Glow Discharges with Gridded Electrodes: Models and Applications

S. I. Eliseev[1], A. I. Saifutdinov[1], S. S. Sysoev[1], A. A. Kudryavtsev[2]

[1]*Saint Petersburg State University, St. Petersburg. Russia*

[2]*Harbin Institute of Technology, Harbin, China*

Low pressure glow discharges with gridded electrodes can be efficiently used to create electron beams and sustain low-temperature plasma in large volumes. Such electrode configurations are now used as plasma sources in experiments on electromagnetic wave propagation in plasma. Besides, the properties of such plasma – weak electric field and low electron temperature – are similar to those of the negative glow region of DC discharge in planar or hollow configurations [1]. Plasma in this region is characterized by nonlocality of electron energy distribution function (EEDF), and several electron groups which behave almost independently can be distinguished. Greater dimensions of plasma created in configurations with gridded electrodes allows obtaining better spatial resolution of probe measurements, which opens doors for experimental investigation of electron kinetics, implementation of selective control of plasma parameters and gas analysis.

Discharges with gridded electrodes require low *pL* values (product of pressure and intereletrode gap), which corresponds to the left branch of Paschen curve. In this case a cathode sheath is formed between the electrodes which accelerates electrons up to high energies and injects them through the electrode grid into the space where they lose acquired energy on ionization of neutral atoms [2]. This way plasma is created outside the interelectrode gap, and its size depends on the range of beam electrons. The ionization rate induced by these beam electrons depends on parameters of the sheath and can be expressed analytically. In this work such formulation of ionization source was used to create clear models of such discharges, both for purposes of carrying out efficient numerical simulations and writing simple expressions for dependence of discharge parameters from external conditions, i.e. scaling laws. Comparison of results obtained using both methods with each other and with data obtained from probe measurements is presented. Self-sustainment of discharges in various electrode configurations, especially the role of ions coming into the cathode sheath from plasma, is investigated.

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