Gas Temperature, Electron Density and Absolute UV-Irradiance Measurements of Cold Atmospheric Pressure Plasma Jets

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In this work power dissipation, gas temperature, UV-irradiance and electron density of an RF driven helium and argon plasma jet in atmospheric pressure are investigated. The gas temperature was measured with Rayleigh scattering, van der Waals broadening of the H_α and H_β lines and the emission spectrum of the OH(A-X)(0,0) rotational band. The (dis-)advantages and accuracy of these methods close to room temperature were evaluated. The gas temperature obtained for helium and argon was in the range of 300-600K.

Electron densities obtained by the Stark broadening of the H_β line yield densities of the order of $10^{20}m^{-3}$ and $10^{19}m^{-3}$ for argon and helium, respectively. The dissipated power in the plasma was obtained by voltage and current measurements, with accurate correction for the power loss in the matching network. A power balance estimation was used to validate the value of the electron density of helium.

Furthermore, the behavior of a pulsed RF plasma was investigated in terms of dissipated power, power density and absolute UV-A and UV-B irradiance. Radial contraction of the plasma jet was observed for the argon plasma. Time scales of the most important electron-ion loss mechanisms were estimated to explain this radial contraction due to a transition from a diffusion dominated charge loss to an electron ion dissociative recombination dominated charge loss. The effect of an additional electrode (e.g. skin-like material) on the discharge properties is also briefly discussed.