Mechanism of High Luminous Efficiency in Delta Color Arrayed, Enclosed Sub-pixel Structured AC PDP with High Xe Content

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Abstract

We investigated the effect of Xe content variation on the luminous efficiency of two different sub-pixel types, i.e., segmented electrode in delta color arrayed enclosed sub-pixel (SDE) and conventional stripe barrier type, in an ac plasma display panel through three-dimensional numerical simulations. The conventional cell type was found to have higher VUV generation efficiency as compared with that of SDE structure, but as the Xe content increased, the SDE type showed higher improvements in efficiency due to the lower plasma loss to the barrier walls.

1. Introduction

Recently, PDP(Plasma Display Panel)s with high Xe content (>10%) and high total pressure (>400torr) have attracted considerable attention, because high luminous efficiency could be obtained for high sustain voltages in the high Xe partial pressure gas condition [1-2]

An analysis reported the improved electron heating efficiency under high Xe content, high gas pressure as the mechanism for high luminous efficiency discharge [3].

In this work, we investigated the characteristics of luminous efficiency with the Xe content variation from 5 to 12.5% in two different cell geometries, the conventional and SDE types and delineated the mechanism for higher luminous efficiency improvement with SDE type.

2. Results

Our simulation model consists of the ray-optics code in conjunction with the three-dimensional plasma simulation code whose detailed descriptions can be found in Ref. [4].

Fig. 1 describes the schematics of the PDP cell used in our three-dimensional simulation model. The cell size of a sub-pixel for conventional structure was 820 280 160 and for SDE structure 420 560 160 which were the dimensions of one sub-pixel in 42″ PDP with XGA resolution.

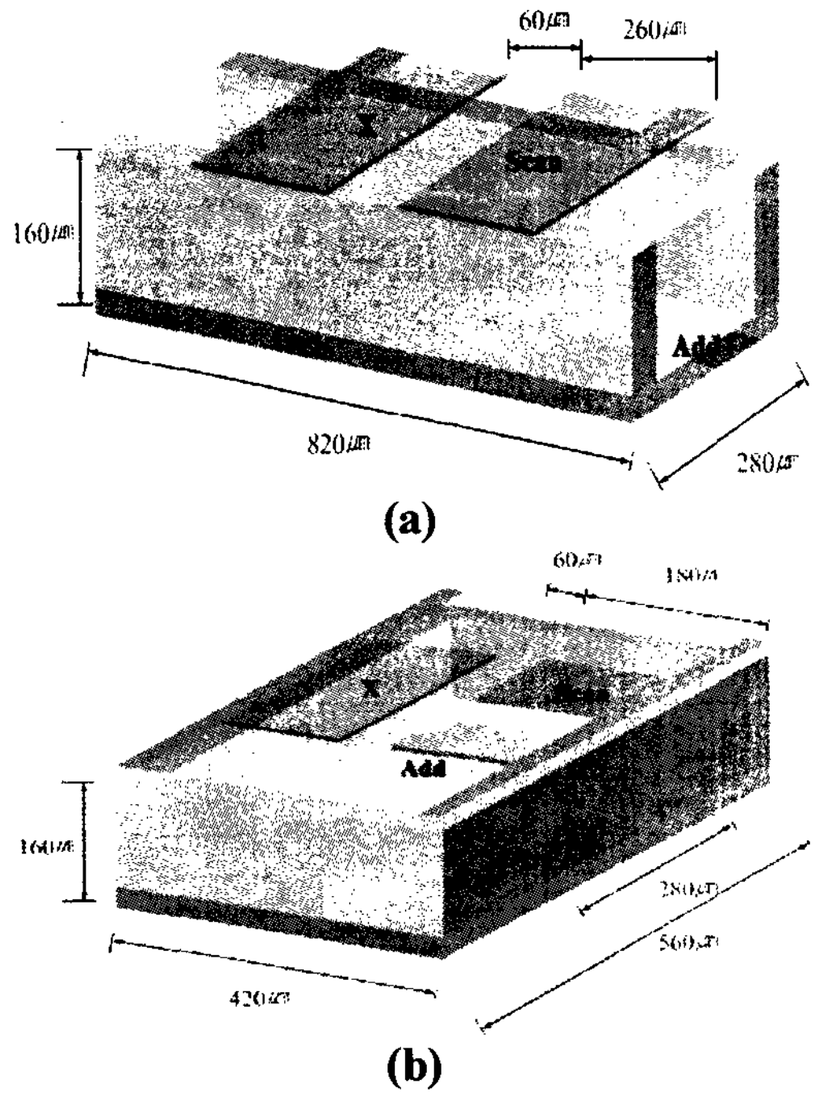


Fig. 1 Schematics of the PDP cell used in our simulation model (a) Conventional structure (b) SDE structure

