INTRODUCTION

Optical techniques are frequently used in the research laboratories to characterize the plasma under investigations. These diagnostic methods have the huge advantage to be non-intrusive, consequently they do not modify the plasma conditions. On the other hand they demand very accurate set-up procedures that are not of practical interest for example in the industrial applications. Another disadvantage is due to their low temporal dynamics, that, as in the present investigations, it does not allow to study very fast time processes or to follow the time changes of the plasma parameters of interest. For these reasons, it is necessary to integrate the optical diagnostics with other different investigations methods as the developing of theoretical models or the set-up of electric probes.

This work describes the results of optical investigations on low pressure non equilibrium plasmas. The analysis is carried out to fully ionized and weakly ionized plasmas. The radiation emitted by the plasma plume of a gas-fed, applied field Magneto-Plasma-Dynamic thruster is observed by an optical multi-channel analyzer (OMA). By these measurements, an estimations of some plasma parameters is performed. In order to have more information on the population and depopulation mechanisms of the levels observed, a collisional-radiative model is developed for the singly ionized argon system. In this model the energy distribution function of the free electrons is calculated by solving the Boltzmann equation. Imaging techniques are used in order to find if some structures occur in the plasma.

The mechanisms of particle generation in the radio-frequency argon-silane discharge is studied with optical emission observations of the discharge as well as with laser light scattering on the formed particles at different gas temperatures. Unfortunately, the detection of particles in the nanometer range presents a particular challenge. Most of the research studying the behaviour of particles in plasmas is performed with lasers. However, a general problem is that these methods allow an high accurate detection of particle with radius greater than 10 nm. On the other hand, the early detection of particle formation and their controlled growth is necessary for the development of more efficient surface processing techniques. Recently, a number of study has pointed out as the particles growth in a plasma strongly affect the discharge impedance. In addition, the non-linear character of plasma brings to a significant anharmonic waveform of the electrical parameters. In particular, higher harmonics seem to be very sensitive to the appearance of particles since the nucleation phase. So, the optical measurements are compared with non-intrusive and accurate voltage, current and phase measurements of fundamental and harmonic RF frequencies. The time analysis of these parameters (discharge current, voltage and phase angle) could become a simple and non-invasive technique to detect the particle occurrence which can be implemented in a simple way on a commercial plasma processing tools.