Low pressure discharge induced by microwave with stochastically jumping phase

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In [1,2] theoretically and experimentally is shown that the anomalous behavior of: the coefficient of a microwave radiation penetration, the terms of the breakdown of gas, the maintenance of microwave gas discharge and collisionless electron heating due to the jumping phase of the microwave radiation with stochastically jumping phase (MWJP). The role of the collision frequency is played by random jumps in the phase of stochastic fluctuations.

To conduct experiments on the characteristics of optical radiation from the plasma discharge in a gas (air), low-pressure-induced MWJP a coaxial waveguide with axial vacuum pumping, the latter connected to the BPG. Coaxial waveguide with impedance of about 75 ohms and a length of 1000 mm made of brass pipes with inner diameter of 45 mm and external - 50 mm. For the experimental studies of the integral intensity of the plasma radiation in the visible spectrum used photoelectron multiplier (17) of type PEM-29, attached to a high-stabilized rectifier (18) VSV-2. Calibration of the dial ISP-51 spectrograph was carried out using known lines emitted by a mercury lamp PRK-2M, which the emission spectrum is shown in Fig.1.

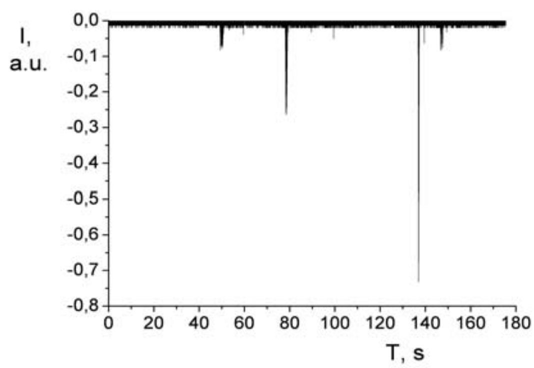

Fig. 1

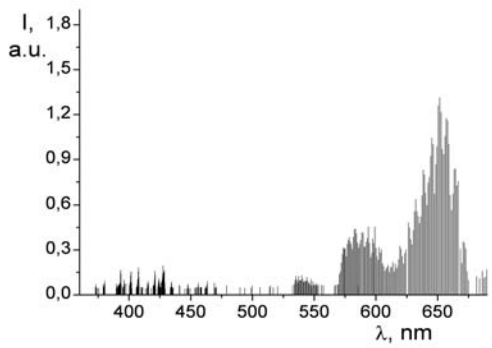

Fig.2

The emission spectra of discharges in air at a pressure P = 28 Pa is shown in Fig.2. The intensity of the glow discharge is significantly reduced with distance of the MWJP entrance to the waveguide, it is inhomogeneous on the cross section, i.e. there is a contraction of the discharge.

