Reactive fluxes and ion activation energy to particulates in air and on dielectric surfaces

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We report on a computational study of the intersection of plasma filaments in a dielectric barrier discharge with two small particulates suspended in air or residing on surfaces. The particulates are separated by a distant commensurate with the filament radius (140 μm). The particulates residing on the substrate surface can be totally or partially enveloped by the sheath formed beneath the positive filament and the substrate. Ion energies and fluxes incident on the particulate depend on dielectric properties of the underlying substrate material. Fluxes of photons, ions and radicals are recoded simultaneously with ion energy and angular distributions. By varying the dielectric constant of the substrate the energies of ions and fluxes of radicals can be controlled.

1. Introduction

We study the ion energy and angular distributions incident on dielectric curved surfaces of particles resulting from the intersection of a DBD filament with small particulates-bacteria suspended in air or residing on surfaces. In this contribution, the model *nonPDPSIM* is used [1,2]. The gas mixture is atmospheric-pressure humid air $N_2/O_2/H_2O$ = 79/20/1 at 300 K. The ion energies are simultaneously recorded along with the fluxes of photons, ions and reactive oxygen species.

2. Results and discussions

We show that the relative location of the particle with respect to the filament axis determines the asymmetry of treatment on a short plasma time scale. The particulates residing on the substrate can be partially or totally immersed in the sheath formed beneath the filament and the substrate. If the size of the particle residing on surface is smaller or commensurate with the width of the sheath region (which is typically 15-20 μm), the sheath may partially envelope the particulate. The electric field in the sheath can accelerate ions to energies as high as a few tens of eV. However, these ions arrive to the surfaces with grazing angles. In addition, the sheath region is depleted by electrons and ions as compared to the bulk. This fact is often ignored while considering the bacteria treatment with positive filaments in DBDs.

Ion and radical fluxes and ion energy and density incident onto the particulate may depend on dielectric constant of the underlying substrate materials (figure 1). By varying the dielectric constant of the substrate on which a particulate or bacteria reside the energies of ions and fluxes of radicals incident onto the surface can be controlled.

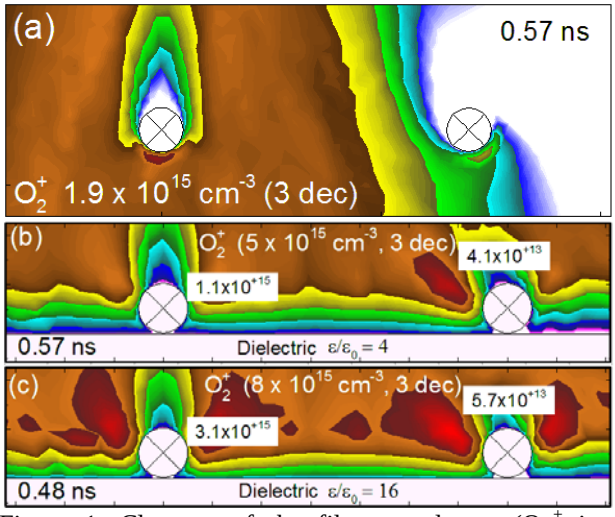

Figure 1. Close-up of the filament plasma (O_2^+ ions density) in vicinity of two particulates (20 μm diameter) suspended in air (a) and on the substrate surface with $\varepsilon/\varepsilon_0$ =4 (b) and $\varepsilon/\varepsilon_0$ = 16 (c).

Our investigation is relevant to the field of plasma medicine wherein the bacteria are treated for sterilization purposes. For this purpose, more study must be done on the size of particulate totally or partially enveloped by the sheath [3].

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3. References

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