Modeling low pressure collisional plasma of argon in DC discharge

F. Bouanaka, S. Rebiaï, H. Bahouh, S. Sahli

Laboratoire de Microsystèmes et Instrumentation (LMI), Département d'électronique, Faculté des sciences et technologies, Université Mentouri de Constantine, Algérie

s_rebiai@yahoo.fr

Abstract:

Plasma is a phase of matter consisting of charged particles, ions and electrons. To describe it correctly, it is necessary to consider the number of species present and their different charge states, then to study the evolution of the density and space distribution function. The investigation is made for all produced reactions, which could be chemical or nuclear in addition to collisions that may occur. Many mathematical models have been developed to simulate various types of plasmas.

We propose in this study a numerical model of particle type PIC-MC applied to a set of charged particles subjected to an electric field in case of a discharge (DC). The model is developed for argon plasma at 0.1 Torr, generated in a reactor consisting of two plane parallel electrodes spaced by 3cm. The cathode is set to potential of -250 volts and the anode is connected to ground.

The systems of equations governing the behavior of these particles under the effect of applied electric field are as follows :

Transport: $\frac{\partial n_a}{\partial t} + \frac{\partial (n_a V_a)}{\partial r} = n_e N k_i$ For α= *e*, *i* $\begin{cases} n_\alpha V_\alpha = n_e V_e = -n_e \mu_e E - D_e \frac{\partial n_e}{\partial r} \\ n_\alpha V_\alpha = n_i V_i = n_i \mu_i E - D_i \frac{\partial n_i}{\partial r} \end{cases}$

The electric potential V is obtained from poison's equation: $\varepsilon_0 \nabla^2 V = -e(n_i - n_e)$

We used the finite difference method for resolution of two-dimensional (2D) model for determining the space distribution of electric fields, electron and ion densities.

The collision treatment is based on the null collision method that includes fictive collisions chosen to keep the total frequency of collision constant. $\nu_{Tot} = \nu_T + \nu_{null} = Cte$

The objective of the numerical model is to obtain the spatial distributions of electron and ion densities. Figure 1 shows the results of our simulation.

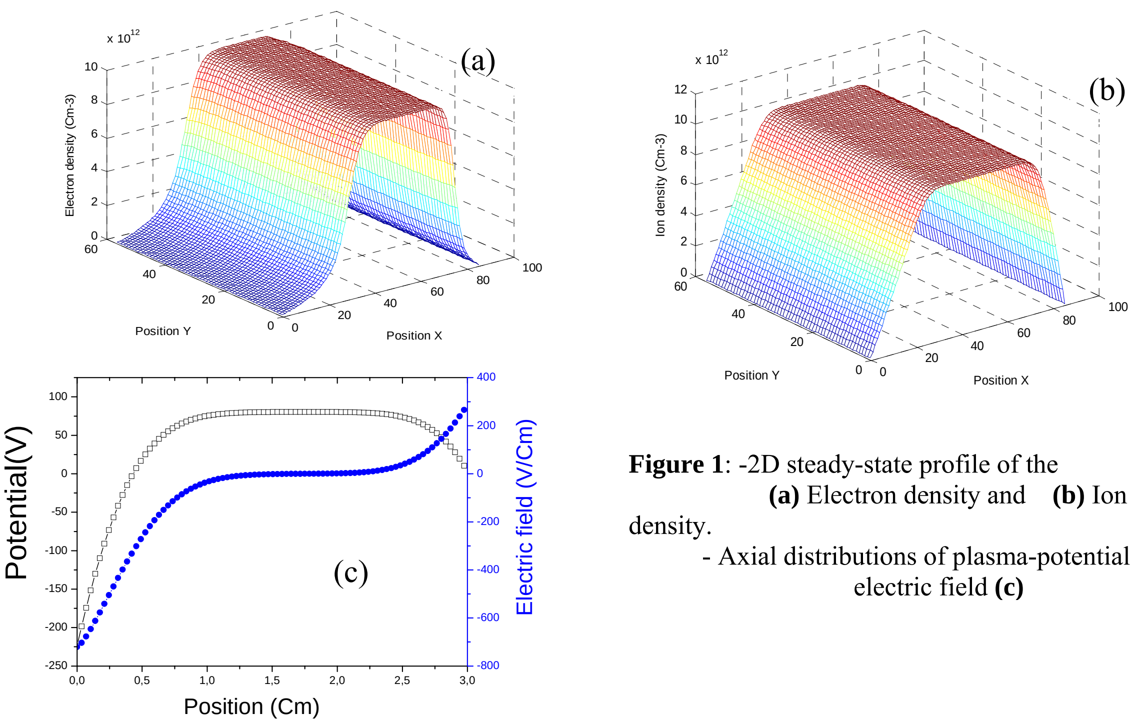

Figure 1: -2D steady-state profile of the **(a)** Electron density and **(b)** Ion density.
- Axial distributions of plasma-potential and electric field **(c)**