Dusty plasma structures in gas- metal vapor mixtures

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In this paper the results of experimental study of the properties of the buffer and dusty plasma in mixtures of metal vapor and gas (Ar and He) are presented. Time characteristics (p=*f*(t); I=*f*(t)) of the gas discharge were obtained and analyzed. In addition, number of features of combustion of buffer discharge in a mixture of metal vapors and gas, and change of the properties of plasma-dust structures in it were identified.

1. Introduction

The discharge in mixtures of metal vapor with inert gases is commonly used in various practical applications: to create pulsed atomic lasers with high temperature active element to create discharge light sources.

Recently, technologies to produce nanoparticles from condensed metal vapors in different plasma environments leading to the formation of complex plasma are intensively tested.

Thus, there are two types of plasma of complex composition. Firstly, discharge in mixtures of metal vapor with inert gases. In this case, during discharge metal vapors do not agglomerate, and participate in the form of individual atoms and molecules. Since the metal atoms are easily ionized compared to the atoms of the gas, it is easier to ionize gas-discharge medium. Secondly, the metal vapors, for example during cathode material sputtering, entering the discharge zone of the cathode agglomerate and become part of the plasma as individual charged nano- and micro particles.

Effect of composition of gas on the characteristics of the dust formations was investigated in [1-3], where it is shown that the discharge in a mixture of different gases leads to a very significant change in the characteristics of both electronic and ionic plasma components. Moreover, the gas discharge characteristics can vary greatly even at very low concentration of impurities.

2. Results

Experiments were carried out in a vertical discharge tube in classic version. The procedure of the experiment is as follows: the discharge tube is filled with homogeneous gas and the initial value of pressure is set, it is usually p≈0.17 tor. In a few minutes discharge is ignited (Fig. 1, vertical dotted line on the left). The initial value of the discharge current is set so that during combustion of discharge cathode material is sputtered. This is evidenced by increase in pressure within the tube, the process continues relatively long time until the discharge is extinguished (Fig. 1, vertical dotted line on the right). The result is formation of discharge in mixture of cathode metal vapors and gas.

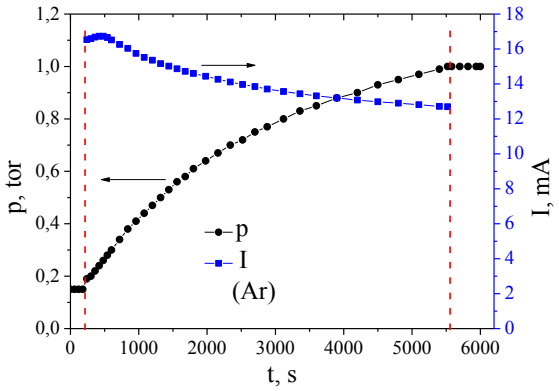

Figure 1. Time characteristics of the gas discharge (p=*f*(t); I=*f*(t))

So, the dust-plasma formations in a stratified glow discharge (first striation from the cathode) in pure gas and in mixture of pure gas and metal vapor were investigated. For characteristics of structural properties of dust formations pair correlation functions were also obtained.

3. References

[1] S.A. Maiorov, T.S. Ramazanov, K.N. Dzhumagulova, A.N. Jumabekov, M.K. Dosbolayev. Physics of Plasmas **15** (2008) 093701.

[2] T.S. Ramazanov, T.T. Daniyarov, S.A. Maiorov, S.K. Kodanova, M.K. Dosbolayev and E.B. Zhankarashev, Contrib. Plasma Phys. **51**, (2011) 505-508.

[3] M.K. Dosbolayev, A.U. Utegenov, T.S. Ramazanov, and T.T. Daniyarov, Contrib. Plasma Phys. **53**, (2013), 426 –431.