THE USE OF LASER EXCITED RO-VIBRATIONAL SPECTRA OF OH RADICALS AS A PROBE OF A GAS PHASE COMPOSITION

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Atmospheric pressure plasmas characterized by high concentration of radicals and low gas temperatures are found to be suitable for many applications [1]. Often the gas composition in the discharge is unknown because of the air diffusion in to the stream of the feed gas. Correspondingly, methods to probe the gas composition in the discharge zone with high spatial resolution are strongly desirable. In the present work the high resolved laser-induced fluorescence (LIF) ro-vibrtational spectroscopy is used to probe the gas composition through the excitation of OH radicals generated in the discharge region and measurement of the fluorescence signal decay time accompanied by rotational/vibrational energy transfer. Two types of discharge are investigated: glow discharge above water surface [2] and so called Ar "plasma jet" working in ambient air [3].

Ground $X^2\Pi$ state of OH radicals was excited by the tunable dye laser to the vibrational level $v^{'}$=1 of $A^2\Sigma^+$ state. The effect of N_2, O_2 and H_2O addition as OH quenchers on LIF signal intensity and decay time was measured. From LIF spectra it is found that at 20-40 ns after the laser excitation the intensity of the vibrational band (1,1) drastically decreases because of collisions with N_2, whereas much stronger vibrational band (0,0) starts to dominate in all the spectra. Time decay of the LIF signal at band (0,0) reveals exponential decay with time constant of 39 ns in "plasma jet" and even shorted decay in the glow discharge. The radiative decay time of OH $A^2\Sigma^+$ (v'=1, v'=0) to ground state is about $0.6\text{x}10^{-5}$ s and hence experimentally observed much shorter decay time is related to collisional quenching of OH by N_2, O_2, H_2O. The high resolution LIF rotational spectra of OH ($A^2\Sigma^+$ -$X^2\Pi$) in the plasma at 0 ns, 50 ns and 150 ns after the laser pulse is used in order to investigate the rotational energy transfer processes. Based on experimental results the model of LIF ro-vibrational transfer has been developed in order to calculate mole fractions of N_2, O_2 and H_2O in the plasmas with high spatial resolution. The method is used to determine the gas composition in the "plasma jet" working in ambient air with a spatial resolution of better than 1 mm and to calculate the water vapor in the center of glow discharge above water where as high as 10% of H_2O was detected which is explained by non-equilibrium evaporation and sputtering of water surface.

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