Drift-diffusion modelling of a DBD volumetric reactor

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Non-thermal plasmas play a significant role in a large set of applications, ranging from the industrial and aerospace fields to agriculture and medicine. One of the most common techniques to obtain a non-thermal plasma is through a Dielectric Barrier Discharge (DBD) [1]. Although being well established devices, the operation of DBD reactors is governed by a number of complex physical mechanisms, that are worth investigating.

In this work we describe the implementation of a drift-diffusion model for the simulation of a volumetric DBD reactor such as the one sketched in Fig. 1 (Left), operating with atmospheric-pressure humid air. The aim of the model is to follow the temporal and spatial evolution of the main neutral and charged species produced in the discharge. We extend the code described in [2] by adding more realistic boundary conditions and expanding the set of considered gas phase and surface reactions. Indeed, charge accumulation on dielectric layers and kinetic source terms exert influence on the computed gap voltage and current density. An example of calculated values of such quantities is provided in Fig. 1 (Right). Finally, we introduce a numerical treatment of the electron dynamics based on coupling the Poisson equation with the Boltzmann relation, and compare the obtained results against a classic full drift-diffusion approach.

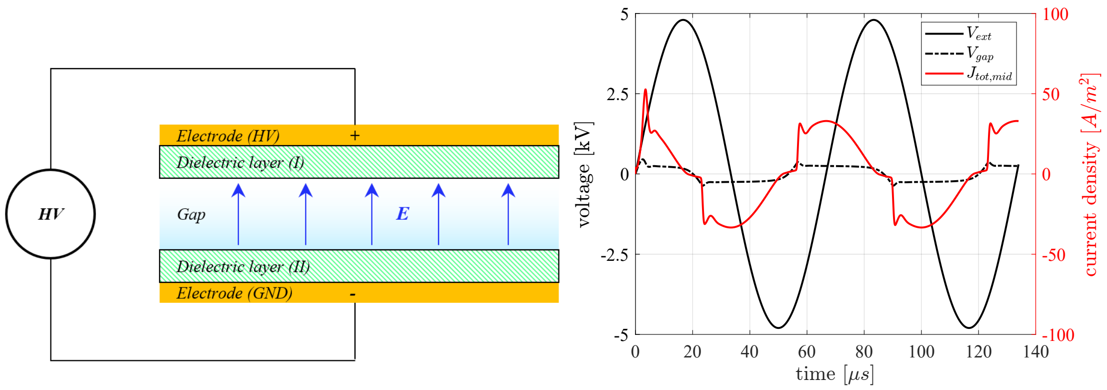

Figure 1: *Sketch of the modeled DBD reactor (Left); Applied voltage waveform, computed gap voltage and current density (Right).*

References

[1] U. Kogelschatz, Plasma Chemistry and Plasma Processing **23**, 1 (2003)

[2] A. Cristofolini, A. Popoli, and G. Neretti, International Journal of Applied Electromagnetics and Mechanics **63**, S1 (2020)