ACETYLENE ON TITAN: LABORATORY EXPERIMENTS FOR REMOTE DETECTION USING CASSINI/VIMS DATA. T. Cornet[1], S. Singh[2], V. F. Chevrier[2], A. Luspay-Kuti[2], F. C. Wasiak[2], W. D. D. P. Welivitiya[2], L. Roe[2], S. Le Mouélic[1] O. Bourgeois[1] and E. Le Menn[1], [1]*LPGNantes, Université de Nantes, UMR 6112 CNRS, OSUNA, 2 rue de la Houssinière BP92208, 44322 Nantes, France,* [2]*Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, USA.* (Thomas.Cornet@univ-nantes.fr).

Introduction: Titan's atmosphere is mainly composed of nitrogen (N_2, 95 – 98 %) and methane (CH_4, 1 – 5%). Both compounds are photodissociated and produce heavier hydrocarbons and nitriles that are able to sediment down to the surface and accumulate over geological timescales [1]. Among all these hydrocarbons, acetylene (C_2H_2) is one of the most abundantly produced according to most photochemical models [2,3,4,5]. An acetylene layer, several tens to hundreds of meters in thickness, could have accumulated onto the surface over the past Gy [3,6].

Although probably mixed with other hydrocarbons at the surface of Titan, a hydrocarbon produced in such abundance could be detected at some locations of the surface. The detection of a widespread acetylene layer that would cover Titan's surface is however still lacking [7], whereas it has been tentatively detected in some local areas such as in the bright annulus surrounding Ontario Lacus [8].

The Titan Module developed at the University of Arkansas has already proved its capabilities in reaching Titan's low temperature and pressure (90 - 95 K, 1.5 bar) [9] and monitoring evaporation rates of liquid methane-nitrogen mixtures [10]. We used this facility to synthesize solid acetylene under Titan's surface conditions and to study its infrared properties between 1.0 and 2.6 µm.

Description of the Titan Module and data acquisition: The Titan Module is primarily designed to monitor evaporation rates of liquid hydrocarbons [10]. The liquids are usually synthesized in a condenser, the temperature of which is cooled at the melting point of a given compound to pour it into a sample pan. The sample pan is continuously weighed by a balance to record the loss of mass over time, i.e. the evaporation rate.

A Fourier Transform InfraRed spectrometer (FTIR) is also connected through a fiber optics to the Titan Module, with the probe located just above the sample pan. The fiber optics operates from 1.0 to 2.6 µm with a spectral resolution of 4 cm^{-1}.

We used here the Titan module with the same settings to synthesize solid acetylene under Titan's surface conditions (92 K, 1.5 bar of N_2). We used industrial acetylene gas for the experiment, mixed with acetone for safety reasons. The mixture was synthesized inside the condenser as a slurry close to the melting point of acetylene (T = 192 K) and in the liquid range of acetone (T > 178 K) and was be poured into the sample pan. Once in the pan, the temperature of the module is cooled down to Titan's temperatures and the spectral behavior of the acetylene/acetone slurry (Figure 1) is monitored using the FTIR.

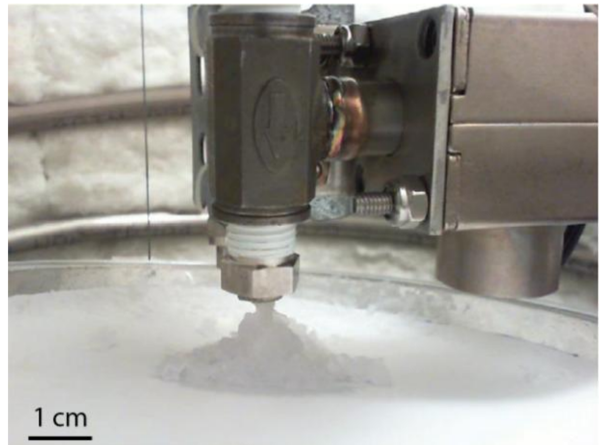

Figure 1: The acetylene/acetone slurry synthesized using the Titan Module is poured into the sample pan [9].

Laboratory spectra interpretation: Figure 2 shows the reflectance spectrum of the solid acetylene/acetone slurry acquired at 92 K under a pressure of 1.5 bar of N2. Several absorption bands are detected in the spectrum. In order to evaluate which absorption bands are due to acetylene alone, we also acquired a spectrum of pure acetone at 92 K at the LPGNantes and we compared both spectra with a spectrum of water ice at 77 K from the USGS library (Figure 2). A strong and sharp absorption feature centered at 1.54 µm and a negative slope in the 2 µm region can be attributed to acetylene while several small absorption bands in the 1.6 – 1.8 µm region and beyond 2.1 µm are more likely due to acetone. We cannot see any contamination by water ice in the acetylene/acetone slurry spectrum.

