SELF-CONSISTENT MODEL OF THE POSITIVE COLUMN WITH DUST PARTICLES

Leonid M. Vasilyak, Dmitry N. Polyakov,
Valeria V. Shumova and Vladimir E. Fortov
JIHT RAS, Moscow, Russia

In recent years the large number of well developed theoretical models for the description of RF discharge plasma in the presence of dust particles, were developed [1]. The local characteristics of such complex plasma around the dust particle, the charge gain and interaction between dusts particles may be now described rather correctly using adequate assumptions on the plasma parameters. Nevertheless, the change of plasma parameters under the presence of dust is not sufficiently up to now and usually drops out of the consideration. The influence of dust component on the DC discharge plasma is described as the first step to solve the self-consistent problem of complex plasma description. The DC discharge plasma is described in frames of diffusion approximation, combined with OML approximation for dust component. The problem is solved for the dust particles of 2 μm radius, embedded into the gomogenious glow discharge column with diameter of 16 mm at air pressure P=0.5 Torr, current I = 0.5-3 mA, particle concentration n_d up to 10^5 cm^{-3}. The current-voltage characteristics for discharge with and without dust are calculated and compared with the available experimental measurements [2,3]. The radial distributions of plasma components, as well as electric field and particle charges are calculated. It is shown that the higher is the current, the higher is stability of the discharge against the disturbing action of dust. The current-voltage characteristics represent the experimentally observed falling down with the increase of the discharge current. The particle charge values range about $(4.0\pm1.5)10^3$ electron unit, that agrees well with the experimental data. The higher is the dust particles concentration, the lower is the radial electric field inside the dust cloud. When the dust concentration attains some critical value, the radial electric field changes the direction in some regions inside the dust cloud. In that region, the corresponding force acts on the dust particles, tending to change their positions. This force has not been taken into account in this work, and will be included in the model as the next step.

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3. L. M Vasilyak et. al., “Cooperative Formation of Dust Structures in Plasma”, Journal of Experimental and Theoretical Physics, Vol. 94, No. 3, 2002 pp. 521-524.