LIF Observation of Ground-State OH Radicals in DC Nozzle-to-Plane Positive Streamer Corona

M. Kocik*,[1], J. Mizeraczyk[1], S. Kanazawa[2], and T. Ohkubo[2]

[1]Centre for Plasma and Laser Engineering, The Szewalski Institute of Fluid Flow Machinery, Polish Academy of Sciences Fiszera 14, 80-231 Gdańsk, Poland
[2]Department of Electrical and Electronic Engineering, Oita University, 700 Dannoharu, Oita 870-1192, Japan

Abstract: In this study, the planar LIF detection of the hydroxyl (OH) radicals was performed in a nozzle-to-plane electrode system having an electrode gap of 30 mm during the steady-state positive streamer corona discharge at atmospheric pressure. For monitoring the ground-state OH radicals, OH transition at 282 nm was used. The two-dimensional OH distribution in the DC corona discharge in air/H_2O/Ar mixture was measured. The time relationship between the regular streamer coronas, laser pulse, OH fluorescence and laser-induced streamer was measured. The time course of OH radicals between the successive streamers was measured for the evaluation of OH dynamics during the steady-state positive streamer corona discharge. The two-dimensional OH distribution in the DC corona discharge was observed. The obtained results showed that the ground-state OH radical were generated mainly in the filamentary part of the streamers. It was found that LIF detectable amount of ground-state OH radicals stayed in the region where streamers propagate during the steady-state DC positive streamer coronas.

Introduction

Streamer coronas at atmospheric pressure play an important role in the non-thermal plasma processing of harmful gases. The streamer coronas generate radicals e.g. hydroxyl (OH) radicals, which enhance the plasma chemical reactions in the reactor. The direct study of the streamer-induced plasma chemical processes in non-thermal plasma reactors is of great importance. Laser-induced fluorescence (LIF) is a useful diagnostic method for *in-situ* observation of the phenomena during the non-thermal plasma processing of gaseous pollutants. The LIF has been already employed by us (*1, 2*) and others (*3-6*) for studying NO molecule processing in various non-thermal plasma reactors.

The LIF method for measuring the concentration of a given gaseous species consists in the excitation of this species using a laser radiation and in measuring the intensities of the fluorescence induced by the laser radiation. Usually the laser induced fluorescence comprises the emission of several spectral lines which are characteristic for the given species.

Recently, several researchers succeeded in measuring the OH radicals using LIF technique in the pulsed corona discharges (*7-9*). However, there are still no experimental data of OH radicals concentration in the DC corona discharges. This is mainly due to difficulties in the synchronization of the DC corona streamers, LIF signals and observation time. The DC positive corona discharge consists of more or less regular self-repetitive current pulses (streamers) with a pulse duration up to several hundred nanoseconds and repetition frequency in the range of 1 to 100 kHz. When the DC voltage is high enough, the inception probability of each DC corona current pulse is one. However, the inception time-lag of the DC corona current pulse usually fluctuates. On the other hand, OH radicals lifetime is short (up to 1 ms), and to perform the LIF measurement of OH synchronization of laser excitation and LIF signal recording with DC corona streamers is necessary.

In this study, the planar LIF detection of the hydroxyl radicals (OH) was performed in a nozzle-to-plane electrode system having an electrode gap of 30 mm during the steady-state positive streamer corona discharge at atmospheric pressure. For monitoring the ground-state OH radicals, OH transition at 282 nm (1-0 band) was used.

One of the purposes of the present paper is to make clear whether DC streamer corona generate OH radicals or not. A second purpose is to observe the state of OH radicals during steady-state positive streamer corona discharge if OH radicals are generated.

Experimental Set-up

The schematic diagram of the experimental apparatus is shown in Figure 1. In order to observe the ground-state of OH radicals in the reactor using

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*E-mail address: kocik@imp.gda.pl