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GAS DISCHARGE DEVICE FOR SYNTHESIS OF COMPOSITE COATINGS BASED ON SPRAYING OF PLANAR MAGNETRON ELECTRODES BY ION BEAM

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INTRODUCTION

• The adopted approach of ignition in a magnetron of an anomalous low-pressure glow discharge < 0.10 Pa under bombardment of the cathode and anode of the magnetron by an ion beam expands the functionality of the magnetron and deserves independent discussion.

• The type of specific gas discharge device, the principle of operation and operational characteristics are considered in this report.

SCHEME GAS DISCHARGE DEVICE

Water 4 Water 2 13 9 8 Gas Water Water 3 Gas 1 12 11 10 5 7 6

Fig. 1. Gas discharge device: 1,5,6 – cathodes; 2,3,7 – anodes; 4,8 – ring magnets; 9 - emission channel; 10 - accelerating electrode; 11 - ion beam; 12 - substrate; 13 - shutter flap

EXPERIMENTAL SETUP

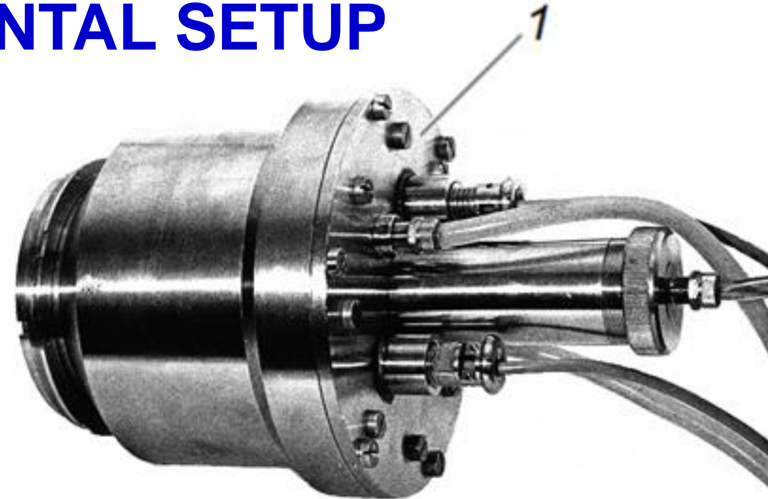

Fig. 2. General view of plasma ion source (1) and planar magnetron (2)

RESULTS AND DISCUSSION

- Discharge current in the ion source 50 mA, accelerating voltage U_i increases from 0 to 10 kV, argon pressure $8 \cdot 10^{-2}$ Pa, dependence (1).
- Ion accelerating voltage of 8 kV, the discharge current in the ion source increases from 0 to 100 mA, the argon pressure is $8 \cdot 10^{-2}$ Pa, dependence (2).

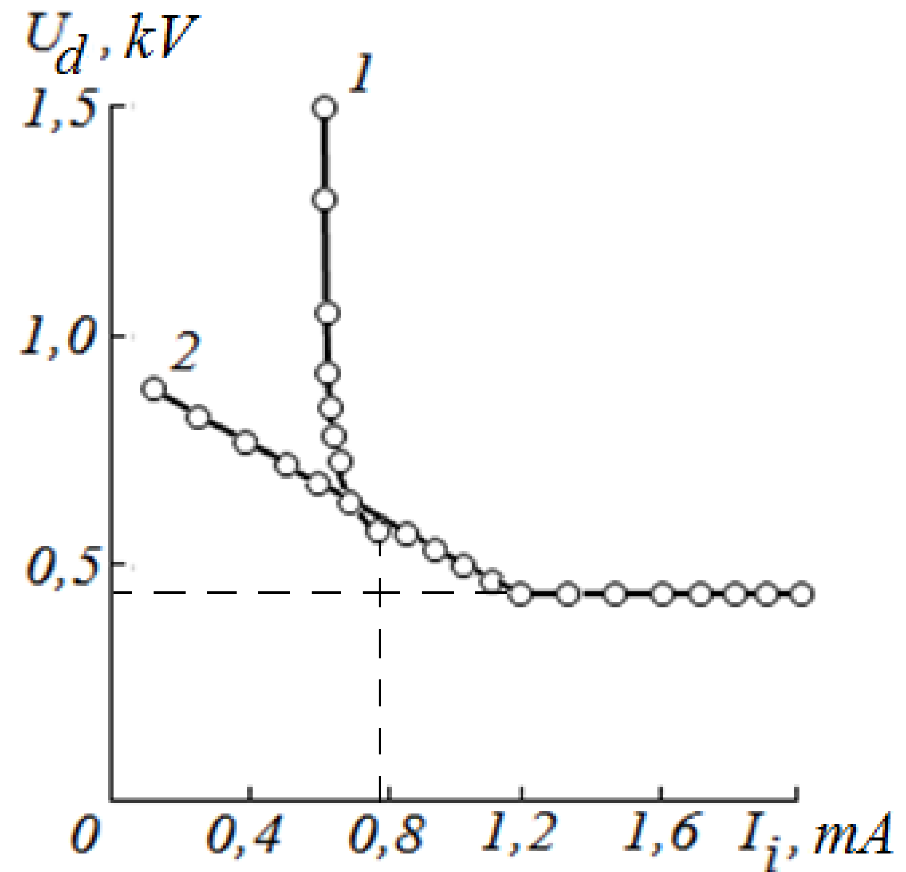

Fig. 3. Dependences of the ignition voltage on the ion beam current

- Along with the enhanced capabilities for initiating an anomalous low-pressure glow discharge, the new approach makes it possible to simplify the control of the elemental and chemical composition of coatings grown by reactive magnetron sputtering, in particular, superhard composite TiN-Cu coatings.
- Using a magnetron cathode 1 from Ti, a central anode 3 from Cu, and a plasma-forming mixture of Ar and N_2 gases (molecular nitrogen dissociates into a chemically active atomic $N_2 \leftrightarrow 2N$ in a magnetron discharge plasma), TiN synthesis can be directed in Cu vapors. Fine control of the fractional filling of the growing coating with Cu impurity introduced by sputtering an additional target (central anode) with an ion beam makes it possible to directly affect the internal structure and phase composition of TiN-Cu coatings.

CONCLUSION

• Testing of a planar magnetron with an ion source showed high reliability of the developed gas discharge device and stability of parameters.

• The longitudinal injection of an ion beam into a magnetron, combining the advantages of the new principle of constructing a gas discharge technique for growing coatings in vacuum by spraying targets with plasma ions of an anomalous glow discharge and an ion beam, significantly expands the functionality of the magnetron and makes it possible to fundamentally improve its physical and technical characteristics.

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