

TIME RESOLVED BROADBAND SPECTROSCOPY OF NITROGEN DIELECTRIC BARRIER DISCHARGE AROUND ATMOSPHERIC PRESSURE

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Abstract. Our investigation was focused on the observation of the visible and near infrared emission spectra of dielectric barrier discharge (DBD) at various discharge conditions. We observed molecular nitrogen (2nd positive, Herman infrared) and oxy-nitrogen compounds (NO gamma, O-N₂ green) systems. Spectra were acquired in range from 200 to 900 nm with 5 μs time resolution. Synchronized nitrogen emission systems lead to evaluation of ro-vibrational distribution within observed systems in various discharge conditions (time and pressure dependence).

1. INTRODUCTION

Dielectric barrier discharges (DBD) represent an example of high pressure discharge with unique combination of non-equilibrium and quasi-continuous behavior [1,12]. DBD in different configurations became an important discharge for a broad range of studies both in research and in direct technological applications during the last years. A broad study of DBD properties concerning filamentary or glow character of the discharge, investigation and modeling of its physical and chemical properties and application has been done by Massines et al. [f.e. 2-5,13,15,16]. There are also other publications dedicated to electric or spectroscopic simulation of DBD e.g. [6,7].

In our case we are working with filamentary DBD. Our aim is to study the vibrational excitation of various nitrogen systems during the discharge in various conditions. As showed by Simek et al. [8-10] simultaneous observation of emitted spectra could be used as an efficient monitoring tool for discharge behavior (metastable states concentration). In contrast to our last observation of DBD [14] where we were focusing on comparing vibrational excitations of nitrogen 1st positive and Herman infrared systems in this work we set the experiment (nitrogen flow adjustments) to conditions where the 1st positive system vanishes. Thanks to that we had non-perturbed spectra of Herman infrared. Also with a different spectrometer we were able to cover the 2nd positive, NO gamma and N₂-O green transitions.

2. EXPERIMENT

A simple scheme of our experiment is presented in Figure 1. The setup is designed to achieve variable conditions for discharge generation for different pressures, gas flow, input power, frequency and discharge configurations. The discharge reactor (Figure 2.) has a rigid steel construction suitable for both low and high pressure (up to 3 atm.) measurements. The discharge is generated between two parallel electrodes covered by Al₂O₃ dielectrics with a form of a round cup (with 2 cm bottom diameter and 1 mm dielectric thickness). The length of a discharge gap is variable up to several mm. Gas is injected into the system after the flow regulation just over the discharge gap. The output is situated at the end of the reactor together with the pressure measurement and regulation valve. A rotational pump is used in case of lower (than atmospheric) pressures.