DISCHARGE IN AIR MEDIUM INITIATED BY THE MICROWAVE BEAM AND SELF-INTERACTION OF THE MICROWAVE BEAM

1Artem’ev K.V., 1Batanov G.M., 1Berezhetskaya N.K., 1,2Borzosekov V.D., 1Kolik L.V., 1Konchekov E.M., 1Kossyi I.A., 1,2,3Malakhov D.V., 1,2Petrov A.E., 1Sarksyan K.A., 1,2Stepakhin V.D., 1Kharchev N.K.

1Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow, Russia,
 khar@fpl.gpi.ru
2Pirogov Russian National Research Medical University, Moscow, Russia
3Moscow Technological University (MIREA), Moscow, Russia

Study of microwave beams propagation through quasi-optical transmission lines and oversized waveguides in eighties of the last century resulted in discovery of a new peculiar form of a microwave discharge. Characteristic feature of this discharge form is principal role in discharge propagation of outgoing UV (ultraviolet) radiation from the halo region and role of plasma instabilities of the halo region plasmas in the presence of microwave field [1,2]. In the present work parameters of the discharge initiated by a Gaussian microwave beam in air medium at atmospheric pressure were studied using optical and microwave diagnostics. Intensity of microwave radiation used in the experiments was 10-30 kW/cm2, and this value is lower than threshold value for air breakdown. Microwave radiation of 4 mm wavelength in the experiments were generated by a gyrotron at pulse mode generation with pulse lengths 2-6 ms. A ring-shaped initiator was used to excite a discharge at sub-threshold electric fields.

It was found that localized narrow radiant (in the ultraviolet range) region exists in the front of the discharge. Plasma density in this narrow region exceeds value of 1022 m-3. During propagation of the discharge front along the beam line through the region of stronger microwave electric field increase of the propagation speed from subsonic (104 cm/s) to supersonic (6-8·104 cm/s) is observed, while opposite is observed during discharge propagation towards weaker field region. Maximum gas temperature at discharge propagation speed 104 cm/s is 5300 K.

 It was found that microwave radiation during millisecond time periods eventually penetrates through the discharge head section. This phenomenon can be qualitatively explained by refraction of the radiation due to formation of hollow radial profiles of microwave beam intensity and plasma density which in turn is caused by screening effect of the discharge head section.

The study was funded by Russian Science Foundation grant within the frame of the 17-12-01352 project.

References

1. G.M. Batanov, S.I. Gretsnin, I.A. Kossyi, A.N. Magunov, V.P. Silakov, N.M. Tarasova // Plasma Physics and Plasma Electronics,1985, Ed. L.M.Kovrizhnykh, Nova Science Publishers, Commack, P.241.
2. S.V. Golubev, S.I. Grishin, V.G. Zorin, I.A. Kossyi, V.E. Semenov // Visokochastotnyi razryad v volnovih polyah [in Russian], IAP AS USSR, Gorky, 1988, P.136.