First steps in obtaining Monte Carlo model of RF breakdown

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In this paper we present first few steps in obtaining complite Monte Carlo model for radio-frequency discharge. Model includes electrons only. Background gas that we used is argon. We have observed influence of ionization and its spatial distribution on breakdown conditions. Also, we included influence of surfaces (reflection and emission of secondary electrons from electrode).

The mechanism of gas breakdown in radio-frequency (rf) electric fields represents a topic of fundamental [1] and practical importance [2] in the field of low-temperature plasma physics and applications. Capacitively coupled rf discharges are receiving an increased attention due to their wide applications in many technological processes such as plasma etching for semiconductor materials [3], thin film deposition [4] and plasma cleaning [5]. In order to optimize plasma technological processes it is often necessary to know gas breakdown conditions in a discharge device. Therefore, it is of considerable interest to measure and to simulate the rf breakdown voltage curves.

MC code used for these studies has been developed and tested in our group [6]. The code follows transport of electrons across the gap between electrodes. Cross sections data were also well tested for argon swarms [7]. In our calculations we used cross-sections data for: elastic scattering, two excitations and ionization. Simulation conditions were based on the experimental conditions taken from [8].

Figure 1 shows comparison of published experimental data [8] and our results obtained by MC code. Obtained agreement is satisfectory. But if in the next step we include surface effect by taking into account data from figure 2 (left side), we assume that we can get better agreement on the right hand side of the Paschen curve. As expected, involving reflected and emited from surface electrons, breakdown pressure is decreasing for the same voltage volue. On the higher voltages one can notice very big increase in number of electrons due to multipactor effect.

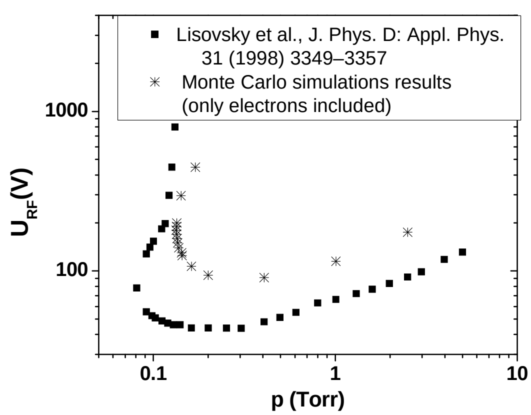

Fig. 1: Paschen curve for rf breakdown in argon, at 13.56 MHz and gap size 23mm, comparison of experimental and MC simulation results

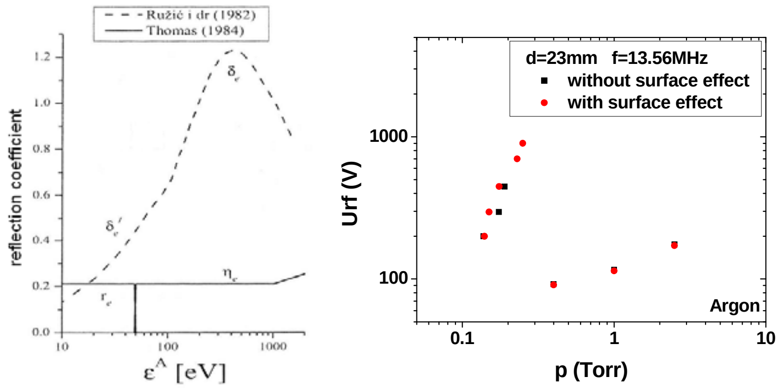

Fig. 2: Figure from the left side presents coefficient of reflection and emission of secondary electrons from surface of electrode made of steel [9] (our input data). Figure on the right side is Paschen curves with and without surface effect included.

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