Dust Cloud Formation in the Striation of a dc Glow Discharge in Helium

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The experimental and theoretical investigations of the formation of dust particles clouds in the stratified positive column of a dc glow discharge in helium in a vertically oriented glass tube were performed. The experimental setup was similar to the one described in [1]. We used monodisperse melamine formaldehyde particles, 4.25 μm in diameter. Gas pressure varied in the range from 0.1 to 0.5 Torr and discharge current was maintained at the value of 1 mA. The size and shape of the dust cloud that levitated in the strong electric field of the striations were measured experimentally under different helium pressure. The strength of an axial electric field was also estimated. It is assumed that in every regime a maximum possible number of captured dust particles in the cloud is reached and that a further capturing of dust particles is impossible.

A model for radial distributions of all dusty plasma parameters of the positive column of a dc glow discharge was developed to describe the obtained experimental results. The model is based on previously developed models [2-3]. The non-local Boltzmann equation for the electron energy distribution function, drift-diffusion equations for ions and dust particles and the Poisson equation for a self-consistent radial electric field were solved simultaneously. It was assumed in the model that the axial electric field is constant along the discharge axis, which is equal to the mean value over striation. As a result, the radial distributions of dusty plasma parameters were calculated under different helium pressure. It is shown that the calculated radial distributions of dust particles density and the strength of a mean axial electric field are in good agreement with the experimental data. The results show that with the increase of gas pressure the size of the dust cloud decreases, the density of dust particles in the center of the cloud increases and the axial electric field strength increases.

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