NEW MODULATED PULSED DRIVING SIGNAL FOR EFFICIENT EXCITATION OF DBD DISCHARGES

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Abstract. We demonstrate a driving voltage waveform with the aim to optimize the system efficacy value of a fluorescent dielectric barrier discharge (DBD) light source. The waveform is suitable to produce stable spatially homogeneous Xe DBD plasma possessing high electrical to VUV Xe_2^* excimer radiation (~172 nm) energy conversion efficiencies, and in addition requires significantly less complex and higher efficiency electrical driver unit compared to the pulsed waveform generator. Simulation results predict improved discharge efficiencies above 60 %. Most power deposited into the plasma efficiently produces Xe_2* excimers, while other energy dissipation processes (ion heating, e-Xe elastic collision) are kept at a low rate. Simulation and experimental results are compared in terms of discharge efficacy and show good agreement.

1. INTRODUCTION

Generating incoherent UV and VUV excimer radiation by means of dielectric barrier discharge (further called DBD) excitation of rare gases and rare gas-halides represents a promising concept for novel types of excimer lamps. Much research has been devoted to develop and optimize such lamps and related processes, since they are of great practical use.

Recent investigations show that Xe dielectric barrier discharges have achieved high efficiency (more than 60%) by a well defined excitation procedure, using high voltage unipolar pulses [1]. By producing regular starting conditions for the electrons – in short, to pulse them - the discharge appearance also changed from filamentary mode to form separate glow discharge domains ore to become spatially entirely uniform. However pulsed excitation requires high voltage, complex electrical ballasts which usually operate only at moderate efficiencies. Total high system efficiency requires efficient ballast as well. Ballast efficiency ratio between modulated sinusoidal and pulsed drivers is about three-fold.

2. DESCRIPTION OF THE BURST WAVE

The purpose of this work to demonstrate an amplitude-modulated high frequency (~ few MHz) sinusoidal waveform that is suitable to produce a stable spatially homogeneous Xe discharge plasma possessing a high electrical to VUV energy conversion efficiency. The waveform can be considered an interim waveform between sinusoidal and pulsed wave, and is called hereafter as burst wave (figure 1).

The concept behind the burst wave excitation is that we attempt to prevent the formation of the cathode sheath and the ionization wavefront to reach the barriers by changing the polarity of the applied voltage in a rate that is comparable to the time needed for the ionization wavefront to bridge the gap (in the order of 100 nanoseconds in case of pd value of 100-300 mbar cm). However, as charging cannot be completely avoided, after few voltage polaritiy change we install zero voltage idle

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