Fig. 2 shows the VUV generation efficiency where VUV efficiency is defined as the ratio of the energy of total VUV photons emitted during one sustain pulse to the electrical energy dissipated in the discharge. The VUV generation efficiency of SDE structure is lower than that of conventional type. However, the increment of VUV efficiency is higher in SDE structure as the Xe content increases.

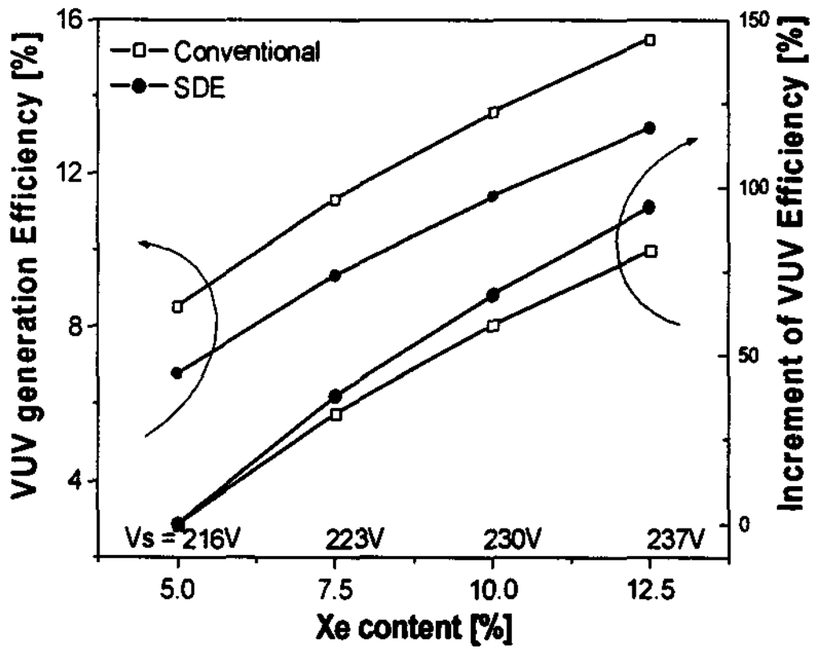
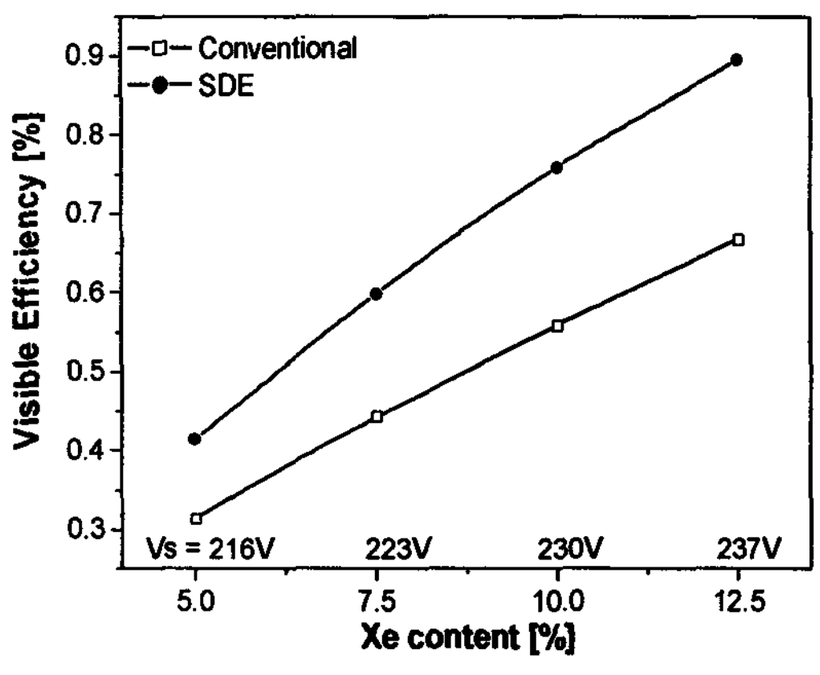
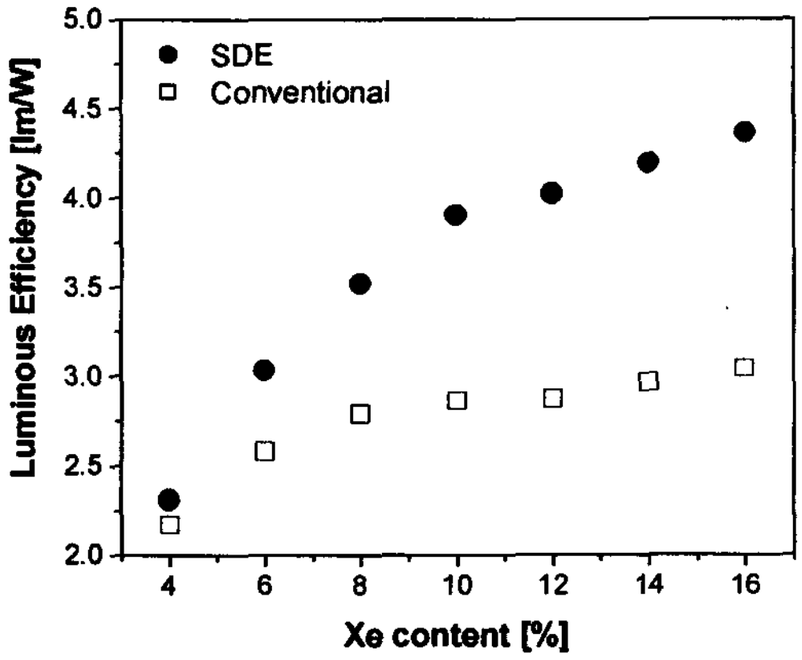


