



Formation of HCN and NH₃ as primary compounds of Titan's atmosphere simulations using N₂-CH₄ afterglow plasma

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Molecular nitrogen is, together with methane, the main precursor of Titan's atmospheric chemistry which evolution is driven by high energy electrons from Saturn's magnetosphere as well as solar UV photons. A great number of laboratory experiments have been carried out to mimic Titan's atmospheric chemistry. But, up to now, N₂/CH₄ mixtures have been submitted to a unique type of energy source: UV light, high energy particles or electric discharges.

We are developing a new program of Titan's simulations (named SETUP, a French acronym for Theoretical and Experimental Simulations Useful for Planetology) which aims to improve the representativeness towards Titan's condition in term of energy deposition: we chose to initiate, in a flow reactor, the coupled N₂/CH₄ chemistry using both electrons (microwave plasma discharge) and photons (Lyman alpha delivered by a continuous H₂/He lamp). Thus, studies have been undertaken on N₂/CH₄ discharges as well as N₂/CH₄ post-discharges. In this later experimental set-up, CH₄ is introduced downstream of a flowing afterglow of a pure N₂ discharge. It is then eventually submitted to UV photons in order to be able to disentangle the relative contribution of the mechanisms occurring in the post-discharge between molecular/atomic nitrogen high energetic species and methane from those resulting from the methane photolysis itself. Ex-situ qualitative and quantitative analysis of the resulting gas mixture recovered in a cold trap has been performed, for the first time, by IRTF spectroscopy.

In the first set discharge experiments, more or less similar to those commonly conducted (the difference lies in the type of plasma used), the obtained products are HCN, NH₃, HC₃N, HC₅N, C₂H₂, C₂H₄, C₂H₆, C₃H₄, C₄H₂ and C₆H₂ with abundances compatible with those retrieved from observations of Titan's high atmosphere in the range between 900 to 1200 km. More surprisingly, in the post discharges experiments, only HCN and NH₃ are observed and this regardless the fact that methane is photolyzed or not. A tentative explanation by a dedicated kinetic model developed in parallel will be discussed. Implications of this work for the future development of the SETUP Titan's simulations program will be given.