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The formation of shock waves during explosive processes at the cathode

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The relevance of studying high-voltage nanosecond pulsed gas discharges is due to their wide practical applications such as plasma-stimulated combustion, plasma aerodynamics, plasma medicine, surface treatment. At the same time, the rich variety of physical also determines the complexity of interpretation of observed phenomena. From a practical point of view, the study of spark discharges is considerably interested because they arise very often in high-voltage technology, including as a negative factor in the form of breakdown which leads to short circuits and to an erosive effect on electrodes and insulators. It is known that acting as a piston an expanding spark channel forms a cylindrical shock wave. In all cases, these waves propagate in weakly ionized plasma.
This work is devoted to the results of studies of the formation and propagation of shock waves from an expanding cathode spot and a spark channel and it researches the features of waves formation in magnetic fields. An explosive model of the cathode spot's development [2, 3] involves the release of large energy at the emission center and then subsequent heating and explosion of the micro-tip. It was shown that an energy of 60 kJ/g is released in the cathode spot during a short time 10 ns. In this case, the cathode spot plasma is characterized by the intense lines of ions of the cathode material and with continuous radiation in a wide range of wavelengths (260-360 nm). The maximum spectrum intensity is reached after 20-30 ns.
The plasma expansion of cathode spot occurs at a speed which is much higher than the speed of sound and then electrons temperature significantly increases in wave's front. The ionization at shock wave front is transferred with its velocity at the first 40-50 ns, in the future the size of ionized region changes slightly.
Moreover, it was demonstrated that the rate of cathode spot expansion in air with comparable energy deposition is much lower than the rate of cathode spot expansion in argon. It indicates that the attenuation of the shock wave transporting the ionization front in air occurs faster than in argon. This can be explained by the fact that in air the wave energy is additionally spent on the dissociation of air molecules. The dependence of the cathode spot's radius on time is obtained, which is in satisfactory agreement with the experimental values at the initial stage of cathode spot's expansion.
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