Experimental study of chlorine effect on krypton chlorine excilamp

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An experimental setup for studies of Dielectric Barrier-Discharge (DBD) Excilamp in Mixtures of Krypton and Molecular Chlorine is presented. A pulsed excitation for KrCl* excilamp is used for its efficiency. The oscillograms of the applied voltage, the total current, and the displaced charge are presented. The spectral characteristics of the DBD KrCl* excilamp that emit in the wavelength range 200–300 nm are presented. It is dominated by the wavelength at 222 nm of KrCl* excimer. The effect of chlorine concentration on the total power density is presented. The optimum concentration of chlorine is found between 0.5 to 1 relative to 250 of krypton

In the last decade interest in pulsed light sources for production of incoherent ultra-violet (UV) and vacuum ultra-violet (VUV) radiation, particularly in excilamps, has grown. The excilamp is a gas-discharge source of UV and VUV radiation based on nonequilibrium spontaneous radiation of excimer or exciplex molecules [1–2]. Excilamps have a relatively narrow-band spectrum of radiation that distinguishes them from luminescent and thermal radiation sources.
The purpose of our experiments was to investigate how the chlorine concentration affects the power density of krypton chlorine excilamp.

We have used a coaxial DBD excilamp with internal and external cylinder radius of 20 mm and 43 mm respectively. The barrier quartz, with a thickness around 1.5 mm, is used as the dielectric material with a transmission coefficient 86.7% at a wavelength of 222 nm. The confined volume within 8.5 mm of gap is filled with a mixture of Krypton and molecular Chlorine. An aluminium half cylinder (diameter 19.4 mm and length 45 mm) is used as internal electrode, which is connected to the pulsed power supply. The outer surface of cylinder was covered by a copper mesh acting as electrode (diameter 44 mm) . A pulse voltage with a maximal value of 5 kV and a rise time of 200 ns is applied across the excilamp, with an adjustable frequency from 30 to 140 kHz. The discharge emission spectrum is measured with a high-resolution spectrometer (Ocean Optics B.V. HR4000, 2400-grooves/mm diffraction grating) in the spectral interval 200–1100 nm and its spectral resolution of 1 nm. Furthermore, we have used a UVC photodetector (hagner SD8-C-002) placed on the excilamp wall.

The detected spectrum consisted of two bands, the intense band of KrCl* at 222 nm and the lower band of Cl_2* at 258 nm. In our experiments, we have varied the concentration of chlorine of mixture. The electrical input power was determined from both voltage and current oscillograms or from both voltage and displaced electrical charge signals.

The electrical oscillograms of the used exciting pulses are shown in figure 1-2.

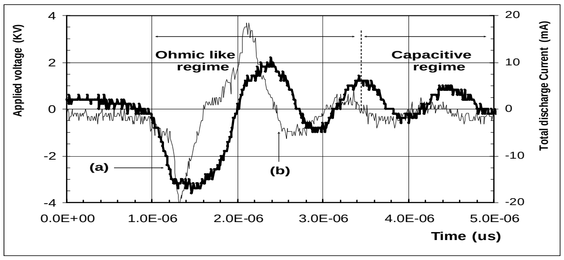

Figure 1: Typical waveforms of the voltage (*a*), current pulses (*b*), **at 120Khz and 1.0us of width.**

The ohmic like and capacitive regimes of the pulse are observed in figure 1. The peak in the total discharge current is observed in figure 1 where the applied voltage is constant about 200 ns as shown clearly by V-I characteristic in figure 2.

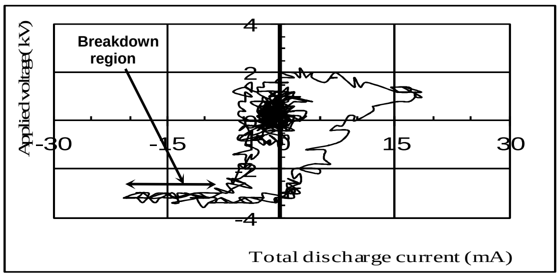

Figure 2: Lissajous V-I applied voltage on total discharge current

The effect of chlorine concentrations in the mixture of Kr–Cl_2 is given in figure 3. The optimized results were obtained for the concentration between 0.5 and 1 of chlorine in mixture with Kr: Cl_2 = 250: (1–0.5) as shown in figure 3. As the Cl_2 content in the mixture was decreased, the uniform mode of bulk discharge became more homogeneous but the emission UV irradiance decreased. An in the Cl_2 content in the mixture led to a discharge contraction by means of the formation of bright channel (filamentary mode), which was also accompanied by a decrease in the emitted power (few numbered filaments).

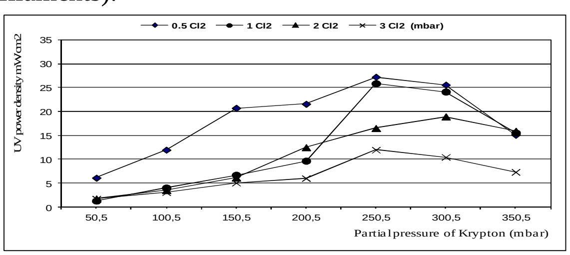

Figure 3: UV irradiance with partial pressure Krypton and chlorine at frequency of 100 kHz and width of 1.0 μs, taken on the excilamp wall.

References

[1] S. M. Avdeev , A. M. Boichenko , E. A. Sosnin , V. F. Tarasenko , S. I. Yakovlenko Laser Physics, 2007, Vol. 17, No. 9, pp. 1119–1123.
[2] R P Mildren and R J Carman, J. Phys D: Appl.Phys. Vol. 34, no. 1, L1-L6, 2001