NON-LOCAL KINETIC MODEL FOR RADIAL DISTRIBUTIONS OF DUSTY PLASMA PARAMETERS IN A GLOW DISCHARGE*

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There are many papers devoted to the influence of dust particles on gas discharge plasma parameters$^{1-4}$ in which it was shown that dust particles act as an electron and ion sink, and a high concentration of dust particles leads to electron and ion losses on dust particles and should be compensated for in ionizing collisions. Therefore, an average electric field in a discharge should increase.

In the present work, radial dependencies of dusty plasma parameters in a positive column of axially homogeneous glow discharge are studied with the help of a non-stationary non-local kinetic model based on the solution of Boltzmann equation for the electron energy distribution function, drift-diffusion approximation for ions, and Poisson equation for a self-consistent electric potential. Electrons and ions production in ionizing collisions and their recombination on the dust particle surface were taken into account. The dust particle density radial distribution was taken as a given step-like function. The radial distribution of a dust particle charge was obtained with the help of OML model equating electron and ion fluxes towards the particle surface.

It was shown that at high dust particle density the recombination of electrons and ions in the dusty cloud can exceed their production in ionization collisions. In this case the non-monotonous radial distribution of the electric field is formed. The radial electric field becomes reversed and the radial electron and ion fluxes change their direction toward the center of the tube. The electron mean energy decreases in a dusty cloud in contrast to the local model$^4$, where the ionization rate in the region of the dusty cloud increases due to an increase of electron mean energy. The ionization balance is achieved in the whole discharge tube including the region outside the dusty cloud. Self-consistent consideration of the radial electric field action on the dust particles should lead to the redistribution of dust particles in the cloud and to the vanishing of radial electric field in the central part of the dusty cloud.


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