EXCITATION OF HYDROGEN MOLECULES IN the PLASMA OF DIPOLAR DISCHARGE

A. Lacoste1, S. Bechu1, Yu.А. Lebedev2, and V.А. Shakhatov2

1Centre de Recherche, Plasma – Materiaux – Nanostructures, Grenoble, France,   
 [ana.lacoste@ujf-grenoble.france](mailto:ana.lacoste@ujf-grenoble.france)   
2Topchiev Institute of Petrochemical Synthesis, Russian Academy of Sciences, Moscow,  
 Russia, [lebedev@ips.ac.ru](mailto:lebedev@ips.ac.ru)

Distribution function on the rotational (RDF,  = 1–5), and vibrational (VDF,  = 0–2) levels of the hydrogen molecule in the  excited state are investigated by the method of emission spectroscopy in the plasma of the dipolar discharge in hydrogen (the source of plasma under conditions of electron-cyclotron resonance) [1]: the vibrational temperature  of the ground state  of the hydrogen molecule, rotational  and translational  temperatures are determined. It is established that the measured RDFs of the hydrogen molecules in the  excited state are the Boltzmann distribution. The values of  lie in the range of 205–325 K. The VDF of the hydrogen molecules in the  excited state are different from the Boltzmann distribution. Results of the VDF measurement are consistent with a model in which the  state is excited due to collisions of the electrons with vibrationally excited molecules of hydrogen  and died by its radiative decay. Calculations performed within the model: confirm the presence of population inversion, which is observed for the level  = 1; show that the VDF in the ground  and excited  states depend upon the values of the Frank-Condon factors for transition . The values of  obtained using the Franck-Condon factors from [2] are too high and are outside the range of the vibrational temperature ever measured by the methods of the CARS spectroscopy in radiofrequency and microwave discharges in hydrogen [3]. This is due to the problem of the correct determination of the Frank-Condon factors for transition  from [2]. The use of the Frank-Condon factors for transition  from [3] gives a reasonable value of , which is equal to 3100±400 K. It is confirmed by numerical modeling of vibrational kinetics of the hydrogen molecules. The obtained value of  is significantly higher than the measured values of  = 420–650 K. Ratio these values indicate that the plasma of the dipolar discharge is an effective source of the vibrationally excited molecules of hydrogen .

References

1. S. Bechu, A. Soum-Glaude, A. Bes, A. Lacoste et. al. Phys. of Plasmas. 2013. V. 20. P. 101601.
2. U. Fantz, B. Heger Plasma Phys. Control. Fusion. 1998. V. 40. P. 2023.
3. S. Bechu, A. Lacoste, Yu. A. Lebedev, V. A. Shakhatov in Proceedings of the 9th International Workshop “Microwave Discharges: Fundamentals and Applications” Cordoba, Spain, September 7–11, 2015, Cordoba: Cordoba University, 2015, p. 32.