The role of cathode sputtering in low-pressure glow discharge

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In this work the results of an experimental study of the properties of low pressure glow discharge during the cathode sputtering are shown. The process of atmospheric gas adsorption on the cathode surface and its influence on the parameters of the gas discharge are investigated. Optical emission spectroscopy measurements of the near-electrode and volumetric gas discharge at cathode sputtering was carried out. The dependence of pressure, current and discharge voltage on time at different parameters of cathode sputtering process is obtained.

1. Introduction

The DC glow discharge successfully used in many technological processes, and also in everyday life. One of the problems in the operation of the glow discharge is the erosion of the electrode material. This leads to the formation and injection of metal impurities and nanoclusters (nanoparticles) to the gas discharge volume. Also the formation of thin coatings on the walls of the discharge tube. This depends on many factors, in particular on the cathode material, the adsorbed gas on its surface and the magnitude of the applied voltage on the electrodes [1-2].

2. Experimental setup

The experiment was conducted in a glass tube with a diameter of 4.6 cm and a length of 50 cm. As plasma forming argon and helium were used. The cathode was made of copper, in the form of a hollow cylinder.

The experiments were performed in the following order. A stratified DC glow discharge was ignited in the discharge tube. Conventional experiments with a glow discharge are usually carried out at low currents of the order of 1 mA. For our task, we set a relatively high current, more than 14 mA, so that heavy ions sputter out metal impurities (secondary emission) from the cathode surface.

Figure 1 shows the dependence of the glow discharge parameters on time. At the initial time interval (0 and t_1) there is a decrease in the current, and an increase in the pressure in the discharge tube. This phenomenon can be explained by the presence of metal impurities in the volume, which creates an additional component to the gas concentration. This reduces the mean free path of electrons (due to the increase in pressure) leading to a decrease in the discharge current. This process lasts until t_1 time. At the time moment t1, we turn off the discharge and see that the pressure in the tube becomes stable (since the cathode sputtering process is not active). In the time interval t_2 and t_3, we establish a small current, which is typical for the classical experiments with a glow discharge. The Figure 1 shows that the parameters of the gas discharge become stable. At the time moment t_3 we set again a large current and we can see that the process is repeated as in the time interval 0 and t_1.

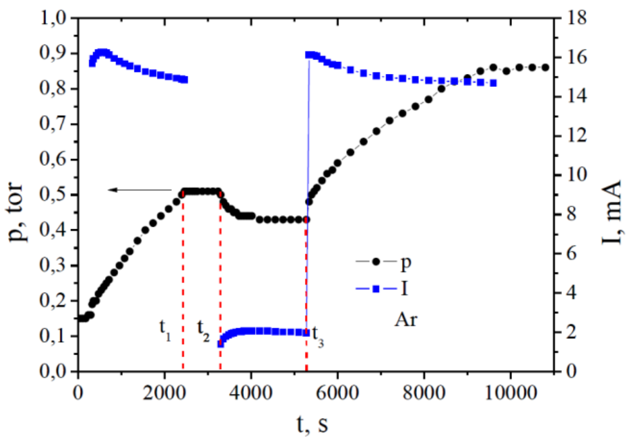

Fig. 1. Time characteristics of the gas discharge (p=f(t); I=f(t))

Also under such conditions, the temperature of the electrodes was measured and optical-spectroscopic diagnostics of the near-electrode region and uniform gas discharge volume was carried out.

References

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