

SIMULATION IN LABORATORY EXPERIMENTS THE COLOR OF RED SPRITES*

N.P. VINOGRADOV, V.F. TARASENKO, E.KH. BAKSHT

Institute of High Current Electronics SB RAS, Tomsk, 634055, Russia

Currently, much attention is paid to the study of transient luminous events (TLEs) [1–3]. Many photographs are given in articles and on the Internet, see for example [4–6]. A large number of works are devoted to research on the properties of red sprites, blue jets and analogs of blue jets (starters, giant jets) and elves. In particular, experimental studies of laboratory discharges are being carried out, which in their properties correspond to the most common TLEs [7–9].

This work presents the results of studies of pulsed discharges in atmospheric air at pressures that correspond to those recorded at altitudes for the appearance of red sprites.

The figure 1 shows photographs of the design of electrodes and of light from different discharge modes with different pressures of air.

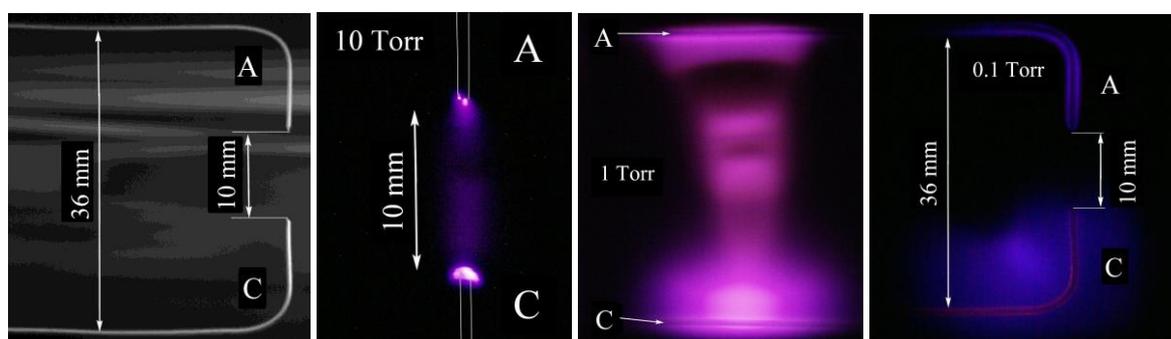


Fig.1. Photographs of the design of electrodes and light of the diffuse discharges in air with different pressures.

It has been established that the pressure range at which the emission of red sprites is recorded is much wider than with a glow discharge in laboratory experiments. For example, red sprites are observed at altitudes from 40 to 100 km, which roughly corresponds to air pressures from 10 to 0.001 Torr. Whereas the color of a pulsed discharge in air with pulse durations of a few to tens of microseconds had a pronounced red color only at a pressure of about 1 Torr.

The report will present data on the properties and color of various modes of pulsed discharges correspond to the most common TLEs. In particular, oscilloscope traces of voltage pulses and discharge currents, radiation spectra, and the dynamics of air breakdown development at pressures from 0.1 to 30 Torr will be presented.

REFERENCES

- [1] D.D. Sentman, E.M. Wescott, "Red sprites and blue jets: Thunderstorm-excited optical emissions in the stratosphere, mesosphere, and ionosphere," *Physics of Plasmas*, vol. 2, no. 6, pp. 2514-2522, 1995.
- [2] V.P. Pasko, U.S. Inan, T.F. Bell, Y.N. Taranenko, "Sprites produced by quasi-electrostatic heating and ionization in the lower ionosphere," *J. Geophys. Res.*, vol. 102, pp. 4529–4561, 1997.
- [3] Y.P. Raizer, G.M. Milikh, M.N. Shneider, "Streamer and leader-like processes in the upper atmosphere: Models of red sprites and blue jets," *J. Geophys. Res.*, vol. 115, p. A00E42, 2010.
- [4] O. Chanrion, T. Neubert, A. Mogensen, Y. Yair, M. Stendel, R. Singh, D. Siingh, "Profuse activity of blue electrical discharges at the tops of thunderstorms," *Geophys. Res. Lett.*, vol. 44, pp. 496–503, 2017.
- [5] A. Huang, G. Lu, J. Yue, W. Lyons, F. Lucena, F. Lyu, S.A. Cummer, W. Zhang, L. Xu, X. Xue, S. Xu, "Observations of red sprites above hurricane matthew," *Geophys. Res. Lett.*, vol. 45, pp. 13-158, 2018.
- [6] Flickr.com. Available online: <https://www.flickr.com/photos/frankie57pr/49610428072/> (accessed on 10 February 2022).
- [7] F.J., Gordillo-Vázquez, A. Luque, M. Simek, "Spectrum of sprite halos," *J. Geophys. Res.*, vol. 116, p. A093919, 2011.
- [8] V.F. Tarasenko, E.A. Sosnin, V.S. Skakun, V.A. Panarin, M.V. Trigub, G.S. Evtushenko, "Dynamics of apokamp-type atmospheric pressure plasma jets initiated in air by a repetitive pulsed discharge," *Physics of Plasmas*, vol. 24, no. 4, p. 043514, 2017.
- [9] E.A. Sosnin, N.Y. Babaeva, V. Y. Kozhevnikov, A. V. Kozyrev, G. V. Naidis, V. A. Panarin, V. S. Skakun, and V. F. Tarasenko, "Modeling of transient luminous events in Earth's middle atmosphere with apokamp discharge," *Phys.-Uspekhi*, vol. 64, no. 2, pp. 191–210, 2021.

* This research was supported by the Ministry of Science and Higher Education of the Russian Federation (agreement no. 075-15-2021-1026 of November 15, 2021).