C4-P-005501

# INFLUENCE OF CARBON CATHODE PLASMA PARAMETERS ON THE STRUCTURE AND PROPERTIES OF THE DEPOSITED COATINGS

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The interest in carbon coatings (ta-C) stems from their unique optical, electrophysical, and mechanical properties [1, 2]. Energy, carbon ion flux density, presence of carbon microparticles in the flux, incidence angle and substrate temperature are among the most important parameters determining the structure of carbon-carbon bonds and, consequently, the properties of coatings deposited from pulsed cathode plasma [3, 4]. The influence of these parameters on the structure and properties of the coatings is largely related to the nonequilibrium nature of pulsed plasma flow generation, the course of intensive energy exchange between ions in the flow, which leads to changes in the phase composition and properties of the coatings [4]. The effect of the carbon plasma pulse repetition rate on the ratio of $sp^3/sp^2$ bonds, hardness, optical properties and the band gap width during the deposition of the composite ta-C coatings is particularly noticeable, since in this case there is a change in the mass ratio of individual ingredients in the flows entering the substrate surface. When evaluating the possible causes that determine the change in the properties of coatings, it is necessary to consider the interaction peculiarities between carbon ions directly in the pulse, the change in the charge state and energy of the particles at the leading and trailing edges of the pulse when they move from the generation zone to the substrate surface. One of the most effective methods of forming a given charge and energy structure of the pulse is to change its duration and particle energy at different stages of plasma discharge generation.

This work aims to establish the influence of energy and time parameters of the discharge on the phase composition, structure and mechanical properties of the resulting carbon coatings. The equipment has been developed that allows forming ta-C coatings by eroding a carbon cathode with a pulsed discharge having two zones that differ in voltage. At the same time, it is possible to control temporal (pulse duration, pulse repetition frequency) and energy (pulse energy and its distribution) parameters of a pulsed cathode-arc discharge. Changing these parameters makes it possible to regulate the energy and density of the ion flux during the evaporation of the graphite cathode, as well as to provide the required thermal load on the substrate. The influence of the operation modes of the pulsed carbon plasma generator on the phase composition and mechanical properties of the carbon coatings has been established. It has been shown that the highest $sp^3$-phase content and, consequently, hardness, the lowest roughness, a more homogeneous structure of the surface layer, are achieved by creating a high-current pulsed arc discharge between the graphite cathode and the anode, at the leading edge of which the voltage value exceeds significantly the value at the trailing edge. It has been demonstrated that the change in the energy of evaporated carbon particles at the stage of their generation and in the transfer process affects the nature of deposition and determines its dependence on the distance to the substrate: near the evaporation zone, deposition is performed from a pulse flow, at larger distances - from a quasi-homogeneous flow. The optimal values of the duration and frequency of pulses have been determined, at which the maximum physical and mechanical properties are achieved.

The research findings are of interest when developing technological processes for creating new functional coatings based on amorphous carbon.

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