Effect of the Voltage Waveform on the Characteristics of a Dielectric Barrier Microdischarge

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Dielectric barrier discharges (DBD) have been known for a rather long time. The renewed interest in this type of discharge stems from the fact that dielectric barrier discharges at pressures close to atmospheric one have a wide range of applications—from plasma aerodynamics to plasma medicine and plasma decomposition of gaseous substances. The possibility to control the DBD parameters is of great practical importance. In addition to the influence of the frequency and amplitude of the feeding voltage, experimental studies of the effect of the shape of the feeding voltage on the discharge characteristics are very challenging. As for publications devoted to numerical analysis of the effect of the shape of the feeding voltage on the spatiotemporal characteristics on the DBD, they are very scarce in number. The aim of the present work was to numerically analyze the effect of the shape of the feeding voltage on the spatial and temporal characteristics of a DBD in argon. Two waveforms of the feeding voltage were considered: sinusoidal and square ones.

In this work, an extended fluid model describing the spatiotemporal characteristics of an atmospheric pressure dielectric barrier microdischarge in argon has been formulated. Numerical simulations have been carried out for sinusoidal and square feeding voltages in a wide range of external conditions. In particular, the spatiotemporal behavior of the charged particle densities; the strength and potential of the electric field; and the time dependences of the discharge current, the voltage drop across the discharge gap, and the charge accumulated on the right and left dielectric barriers have been calculated.

It is shown that the spatiotemporal characteristics of an atmospheric-pressure dielectric barrier microdischarge in argon depend on the shape of the applied voltage. For a square feeding voltage, two current pulses are always observed during one period, regardless of the voltage amplitude. For a sinusoidal feeding voltage, the number of current pulses per period increases with increasing voltage amplitude. This indicates that the spatiotemporal characteristics of the DBD plasma differ significantly for different shapes of the feeding voltage, the other conditions being the same.

The work was supported by Russian Science Foundation (RSF, grant № 17-79-20032) and Russian Federation Presidential Grant (grant № MK-539.2017.1)