Viana do Castelo
ESCAMPIG 2012

Europhysics Conference on the Atomic and Molecular Physics of Ionized Gases

Viana do Castelo, Portugal

10-14 July, 2012

EPS

Home ▽ Program ▽ Registration ▽ Contribution ▽ Important dates Venue ▽ Accomodation ▽

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XXI Europhysics Conference on Atomic and Molecular Physics of Ionized Gases (ESCAMPIG)

will be held in **Viana do Castelo, Portugal, July 10-14, 2012.**

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XXI Europhysics Conference on the

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Tuesday 10 July to
Saturday 14 July 2012

at Castelo de Santiago da Barra
Viana do Castelo, Portugal
http://escampig2012.ist.utl.pt

PROCEEDINGS

Edited by
Pedro G. C. Almeida, Luís L. Alves and Vasco Guerra

Universidade Técnica de Lisboa

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Experimental characterization of capacitively coupled radio-frequency discharges in N_2-CH_4

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We have performed extensive measurements in capacitively coupled radio-frequency discharges, producing N_2-CH_4 plasmas for methane concentrations between 0% and 10%. These dusty plasmas are well characterized by monitoring the evolution, with the methane concentration, of the electron density, the self-bias voltage, the coupled power, and the spectral line intensity of a number of optical transitions. The plasma properties exhibit drastic changes that are found correlated with the dust production regime.

Introduction

The interest in N_2-CH_4 capacitively coupled radio-frequency discharges (ccrf) has grown in recent years due to its potential to simulate, at laboratory scale, the atmosphere of Titan. In particular, the large amount of dusts and precipitates produced by these plasmas are of great interest to planetology, given their analogy with the *tholins* found in Titan's atmosphere [1].

Experiment

This work reports an extensive study of these plasmas, performed in the PAMPRE experiment at the LATMOS laboratory. The experimental setup is thoroughly described in [1-2]. The discharge is driven by an rf power generator, running at 13.56 MHz, coupled to an asymmetric parallel-plate cylindrical reactor through an impedance matching box. Both the rf-applied voltage V_{rf} and the dc-self-bias voltage V_{dc} were measured, in addition to the effective power coupled to the plasma W_{eff} (obtained by using the subtractive method [3]), and the electron density n_e (obtained by micro-wave resonance frequency shift [4], using the TM_{010} cavity mode). Optical emission spectroscopy (OES) measurements were performed upon the second positive and the first negative systems of N_2, as well as upon the violet CN bands.

Measurements were carried out both at constant V_{rf} and at constant generator power, bearing in mind that the applied voltage is an input parameter to simulations [5], whereas the coupled power is the key parameter controlling the experiment.

Results

Figure 1 presents measurements, at constant V_{rf} and at constant generator power, of the electron density (accuracy of $4x10^{13}$ m^{-3}) and of the absolute value of V_{dc}, as a function of the methane concentration. For the measurements at fixed power, one notices a sudden drop in the values of both n_e and $|V_{dc}|$, when the gas composition goes from pure N_2 to a mixture containing 1% of CH_4. At constant power [see figure 1(b)], after the initial drop the electron density and the self-bias voltage increase with the concentration of CH_4, becoming similar to those observed in pure N_2 plasmas for mixtures containing 7-8% methane. The decrease of these two quantities from the pure N_2 values is well correlated with the variation of dust production efficiency as a function of CH_4 concentration [6]. At constant V_{rf}, however, [see figure 1(a)] the effect of dust is somewhat masked by the fact that the experiments were ran by varying the generator power, in order to maintain the desired V_{rf}.

This behavior can be confirmed in figure 2. Here, one observes that: (i) the coupled power must initially increase [see figure 1(a)], to compensate for the drop in the applied voltage [see figure 1(b)] due to the formation of dust; (ii) for CH_4 concentrations above 1%, W_{eff} decreases to ensure a constant

V_{rf} [see figure 1(a)], since the applied voltage tends to increase with the admixture of methane, at constant power [see figure 1(b)].

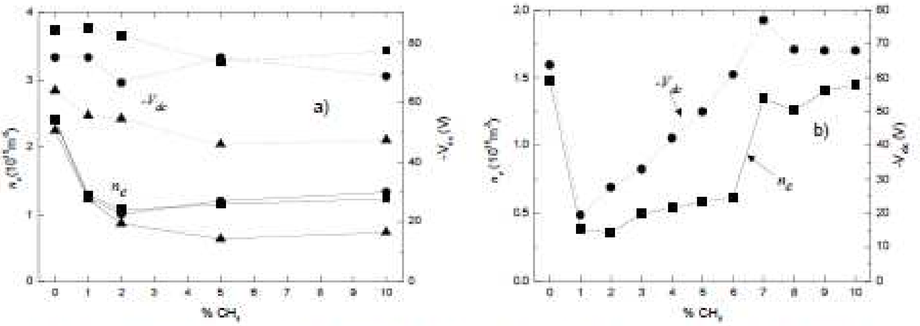

Fig. 1: Electron density (solid lines) and self-bias voltage (dotted), as a function of the CH_4 concentration, at: a) fixed V_{rf} = 220 V and three different pressures (■-0.50 mbar; ●- 0.77 mbar; ▲-0.98 mbar); b) fixed 30W generator power and 0.9 mbar pressure.

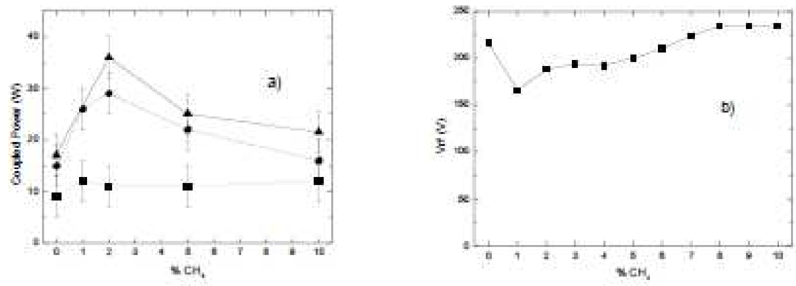

Fig. 2: a) Effective power coupled to the plasma, as a function of the CH_4 concentration, at fixed V_{rf} = 220V and three different pressures (■-0.50 mbar;●-0.77 mbar; ▲-0.98 mbar); b) Applied voltage, as function of % CH_4, at fixed 30 W generator power and 0.9 mbar pressure.

The paper will also present and discuss the OES measurements performed for the different operating conditions.

Acknowledgements

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