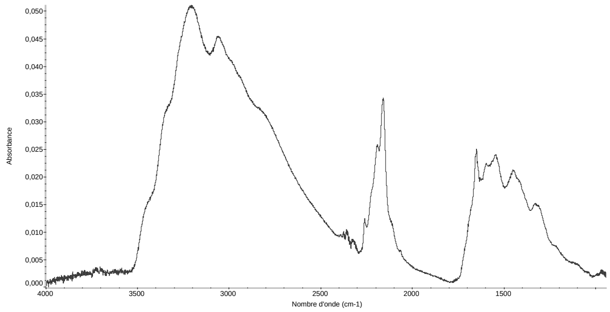

Figure 3: Infrared spectrum of Titan *Tholins* obtained by photolysis of pure C_4N_2 ice

4. Summary and Conclusions

Cyanopolyynes have been detected to be abundant in Titan's atmosphere. At low altitudes and on the surface, only the long wavelengths penetrate and most of these molecules condense and form organic solids. Photochemical experiments developed on pure Cyanopolyynes ice induce the formation of *Tholins*.

When cyanopolyynes are trapped with an excess of other Titan molecules, photochemical products are observed.

References

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