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Amines and optical properties of Titan's aerosols

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Abstract

This work deals with the optical characterization of Titan aerosol analogues or "tholins". Those have been produced in different N_2–CH_4 gaseous mixtures to study the effect of the initial methane concentration on their optical properties. We studied the FIR- and MID-IR absorption properties on the SMIS beamline of the French SOLEIL synchrotron. And we determined the UV-visible-near IF optical indices by using the spectroscopic ellipsometry technique in the 370-1000 nm wavelength range.

1. Introduction

Titan's aerosols play an important role in the climate, the composition and the properties of Titan's atmosphere as well as its surface. This haze is one of the main drivers of the radiative transfer in the atmosphere of Titan [1] and strongly influences its thermal structure [2-3]. In Titan's atmosphere, the CH_4 concentration may have varied through time during the evolution of this atmosphere [4]. So we have studied the sensitivity of the optical constants of tholins synthesized from N_2-CH_4 mixtures towards different CH_4 concentration.

2. Mid- and Far- Infrared spectroscopy

We present mid- and far-Infrared absorption spectra of Titan's aerosol analogues produced in the PAMPRE experimental setup [5].

We provide a complete dataset regarding the influence that the concentration of methane vapor in the gas mixture has on the tholins spectra. Among other effects, the intensity of the 2900 cm^{-1} pattern (attributed to methyl stretching modes) increases with the methane concentration. On the opposite, tholins produced with low methane concentrations are more amine-based polymers (see Fig. 1).

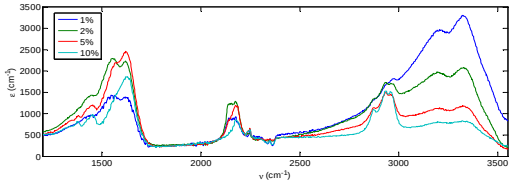

Figure 1: Mid-infrared spectrum of tholins produced with different methane concentrations

3. Optical indices in the 370-1000 nm range

We find that optical constants depend strongly on the methane concentrations of the gas phase in which tholins are produced (fig.2): imaginary optical index (k) decreases with initial CH_4 concentration from 2.2×10^{-2} down to 2.7×10^{-3} at 1000 nm wavelength, whereas the real optical index (n) increases from 1.48 up to 1.56 at 1000 nm wavelength. [6]

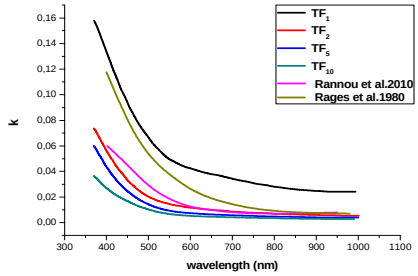

Figure 2: Tholins films k values compared with Titan's aerosols deduced from Voyager and Cassini/VIMS observations. TFi names a tholin film

sample produced with i% of methane in the initial gas mixture.

Thanks to Mid-infrared spectra recorded for tholins thin films produced at different methane concentration, the larger absorption in the visible range of tholins produced at lower methane percentage is explained by an increase of the secondary and primary amines signature in the mid-IR absorption.

Acknowledgements

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