STRUCTURE OF A SUPERSONIC IONIZATION WAVE IN ATMOSPHERIC PRESSURE ARGON IN A MICROWAVE BEAM [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.171

Artem’ev K.V., Batanov G.M., Berezhetskaya N.K., Borzosekov V.D., Davydov A.M., Kolik L.V., Konchekov E.M., Kossyi I.A., Moryakov I.V., Petrov A.E., Sarksyan K.A., Stepakhin V.D., Kharchev N.K.

Prokhorov General Physics Institute of the Russian Academy of Sciences, borzosekov@fpl.gpi.ru

High velocities of step-like propagation of the subthreshold microwave discharge in krypton were established in [1] in comparison to a discharge in air. In [2], the effect was explained by the development of ionization instability caused by the accumulation and ionization of excited atoms in the UV discharge halo. Since the onset of ionization-overheating instability is characteristic of subthreshold discharges in molecular gases, it was of interest to study the structure and heating of particles in a subthreshold discharge in argon.

In the experiments, a Gaussian beam of the Borets 75/08 gyrotron radiation was used. The wavelength is 4 mm, the radiation power varied from 70 kW to 200 kW (5.5·10-17 V·cm2 ≤ *E*/*N* ≤ 8.9·10-17 V·cm2), the pulse duration varied from 0.35 ms to 1.6 ms. The velocity of the discharge front was measured by the location technique [3], and the temperature was measured using the AVASPEC-2048 spectrometer by the continuum of the discharge radiation [4].

Along the entire discharge length (~ 45 cm), two types of glow are recorded: homogeneous and structured in the form of a system of narrow channels elongated mainly along the wave field. The region of structured glow corresponds to the region of the highest intensity of the wave beam on its axis (beam waist) and expands with increasing pulsed radiation power. The discharge region with uniform glow is characterized by the appearance of a narrow peak at 250 kHz in the spectrum of the reflected signal, which corresponds to a discharge front velocity of ~ 0.5·105 cm/s at *E*/*N* ≈ 6·10-17 V·cm2 and lower. The regions of structured glow are characterized by wide spectra of reflected radiation with a cutoff of about 350 – 550 kHz and higher, which corresponds to a speed above 0.7·105 cm/s (up to 2.9·105 cm/s) at *E*/*N* ≈ 9·10-17 V·cm2.

The dependence of the velocity of the discharge front on power can be described by a power-law function with an exponent from 1.5 to 2.0. In this case, the velocity of the discharge front is 20–30 times higher than in air.

Measurements of the gas temperature at the discharge front give a value of ~ 6 kK at *E*/*N* ≈ 7.8·10-17 V·cm2, which indicates the existence of narrow superheated regions in the discharge, the volume of which is no more than 0.01 of the discharge volume.

The establishment of a fine-cellular structure and high local temperature values favors the mechanism of discharge propagation associated with the simultaneous effect of ionization and ionization-overheating instabilities.

The work was funded by the Russian Science Foundation, project No. 17-12-01352.

References

1. *Bogatov N.A., Brodsky Yu.Ya., Golubev S.V., Zorin V.G.* Proc. XVIII Intern. Conf. on Phenomena in Ionized Gases, 1987, Swansea, Contributed Papers 4, pp. 864–865.
2. *Mnatsakanyan A. Kh., Naidis G.V.* Soviet Journal of Plasma Physics, 1990, V. 16, No. 4, pp. 275–278
3. *K.V. Artem’ev, G.M. Batanov, N.K. Berezhetskaya et al. Plasma Physics Reports, 2019, V. 45, No. 10, pp. 965–972.*
4. *Batanov G.M., Berezhetskaya N.K., Kop'ev V.A. et al. High Temperature, 2008, V. 46, No. 1, pp. 124–130.*
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Pt/ru/GZ-Borzosekov.docx) [↑](#footnote-ref-1)