INFLUENCE of SMALL ADDITIVES OF Ar on DC DISCHARGE IN HYDROGEN. SIMULATION AND EXPERIMENT

Yu.A. Lebedev, A.V. Tatarinov, and I.L. Epstein

Topchiev Institute of Petrochemical Synthesis, Russian Academy of Sciences, Moscow, Russia, lebedev@ips.ac.ru

In recent years, the numerical modeling and experimental works have shown that in strongly inhomogeneous microwave discharge a small additive of argon leads to a change of the plasma parameters (electron density, intensity of the microwave field and the emission intensity of the plasma particles). This has been demonstrated for nitrogen [1] and hydrogen [2]. Modeling has allowed us to show that the effect is observed if the transport coefficients of an ion of the additive differ from the transport coefficients of the main ion of the plasma.

The question arises whether this effect is observed in other types of the discharge? Here this problem is investigated by means of a two-dimensional model of a dc discharge in hydrogen. Argon is used as a small additive. Spatial nonuniformity in this work is determined by the shape of the electrodes.

A self-consistent model in the local approximation [1] is used for the description of the discharge. The model includes the Poisson equation, Boltzmann equation for the free plasma electrons and kinetic equations for electrons, argon and hydrogen ions and the electronically excited states of argon and hydrogen. Simulation is carried out by means of the program Comsol 3.5a using the finite element method [3].

The experiments were carried out in the discharge tube of 5 cm diameter at a hydrogen pressure 2 Torr. The electrodes are placed in side branches of the discharge tube. We used a stabilized DC power supply SL1200. In pure hydrogen the voltage applied to the tube, connected in series with the ballast resistor (82 kΩ), equal to 3.7 kV and the discharge current is about 20 mA. The hydrogen flow rate was 70 cm3/min under normal conditions, the flow rate of the argon ranged 0–5% of the consumption of hydrogen. Emission spectra of hydrogen were recorded by a spectrograph AvaSpec 2048. It is shown that when the argon is added the discharge current decreases and the voltage across the discharge tube increases. The intensity of the emission lines and bands of hydrogen in the positive column changes weakly, but in the anode region (in the non-uniform part of the discharge) the intensity is reduced. The results show that the possibility of using gas additives for plasma diagnostics must be examined in each case. On the other hand they show that even small additions of inert gas can be used to control the plasma parameters.

The simulation results are in agreement with experiments.

This study was partially supported by RFBR grant # 15-08-00070.

References

1. Lebedev Yu.A., Mavlyudov T.B., Epstein I.L., Chvyreva A.V. and Tatarinov A.V., Plasma Sources Sci. Technol., 2012, **21**, 015015
2. Lebedev Yu.A., Tatarinov A.V., Titov A.Yu., Epstein I.L., Krashevskaya G.V. and Yusupova E.V., J. Phys. D: Appl. Phys. 2014, **47**,335203
3. COMSOL 3.5a, <http://www.comsol.com>