Effect of accumulated charge desorption in atmospheric pressure dielectric barrier discharges

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Recently, atmospheric dielectric barrier discharges are widely applied to various fields, such as ozone generation, surface modification and so on. In dielectric barrier discharges, there are many parameters which affect to plasma significantly, so less attentions on interaction between plasma and dielectric surfaces. In the present paper, desorption of accumulated charges on dielectric surfaces is considered in atmospheric pressure dielectric barrier discharges using two dimensional fluid model. It is found that the waveforms of discharge current and voltage are similar to the results of no desorption case, however, electrons and ions in the vicinity of the dielectrics significantly increase with consideration of desorption, such as low secondary electron emission condition.

1. Introduction

Recently, atmospheric dielectric barrier discharges (DBDs) are widely applied to various fields, such as ozone generation, decomposition of toxics, surface modification, medical sterilization and so on. However, in dielectric barrier discharges, there are many parameters which affect to plasma significantly, such as dielectric materials and its thicknesses, geometries of electrodes, gas, gas pressure and gas mixtures, applied voltage waveforms, and so on. Less attentions on the interaction between plasma and dielectric surfaces and have been almost neglected. Golubovskii et al [1], simulated Atmospheric Pressure Townsend Discharges (APTG) using one dimensional fluid model. Recently, Itoh et al [2] also mentioned about desorption from dielectrics in DBDs. In the present paper, desorption of accumulated charges on dielectric surfaces is considered in atmospheric pressure dielectric barrier discharges using two dimensional fluid model [3,4] and the effect of desorption on DBD has been discussed.

2. Simulation model and Results

The present simulation model is the same as ref.[3,4]. 7.5kV and 200kHz sinusoidal voltage is applied to 760Torr Oxygen gas. Boundary condition at x=0, 0.6cm is periodical. And charges are accumulated on the dielectric surfaces. In the present paper, desorption from dielectric is considered.

Figure 1 shows the one cycle averaged spatial distributions of electron densities w/o and w/ the desorption effect. As shown in the figure*(a), electrons are locally generated and each high density regions consist of 5 filaments (streamers). However, with the considering desorption, high electron density regions are formed widely in x direction in the vicinity of the dielectrics. In the case of w/o desorption, electrons are recombine with ions on the dielectrics, but distributed on the dielectrics uniformly. In the case of w/ desorption, the accumulated electrons uniformly distributed on the dielectrics desorb gradually into the discharge space. As a result, total electron density in the discharge space becomes higher than conventional model. And only two kinds of streamers can be obtained with consideration of desorption case in spite of three without consideration of desorption case.

3. References

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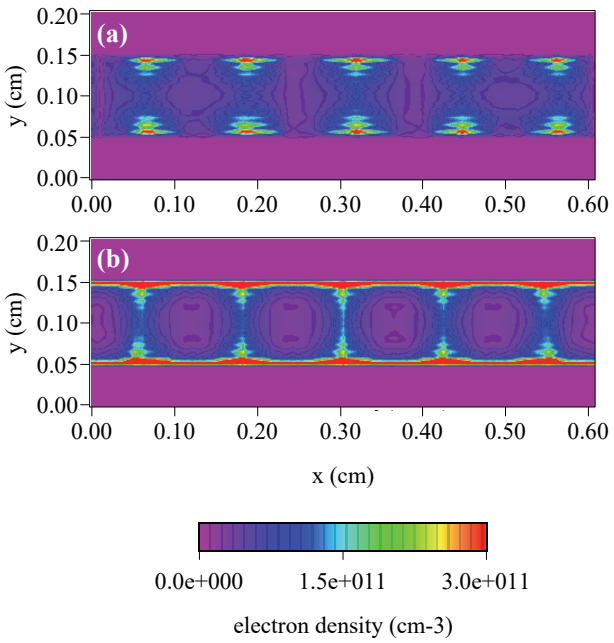

Fig.1. Spatial distributions of electron density (one cycle average). (a) without consideration of desorption. (b) with consideration of desorption.