degradation OF the thin corona electrodes in SURFACE barrier discharge

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The dielectric barrier discharge (DBD) is widely used in various applications, for example surface treatment, plasma chemistry, plasma medicine and biology, plasma aerodynamics. One of the most important requirements for devices based on DBD is the long-term stability of their characteristics, that is possible only with constant characteristics of the barrier discharge. As was shown in [1], at long exposures foil electrodes significantly change their morphology, which leads to significant changes in the discharge characteristics. In [2], it was shown that such changes are observed even when materials used are resistant to active plasma components.

In this work, the effect of discharge exposure on the characteristics of a surface dielectric barrier discharge in the case of using thin deposited electrodes made of copper, aluminum, and platinum is studied. The study was conducted for dischargers on a ceramic dielectric (alumina ceramics, thickness 1 mm), insensitive to the treatment in surface discharge plasma. The thickness of the electrodes was 0.5–2 µm. The electrode system was powered by a sinusoidal voltage with a frequency of 100 kHz and an amplitude of 3.4 kV. Exposure was carried out for 6 hours in air at atmospheric pressure with a weak air flow (protective hood).

To measure the electrical characteristics of the DBD, the volt-coulomb curves method was used, which allows to obtain the values of the power dissipated into the discharge, as well as to control changes in the discharge arrangement capacity without the discharge (cold capacitance) with an accuracy of 0.1 pF. An Olympus Lext OLS4000 laser confocal microscope was used to obtain pictures of the morphology of the electrode edges.

The structural changes of the electrode edge, their influence on the dynamics of microdischarges are investigated. It was found that the processes of degradation of electrodes from different materials are fundamentally different. It was shown that in the case of platinum electrode, blackening of the regions adjacent to the edge is observed, which is accompanied by some decrease in the cold capacity of the discharge arrangement. Also, deposition of metal on the dielectric areas adjacent to the electrode edge is observed. At the same time, there is a decrease of power dissipated in the discharge. Visually, the discharge operation mode does not change over time. In the case of using an aluminum electrode, a “parching” of the electrode is observed along the corona edge, accompanied by a significant decrease in the discharge arrangement’s cold capacity, as well as a decrease in discharge power by 40–60% from the initial one. When using a copper electrode, no decrease in the cold capacitance was observed. The discharge power increases by 30–50% of the initial one. Changes in the morphology of the copper and aluminum edges, as well as changes in the operates modes of discharge, have similar dynamics to those observed in the case of using foils of these materials, described in [1].

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References

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