PLASMA PROPAGATION ALONG THE LONG POSITIVE COLUMN PLASMA: I. LIGHT SIGNAL OBSERVATIONS

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The light propagation along a long positive column has been observed in a fine-tube fluorescent lamp and a general lighting fluorescent lamp, such as a cold cathode lamp (CCFL), an external electrode lamp (EEFL), and a hot cathode lamp (HCFL). The observations are conducted in the operation of DC voltage as well as AC voltage. However, these observations of light propagation along a long positive column is the first report in 70-years history of long discharge lamps such as neon-sign lamps, fluorescent lamps for general lighting, and CCFLs and EEFLs for LCD-TVs.

The experimental observations are summarized as: (i) Light always propagates from the high voltage side to the ground. The propagation direction is independent of the electron drift velocity u_d whose directions are varied according to the electric field with polarity of the applied voltage. (ii) The speed of light propagation is u_p~(10^5-10^6) *m/s* according to the lamp current. The light propagation velocity is u_p~10^5 *m/s* at a low current ~1 mA. As the current increases at the normal glow, the propagation velocity also increases over 10^6 *m/s*. (iii) The optical signals represent the type of ripple wave as $O(t)=O_o+dO\sin\omega t$. When the operation frequency is ω_o in AC-voltage, the frequency of optical ripple wave is $\omega=2\omega_o$, 2-times of AC-operation frequency. At a low current before breakdown, the signals decay along the z-direction of positive column as $O(t, z)=O_o+dO\exp(-z/z_D)\sin\omega t$. The decay scaling is about the lamp length L as z_D~L. At the normal glow of high current, the optical signals would not decay much with a large decay scaling as $z_D>L$ and the ripple ratio is about dO/O_o~20-30 % [1].

1. G. S. Cho, J. H. Kim, J. M. Jeong, B. Hong, J. Koo, E. H. Choi, J. P. Verboncoeur, H. S. Uhm, “Electron plasma wave propagation in external electrode fluorescent lamps.”, Appl. Phys. Lett. Vol. 92, No. 2, 2008, p. 021502.