

## On the separation of arc discharge plasma near the sputtering cathode

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**Abstract.** In the method of the molecular dynamics simulation of the motion of atoms and ions of titanium in spatial inhomogeneous electric and magnetic fields. An attempt is made to explain the experimental distribution of the coating thickness on the surface of the condensed ring anode installation NNV, at the film condensation method with ion bombardment.

### 1. Introduction

In many papers [1-4] on the calculation of the distribution of the coating thickness when applied ion- plasma methods do not include the effect of an external magnetic field (even if it is provided condensation technology). In this case, the trajectory of the charged particles is taken close to linear. This is true in low magnetic fields (up to several hundred gauss) and a relatively high ion energies (from tens of eV). At the same time, within the framework of these models can not explain the distribution of the thickness of the coating produced near the cathode (Figure 1) [ 5]. The experimental scheme is shown on Figure 2 (1 - cathode, 2 - substrate, 3 , 4 - stabilizing and focusing coils, respectively, O - origin; L - distance cathode -substrate ).

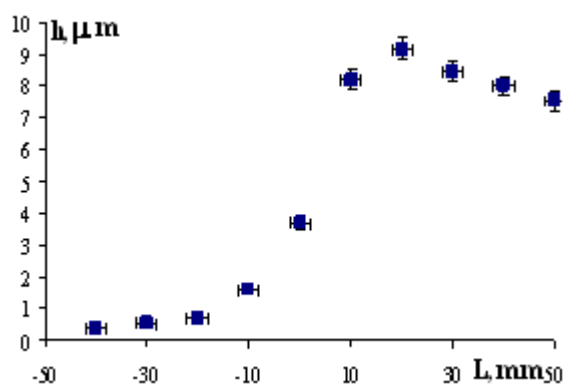


Figure 1. Distribution of film thickness

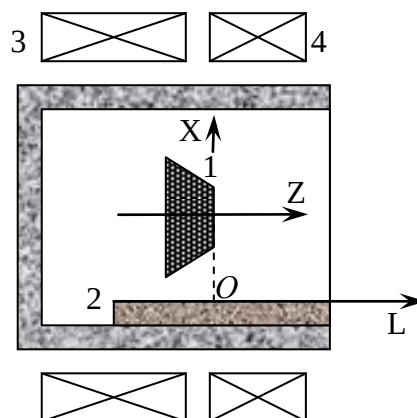


Figure 2. The scheme condensation coating

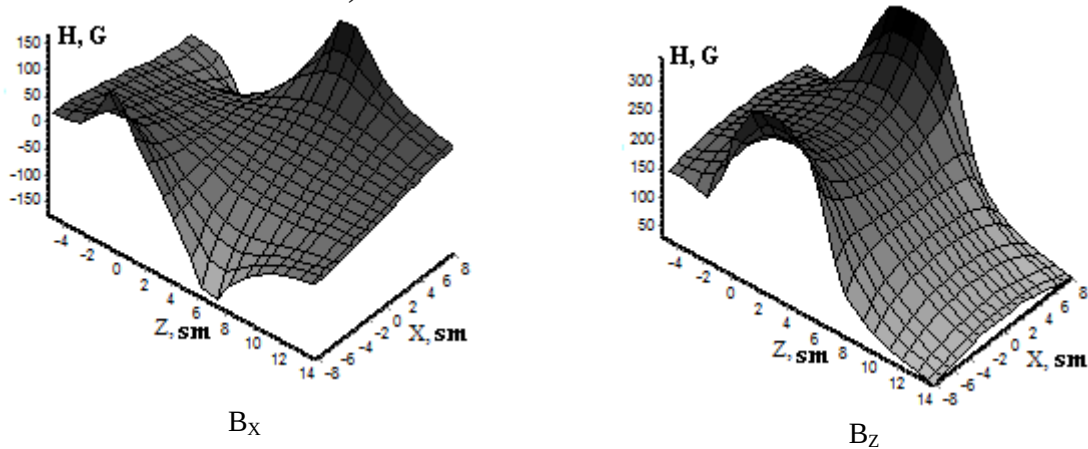
The aim of this work was the theoretical calculation of the coating thickness depends on the geometry of the samples near the placement of titanium cathode. The calculation scheme is shown in Figure 2. Thus treated, the titanium ions having a charge of from 0 to  $3e$  ( $e$  - the charge of an electron). Taken into account the external magnetic field using the system of focusing and stabilizing coils position NNV and the bias potential. The ion energy, the process simulation, varied from 1 to 100 eV.

