Interpretation of the charge-voltage plot derivative for surface dielectric barrier discharges

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ABSTRACT

Understanding the dependence of the applied voltage on the resulting power of surface dielectric barrier discharges (SDBDs) is of enormous importance for several applications [1]. Pipa et al. [2] developed a simplest equivalent circuit model for SDBDs which analytically describes the power-voltage dependence as relation $P \sim aV^3 - bV + c$. This model explains the variation between a quadratic and a cubic dependence observed in different experiments. However, a linear increase of the power with the voltage was observed for SDBDs at low applied voltages as it is only known from volume dielectric barrier discharges (VDBDs) [3]. Photographs with a long exposure time confirmed that in this voltage range the discharge does not expand along the dielectric.
To observe this and other DBD related phenomena we suggest a new method of analysis by plotting the charge derivative versus the applied voltage which we refer to as bow tie plot. This bow tie plot allows to interpret the experimental data in the framework of the equivalent circuit model [2]. E.g. the parameters α and C_0 of the model can be directly extracted from a linear fit of the experimental data. Furthermore, a method to determine the ignition voltage is shown. A comparison of the experimental determined parameters with those obtained by fitting the data revealed a good conformity.

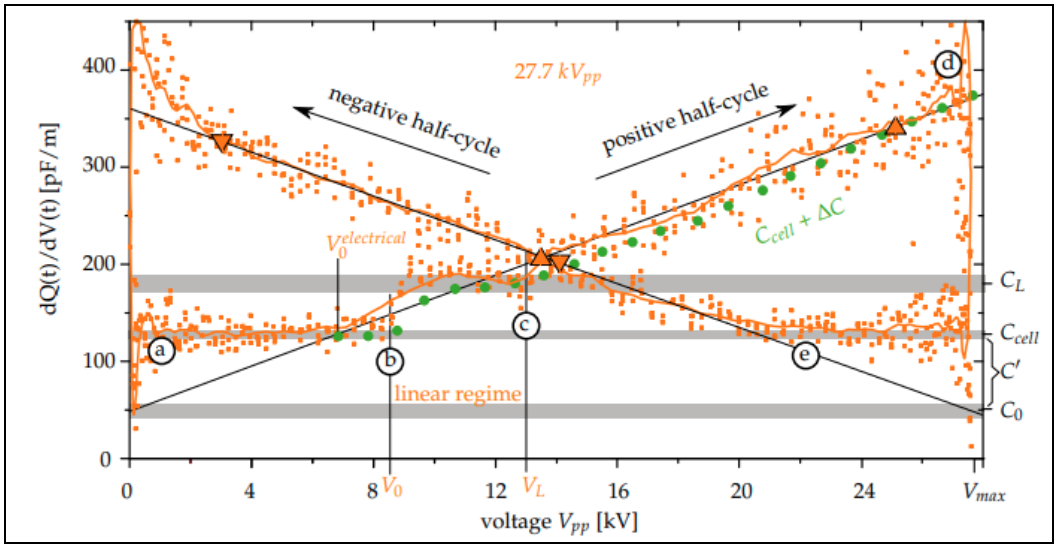

Figure 1 Plot of the charge derivative versus the applied voltage and data smoothing (orange data). The green dots represent an estimated capacity change from optical measurements. This bow tie plot allows to derive several modelling parameters from simplest equivalent circuit models.

References

[1] Lindner, M., Pipa, A., Karpen, N., Hink, R., Berndt, D., Foest, R., Bonaccurso, E., Weichwald, R., Friedberger, A., Caspari, R. & 415 Others Icing Mitigation by MEMS-Fabricated Surface Dielectric Barrier Discharge. Applied Sciences. 11, 11106 (2021)

[2] Pipa, A., Hink, R., Foest, R. & Brandenburg, R. Dependence of dissipated power on applied voltage for surface barrier discharge from simplest equivalent circuit. Plasma Sources Science and Technology. 29, 12LT01 (2020)

[3] Manley, T. The electric characteristics of the ozonator discharge. Transactions Of The Electrochemical Society. 84, 83 (1943)