INFLUENCE OF SURFACE CHARGES ON ELECTRIC FIELD DISTRIBUTION IN GAS NEAR DIELECTRIC SURFACE

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Abstract. Results of calculations of electric field distribution in gas near dielectric surface formed by an electrode tip are presented. The calculation program is based on fine element method and takes into account electric charges that are set on to the dielectric surface during the development of a surface discharge for positive half-cycle of the applied voltage. The aim of the work was to explain experimental data presented in [1] on the location of the surface discharge channels that develop about 0.5 – 1.6 mm above dielectric plate with an electrode on it. According to calculated results the distance between the channel and the surface is dependent on the surface charge density and on the character of its distribution.

1. INTRODUCTION

The experimental data that is presented in several papers [1,2] show that surface discharge (SD) constitutes of a series of streamers that appear at the edge of an electrode placed on the surface of a dielectric plate. The configuration of the applied electric field at the electrode edge depends on the electrode system and can have domination of a normal or a tangential component. For a coplanar electrode system a tangential component is the main one. In case of the electrode system such as in [1,2] and shown in Fig.1, the normal component dominates. It is usually believed that after its appearance the SD in such an electrode system as in Fig.1, develops along the barrier surface as a result of the influence of the normal component of the electric field.

The experiments described in [3], show that the streamer channels of the SD in the electrode system such as given in Fig.1, lay at a certain distance from the dielectric plate surface, the value of this distance being about 0.6 – 1.5 mm. It has been proposed that such a behavior of the streamer is the result of the influence of the charges that are set down on to the dielectric plate surface during the streamer development. The aim of the work was to analyze a possibility of the streamers to move at a distance from the barrier surface. A model of the streamer development near the dielectric surface is proposed in which the calculations of the electric field near the electrode edge take into account the field of the charges that are set on to the surface during the ionization processes in the gas.

CALCULATION MODEL

The calculation program is based on fine element method and is modified for an electrode system shown in Fig.1, which has been used for experiments in [3]. A thin electrode (an aluminum foil 30 μm in thickness) is placed on the surface of a dielectric plate made of ceramic ($\varepsilon = 9$), its thickness being about 1.5 mm. The high voltage electrode is placed on the other side of the dielectric plate (in the following called a barrier). The tip of the electrode, where the surface discharge appears, has radius of curvature about 10 μm.

The initial and board conditions of the calculation program and calculation algorithm are based on a physical model of the surface discharge processes that takes into account certain moments.

1. At the beginning of the discharge process the electric field at the electrode edge is formed by the applied high voltage and by charges of the polarization of the barrier material. The field of theses charges is opposite to the applied field formed by the electrode. For a positive electrode the surface of the dielectric barrier would be negatively charged as a result of the polarization.