INFLUENCE OF SURFACE CHARGES ON THE STRUCTURE OF A DIELECTRIC BARRIER DISCHARGE IN AIR AT ATMOSPHERIC PRESSURE: EXPERIMENT AND MODELING

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Abstract. The Dielectric Barrier Discharges (DBD) in air at atmospheric pressure and at low frequency are mainly constituted of thin transient plasma filaments (or microdischarges) with radii of a few hundreds of micrometers. Plasma filaments are initiated by streamers, starting from a high-field region. The plasma filaments deposit charges on the dielectric plate which screen the electric field and lead to an extinction of the discharges filament. In this work we experimentally demonstrate the synchronous start of several filaments in a time range of less than a few tens of nanoseconds and we show that the charges deposited on the dielectric have a strong impact on the discharge structure. This is validated using a simple electrostatic model. Modeling the streamer dynamics in an inhomogeneous field and its interaction with a charged dielectric is a much more difficult task. First simulation results of the streamer are presented.

1. INTRODUCTION

Currently, Dielectric Barrier Discharges (DBD) are widely used for various industrial applications [1], [2]. At atmospheric pressure (for inter-electrode gaps between a few millimeters and a few centimeters) DBD are generally constituted of one or several plasma filaments, also called microdischarges. In such a regime, the very short duration (a few tens of nanoseconds) and the unpredictable feature of the triggering of a filament, make them difficult to study experimentally. Guikema *et al.* [3] observed self-organized patterns of microdischarges (for frequency on the order of a few kHz in noble gases) controlled by the residual surface charges on dielectric surfaces. Recently, Guaitella *et al.* [4] described the bimodal behavior of the statistical distribution of current peaks in a cylindrical DBD, and they concluded that the high-current peaks group was due to the self-triggering of several filaments (supposed to be correlated by a radiative effect), called "collective effect" (see also [5]). They also studied the impact of this effect on the injected energy in the discharge, which directly controls the chemistry. More recently, we have shown that an auto-organization of microdischarges similar to [3] in space and time was possible in air at atmospheric pressure and low frequency (50Hz) [6] and demonstrated that this behavior was also controlled by phenomenon of charge deposition upon the dielectric. The influence of the charges deposited on a dielectric surface in a DBD is then essential to understand the behavior of the discharge. In this work, we have carried out experiments and simulations to further understand the interaction of a discharge with a dielectric surface at atmospheric pressure. First, the study is carried out experimentally between the cylinder tip and the dielectric plane. Secondly we compare the results with an electrostatic model, and then we present the results of the simulation of the streamer discharge dynamics between a hyperbolic needle and a metallic cathode plane.

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