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Lifetime of cathode spots on the titanium surface when exciting a microplasma discharge

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The structure of the glow of a microplasma discharge initiated in vacuum by a pulsed flow of external plasma on the surface of a titanium sample coated with a natural 2–6-nm-thick oxide film has been experimentally investigated. When a plasma with a density of about 10^{13} cm^{-3} and an electron temperature of 10 eV interacts with a sample under a negative potential of –400 V relative to the plasma potential, the outer surface of the oxide film acquires a positive electric charge as a result of the flow from the plasma. In this case, a strong electric field of about 4 MV/cm arises inside the dielectric film. An electrical breakdown between the charged surface of the film and the metal initiates the excitation of a microplasma discharge on the surface of titanium. The integral glow of a microplasma discharge at the macroscale is a branched structure of the dendrite type, which at the microscale consists of a large number of brightly glowing "point" formations – cathode cells localized on the metal surface. Using the IMACON-468 high-speed photo recorder, a fragment of the titanium surface with an area of 0.5×0.4 mm^2 in the area of the cathode spots glow was studied. Based on the analysis of the optical glow of cathode spots on 7 consecutive frames of the high-speed photo recorder with an exposure of each frame of 100 ns and an interval between frames of 400 ns, the expected "lifetime" of cathode spots in the range of values of 0.5±0.2 microseconds is calculated. According to the spatial distribution of the glow of micro-discharges, it was determined that the average diameter of the cathode spots is about 16±4 microns, while the average size of the luminous halo around a single cathode spot reaches a value of 100 microns.

Keywords: microplasma discharge, interaction, titanium surface, oxide dielectric film, optical glow, propagation, cathode spot, microcrater, erosion.

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