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QUASI-STATIONARY PLASMODYNAMIC SYSTEMS IN SCIENCE AND TECHNOLOGY *)

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The results of studies of quasi-stationary gas-discharge and erosion plasmodynamic systems conducted at the A.V. Lykov Institute of Heat and Mass Transfer of the National Academy of Sciences of Belarus are presented. These systems cover a wide range of energies stored in accumulators (from 1 to 215 kJ) and are intended for solving a number of scientific and technological problems, such as plasma filling of magnetic traps of various types, modeling of conditions on the first wall of the fusion reactor, creation of plasma engines for space purposes, as well as for effective plasma modification of the material surface.

At the Institute have been created quasi-stationary high-current plasma accelerators operating in the ion current transfer mode, in which ion-drift acceleration of magnetized plasma is realized. Such accelerators generate compression plasma flows of a given composition, which exceed all existing plasmodynamic systems by a set of parameters. The conception about the determining influence of ion-exchange processes in an accelerating channel with permeable electrodes on the flow of magnetized plasma and on the character of the discharge current distribution, providing the formation of the compression flow with controlled plasma parameters, are considered.

New opportunities for obtaining plasma formations with extremely high energy content are opened by the plasmodynamic interaction of counter-directed current-carrying compression plasma flows, when, due to the processes of viscous dissipation (thermalization), the transition of the kinetic energy of the colliding flows into the internal energy of the forming spherical plasma build, held by its own magnetic field without gaps and stably existing for about 100 μs.

The physical principles of creating a unique electric-discharge erosion traction element with a sectioned external electrode for a plasma micromotor for space purposes are considered. Such device makes it possible to control the spatial orientation of the thrust vector by establishing the given configuration of electromagnetic fields formed in a self-consistent manner by distributed currents of the electric-discharge system, and characterized by the absence of moving mechanical components and external magnetic systems.

The technological approach for creating anti-meteor screen elements with increased resistance, containing two-layer composite coatings modified as a result of exposure to a compression plasma flow, are presented. To test the impact resistance of such screens, a unique two-stage ballistic installation was created. The first stage is a quasi-stationary erosion plasma accelerator, and the second is a light gas section. The ballistic installation is capable of accelerating bodies weighing up to 0.2 g to speeds of 3–5 km/s.

The physical principles of the proposed new scientific direction - surface plasma metallurgy - are considered, within the framework of which methods are being developed for effective structural-phase modification of the surface properties of materials when exposed to high-energy compression flows loaded with finely dispersed strengthening particles specially introduced into the plasma. Such action of the compression plasma flow leads to melting of the surface layer of the material, liquid-phase mixing in a molten layer of alloying elements with a substrate and simultaneous synthesis of new strengthening compounds (intermetallic compounds, nitrides, carbides and their solid solutions).

*) abstracts of this report in Russian