probe study of the structure of non-uniform microwave discharge in nitrogen

1,2G.V. Krashevskaya, 1Yu.A. Lebedev, and 1M.A. Gogoleva

1Topchiev Institute of Petrochemical Synthesis RAS (TIPS RAS), Moscow, Russia,  
 [lebedev@ips.ac.ru](mailto:lebedev@ips.ac.ru)  
2National Research Nuclear University «MEPHI», Moscow, Russia

One of the important problems in the physics and applications of non-equilibrium gas discharge low temperature plasma is the study of the structure of discharges. This is especially important in the study of strongly inhomogeneous discharges in which the plasma composition and physico-chemical processes depend on the spatial coordinates. Non-equilibrium electrode microwave discharge at pressures of 0.5-20 Torr can be attributed to this type of discharges [1, 2]. Heterogeneity is caused by the method of the excitation of the discharge and by the presence of the plasma resonance. The first probe study of such a discharge in nitrogen was performed previously, but only the radial distribution of the parameters of electronic components was investigated [3].

In this paper we describe the first results of a study of the axial and radial distributions of the parameters of the electron component of the plasma in nitrogen at a pressure of 1 Torr and incident power of 60-100 W (frequency 2.45 GHz). Double electric tungsten probe was use (probe diameter is 100 mm, length of the non insolated part is 2.1 mm, the distance between the probes is 2.8. mm). a resistor of 20 ohms, consistently included in the probe circuit near the probe was used as the filter. System was developed for displacement of probes along the axis of the discharge and the radius with steps of 0.1 mm. Sinusoidal signal with frequency of 10 Hz and an amplitude of ± 38 V was used as the probe voltage, probe current was measured by the resistance of 5.6 kOhm. Oscillograms of current and voltage were recorded using a digital storage oscilloscope Tektronix TPS2024 with isolated channels from the ground. This enables measurements with galvanic isolation of the probe from the grounded chamber. Outside the luminous region of the discharge the single-probe voltage current characteristics were obtained by using discharge chamber as a reference probe. The results obtained using the single-probe and double-probe techniques are in satisfactory agreement.

Measurements showed that the electron temperature ranges from 4.5 eV to 1.0 eV near the antenna and away from it. Ion concentration exceeds a critical concentration near the antenna, and decreases by one order of magnitude as the distance from it. The potential difference between the probes is of 10 V in the luminous region of discharge and almost absent outside it. It is important to note that the dependence of the potential difference on the axial coordinate is non-monotonic and non-monotony increases with increasing incident power. This means that the non-homogeneity of the discharge increases with increasing incident power.

References

1. Lebedev Yu.A., Mokeev M.V, Solomakhin P.V., Shakhatov V.A., Tatarinov A.V., Epstein I.L. J. Phys. D: Appl. Phys., 2008, V.41, 194001
2. Lebedev Yu A , Tatarinov A V, Shakhatov V A, Epstein I L 2010 J. Phys.: Conf. Series, 207 012002
3. Lebedev Yu.A., Bardosh L. High Temperature, 2000, Vol. 38, p. 528