TITAN ATMOSPHERE PLASMA CHARACTERIZATION USING SPECTROSCOPIC MEASUREMENT TECHNIQUES

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During Titan atmosphere entry, the heat shield of a planetary exploration vehicle experiences high radiative heat loads. In these conditions, owing to the composition of Titan's atmosphere, the radiative heat flux can be comparable to or greater than the convective heat flux. Therefore, proper design of the heat shield necessitates a good knowledge of the radiative properties of the high temperature gas present in the shock layer. Few experimental data are available on this problem. We present in this study measurements aimed at producing experimental data representative of Titan entry conditions.

The Titan atmosphere is mainly composed of N2 and contains a few percent of CH4. When heated up to high temperature this mixture produce up to a few percent of the CN and C2 radicals. Those radicals are known as strong radiators and the emission of the resulting plasma is dominated by their spectra. In the spectral range from 350 to 1000 nm, the main molecular systems of CN and C2, the CN violet, CN red systems and C2 Swan systems, are therefore investigated using emission spectroscopy.

The plasma is produced in an inductively coupled plasma wind tunnel. In this configuration the test conditions are stable, repeatable and the plasma has a cylindrical symmetry, filling a priori the requirements for the present spectroscopic analysis. Spectrally resolved, local and absolute emission spectra were measured in the spectral range from 350 to 1000 nm. Information on the plasma state is obtained from the emission spectroscopy measurements analysis. Those measured spectra are dominated by molecular systems and the information contained in the atomic emission lines is not available. Laser techniques are envisaged to give more insight into the thermodynamic state of the plasma. The TALIF (Two Photon Absorption Laser Induced Fluorescence) was implemented to probe nitrogen and hydrogen atoms. During the implementation of TALIF the energy in the plasma flow was found to be oscillating. The effects of these fluctuations on the emission spectroscopic measurements and on the conclusions about the state of the plasma are under investigation.

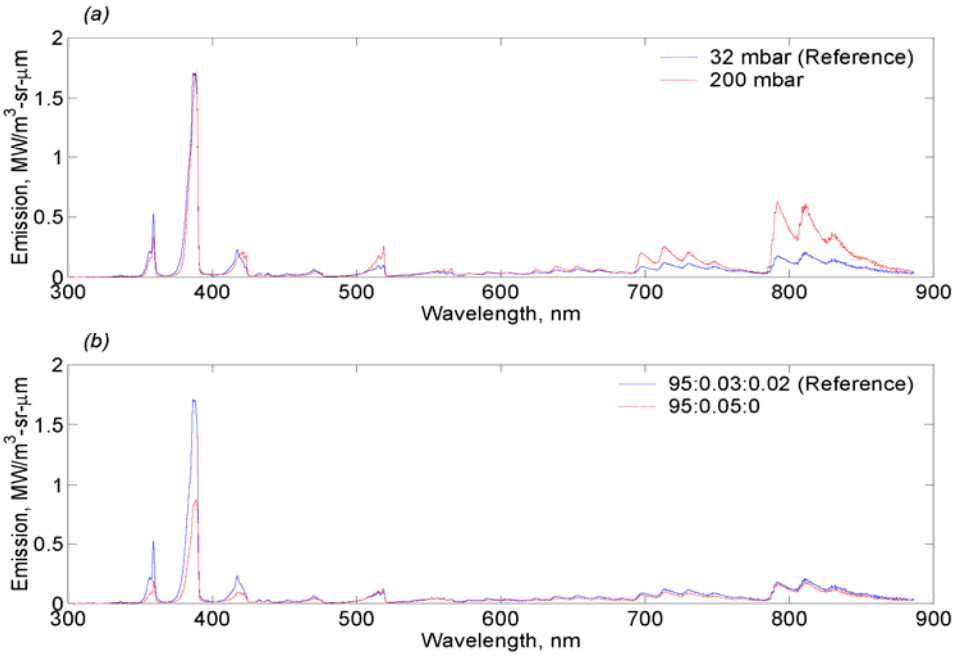

Figure 1: Effect of pressure (a) and mixture composition (b) on the measured spectra: the reference spectra was measured for a pressure equal to 32 mbar and a mixture composition of x_{N2}:x_{CH4}:x_{Ar}=0.95:0.03:0.02 (mole fraction)