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Laboratory simulation of Titan's atmosphere chemistry by RF plasma: plasma properties determined with optical emission spectroscopy

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Several laboratory experiments have been developed to simulate the production of Titan's solid organic aerosols, due to their interest for the understanding of the formation of complex organic materials linked to the emergence of life, and of their role in the climate of the satellite of Saturn. Different types of laboratory experiments have been used, but in these devices, solid products are generally deposited on solid surfaces, e.g. substrates or reactor wall. In RF capacitively coupled plasma discharges, dusts are produced in volume, preventing any wall effect and enabling the in situ study of the dust production. This is why we currently use for the first time this original technique to produce analogues of Titan's aerosols from a N2-CH4 gaseous mixture representative of the Titan's atmosphere gaseous composition. In order to be capable to understand the conditions of formation of the particles, and to transpose the results collected in laboratory to Titan's atmosphere, it is however necessary to properly know the plasma properties. With this aim, we use the optical emission spectroscopy (OES) as the main diagnostic. The light emitted by the plasma is collected and analysed with a UV-visible spectrometer. The signal thus collected is mainly used to determine the gas temperature, part of the plasma composition and the electrical properties of the plasma, and to follow these parameters as a function of the plasma operating conditions. We present in this paper the results obtained from these investigations: 1) the gas temperature is deduced from the rotational spectra of the nitrogen second positive system, and it is determined for different plasma conditions. 2) the intensities of nitrogen bands is measured as function of plasma conditions. It enables to point out that some evolutions could be attributed to an evolution of electron temperature inside the

plasma. 3) the plasma chemistry was studied as a function of the operating conditions from the observation of the CN, CH and the Ha and Hb lines. The results dealing with the plasma composition will have to be compared with the composition of the produced solid particles to understand the gas to solid phase conversion of the organic species.