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ADVANCED EQUIPMENT AND PROCESSES OF ELECTRON-ION-PLASMA MODIFICATION OF THE SURFACE OF MATERIALS AND PRODUCTS *)

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The principles of operation and design features of new electron-ion-plasma equipment created on the basis of plasma formations generated in large vacuum volumes by low-pressure discharges are considered [1].

Volumetric homogeneous plasma is created by self-sustained and non-self-sustained arc and glow discharges at pressures of 0.01–1 Pa with currents from units to hundreds of amperes, providing a concentration of 109–1011 cm–3 in volumes up to fractions of a cubic meter. Materials and products placed in plasma are bombarded by ions extracted from the plasma and accelerated in the space charge layer, which leads to modification of the surface, improving its physicochemical and functional properties [2].

In addition, electron beam energy complexes and installations are considered, based on the extraction from volumetric plasma formations and the formation of electron beams of a large (1–1000 cm2) cross section.

As an example, the description and main characteristics of the complex electron-ion-plasma installation “COMPLEX” are given, which combines in a single vacuum cycle electric arc devices for cleaning, activating the surface of materials, plasma-assisted deposition of a functional layer up to several micrometers thick with further electron beam mixing of the coating to obtain a highly adhesive reinforced layer with improved characteristics. The implemented technology makes it possible to significantly increase the wear resistance of the surface of materials and products.

Experimental data on the study of modified layers and coatings on various materials for instrumental and structural purposes are presented, demonstrating both a change in the structural-phase state and an improvement in the performance properties of materials.

Another example of developed and created electron beam equipment is the “DUET” electron accelerator based on a pulse-periodic grid plasma emitter with a low-pressure arc discharge. The created accelerator provides an electron beam with a cross section of 15 × 75 cm2 released into the atmosphere with an electron energy of up to 200 keV and an average power of several kilowatts. The main feature of the accelerator is the ability to independently adjust all its main parameters: current, accelerating voltage, pulse duration and repetition rate in a fairly wide range, which makes it convenient for conducting experiments on radiation effects on materials and products, plasma chemistry, as well as searching for optimal modes when developing technological processes.

The developed and created equipment, as well as the processes implemented using it, have good prospects for implementation in real production.

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*) abstracts of this report in Russian