DOI: 10.34854/ICPAF.52.2025.1.1.188

FORMATION OF A NANOSECOND VOLUME DISCHARGE IN FRONT OF A DIFFRACTED SHOCK WAVE *)

Mursenkova I.V., Ivanova A.A.

M.V. Lomonosov Moscow State University, Faculty of Physics; Moscow, Russia;
murs_i@physics.msu.ru

The present objective is experimental study of combined volume discharge in the presence of a shock wave with a curved front in the discharge volume. The curved shock wave occurs while diffracting on an obstacle in a discharge chamber. The results obtained can be used to control the shock waves by means of pulsed discharges.

The experiments were conducted on a shock tube with a discharge chamber of rectangular cross-section, in which a combined volume discharge was initiated in a volume of 100×30×24 mm^3 at a pulse voltage of 25 kV [1, 2]. ICCD camera [1] recorded the discharge emission with nanosecond resolution. The discharge current reached 1000 A with a duration of ~ 500 ns. The initial plane shock wave (Mach numbers 2.2-4.5) diffracted on a small obstacle located on the lower wall of the discharge chamber. Consequently, a flow with a curved shock wave (SW) front and a non-uniform flow behind the front was formed in the discharge chamber (Fig. 1 a, [3]).

As shown earlier, in the presence of a plane shock wave, the current of the volume discharge occurs ahead of the front, in the low-pressure region [1], the glow duration of the volume phase reaching 2000 ns [2]. The plasma region extension in front of SW was 0-40 mm (Fig. 1 b, c) in the experiments performed. The discharge formed ahead of the diffracted shock wave front in the experiments, and the breakdown was volumetric. As a result, the glow boundary clearly corresponds to the shape of the curved SW front (Fig. 1 a, b). The discharge current dynamics and the glow duration depend on the initial air pressure (air density) ahead front and the position of the shock wave in the discharge volume. The duration of radiation is much longer than the duration of the discharge current. According to ICCD registration, the glow duration of the volume phase can reach 2 μs, for surface discharges – 3 μs.

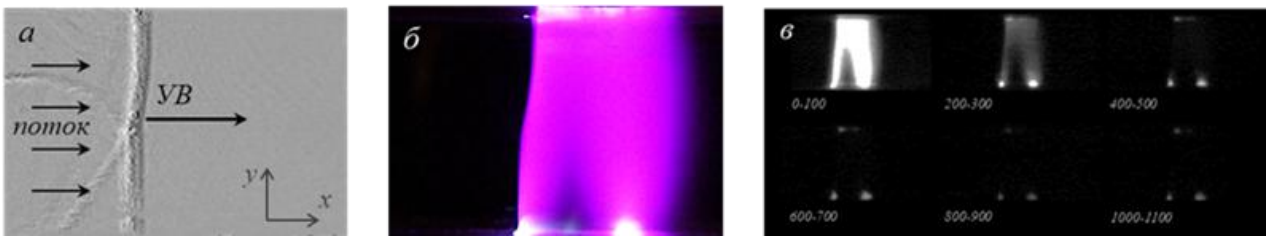

Fig. 1. a) shadowgraphy image of the flow in the discharge chamber; b) photo image of the discharge in front of the diffracted shock wave; c) sequence of frames of the glow captured by ICCD camera (the numbers indicate the time in nanoseconds). The shock wave Mach number is 4.20, the initial air pressure is 10 Torr.

References

[1]. Znamenskaya I., Mursenkova I., Doroshchenko I., et al. // Physics of Fluids, 2019, 31, 11. 116101. DOI: 10.1063/1.5125884

[2]. Kuznetsov A.Yu., Mursenkova I.V. Features of a radiation of the nanosecond volume discharge interacting with a plane shock wave in air. Prikl. Fiz., 2016. No. 5, pp. 16-21.

[3]. Mursenkova I., Ivanova A., Ivanov I., et al. // Scientific Visualization, 2023, 15, 3, p. 40-49. DOI: 10.26583/sv.15.3.05

*) abstracts of this report in Russian