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In situ and ex situ studies of the gas phase in PAMPRE, a dusty plasma experiment for the study of Titan's atmosphere

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Abstract

The complex organic chemistry that takes place in Titan's dense atmosphere, composed mainly of N_2 and CH_4, and that leads to the production of aerosols, called tholins, as been puzzling scientists for many years. Until recently, tholins were thought to be formed in the lower stratosphere, at altitudes about a few hundred kilometres, where the atmosphere is dense and neutral. The recent observations of the INMS and the CAPS instruments on Cassini showed that these organic aerosols are actually formed at higher altitudes, in the ionosphere, where an active chemistry coupling ion and neutral species occurs [1].

To try and understand this chemistry, we use a dusty plasma experiment that reproduces in a laboratory setting, the atmospheric reactivity on Titan [2]. This experiment, called PAMPRE, uses a Capacitively Coupled Plasma (CCP) discharge, produced in a continuous gas flow, to induce the chemistry between N_2 and CH_4. More complex molecules are then formed in the plasma and lead to the production of solid particles, analogues of Titan's aerosols.

In the study presented here, different nitrogen-methane mixtures (from 1% to 10% CH_4) have been used to study the influence of methane on the chemistry and on the subsequent production of aerosols. Using a quadrupole mass spectrometer, in situ measurements of the evolution of the gas phase composition have been achieved. An initial methane consumption phase, lasting up to a hundred seconds, has been observed. This CH_4 consumption phase is longer than the time of appearance of tholins in the discharge [3]. This phase is followed by a stationary regime where the methane concentration is lower than in the initial gas mixture and no longer changes. This regime corresponds to the continuous working conditions (CWC) where the tholins are produced. For each initial N_2-CH_4 gas mixture (from 1% to 10% CH_4), we have used in situ mass spectrometry measurements to determine the real CH_4 concentration in the gas mixture at CWC. In situ measurements of the gas phase in PAMPRE are fundamental since they have made it possible for us to determine which initial CH_4 concentration needs to be used to produce tholins in experimental conditions close to Titan's conditions. Using mass spectrometry, we have also been able to detect some of the products of the complex chemistry like the production of a molecule of mass 27, attributed to the production of HCN in the plasma.

Since mass spectrometry cannot detect the minor compounds present in the gas phase, a cold trap which condenses and accumulates these minor compounds at liquid nitrogen temperature has been installed, as a complementary ex situ diagnostic. This trap is similar to the one used by Coll et al. in their DC plasma discharge experiment [4]. Once accumulated, the condensed molecules are then evaporated into a gas chromatograph coupled to a mass spectrometer (GC-MS). Hydrocarbons and nitrides have been detected ex situ using this method. HCN has been detected both in situ by mass spectrometry and ex situ by GC-MS.

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References

[1] Waite, J.H. Jr., Young, D. T., Cravens, T.E., Coates, A.J., Crary, F.J., Magee, B., Westlake, J. (2007) *Science*, 316, 870-875.

[2] Szopa, C., Cernogora, G., Boufendi, L., Correia, J.-J. and Coll, P. (2006) *Planet. Space Sci.,* 54*,* 394–404.

[3] Alcouffe, G., Cavarroc, M., Cernogora, G., Ouni, F., Jolly, A., Boufendi, L., Szopa, C., submitted to *Plasma Sources Sci. Technol.*

[4] Coll, P., Coscia, D., Smith, N., Gazeau, M.-C., Ramirez, S.I., Cernogora, G., Israel, G., Raulin, F. (1999) *Planet. Space Sci.,* 47, 1331-1340.

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