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Study of a dusty plasma used for the production of Titan's aerosols analogues

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Titan s atmosphere contains a large amount of aerosols produced by an organic chemistry induced by the photochemistry of N2 and CH4, the major gaseous atmospheric components. Even if observed with remote sensing techniques, the physico-chemical properties of these organic aerosols and their formation are still not well known. For this reason, the experiment named "PAMPRE" (French acronym for Production d Aerosols en Microgravité par Plasmas REactifs) is developed to produce analogues of Titan s aerosols (tholins) in laboratory. The plasma is produced by a Radio Frequency discharge. These plasmas are known to be a source of dust and a field of studies is in development: the dusty plasmas. In this RF plasma the produced tholins are maintained in suspension into the reactive gas by electrostatic forces and are formed in volume without any solid surface interaction. This paper is devoted to the description of the RF plasma device and to the diagnostic used to study the plasma. The plasma is produced at low pressure, from 0.2 to 3 mbar in a N2-CH4 gas mixture with concentrations of methane between 0% to 10% . The absorbed RF power can reach 100 W. As the plasma discharge is luminous, Optical Emission Spectroscopy is used to characterize the properties of the plasma. Light emitted from the plasma is analyzed with a UV visible monochromator. The gas temperature is deduced from the rotational spectra of the nitrogen second positive system. The evolution of this temperature is measured for different methane percentage from 1% to 10% . We also observe the emission of the CN violet system. The evolution of the CN radical is studied as a function of plasma characteristics: pressure, methane percentage, RF power. Moreover, the intensity of the first negative band of the nitrogen molecular band is also observed as a function of

the same plasma parameters. As the plasma is confined in a metallic cage, this cage is a resonant cavity for microwaves. The presence of the plasma in this cavity modifies the resonance frequency and the frequency shift is proportional to the electron density. Then electron density is measured for all the plasma conditions used for the tholins production. These cavity results are compared to electrostatic probe measurements of positive ions density. From the study of the correlations between Optical Emission Spectroscopy and charges particles densities, we can deduce an evolution of the electronic reaction rate coefficient as a function of plasma parameter. In RF plasma discharge, the presence of charged solid particles modifies the plasma impedance. Then the polarisation of RF electrodes is strongly dependant of the presence of particles. From the measurement of time variation of the electrode polarisation, we point out different phases for the particles grow. First results obtained by this technique are presented.