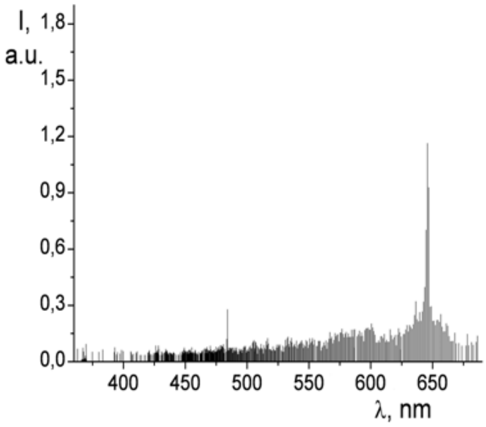

Fig.3

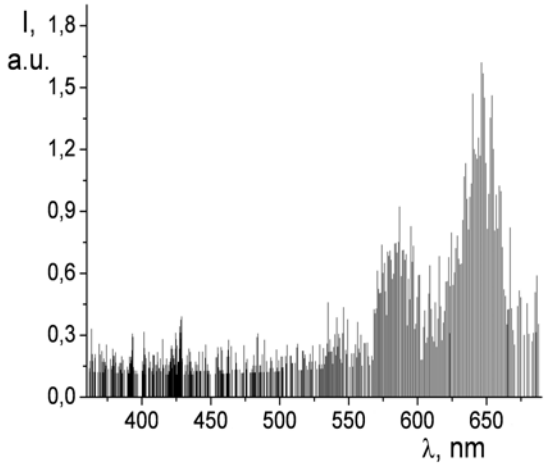

Fig.4

From Figs. 2-4 it is seen that the spectrum of optical radiation from the discharge depends strongly on the pressure of the working gas (air) in a coaxial waveguide. In particular, a decrease in air pressure range of the optical radiation from the discharge is enriched with shorter wavelengths, so if P = 28 Pa and P = 4.8 Pa the spectrum is depleted at wavelengths shorter than 550 nm, i.e. it is prevails red radiation - (Fig. 2, 3), then when the pressure is reduced nearly an order of magnitude spectrum significantly enriched with short wavelengths, i.e. it is prevail blue light (Fig. 4). The results of experimental studies of the temporal characteristics of optical radiation for two specific wavelengths within the duration of the single high-voltage pulse (160 mks) are shown in Figs.5,6. Fig.5 shows the dependence of the optical radiation intensity on time for two wavelengths: left - 485 nm; right – 651nm (within duration of one high-voltage pulse at a pressure P = 28 Pa). Fig.6 shows the dependence of the optical radiation intensity on time for two wavelengths: left - 485 nm; right – 651nm (within a duration of one high-voltage pulse at a pressure P = 4.8 Pa). The optical emission starts with a delay relatively to the beginning of current (marked on these figures, vertical risk) pulse, however, its duration exceeds the duration of the pulse of high voltage. For the pressure P = 2 Pa and the power is sufficient to breakdown the air and maintain the stationary

