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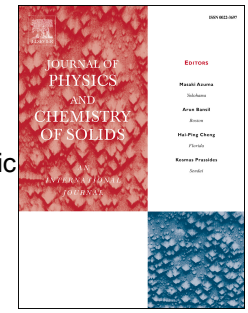

Numerical investigation of the optimal characteristics of a transverse layer of dielectric barrier in a non-uniform electric field

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Numerical investigation of the optimal characteristics of a transverse layer of dielectric barrier in a non-uniform electric field

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Abstract

A numerical equation to satisfy the effect of the transverse layer of a dielectric barrier located at a non-uniform electric field distribution resulting from a rod-to-plane gap configuration is presented. The accuracy of the presented numerical model has been investigated using a simulation model with the concept of finite element method. The investigation of the proposed numerical equation for studying the optimum location of the transverse layer of different dielectric barrier materials in a non-uniform field configuration has been assessed using COMSOL Multiphysics software. The effects of varying the barrier permittivity, position, and thickness on the electric field maximum values are introduced. The proposed numerical model effectiveness has been validated and evidenced by the good agreement between the simulated results and the proposed equation. The per cent error between the proposed numerical and the simulated models is less than 2.74%. The results show that, a thin insulating barrier that have low relative permittivity of the studied materials at 20% of the air gap, leads to a considerable increase in the value required for the breakdown voltage. Finally, from the numerical and simulation investigations regarding to the maximum electric field value, the barrier optimum thickness was found to be 1 mm.

Keywords: Dielectric barrier, optimum barrier characteristics, numerical calculation, electric field simulation, finite element method, COMSOL Multiphysics.

1 Introduction

Recently, the dielectric barrier (DB) has an increasing attention, especially in the dielectric barrier discharge (DBD) system applications [1]. Different experimental techniques have been presented to investigate the role of DB for proscription arc discharge through a gap subjected to a high electric field [2-7]. Also, the role of DB in industrial applications has been investigated by several experimental studies [8-12]. In the experiment of regeneration of diesel particles using nanosecond pulsed DB was presented considering the polarity and changing the applied voltage [8].

In the power generation and distribution systems, the DB plays an important role. This role is very clear in Gas Insulated Systems (GIS) [5]. GIS uses either pressurized sulphur hexafluoride (SF_6), atmospheric air, or gas mixtures with self-restoring gaseous dielectrics as insulating medium having SF_6 as one