Comparison with VIMS infrared spectra: The Visual and Infrared Mapping Spectrometer (VIMS) [11] is the hyperspectral camera onboard the

Cassini spacecraft. It is composed of two detectors, one of which operates from 0.88 to 5.10 µm, thus fully covering the spectral range covered by our experimental apparatus, with a spectral resolution of 16.6 nm. VIMS is able to detect Titan's surface in 7 narrow atmospheric windows centered at 0.93, 1.08, 1.27, 1.59, 2.01, 2.7 – 2.8 and 5 µm. The fiber optics of the Titan Module thus covers 4 of the 7 atmospheric windows resolved by VIMS.

The acetylene spectral features seen at 1.54 µm and in the 2 µm region lie within two of the largest VIMS atmospheric windows. The absorption features seen in the laboratory spectra are large enough to be potentially detected in VIMS data (Figure 3). Recent VIMS data processings aiming at mitigating the atmospheric scattering blurring effects in the data at short wavelengths [12,13] will help to detect surface compositional heterogeneities in the VIMS cubes.

Upcoming work: Future work will include the comparison between laboratory spectra acquired using the Titan Module and Cassini VIMS spectra acquired over targeted areas that display compositional heterogeneities. Those areas will include high resolution cubes acquired over regions of interest such as Ontario Lacus, Hotei and Tui Regios, and the North Polar Region, where lakes coexist with 5 µm-bright deposits interpreted as possible evaporites [14]. Such potential evaporite deposits are of great interest for the detection of acetylene on Titan, since acetylene is soluble in Titan's liquids (methane and ethane) [6,15] such as evaporite minerals (halite, gypsum) are in water on Earth.

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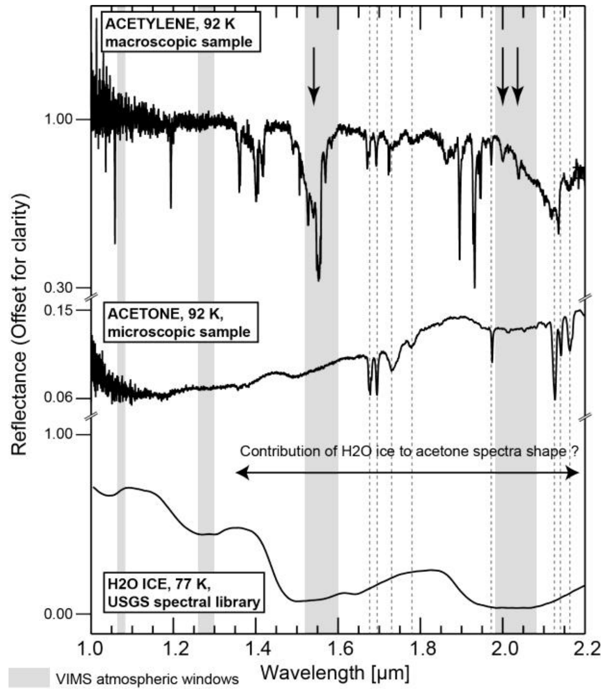

Figure 2: Comparison between a spectrum of an acetylene/acetone slurry acquired with the Titan Module at 92 K, a solid acetone spectrum acquired at the LPGNantes at 92 K and a water ice spectrum from the USGS Library acquired at 77 K.

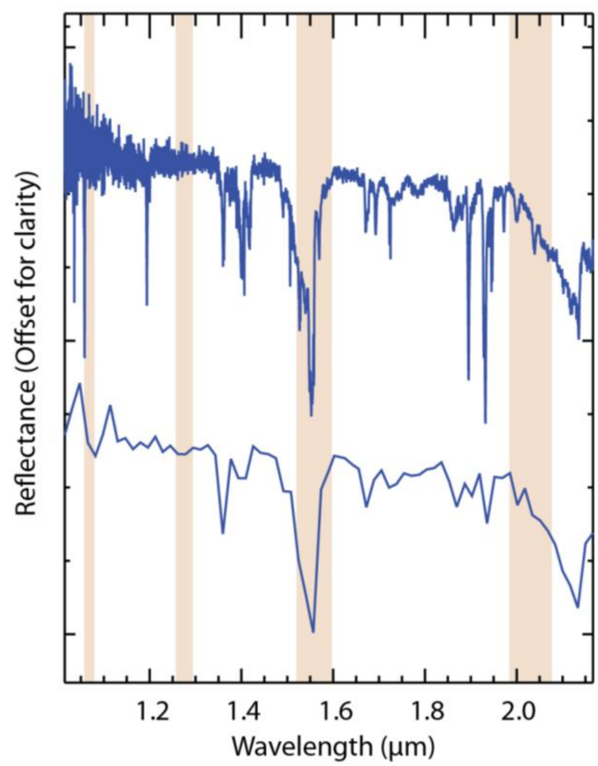

Figure 3: Same acetylene/acetone spectra acquired at 92 K, convolved at VIMS spectral resolution. VIMS atmospheric windows are represented in light brown.