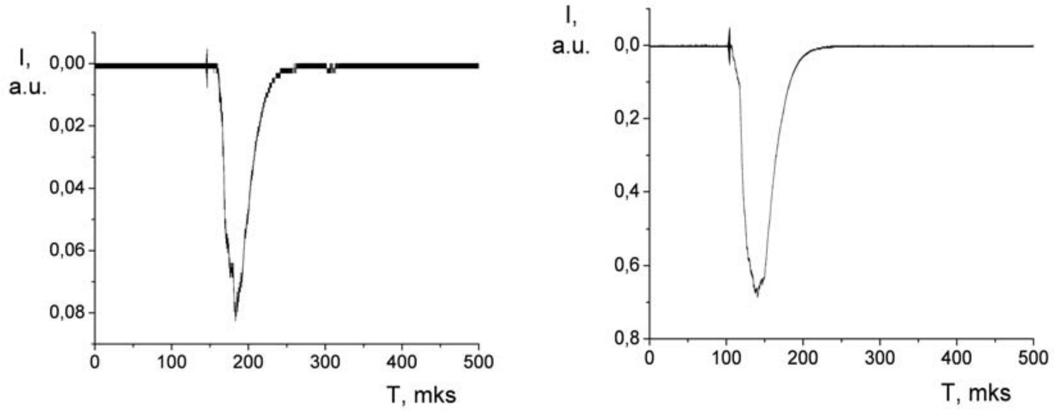

Fig.5

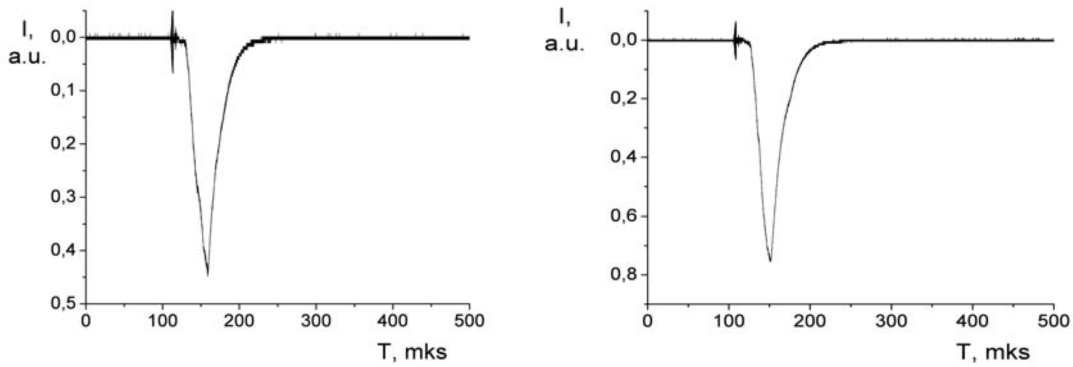

Fig.6

discharge. But, as seen in Fig. 7, the amplitude of realizations MWJP and their local spectra at input and output coaxial waveguide are substantially different. Fig. 7 shows waveforms of MWJP at the (*1*) input and (*2*) output of the coaxial waveguide, respectively, and local microwave spectra in a logarithmic scale (10 dB/div) at the (*1*') input and (*2*') output of the coaxial waveguide, respectively. The gas pressure in the waveguide is *P* = (a) 2.0 and (b) 30 Pa, respectively. The time scale is 5 ns/div, and the voltage scale is 100 (V/cm)/div. Ignition of the discharge does not affect the penetration into dense plasma MWJP evidenced by nearly constant amplitude at the entrance to the waveguide (curve 1 in Fig. 7), because the same amount of energy radiation on air ionization for the discharge maintenance MWJP amplitude at the output of the coaxial waveguide (curve 3 in Fig. 7) exists, but it decreases. In addition, it is important that it changes significantly as the local spectrum on the output waveguide. There is no peak associated with the main spectral component MWJP. It should be noted that there observed a similar situation in the pressure range from P = 30 Pa to P = 2 Pa at a power MWJP.

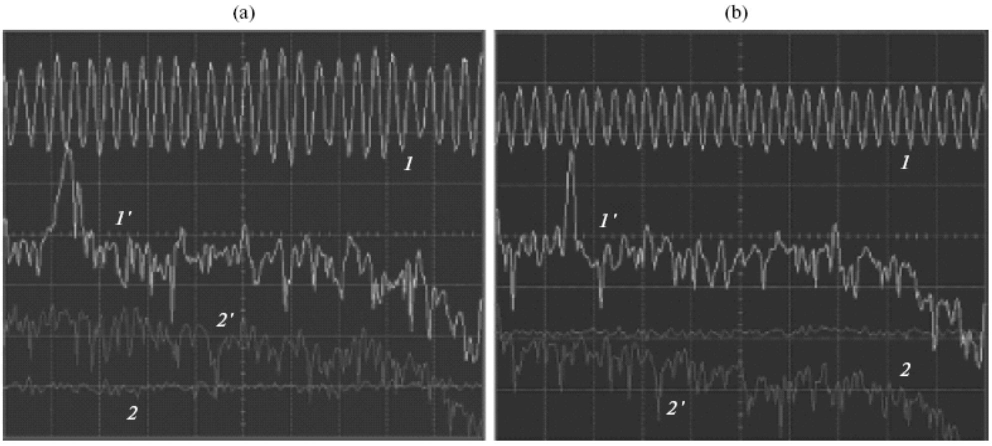

Fig.7

The results of studies of optical characteristics of the discharge plasma, initiated by MWJP in a coaxial waveguide with optimal operation of the beam-plasma generator, in a wide range of air pressure, in which the discharge is ignited and maintained stably is discussed. Due to strong absorption capacity MWJP upon ignition of the discharge in the coaxial waveguide an axial discharge becomes non uniform along its length. During the maintenance of the MWJP discharge in the waveguide, gas ionization leads to almost complete damping of the main spectral components of the input microwave signal. The results can be used to develop new type high effective sources of optical radiation with quasi solar spectrum, which makes a fundamental breakthrough in lighting technology. The results might also be of some use in connection with additional plasma heating in nuclear fusion devices due the fact that, the electron heating by microwave radiation with jumping phase is collisionless.

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