

# HEXAGONAL AND HONEYCOMB STRUCTURES IN DIELECTRIC BARRIER DISCHARGES

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## Abstract

We present an experimental study of a Dielectric Barrier Discharge (DBD) under conditions of pattern formation. An intensified CCD camera is used to analyze the time evolution of the patterns during one cycle of the voltage waveform. The formation of a hexagonal pattern of filaments in a transient, glow-like regime is observed, followed by a honeycomb structure that corresponds to a Townsend discharge occurring outside the regions delimited by the previous filaments. A 2D fluid model can reproduce these features and is used to help interpreting the experimental results.

## 1. INTRODUCTION

Non equilibrium discharges are essentially nonlinear physical systems that can manifest a variety of instabilities. Dielectric Barrier Discharges (DBDs) [1] at or around atmospheric pressure are known to exhibit different forms depending on conditions (pressure, gap length, voltage amplitude and frequency, gas mixture ...)[2,3]. In some very specific situations the plasma can be homogeneous, but in most cases the plasma is composed of filaments that can be self-organized in space, synchronized or not in time, or apparently chaotic.

A large variety of patterns can be observed in DBDs, the simplest of them being stationary hexagonal filament arrangements, stripes or concentric ring patterns, and some of them exhibiting complex dynamic behaviors. Some of the observed patterns are typical of reaction-diffusion systems, and these discharges therefore provide flexible and experimentally convenient objects to study non-linear reaction-diffusion systems.

The main purpose of the present work is to investigate hexagon pattern in neon trough experimental and numerical modeling studies. The first part of this article presents electrical measurements and high speed imaging of a hexagon structure, the second part shows numerical results that qualitatively reproduces the experimental results.

## 2. EXPERIMENTAL CONFIGURATION

The experimental setup is schematically shown in Fig 1. It consists of an electrode system placed in a vacuum chamber, a high voltage ac power supply and an image acquisition system connected to a personal computer. The electrode system has a sandwich-like structure. Between two thin dielectric glass plates, three spacers maintain a constant gas gap at 1 mm in the experiments reported below. The electrode system is hold by a PVC structure. In order to investigate pattern formation, transparent electrodes have been used. Those transparent electrodes are made of a copper mesh inside a PET film and are stuck on the back of the glass plates. They provide good homogeneity of the electric field thanks to the high conductivity and small thickness of the mesh.