Fig. 2 VUV generation efficiency

Fig. 3 shows the simulation and experimental results of visible light luminous efficiency with Xe content variation in conventional and SDE structure, where we can see that SDE structure shows higher luminous efficiency value and bigger increment in efficiency with the increase of Xe content than the conventional structure does. These figures show that the simulation result agrees well with the experimental result. In Fig. 3(a), the shadow effect due to barrier ribs is incorporated into the simulation for the visible light luminous efficiency calculation by the use of ray optics code which results in high visible luminous efficiency with SDE structure [5].



(a)

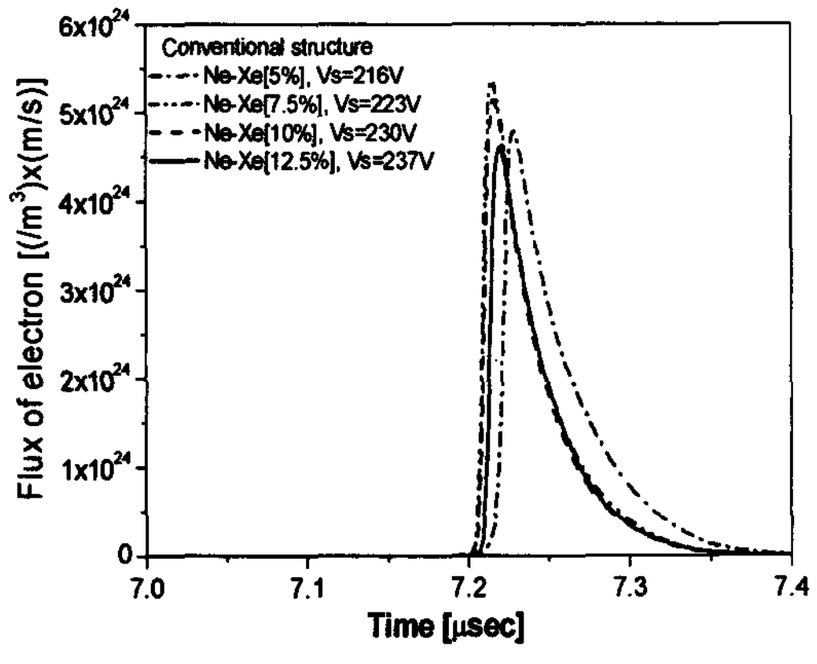


(b)

