Geophysical Research Abstracts, Vol. 8, 09225, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09225

Characterization of Titan's aerosols analogues produced by a dusty plasma

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The Titan's atmosphere contains aerosols produced by an organic chemistry induced by the photochemistry of N_2 and CH_4. These organic aerosols are important as: i) they have a significant influence on the properties of the atmosphere, linked to their optical properties; ii) they represent the best known example of transition from the gaseous to the solid phase by chemical processes; iii) they represent the most complex organics produced in Titan's atmosphere, making them particularly interesting from the astrobiological point of view.

In order to contribute to the understanding of the formation of Titan's aerosols, we use a low pressure Radio Frequency (RF) plasma discharge. In RF plasma solid particles are produced into the gas, without wall effect, because they are maintained in levitation in the reactive medium by electrostatic forces. This type of discharge is used in the field of "dusty plasmas". In our experiment, the RF discharge works in a N_2-CH_4 gas mixture in order to produce "tholins", i.e. analogues of Titan's solid aerosols. The CH_4 percentage is changed from 0% to 10% by adjusting gas flow a pure N_2 and premixed N_2 + 10% CH_4. In order to study the influence of the plasma on the physical properties and chemical composition of the produced tholins plasmas parameter like total gas flow rate, total gas pressure and absorbed RF power are changed.

The morphology of the produced tholins is observed by scanning electronic microscopy. The tholins are quasi spherical and their size and dispersion are studied as a function of the plasma conditions. The correlations between the plasma parameters and the particles shape are presented.

Some samples are observed by laser light diffusion in order to study the evolution of the polarimetric phase curve at two wavelengths: 543.5 nm and 633 nm. A difference is pointed out for tholins produced in plasmas with 2% and 10% of CH_4.

The tholin's refractive index is measured for the same samples produced with 2% and 10% of CH_4.

IR absorption is used to identify the bounding in the tholins. We observe that an increase from 2% to 10% of CH_4 induce significantly the C-H bounding.

We also study of the elemental composition of the produced tholins when the CH_4 percentage is changed from 1% to 10%, and we measure the relative concentration of C, N and H. The measured ratio C/H and C/N are compared with results of tholins obtained by plasma devices used by other teams.

With the relatively extended variation of physical and chemical properties of the produced tholins, we can create a data bank. These data can be used as a reference to treat and interpret the information collected from the Cassini-Huygens space mission and observations of the Titan's atmosphere. We hope that the correlation between the gas phase properties and solid particles properties could be transposed to the Titan's atmosphere case to retrieve the processes of formation of the Titan's aerosols.