EPSC Abstracts
Vol. 10, EPSC2015-705, 2015
European Planetary Science Congress 2015


# Complex organics in Titan lakes: Spectral detection and Chemical behavior

**D. Nna-Mvondo (1)**, S. Singh (2), V. F. Chevrier (2), G. Tobie (1), D. Mège (3,1)

(1) Laboratoire de Planétologie et Géodynamique, LPG Nantes, CNRS UMR 6112, Université de Nantes, France, (2) Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, AR, USA, (3) WROONA Research Group, Institute of Geological Sciences, Polish Academy of Sciences, Wrocław, Poland.
(delphine.nnamvondo@univ-nantes.fr)

## Abstract

The chemical composition of Titan's lakes is still poorly determined. Liquid ethane and methane may be abundant with the presence of other organic species from atmospheric precipitation, such as complex organics similar to Titan tholins. Our study aims to examine how Titan tholins may interact with non-polar solvents (liquid methane, liquid ethane and their mixture) and if in such liquid medium their spectral identification is possible, in application to future exploration of Titan's lakes.

## 1. Introduction

Due to its complexity, heterogeneity and chemical singularity, Titan surface composition is particularly intriguing and still poorly identified and determined. In 2005-2006, Cassini ISS and RADAR (SAR) instruments discovered a large dark lake feature in the Titan south-polar region (Ontario lacus) [1] and of a vast array of lake and sea like features in the north polar region [2]. Observations of the Titan's lakes and seas by Radar radiometry and VIMS have emerged to try to characterize the polar lakes and seas, however, their chemical composition is still undetermined. It is supposed that they should be composed of the Titan atmospheric precipitates, mainly hydrocarbons, such as ethane and methane. Thermodynamic equilibrium models predict liquid ethane and methane to be the most abundant constituents in Titan lakes [3] and other organic species from atmospheric precipitation to be additional constituents such as complex organics including the refractory macromolecular material of Titan's aerosols (Titan tholins). While VIMS is still providing data on Titan surface, it is important to study how the deposits of the atmospheric organic aerosols may interact optically and chemically with the hydrocarbons lakes. In this work, we present the results of experiments examining the spectroscopic signatures of a liquid ethane, liquid methane and the mixture of both in contact with laboratory analogs of Titan's aerosols.

## 2. Laboratory simulation of Titan's lakes

Experiments have been performed in the Titan simulation facility of the W.M Keck laboratory at the University of Arkansas [4]. An insulated cylindrical steel cryo-vacuum chamber accommodates out a Titan module that sits inside a main chamber. Titan module contains a temperature control box internally and externally lined with $LN_2$ cooling pipes allowing approaching temperatures relevant to Titan surface (90-94 K). 128 mg of Titan tholins synthesized at Keck lab were introduced inside a Petri dish into the sample collection pan sit inside the module. The pressure was maintained at 1.5 bar $N_2$ atmosphere throughout the experiments to simulate Titan atmospheric pressure at the surface. Once the required temperature and pressure were reached, the sample (ethane, methane) was introduced into the chamber and the module, through a condenser, using condenser input coils. The behavior of the sample was monitored via FTIR, in the near-infrared from 2.5 to 1.0 µm (4000-10000 $cm^{-1}$).

## 3. Results

Several spectra were acquired during the following experiments: tholins in liquid ethane, liquid methane, in the mixtures of liquid ethane/methane and liquid ethane/acetonitrile.

### 3.1 Ethane-tholins results

Absorption band of tholins are centered at 1.54, 1.62, 1.74, 1.92, 2.0 (Fig. 1, 2). The results for tholins in liquid ethane show modifications of the ethane bands at 1.7 - 1.75 µm and 2.0 µm as flattening and broadening (Fig. 1).

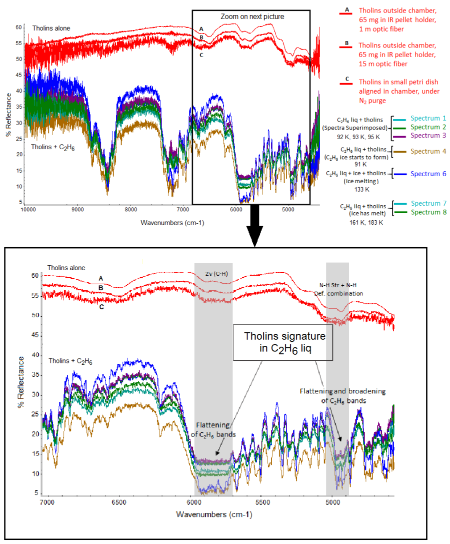


Figure 1: Spectra of tholins and ethane mixtures at 94 K (liquid $C_2H_6$) and between 88 K (solid $C_2H_6$) and 183 K.

### 3.2 Methane-tholins results

In the mixture of tholins and liquid methane, numerous methane absorption bands have been detected (Fig. 2). Identified $CH_4$ bands are centered at 1.16, 1.33, 1.41, 1.66, 1.72, 1.79 and 1.85 εm.

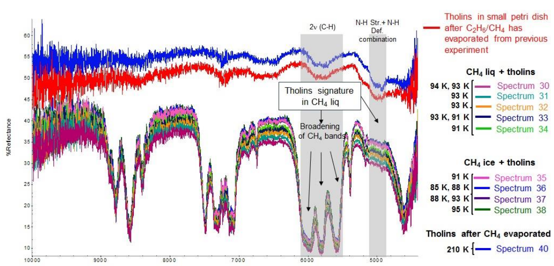


Figure 2: Spectra of tholins and methane mixtures between 95 K (liquid $CH_4$) and 85 K (solid $CH_4$).

In liquid methane, the presence of tholins is observed through a broadening of the $CH_4$ bands between 1.8 and 1.6 µm and a positive slope at 2.0 εm.

Once the solvents are evaporated from the mixtures, all the tholins absorption bands are retrieved and no new feature is noticed, resulting in no detectable reactivity/solubility of tholins with liquid ethane and liquid methane.

## 4. Conclusions

Our laboratory experiments show that tholins can be detected in liquid ethane, essentially through flattening and broadening of bands at 1.7 - 1.75 µm and 2.0 µm and in liquid methane through the broadening of the bands at 1.8 - 1.6 µm. These features might allow tholins identification in Titan's lakes for future in-situ missions. We have observed that tholins when in contact with these solvents are not remaining in suspension. In this case, the refractory material of Titanõs aerosols would not be dissolved in the Titan surface lakes and seas but would rather sinks. However, to confirm these first data, additional experiments are needed and are in the prospect of our next work. Results for the mixtures of liquid ethane with liquid methane and liquid ethane with acetonitrile will be presented at the conference. Our experimental approach and its resulting data are relevant in regards to current VIMS observations of Titanõs lakes and proposed future missions to Titan like the ESAõs Titan Saturn System Mission (TSSM).

## Acknowledgements

This work is funded by NASA Grant project # NNX10AE10G and has also received funding from CNES-funded New Horizons research grant and from the European Research Council under the European Communityõs Seventh Framework Programme (FP7/2007-2013 Grant Agreement No. 259285).

## References

[1] Turtle, E. P. et al.: Cassini imaging of Titan's high-latitude lakes, clouds, and south-polar surface changes Geophys. Res. Lett., Vol 36, L02204, 2009.

[2] Stofan, E. R. et al.: The lakes of Titan. Nature, Vol. 445, pp. 61-64, 2007.

[3] Tan, S. P. et al.: Titanõs atmosphere and surface liquid: New calculation using Statistical Associating Fluid Theory, Icarus, Vol. 222, pp. 53-72, 2013.

[4] Wasiak et al.: A facility for simulating Titanõs environment, Adv. Space Res., Vol. 51, pp. 1213-1220, 2013.