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P2.3010 Investigation of radiation spectrum from pulse discharge in atmospheric pressure argon

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An experimental and theoretical study of the formation of radiation spectra of cathode plasma in a pulsed discharge in argon at atmospheric pressure has been performed. To study the effect of small impurities of the material of the cathode material on the kinetics of ions and electrons in the discharge, the methods of numerical simulation using the particle and Monte Carlo methods were used.
In the experiment, it was found that with the formation of a cathode spot, the spectrum of cathode plasma is characterized by intense lines of the Al II cathode material 396.1 nm, 394.4 nm, 280.1 nm, 281.6 nm with high excitation potentials and an intense continuum in the range 260-360 nm. Aluminum ion lines are recorded simultaneously with the onset of a sharp current increase and reach a maximum value in 20-30 ns. It is shown that after 30 ns from the beginning of a sharp increase in the current, the Stark half-width of the argon line at 480.6 nm is 0.5�0.6 nm, and the line at 422.8 nm is 0.5 nm. These half-widths correspond to an electron density of ~ 1019 cm-3, and after 20 ns the concentration decreases to a value of 21018 cm-3.
It has been established that with increasing magnetic field strength, the maximum of the radiation energy is shifted to the short-wave region of the spectrum: at H = 0 max = 420 nm, at H = 140 kOe - 400 nm, and at H = 200 kOe - 380 nm. Thus, in a magnetic field, the intensity of continuous radiation increases, and the brightness of ion lines in the ultraviolet region also increases: Ar II – 280.6 nm, Ar IV – 280.9 nm, and Al material lines of Al electrodes are: 280.1 nm, 281.6 nm. Starting from the moment t = 500 ns, the brightness of the Al I aluminum lines increases: 302.9 nm, 308.2 nm; Al II - 281.6 nm, 280.1 nm . Since t = 700 ns, the luminescence of aluminum lines 281.6 nm strongly increases in the longitudinal magnetic field: 280.1 nm; 309.27 nm and 308.216 nm.
Estimates were made of the temperature of the channel plasma at various magnetic field strengths determined from the relative intensity of three pairs of argon ion lines (448.2 nm and 454, 5 nm; 480.6 nm and 476.4 nm; 484.7 nm and 476.4 nm). It is shown that the plasma temperature decreases within 300 ns by 10-15%, i.e. at the stage of rapid expansion of the channel, the temperature of the plasma channel practically does not change. In the absence of a magnetic field, the temperature drops rapidly (t = 1.5 s, T26000 K); in a magnetic field, the rate of temperature change decreases (t = 1.5 s, T28000 K).
The Monte Carlo method was used to calculate the kinetic characteristics of the drift of ions and electrons in argon in the presence of aluminum vapor at an electric field strength of E/N = 1-100 Td, taking into account inelastic collisions. The effect of metal vapor concentration on the drift velocity, average energy, diffusion coefficients, and mobility of ions and electrons is analyzed.
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