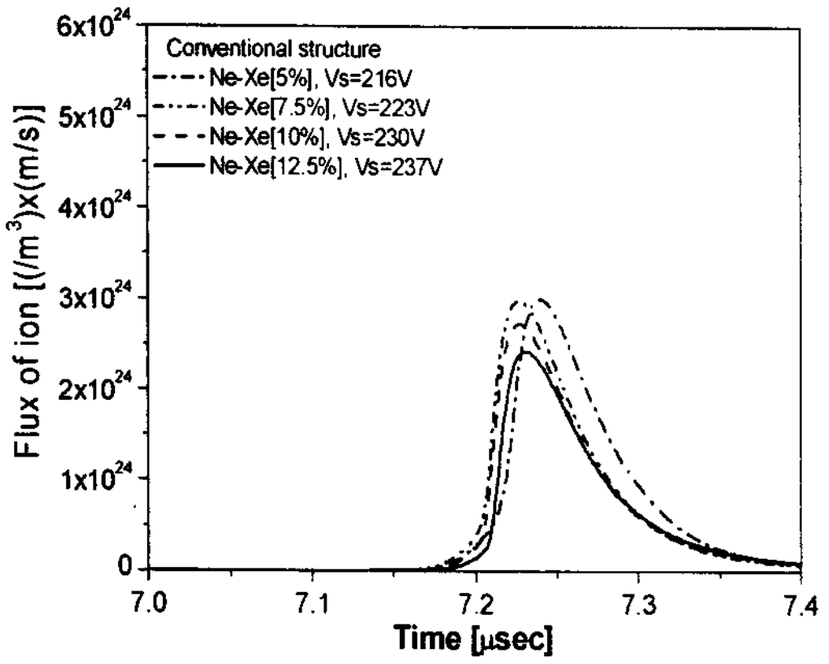
Fig. 3 Luminous efficiency with Xe content variation in conventional and SDE structure (a) Simulation and (b) Experimental result

In order to analyze the mechanism for the discharge characteristic of higher increment in the improvement of luminous efficiency in SDE structure with higher Xe content, a detailed analysis of the flux of charged particles toward barrier walls has been carried out.

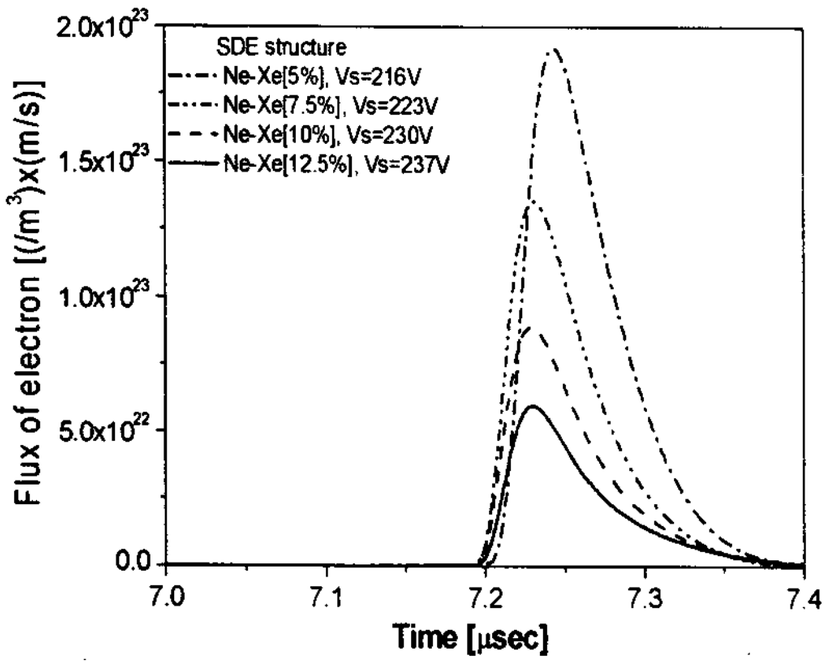
Fig. 4 shows the flux of charged particles toward side barrier ribs in each cell. The conditions for boundary flux could be found in Ref. [4].



