Modelling Of Electric Field Distribution In A Non-thermal Plasma Reactor Using COMSOL Multiphysics®

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Abstract

The state of the art technology is moving towards more complex and multidisciplinary processes and systems. There is a growing interest in using Multi-physics simulations to have a better understating of the underpinning science of the processes as well as providing cost-effective solutions leading to practically realisable systems and products. The importance of the electric field and charged particle dynamics in various applications including but not limited to capacitive structures, batteries, plasma reactors, health care, an electrochemical processes in manufacturing, food industries, and climate studies has been recognised more than ever and it has highlighted the need for an in-depth understanding of the electrodynamics in such processes using computer modelling and simulation. In this work, electric field distribution in a non-thermal plasma reactor has been studied using COMSOL Multiphysics®. The model considered a cylindrical Dielectric Barrier Discharge plasma reactor with an axial high voltage electrode surrounded by a cylindrical glass tube as a dielectric with a ground electrode on the outer circumference of the dielectric. Non-thermal plasma is generated using nitrogen gas that occupies the space between the axial HV electrode and the inner surface of the dielectric. The electric field distribution in the gas gap is investigated with respect to applied potential, frequency, dielectric property of the material, and space charge. Figure 1 shows the basic geometry of the non-thermal plasma reactor that was studied. The electric field at different cross-sections of the reactor is shown in figure 2 and the surface electric field at ground electrode edge is presented in figure 3.The effect of the distance between the HV electrode and the dielectric surface was investigated for different dimensions to obtain the required electric field to initiate and sustain the plasma in the gas gap (Figure 4). Further investigation was carried out to design an encompassing Faraday cage to avoid Electromagnetic interference.

Figures used in the abstract

Figure 1 : Figure 1- Geometry of the system

Figure 2 : Figure 2- Electric field norm at different tube cross section level- 20kV voltage

Figure 3 : Figure 3- Surface electric field norm at ground electrode edge (Z=0.15, V=20kV)

Figure 4 : Figure 4- Parametric results for tube diameter at 20 kV voltage)