EFFICIENCY COMPUTATION OF CURRENT CONTROLED EXCILAMPS

Bhosle S.[a], Piquet H.[a], Diez R.[a], Lomaev M.I.[b], Tarasenko V.F.[b], and Zissis G.[a]

a) LAPLACE, Université de Toulouse, 118 route de Narbonne, 31062 Toulouse cedex 9, France
b) IHCE, Russian Academy of Sciences, 2/3 Akademichesky Avenue, Tomsk 634055, Russia

Abstract. The coupling between the power supply and a Dielectric Barrier Discharge (DBD) for UV production purposes (excilamp) is a major issue for the design of powerful and efficient UV sources. In order to improve this coupling, new power supply topologies have been developed, based on the current control of the DBD. The aim of this paper is to present the modeling results of such a control on the performances of the excilamp.

1. INTRODUCTION

Dielectric Barrier Discharge (DBD) established in rare gas or rare gas/halogen mixtures (excilamps) are promising sources of high power Ultraviolet or Vacuum Ultraviolet (UV or VUV). Their specific properties such as efficiency, high power and mercury free, make these lamps especially suited for various industrial applications [1]. Previous researches have shown that these sources are especially efficient when supplied in pulsed mode [2], [3], [4], [5], and efficiencies above 60% were reported for DBD in xenon [8]. It was shown that the optimum parameters for supplying these excilamps are voltage pulses of some kilovolts applied at frequencies of some tens of kilohertz (around 100kHz) with a duty ratio about 1%. Unfortunately, these values can hardly be achieved with a high voltage switching topology for the power supply and, most of the time, a step-up transformer is used to generate the high voltage pulses. In this case, the strong coupling between the inductive nature of the transformer and the capacitive load of the excilamp leads to a ringing which might affects the efficiency of the system. As a result, the most important issue nowadays for a high efficiency excilamp system is to improve the coupling between the excilamp and the power supply.

In [7] was presented a power supply topology which would improve the UV output control of an excilamp in generating current pulses instead of voltage pulses. The aim of this paper is to evaluate, on a model, the effect of a current source controlled DBD on its UV emission. In a first part, sine wave is considered and in the second part, current pulses are applied in the model.

2. MODEL DESCRIPTION

We have developed a Partial Differential Equation (PDE) based model [9] for a planar double-dielectric layer Xenon excilamp. The plasma is assumed homogeneous and side effects around the electrodes are neglected. The computation is consequently performed in 1D, along the axis of the geometry similar to the one presented in [6]. The thick of the dielectric layers are 2mm, the gas gap is 4mm and the Xenon filling pressure is $5.33 \bullet 10^4$Pa (400Torr). The model solves the drift-diffusion equations for the species considered in the model coupled to Poisson's equation.

A voltage supplied DBD is modeled in imposing a potential on both outer sides of the dielectrics. This leads to two Dirichlet boundary conditions for Poisson's equation. Usually, one side is grounded and the other is held at the voltage chosen for the modeling. A current supplied DBD is modeled in grounding one side of the outer surface of a dielectric and in imposing the electric field, which is proportional to the time integral of the current, on the outer surface of the other dielectric: