Molecules Radicals and Ions produced in a N_2-H_2 CCP RF

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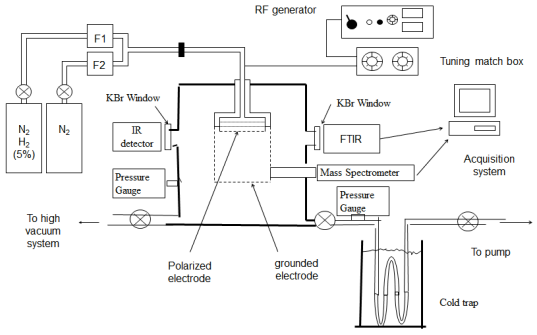
CCP RF discharges are well known to be sources of dusty plasmas. These plasmas are used to simulate the formation of organic solid particles in planetary atmospheres, as Titan with a N_2 CH_4 mixture. As a first step for understanding these plasmas, we study here the formation of molecules, radicals and positive ions in a N_2 H_2 CCP RF plasma. mixture. Radicals and positive ions are measured by in situ mass spectrometry. Neutrals are accumulated in a cold trap downstream the plasma. These molecules are measured, after warming the trap by mass spectrometry and IR absorption spectroscopy. . When mass spectrometry gives relative values of species abundances, IR absorption gives absolute values of the most abundant molecules. A focus is done on NH_3 , this molecule being produced as well in the discharge as by catalytic effect on the metallic wall of the discharge.

1. Introduction

A Capacitively Coupled Plasma in N_2-CH_4 mixture is used for the formation of dust to simulate the formation of solid aerosols in Titan's atmosphere. Details of this experimental device are described in details in [1]. The dissociation of CH_4 produces H_2 molecules. In order to understand the complex chemistry occurring in the N_2 CH_4 mixture, study of the N_2 H_2 mixture is developed as a first step.

2. Experimental device.



Experimental device

The CCP discharge is confined in a metallic cylindrical box of 13.6 cm in diameter. Two slots, diametrically opposed are managed in the cylindrical box. This box is placed into a 30 cm in diameter and 40cm height stainless steel reactor fitted with two KBr windows diametrically opposed. Gas mixture is injected continuously in the plasma and pumped with a rotary pump. The amount of H_2 in N_2 is tuned from 1 to 5%. Pressure in the plasma discharge is maintained at 1 mbar. Between the discharge and the pump, a trap cooled by liquid nitrogen condenses molecules produced in the discharge.

3. Measurements.

The neutral molecules, radicals and positive ions are measured using a mass spectrometer EQP Hiden placed in front of one of the slot.

After few hours of plasma run, the gas injection is turned off, valves upstream and downstream the cold trap are closed and the trap is slowly warmed up to the room temperature. Then the condensed gases are reinjected in the reactor.

The molecules densities are measured using a Nicolet 6700 Fischer FTIR spectrometer through the 40 cm of in diameter of the reactor [2]. Focus is done on the NH_3 molecule measured in the 967 cm^{-1} band. In our experimental conditions, the NH_3 density is on the order of 10^{12} cm^{-3}.

4- Perspectives

These results obtained are now to be compared with the modelling of the plasma in our experimental conditions. The major point is the relative contribution of volume reactions versus catalytic ones for the formation of NH_3.

5. References

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[2] Dubois D., Carrasco N., Petrucciani M., Tigrine S., Vettier L *Neutral Chemistry in Titan's Ionospheric Simulated Conditions*, Dubois D., et al., DPS-EPSC 2016, Oct 2016, Pasadena, USA