OPTICAL DIAGNOSTICS ON COLD ATMOSPHERIC PRESSURE PLASMAS

KARI NIEMI, JOCHEN WASKOENIG, LUCY MARIE GRAHAM
and TIMO GANS
Centre for Plasma Physics, Queen's University Belfast,
University Road, Belfast BT7 1NN, Northern Ireland, UK
E-mail: k.niemi@qub.ac.uk

Abstract. Cold atmospheric pressure plasma jets promise high potential for temperature sensitive surface treatments in biomedicine, see e.g. Stoffels et al. (2006). Stable homogeneous low temperature plasma operation is achieved by using helium feed gas and applying radio frequency excitation. Small admixtures of molecular oxygen to the feed gas lead to the efficient generation of highly reactive oxygen radicals. A quantification of these radical densities and fluxes is not only vital for the plasma source development and fundamental understanding but crucial for the risk benefit analysis in biomedical applications. Diagnostics of atmospheric pressure plasmas are extremely challenging due to small confining structures and the collision dominated high pressure environment demanding exceptionally high spatial and temporal resolution down to microns and picoseconds. The most promising approach is active combination of advanced optical techniques and numerical simulations. Diagnostic based modelling as a method to determine absolute atomic oxygen ground state densities inside such atmospheric pressure plasmas is proposed, see e.g. Niemi et al. (2009). A one-dimensional numerical simulation yields the spatial and temporal electron dynamics and subsequently the excitation efficiency of optical emission lines which intensities are measured temporally integrated. The population dynamics of the O $3p\ ^3P$ (λ = 844 nm) atomic oxygen state is governed by direct electron impact excitation, dissociative excitation, radiation losses, and collisional induced quenching. Absolute atomic oxygen densities are obtained through comparison with the Ar $2p_1$ (λ = 750.4 nm) state. Results for spatial profiles and power variations are presented. An excellent quantitative agreement with independent two-photon absorption laser-induced fluorescence measurements from Knacke et al. (2008) is found.

References

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