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MODELING OF LOW PRESSURE BREAKDOWN BY MONTE CARLO TECHNIQUE

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In a recent analysis, quantitative agreement between the predictions based on binary collision data and the breakdown data were achieved [1] for the breakdown voltage. It was found that the basic assumption of Townsend's theory that ions produce the secondary electrons is correct only in a very narrow range of conditions [1]. According to the revised Townsend's theory [1] secondary electrons can be produced in collisions of ions, fast atoms, metastable atoms and photons with the cathode or by gas phase ionization mainly by fast neutrals.

In this paper, we have tried to build up a procedure for obtaining the secondary electron yields from the gas breakdown data. The motivation for our studies originates from the fact that published results for the secondary electron yields from ion beam experiments and gas discharges are systematically in serious disagreement. The carefully carried out detailed modeling exists only for argon [1] and that was performed by a simplified model of transport. In order to verify these data and form the basis for analyzing other gases, we have performed calculation for argon by a Monte Carlo code, developed and tested at the Institute of Physics [2]. The code follows transport of various particles across the gap between electrodes. When the particle hits the cathode surface, the secondary electron may be emitted depending on the surface conditions and the particle's energy. The calculations were performed by using well established set of cross sections that involves 27 inelastic (excitation) processes, ionization and elastic scattering, while gas number density and the voltage) are chosen in accordance with the Paschen curve taken from the ref. [1].

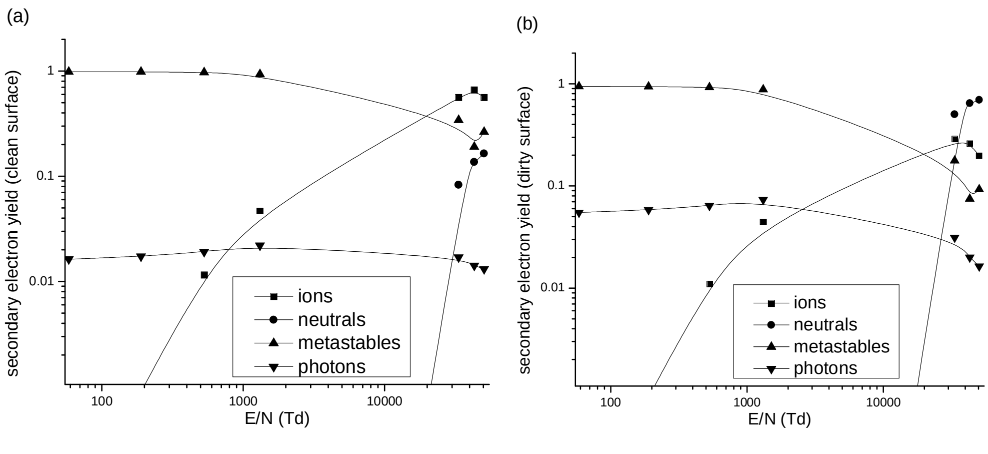

Fig. 1: Secondary electron yield versus the reduced electric field E/N for: (a) clean and (b) dirty cathode surface. The gap size was 1cm, the initial energy of electron was 1eV, while the reflection coefficient was set to 0.2.

Results shown in figures 1(a) and 1(b) represent partial secondary electron yields for different kind of particles for clean and dirty cathode surface, respectively. Results were obtained taking into account reflection of ions from the cathode. Results have a similar trend as those published in ref. [1] indicating that our simulation model can be used for precise description of the secondary electron emission processes.

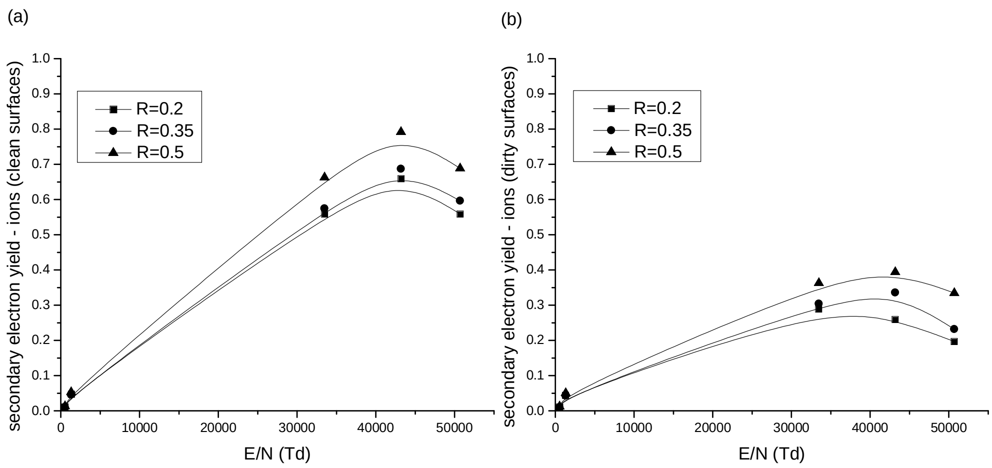

Fig. 2: Secondary electron yield from ions for different reflection coefficient (R=0.2,0.35 and 0.5, respectively) and for different cathode surfaces: (a) clean and (b) dirty surface

The effect of the reflection of the ions is illustrated in Figure 2. As expected, the yield per ion increases with increasing the reflection coefficient due to the fact that a larger number of ions produce a large number of secondary electrons.

Reference

[1] A. V. Phelps and Z. Lj. Petrovic, 1999 *Plasma Sources Sci. Technol.*
[2] Z. Lj. Petrovic and Z. Ristivojevic, to be published.