How ozone seems to influence the gas breakdown voltage in diffuse dielectric barrier discharges operated in air?

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Abstract: This contribution investigates how the production of ozone in a plane-to-plane dielectric barrier discharge operated in air affects the gas breakdown voltage. It is found that the gas breakdown voltage increases when the gas residence time increases and this seems correlated with the creation of ozone recorded by absorption spectroscopy.

1. Introduction

Diffuse dielectric barrier discharge (DBD) has been observed in air and studied since the last decade [1]. However, as it was observed with other gas, before to obtain the diffuse discharge, there is one to many filamentary discharges [2]. This transition from filamentary to diffuse discharge regime is due to many processes enabling the production of seed electrons. Gas breakdown voltage is a good indication of the seed electrons creation: the lower the gas breakdown voltage, the higher the source of seed electrons. Attachment on electronegative species such as ozone can consume seed electrons between successive discharge and can thus strongly modify discharge ignition. This work focuses on the study of the evolution of the gas breakdown voltage as a function of the creation of ozone during the discharge.

2. Experimental details

The vessel and discharge configurations and electrical measurement details are provided in a previous publication [3]. In this study, the gas flow varies between a few sccm to 4 slm to change the ozone concentration. Electrical measurements are made using a segmented electrode, allowing spatially resolved electrical characteristics (as a function of the gas residence time in this study) [4]. As for the ozone density, it is measured at about 2 cm from the discharge inlet after one minute of discharge by absorption spectroscopy, using a deuterium lamp, and calculated by $-\ln(I/I_0)/(\varepsilon \times L)$, where I is the lamp emission after passing through the plasma, I_0 is the lamp emission without plasma, ε is the absorption cross section of ozone and L is the absorption length (here the length of the discharge: 3 cm).

3. Results and Discussion

As shown in Figure 1, the gas breakdown voltage increases with the gas residence time in the diffuse air discharge, which is counterintuitive for a DBD. Indeed, in N_2, we observe in previous studies a huge decrease of the breakdown voltage with the gas residence time and this was attributed to the production of seed electrons thanks to gas phase reactions [4]. In air, the results shown in Figure 1 reveal that the gas residence time has a "negative" impact on the seed electrons production. This could be due to density variation of electronegative species in the discharge affecting seed electron creation through attachment processes. In air, the principal electronegative species produced during the discharge is ozone [5]. Based on absorption spectroscopy measurements, the results presented in Figure 1 confirms that the population of ozone increases with gas residence. In addition, it can be seen that the gas breakdown voltage increases linearly with the

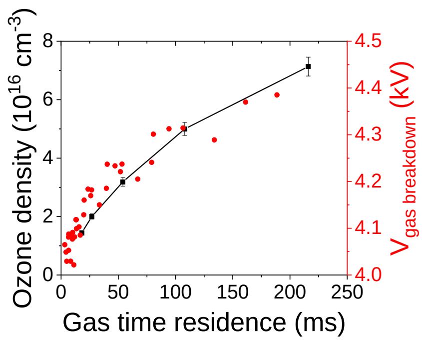

Fig. 1. Gas breakdown voltage and ozone density for different gas time residence

ozone density. Thanks to spatially resolved electrical and optical diagnostics, it can therefore be confirmed that ozone production play an important role on seed electron production and thus on the gas breakdown voltage in in diffuse dielectric barrier discharges operated in air.

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