Plasma parameters of a nanosecond surface sliding discharge in a supersonic air flow [[1]](#footnote-1)\*)

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A correct control of the characteristics of gas discharges in high-speed flows is necessary to determine the mechanism of their influence on airflows in plasma aerodynamics [1]. The paper presents the results of experimental study of a nanosecond surface sliding discharge in supersonic airflows in a shock tube (the Mach number of the flow is up to 1.7). Pulsed surface sliding discharges with an area of ​​100×30 mm2 with a duration of ~300 ns were initiated in the discharge chamber [2]. The discharge parameters were determined in supersonic flows with a plane shock wave and with an oblique shock wave.

To determine the parameters of the discharge plasma, we used the methods of emission spectroscopy and the current measurements. The emission spectra were recorded at a pulse voltage of 25 kV and a current of ~1 kA. The electron concentration, the electron energy, and the electric field strength in the plasma were estimated on the experimental measurements. The electron concentration was determined from the broadening of the hydrogen Hα line and from the current waveforms. It is found that a continuous part is observed in the spectrum in stationary air at pressures above 50 Torr and in flows with a shock wave. The reason for the continuum is bremsstrahlung, according to estimations. The electron energy was calculated on the base of processing the continual part of the emission spectrum, which was compared with the theoretical spectrum calculated for different electron energies. The electric field strength was calculated from the ratio of the intensities of the bands of the second positive system of nitrogen N2 and the first negative system of the nitrogen ion N2 +. The reaction rates of radiation are directly proportional to the density of electrons, which, in turn, depend on the electric field strength.

In supersonic flows, the current of a nanosecond surface sliding discharge is concentrated in the channels of high conductivity in the regions of low density [2, 3]. It has been shown experimentally that the spectra and dynamics of the radiation of discharge channels are determined by their interaction with shock waves. The concentration of electrons in the discharge channels exceeds 1015 cm – 3. The radiation intensity varies no monotonically with time, and the afterglow duration can exceed 2.5 μs [3]. The spatial inhomogeneity of the energy input leads to the generation of shock waves that influence the supersonic flow in the channel for ~ 100 μs after the discharge.

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References

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