Non-local electron kinetics around the cloud of dust particles.

A.V. Fedoseev[1], G.I. Sukhinin[1], N.A. Demin[1], M.V. Salnikov[1]

[1]*Institute of Thermophysics SB RAS, Lavrentyev Ave. 1, Novosibirsk, 630090, RUSSIA*

In laboratory conditions, dusty plasma is often observed in the form of dust particles clouds which levitate in the strong electric field of near-electrode region of rf discharge or striations of dc glow discharge. The influence of dust particles on gas discharge plasma is negligible only for low dust particle concentration and charge. With the increase of dust particles charge number, local plasma parameters change in the region containing dust particles, which in turn leads to a change of the average charge of the dust particles and all properties of dusty plasma [1]. It was understood that electron and ion losses on dust particle surface should be compensated for in ionizing collisions, and an averaged electric field should increase in the region containing dust particles. It was also shown [1] that the increase of dust particle density leads to the increase of electron temperature and ionization rate in the dust cloud, to the decrease of the dust particle charge, and to the decrease of electron density compared to the ion density inside the dust cloud. However, the number of dust particles was a fixed parameter and their influence on discharge plasma was considered in the local approximation.

At high dust particle density, the influence of the dust cloud on the plasma parameters can be non-local and governed by the plasma conditions around the cloud [2]. For example, dust particle charging is provided by the electron and ion fluxes into the cloud from the surrounding plasma. In many papers the behavior of dust particles is investigated in fixed plasma parameters without taking into account the influence of a dust component on these parameters. In particular, the electric field providing the confinement of dust particles is usually taken as a given one.

The aim of this work is to highlight the mutual influence of a dust cloud and a dc discharge plasma in a self-consistent non-local approach based on the proposed model [3]. The non-local effects are considered on the example of radial distributions of plasma parameters in non-stratified positive column of a glow discharge with a dust cloud. The model includes the non-local Boltzmann equation for non-equilibrium EEDF, drift-diffusion equations for ions and dust particles, and the Poisson equation for a self-consistent electric field.

The results show that the ionization balance in the discharge with a dust cloud definitely has a non-local behavior. The production of electrons and ions occurs mainly in the region between the dust cloud and the discharge tube wall, while their recombination takes place in the region of the dust cloud and on the discharge tube wall. A self-consistent distributions of the plasma parameters inside the dust cloud are the following: (1) the ionization rate is equal to the rate of electron and ion recombination on the surface of the dust particles, (2) the radial components of electron and ion fluxes are almost equal to zero, and (3) the radial electric field is expelled from the dust cloud.

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