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INVESTIGATION OF MATERIALS LIGHT EROSION BY SHORT-WAVE RADIATION*

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This study suggests the plasmodynamic structures parameters diagnostic and quantitative description technique. These structures arise due to the exposure on various samples (metals and polymers) by the broadband (from visible to VUV range) high-power (with a radiation flux up to of ≈ 10^6 W·cm^{-2}) radiation from the high-current plasma accelerator – magnetic plasma compressor (MPC) of erosion type. Peculiarity of the method is that information about the processes was obtained as a result of limited series of experiments (practically, a single one). As a result, it is possible to determine both the parameters of the generated gas flows (pressure, density in the shock-compressed layer, etc.) and the thermodynamic parameters inside the plasma (pressure, temperature, and concentrations).

The processes occurring on the surface and in the near-surface vapor-plasma layer when exposed to VUV radiation on different materials understanding is relevant for the creation and optimization of different plasma energy devices (ablative pulsed plasma accelerators, plasmodynamic sources of ultraviolet and soft X-rays, radiation surface strengthening, photochemical installations, etc.) where information is needed on the distribution of heat fields and energy flows arising from the operation of such devices. This explains the interest in these studies.

High-current plasma discharge – the plasma dynamic discharge of magnetic plasma compressor (MPC) of erosion type was used as radiation source. In MPC plasmodynamic heating of electric discharge plasma is carried out as a result of shock-wave thermalization of directed kinetic energy of high-speed flow of dense radiating plasma at its braking in gas medium. The buffer gas simultaneously acts as a filter for the harsh component of the radiating plasma emission spectrum [1, 2]. As a consequence, since the rise times of the light pulses are determined only by the time profile of the hydrodynamic energy flow of the plasma jet in the braking zone, it is possible to significantly differ from the characteristic discharge times in the electrical circuit, which allows to form powerful pulses of VUV radiation with steep leading edge.

Samples in the form of bars with dimensions of 30 mm by 50 mm and thickness of 10 mm were installed with a long side along the discharge at near discharge zone. Thus, the near-to-discharge end of the target received 2-2.5 times more energy than the far one. This made it possible to register significantly different dynamics of vapor-plasma flow disperse when moving from one edge of the target to the other [3].

For visualization of shock waves (SW) and other expansion zones of vapor-plasma flow in external gas with large concentration gradients, two-exposure laser holographic interferometry with visualization of large optical fields and the Toepler method in the light field mode were used [4].

The processing of interferograms, together with the analysis of other data of the experiment, allows to find the distribution of parameters in the plasma layer above the target surface. It has been found that the maximum energy absorption is inside the plasma layer. Spatial distribution of the parameters (temperature, pressure and concentrations of electrons and ions) is defined with the assumption of local thermodynamic equilibrium. The obtained results are discussed.

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