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Kinetic Theory of the Anode Region of DC Discharges[1]
VLADIMIR KOLOBOV, University of Alabama in Huntsville, VALERIAN NEMCHINSKY, Retired — Understanding plasma self-organization in the anode region of DC discharges is far from complete. In this paper, we analyze the formation of electron distribution function, ion generation and transport, and the electric potential distribution near the anode for a wide range of discharge conditions (gas pressures, plasma densities, and the size of the anode with respect to device dimensions (such as the tube radius R and length L for classical discharge geometry)). Four cases can be distinguished in plasmas of nobble gases depending on the relative values of the spatial discharge dimensions, the electron mean free path, the electron energy relaxation length, and the distance over which the electrons gain kinetic energy equal to the first excitation potential of atoms. The developed kinetic theory predicts the length the anode region, the spatial distribution of the electric field, and the anode potential with respect to plasma in these four cases. Simple analytical solutions obtained for some limited cases are compared with results of computer simulations based on the numerical solution of a kinetic equation for electrons coupled with ion generation and transport, and Poisson equations. New insight is provided to explain previous experimental observations.

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