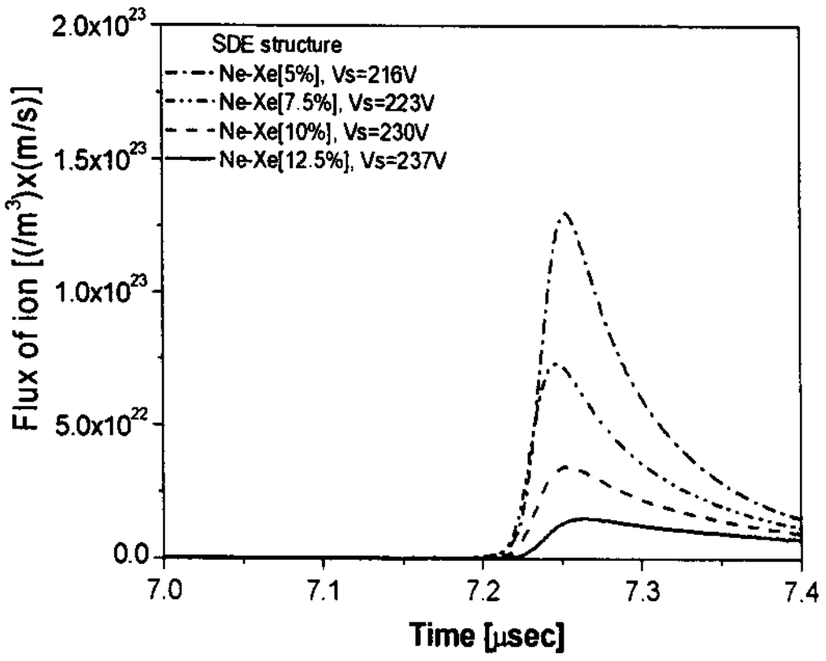
(a)



(b)



(c)



(d)

Fig. 4 Flux toward side barrier ribs (a) conventional structure's electrons (b) conventional structure's ions (c) SDE structure's electrons (d) SDE structure's ions

There are important differences in the decrement of lost particle flux toward side walls as Xe content increases between the two cell structures. The SDE structure shows much bigger decrements in both of the electron and ion fluxes toward the walls and this is because it has larger separation between the center of electrode and the side walls. Since the higher Xe content discharge results in a more constricted discharge volume due to the effect of more local and stronger cathode sheath as shown in Ref. [6], the plasma loss toward the side barrier walls reduces as the Xe content increases, which would results in increased improvement in the VUV and visible light luminous efficiency as the Xe content increases.

When considering the total plasma loss toward horizontal barrier ribs, top and bottom surfaces as well as side walls, Fig. 5 shows the increment of lost flux with Xe content variation. The SDE type shows smaller increment of plasma loss with increasing Xe content than the conventional type does.

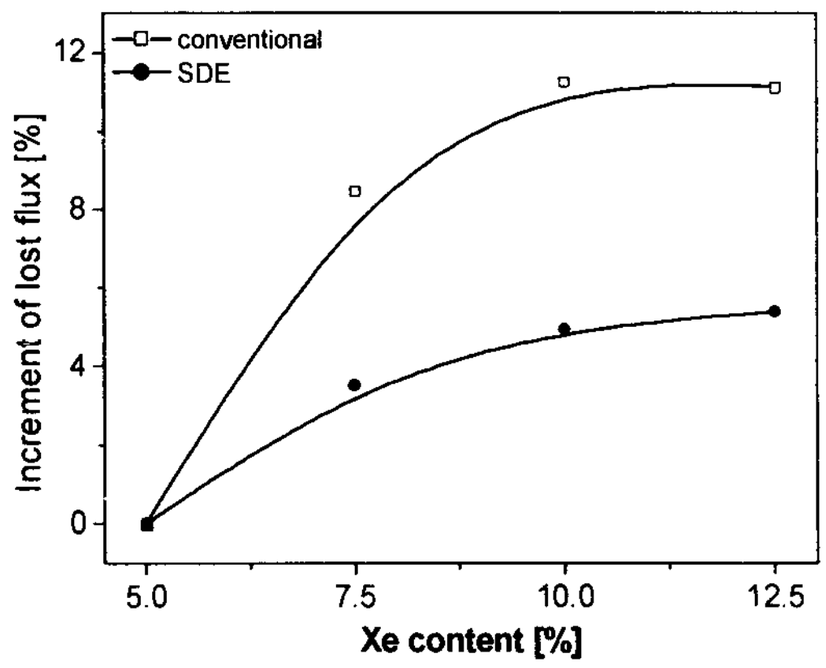


Fig. 5 Increment of lost flux

3. Conclusion

The conventional stripe structure showed higher VUV generation efficiency due to its relatively larger electrode length than that of the SDE structure. On the other hand, when the transport efficiency of visible light from phosphor surface through top plate is considered, the visible light generation efficiency of SDE structure becomes higher than that of the conventional stripe one. The higher increment of luminous efficiency improvement with high Xe content in SDE structure turned out to be due to the reduced plasma loss toward the barrier walls.

4. References

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