## 2. The model calculation

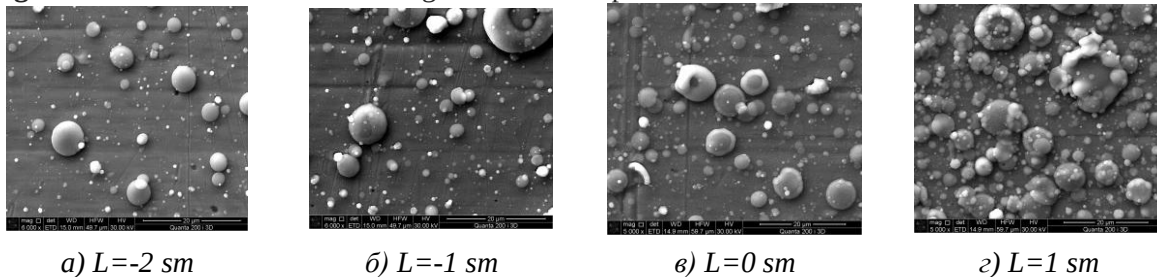
The simulation was performed using the method of molecular dynamics [6]. The equation of motion of each of the ions and atoms of titanium can be written as:

$$m_i \frac{d^2 \vec{r}_i}{dt^2} = q_i [\vec{v}_i \vec{B}] + q_i \vec{E},$$

where  $r_i$  - radius vector of the particle ;  $m_i$  - mass of the particle ;  $q_i$  - the charge of the particle ;  $v_i$  - the ion velocity ,  $B$  ,  $E$  - the magnetic field strength of the electric field, respectively . When building the model does not take into account the interaction of ions with one another. To solve the above system of differential equations of the second order Verle algorithm is used in the form of high-speed [6] . The time step is set equal to 10 ns. In the calculations it was assumed that the distribution of particles in the directions of their departure in the emission from the cathode surface is described by the  $\cos\varphi$  ( $\varphi$  - angle measured from the normal).



**Figure. 3.** The distribution of the magnetic field components



**Figure. 4.** The surface coating of different areas of the anode ring

## 3. Results and discussion

The results of calculating the distribution of the magnetic field for the system shown in Figure 3. The geometrical parameters and operating modes of the simulated

system consistent modes of operations and geometric parameters set NNV-6.6I4 in the coating by condensation with ion bombardment. [7]

The simulation results of the ions of different charge show that when a negative potential difference leads to stretching of the area near the cathode, low energy ions (10 eV). Increase and decrease of charging energy emitted from the cathode of ions leads to the possibility of condensation on the surface of the annular anode. In the simulation we have not found the condensation of atoms and ions of titanium for  $L < 0$ . When the experimental results measuring the thickness of X-ray methods (Fig. 1) and electron microscopy (Fig. 4) indicate the presence of condensed matter at distances of  $L$  is less than zero.

The possibility of condensation in this area is associated with the collision and recombination processes in ion-plasma flow of low-temperature plasma. In this area, condensation may only atomic particles and high-energy ions reflected from the surface of the particulates that are present in the vacuum-arc deposition of films (Figure 4) [5, 7-10]. Also, creating a stream of particles moving in the range of negative values of  $L$  may occur in the Coulomb explosion of charged polyatomic structures (clusters, etc.) , the atom - atom collisions , the emission of particles , "drip" spot , etc. Thus, the basis of the atomic flux particles are particles as ions are strongly pulled out of the area near the cathode by the magnetic and electric fields. Furthermore, a substantial contribution to the thickness distribution of the condensate on the surface of annular anode making drip temperature plasma component, the content of which increases with the distance  $L$ .

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