ONE-DIMENSIONAL MODELING OF MICROWAVE DISCHARGE IN LIQUID n-HEPTAN WITH ACCOUNT SOLID PARTICLES

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

A.V. Topchiev Institute of Petrochemical Synthesis RAS (TIPS RAS), Moscow, Russia, [lebedev@ips.ac.ru](mailto:lebedev@ips.ac.ru)

Plasma in liquids has only recently attracted the attention of researchers. This is explained by the possible prospective applications of this plasma both in solving environmental problems, and for obtaining various gas-phase and solid products. Currently, various types of discharges are used to create such a plasma. Microwave discharges are the least investigated among all other discharges. A detailed experimental study of the microwave discharge in various liquid hydrocarbons [1–5] as well as two-dimensional and zero-dimensional modeling of the discharge in n-heptane [6, 7] has been performed in our earlier studies. In this work, within the framework of the one-dimensional model, further research on the processes occurring inside gas bubbles with plasma, taking into account the formation of soot particles is carried out.

The calculations were carried out on the basis of a self-consistent model, which includes kinetic equations for the concentrations of all gas components, the equation of heat conduction, the equation for the concentration of electrons, and the kinetic equations for solid particles. To determine the microwave field, we used the relation for a field in a spherical capacitor filled with plasma. For the kinetic mechanism of gas-phase reactions, a simplified scheme, compared to that used in our 0-dimensional simulation [7], is used. Pyrene molecules were considered as soot precursors. For calculating further growth of solid particles, we used a polyaromatic model, which was described in detail in [7]. It included both surface growth and coagulation processes for all particles.

It is shown that calculations with a shortened scheme give a good agreement with calculations which use the full kinetic scheme. The influence of the microwave field value at the antenna surface *E*0 on both the resulting composition of the gas products and the gas temperature inside the bubble was analyzed. For *E*0 = 10 kV/cm, the average temperature inside the bubble is about 2100 K and is close to the value measured from the emission spectra [4]. The value of the field is consistent with the one obtained earlier in 2D modeling. The resulting composition of gas products for *E*0 = 10 kV/cm agrees well with the experimental one. Thus our developed one-dimensional model allows to obtain the main properties of the microwave discharge at acceptable computer costs.

References

1. Averin K A, Lebedev Yu A and Shakhatov V A *Plasma Phys.Reports* 2018 **44** 110-13.
2. Lebedev Yu.A., Averin K.A. J. Phys. D: Appl. Phys. 2018, **51.** 214005.
3. Averin K.A., Lebedev Yu.A. High Energy Chem. 2018, **52**, 263.
4. Lebedev Yu. A., Epstein I. L., Shakhatov V. A., Yusupova, E. V., Konstantinov V. S. High Temperature. 2014, **52**, P.319
5. Averin, K. A., Lebedev, Yu. A., Shchegolikhin, A. N., and Yablokov, M. Yu.  Plasma Processes and Polymers 2017, **14**, Issue 9, DOI 10.1002/ppap.20160022
6. Lebedev Yu. A., Tatarinov A. V., Epstein I. L., Averin K. A. Plasma Chem. Plasma Process. 2016,.**36**, P. 535-552
7. Lebedev Yu. A., Tatarinov A. V., Epstein I. L., and Bilera I. V., *J. Phys. D: Appl. Phys*. 2018, ***51***,214007