Topic number

On the electrical properties of the surface DBD and its effect on the resonant power source operation

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The effect of the discharge on the resonant voltage source was studied analytically. The discharge was included into the resonant circuit as a variable capacitor with explicit function $C_p(t)$. This equation was obtained prom charge-voltage cycle The analysis of the resulting linearized equation for voltage perturbation by the discharge was performed by expanding the $C_p(t)$ function into Fourier series and deriving the appropriate coefficients for the harmonics of the perturbation. The aforementioned approach led to the determination of the mean surface charge, voltage decrease, power consumption, voltage nonlinearity, derived as combinations of Fourier coefficients of C(t) function.

Dielectric barrier discharges in surface configuration is widely used in a number of applications, from plasma chemistry to aerodynamics. The key characteristics of the barrier discharge, describing both dissipated power and charge amplitude, is a charge-voltage cycle (CVC). The CVC for surface discharges was studied qualitatively in [1]. The main goal of this work is to built the quantitative physically reasonable model of the system discharge load- power source The work summarizes the measurements of the CVC shape for a wide range of parameters, including operation voltage properties and electrode material and provides a theoretical analysis of the interaction between the discharge load with the resonant output circuit of the power source.

The CVC was measured for a sinuous voltage with various amplitude in the range 0.1-100 kHz, for various electrode materials. It is shown, that for a sufficiently high voltage the shape of the CVC can be described as a piecewise function, including the two "silent "regions and two parabolic regions for forward and backward strokes (fig.1).

The additional capacitance of the discharge can be modeled as $C_p(t)$=dQ/dU in accordance to [1].For lower voltage, the shape of the CVC in a backward stroke phase was shown to depend on the frequency of the supply voltage and the exposed electrode material.

The effect of the discharge on the resonant voltage source was studied analytically. The discharge was included into the resonant circuit as a variable capacitor with explicit function $C_p(t)$.

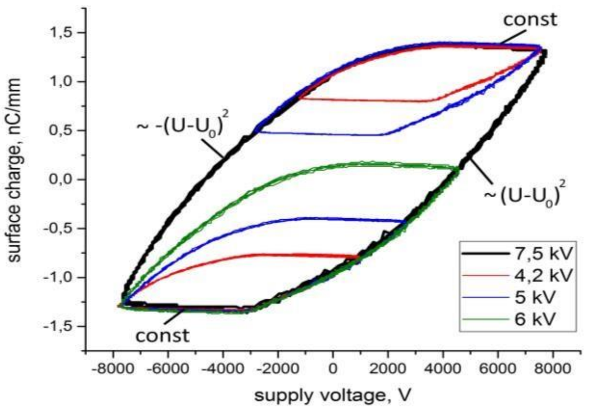

Fig.1 Charge-voltage cycle for different supply voltages

The analysis of the resulting linearized equation (1) for voltage perturbation by the discharge was performed by expanding the $C_p(t)$ function into Fourier series and deriving the appropriate coefficients for the harmonics of the perturbation.
The aforementioned approach led to the determination of the mean surface charge, voltage decrease, power consumption, voltage nonlinearity, derived as combinations of Fourier coefficients of C(t) function.

$$q_p'' + q_p\omega_0^2 - \frac{C_p}{C_0}\frac{U_{0a}}{L}sin(\omega t) = 0 \qquad (1)$$

References

[1] J. Kriegseis, S. Grundmann, and C. Tropea, *J. Appl. Phys.*, vol. 110, no. 1, p. 13305, 2011.