Plasma chemistry in atmospheric pressure plasmas with varying air and humidity

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For sensitive surface treatments in bio-medicine/bio-plasma applications, one of the most essential species is reactive oxygen species. Therefore, in the experiments using micro-scale atmospheric pressure plasma jets (μAPPJs), a small amount of oxygen is added to a carrier gas, helium. In order to further understand the underlying operating principles of the μAPPJ system and to optimize its performance in applications, it is important to know the chemical kinetics of the He-O_2 plasma containing a moist ambient air as an impurity. We describe the influence of humid-air on reactive species in a He-O_2 plasma for wide air fraction of 0-500 ppm with the relative humidity of 0-100% as determined through a zero-dimensional time-dependent global model. Comparisons made with experiments using an rf driven μAPPJ and one-dimensional simulations [1, 2] suggest that the plausible air impurity level in the experiments is not more than hundreds ppm. The evolution of species concentration and its complex chemical links are described for reactive oxygen species, metastable species, radical species and positively- and negatively-charged ions (and its clusters) (Fig. 1). Effects of the air impurity containing water humidity on electronegativity and chemical activity are clarified with particular emphasis on reactive oxygen species.

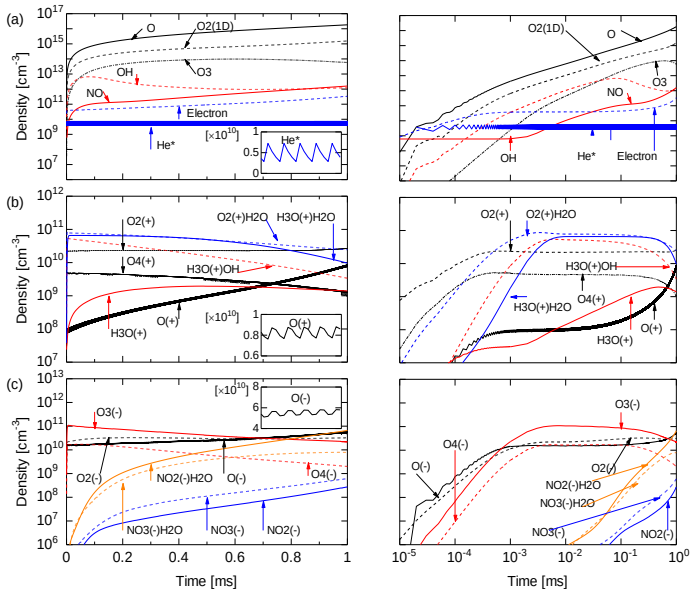

Figure 1: *Temporal evolution of (a) neutral species, (b) positive ions and (c) negative ions. Left-hand side: linear-time-scale plots. Right-hand side: log-time-scale plots.*

References

[1] K. Niemi, et al, Plasma Sources Sci. Technol. (2011), **20**, 055005.
[2] J. S. Sousa, et al. J. Appl. Phys. (2011), **109**, 123302.