BEHAVIOUR OF THE CN EMISSION WITH THE DISCHARGE REGIME

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Abstract. The emission spectra of a plane-to-plane dielectric barrier discharge were studied, during a deposition process in a mixture of hexamethyl disiloxane (HMDSO) and nitrogen. The emission of the violet system of CN (series = 0) appeared to be strongly influenced by the discharge regime. It was found that filamentary discharge would enhance the production of carbon atoms in the discharge that recombine to form CN and C_2 molecules. Furthermore, thanks to a NanoSIMS50 analysis, the production of CN_x micrometric particles during the process was highlighted in a filamentary discharge. This may be the result of a C and N recombination process in the gas phase that leads to the formation of particles, which deposit onto the surface.

INTRODUCTION

The dielectric barrier discharges are known to produce either filamentary or homogenous discharge [1]. When the homogenous discharge is obtained with nitrogen as carrier gas, the term Townsend discharge is employed. The effect of a treatment in a homogenous discharge was shown to differ from the one in a filamentary discharge [2, 3]. Massines et al reported using nitrogen that the optical emission from the discharge depends on the discharge regime [1]. Nevertheless, this emission was not deeply treated when a precursor is introduced in the discharge for coating purposes. However the emitting species could be representative of the reactions taking place in the plasma bulk and during the plasma surface interactions. The aim of this study is to understand the occurrence of some reactions during the process, as a function of the discharge regime, and for a given gas mixture.

The emission of a dielectric barrier discharge during a deposition process in a HMDSO/N_2 mixture was studied, in both Townsend and filamentary regimes. The emission of the violet system of CN ($B^2\Sigma^+ \rightarrow X^2\Sigma$) was influenced by the regime of the discharge. We firstly studied the emission of CN as a function of the applied frequency, for two different inter-electrode distances. We also observed the role of the HMDSO concentration in the discharge in filamentary discharges.

1. EXPERIMENTAL SET-UP

The reactor was designed to produce both glow and filamentary discharges. The volume was less than 175 cm^3, which allowed controlling the gas composition without a preliminary pumping system, but with an appropriate gas flow rate. The first experiments in pure nitrogen demonstrated that a Townsend discharge was produced, which indicates a concentration of oxygen lower than 500 ppm [4]. The electrodes were positioned in a plane-to-plane geometry. The plasma was created on a 8.0 cm^2 rectangular surface. The inter-electrode distance was adjusted from 0.5 to 1 mm. Electrodes were made in stainless steel, and both covered with a 1 mm thick glass, used as the dielectric material. The gas was injected through the inter electrode distance with a total flow rate of 7.0 l/min.

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