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BLUE AND GREEN JETS IN LABORATORY DISCHARGES INITIATED BY RUNAWAY ELECTRONS[1]

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Spectral and amplitude-temporal characteristics of a plasma radiation of a nanosecond pulse-periodic discharge were investigated. Voltage pulses of negative polarity (amplitude is ~13 kV, FWHM is 10 ns, pulse rise time is 4 ns) produced by the NPG-15/2000N pulser were applied to an electrode (cathode) made of different metal (copper, aluminum, stainless steel). Pulse repetition rate was 60Hz. The cathode had a cone form. Diameter of cone base was 6 mm, and radius of curvature of cone apex was about 0.2 mm. Grounded electrode (anode) was a flat with diameter of 38 mm. Interelectrode distance was 2 and 3 mm. Discharge current was measured with a shut made of chip-resisters. Spectrum of optical radiation of a discharge plasma from different regions of the discharge gap was registered with spectrometers HR4000, Ocean Optics B.V., 1st: $\Delta\lambda$ = 330 – 425 nm, 2nd: $\Delta\lambda$ = 200 – 305 nm and EPP-2000C, Stellar-Net Inc., $\Delta\lambda$ = 192 – 850 nm. Temporal characteristic of a discharge plasma radiation from different regions of the discharge gap was measured with monochromator MDR-23 and PMT-100. Discharge chamber was filled with air, nitrogen, argon.

Diffuse discharge is formed in all three gases at pressure up to 100 Torr. At pressure more than 200 Torr a spark channel is formed. Maximum pressure was 760 Torr. At using aluminum and copper cathode bright blue and green jets respectively are observed in a cathode surface at pressure of gases 30 and 50 Torr. At a pressure of more than 100 Torr the blue and green jets are observed only near apex of the cathode (Fig. 1). At using the cathode made of a stainless steel the blue jets are observed at a pressure more than 100 Torr. It was supposed that observed jets are formed due to explosion of microinhomogeneity on the cathode surface and electro-erosion of metal. As the results a vapor of metal are formed.

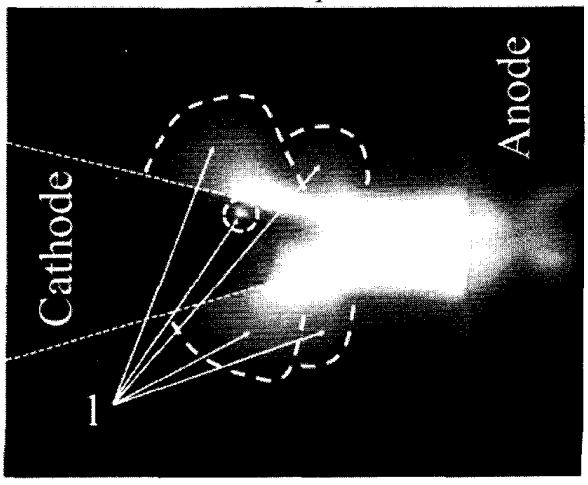

Fig. 1. Image of discharge in nitrogen at pressure of 200 Torr. Interelectrode distance is 2 mm. 1 – green jets. The exposure time is 1s

Spectral investigation have shown that green and blue color of jets is determined by radiation of atoms and ions of metal. It was registered radiation of intense line of AlI at a wavelength of 394.4 and 396.15 nm (upper level $3s^24s\ ^2S_{1/2}$ (3.14 eV) is common and lower level is $3s^23p\ ^2P^0_{1/2}$ (0 eV) и $3s^23p\ ^2P^0_{3/2}$ (0.014 eV) respectively [1]), as well as lines of CuI at wavelength of 510.55 nm (upper level is $3d^{10}4p\ ^2P^0_{3/2}$ (3.81 eV) and lower level is $3d^94s^2\ ^2D_{5/2}$ (1.39 eV) respectively [1]), 515.32, 521.8 nm (upper level $3d^{10}4d\ ^2D_{3/2}$ (6.19 eV) is common and lower level is $3d^{10}4p\ ^2P^0_{1/2}$ (3.79 eV) and $3d^{10}4p\ ^2P^0_{3/2}$ (3.82 eV) respectively [1]) and several hundred lines of FeI and FeII.

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