PARAMETERS AND ACTIVE SPECIES COMPOSITION OF ATMOSPHERIC PRESSURE DC DISHARGE

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Last several years a lot of papers devoted to studies of an atmospheric pressure discharges which were in contact with solution were published. The water purification from organic wastes is one of the applications of such kind discharges. Plasma being in contact with the solution is a source of such strong oxidizers as O, **·**OH, HO2**·**, H2O2, О3 which penetrating into a solution result in a destruction of organic pollutants [1]. For the analysis of process mechanisms in a solution and their optimization it is necessary to have the data on the composition and on rates of formation-loss of active species. The aim of given study is to obtain such data for DC glow discharge burning in air at atmospheric pressure the cathode of which is distilled water.

The scheme of experimental set-up was described elsewhere [2]. Current dependences of electric field strengths, gas temperatures, and vibration temperatures of N2(C3Πu) were determined in the current range of 20-50 mA. Gas temperatures and vibration ones were ~1450 and 4200 К, respectively, and they did not depend on the discharge current. Reduced electric field strengths dropped with the discharge current increase from 28 up to 16 Td. Qualitative composition of emission spectrum shown the existence in a gas phase the excited states of N2, NO, OH molecules and О, Н atoms.

The determination of plasma composition was carried out by means of digital modeling based on combined solution of Boltzmann equation for electrons, equations of vibration kinetics for ground states of N2, O2, NO and H2O molecules and equations of chemical kinetics which include molecules and atoms of N2, O2, NO, H2O, O, H, N, OH, O3, HO2, N2O, NO2, NO3, HNO, HNO, HNO3 and H2O2. Electron densities were found using equation of a plasma conductivity. Since H2O molecules content was unknown the content was specified as a parameter. It was found that measured temperatures of N2(C3Πu) agree well with calculated ones at the water content of ~0.1%. In that case vibration temperatures of O2 were ~1800 К, NO – ~1500 К, Н2О(100, 001) – ~2600 К and Н2О(010) – ~2200 К. Electron densities were increased with discharge current from 1.9×1012 up to 2.9×1012 сm-3.

Calculations shown that the main plasma particles were NO – concentration of ~1016 сm-3, 1%; NO2, H2O2, OH, O2(a1Δg), HNO3 - ~1015 сm-3 or 0.1%; O(3P), N2O, O2(b1Σg+), HNO - ~1014 сm-3. It is interesting to point out that ozone concentration was very low (~1011 сm-3) in comparison with, for example, atmospheric pressure DBD. This is due to a high gas temperature resulting in high rate constants of ozone loss in its reactions with NO and О2 molecules. Also, accomplished calculations allowed revealing the main reactions of formation and loss of particles mentioned above.

References

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