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Simulation of a Multi-Hollow Surface Dielectric Barrier Discharge Device for Cold Plasma Generation

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ABSTRACT

Introduction: This research involved simulating a multi-hollow surface dielectric barrier discharge (MSDBD) device to examine the distribution of the electric field and its potential for plasma ignition. The aim was to identify essential areas where the electric field intensity increases, which play a crucial role in establishing conditions necessary for plasma formation at atmospheric pressure.

Materials and Methods: A two-dimensional model of the MSDBD device was developed using COMSOL Multiphysics 6.3. The geometry and material properties were configured based on experimental samples described in the scientific literature. In this model, a voltage of 5 kV was applied to the nickel and gold electrodes embedded within an alumina insulating layer. To accurately capture variations in the electric field, a highly refined mesh was employed, with element sizes ranging from 0.03 mm to 5.3 mm.

Results and Discussion: The simulation revealed an intense electric field buildup inside the cavities, particularly close to the walls. The peak electric field strength near the walls reached around 9 MV/m, whereas at the center, it dropped to roughly 5.8 MV/m. Both levels were significantly above air's breakdown limit at normal pressure –about 3 MV/m–suggesting that plasma could form in these regions. Changes in relative permittivity, electrode spacing, or surface shape noticeably influenced the field spread, highlighting the significance of material se3lection and exact sizing when building the MSDBD.

Conclusion: The simulations indicated that the designed MSDBD setup is capable of producing plasma when subjected to a voltage of 5 kV. This model serves as a valuable quantitative resource for predicting plasma dynamics, enhancing device design, and minimizing the need for continuous experimental trials. Such evaluations play a significant role in developing local technical expertise and advancing the biomedical uses of MSDBD-powered cold plasma sources.

Keywords: COMSOL Multiphysics, Cold plasma, Electric field simulation, MSDBD

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