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Mass spectrometry investigation of Titan aerosols analogs formed with traces of aromatic compounds

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Abstract

We present a laboratory analysis of Titan aerosol analogs formed with traces of aromatic and heteroaromatic compounds as precursors. We observe an influence of the precursor aromatic compound on the composition and growth process of the aerosol.

1. Introduction

The detection of benzene at ppm levels in Titan's atmosphere [1] by Cassini's Ion and Neutral Mass Spectrometer (INMS) supports the idea that aromatic and heteroaromatic reaction pathways may play an important role in Titan's aerosols formation. In laboratory studies it has been shown that these aromatic molecules are easily dissociated by ultraviolet radiation and can therefore contribute significantly to aerosol formation [2] and be used to dope the production of aerosol analogs [3].

In this work we investigate the effect of the chemical nature of the aromatic reactant on the aerosol composition and growth pattern using Laser Desorption-Time of Flight mass spectrometry (LD-TOF) and Fourier Transform Infrared Spectroscopy (FTIR)

2. Experimental

Samples were prepared using a photochemical reactor developed at GSFC presented in Figure 1. The gas mixture used consisted of nitrogen – methane with traces (100 ppm) of benzene, pyridine, naphthalene or quinoline.

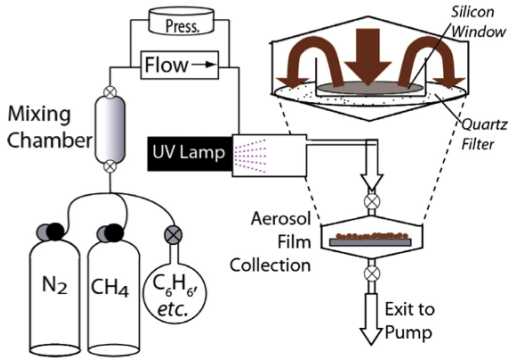

Figure 1: The photochemical reactor is used for the generation and collection of the Titan aerosol analogs.

Samples are collected under inert atmosphere and analyzed both with FTIR and LD-TOF.

3. Preliminary results

Infrared analysis of our samples shows that inclusion of aromatic compounds as trace precursors allows to better fit laboratory data to Titan aerosol spectra observed by Cassini [3,4]. The improvement is especially visible on the far infrared (~200 cm^{-1}) bands observed by CIRS [5] and on the 3.28 µm band reported at an altitude of 950 km by VIMS [6]

Figure 2 presents preliminary LDMS results of some aerosol samples produced with trace amount of aromatic compounds.

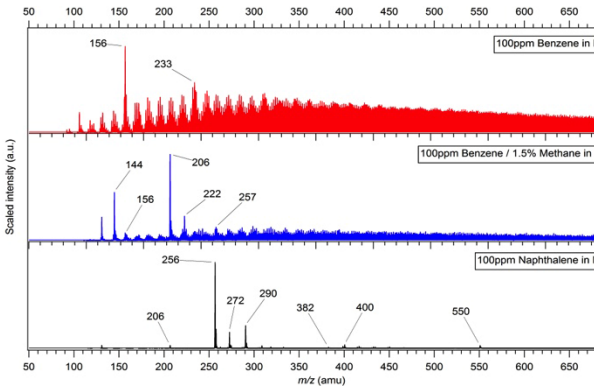

Figure 2: LD-TOF mass spectra of Titan aerosol analogs produced with 100ppm of benzene in N_2 (top); 100 ppm of benzene in N_2:CH_4 98.5:1.5 (middle) and 100 ppm of naphthalene in N_2 (bottom)

LDMS results show that the aerosol growth patterns depend both on the number of rings and on the nitrogen content of the trace precursor used.

We also perform MS/MS analysis on some prominent peaks of aerosol mass spectra. This MS/MS approach allows us to identify some of the key compounds in the aerosol growth processes.

Acknowledgements

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