Electric field distribution and discharge characteristics in accordance with various ITO electrode structures in AC-PDP

Seok H. Cho, P. Y. Oh, J. H. Kim, Y. J. Hong, G. C. Kwon, G. S. Cho and E. H. Choi

Charged particle beam and plasma laboratory / PDP Research Center, Department of Electrophysics, Kwangwoon University, 447-1 Wolgye-Dong, Nowon-Gu, Seoul, Korea
lupy79@kw.ac.kr, Phone : +82-2-940-5662, Fax : +82-2-913-6187

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Abstract

In this study, the electric field distributions have been investigated by simulation in accordance with the various shapes of ITO-electrodes. Also we have measured the density of excited Xe atoms in the $1s_5$ state in discharge cell, where the gap distance of 60 um, gas pressure of 400 Torr, Xe contents of 7%, and sustaining voltage of 200 V are kept in this experiment. The maximum density of excited Xe atoms in the $1s_5$ state in a discharge cell for the fish-boned, T shaped and squared ITO electrodes have been measured to be 3.01×10^{13} cm^{-3} , 2.66×10^{13} cm^{-3} and 2.06×10^{13} cm^{-3}, respectively. It is shown that the electric field distribution with different ITO Electrodes is essential factor for these maximum density of excited Xe atoms in discharge cell.

1. Introduction

Plasma display panel have been noticed as advanced display panel. And the market is growing drastically every year. But there are several problems as low brightness, efficiency and so on. To improve PDPs luminous efficiency, it is needed to search for optimization of plasma display panel(PDP) cell's design. The surface discharged alternating current plasma display panels utilizes the photoluminescence phenomena of phosphors excited by vacuum-ultra-violet(VUV) rays from mixture gas included Xe. The xenon atoms in the 1s4 resonance state generates the VUV 147 nm and the 1s5 metastable state forms to the molecular dimmer throughout the three body collisions to emit the 173 nm VUV light in the Xe plasma. It is found that the intensity of VUV 147 nm emission is proportional to that of the infrared (IR) 828 nm emission, and the VUV 173 nm emission is roughly proportional to that of the IR 823 nm emission. In general, the discharge characteristics are very different from a PDP cell with different shapes of ITO electrodes, since the discharge paths are so different for their corresponding electrode structures. Recently, we have measured the excited Xe atoms density in the 1s5 state by laser absorption spectroscopy(LAS)[1-2] for various shapes of ITO electrodes in alternating-current plasma display panel(AC-PDP) cell. It is of great importance to investigate the electric field distribution and corresponding discharge characteristics of the excited Xe atoms density in the $1s_5$ state for various shapes of ITO electrodes in alternating-current plasma display panel(AC-PDP) cell. The electric field distribution for the different shapes of ITO electrodes has been studied by simulation program.

2. Experimental

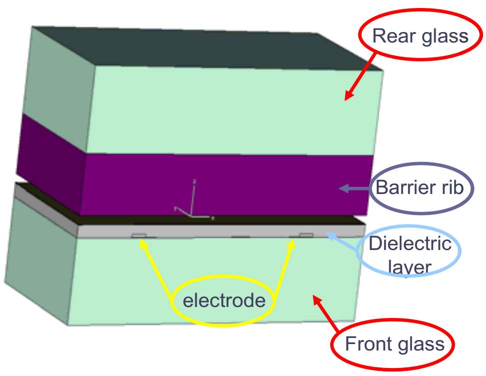


Figure 1. Simulation PDP cell

Figure 1 shows a simulation cell of AC-PDP. The thickness of front and rear glasses is 2.8 mm, the sustaining Ag electrode has 5 um, dielectric layer is 30 um, and MgO protecting layer is 1um in thickness and barrier rib is 160um in height.

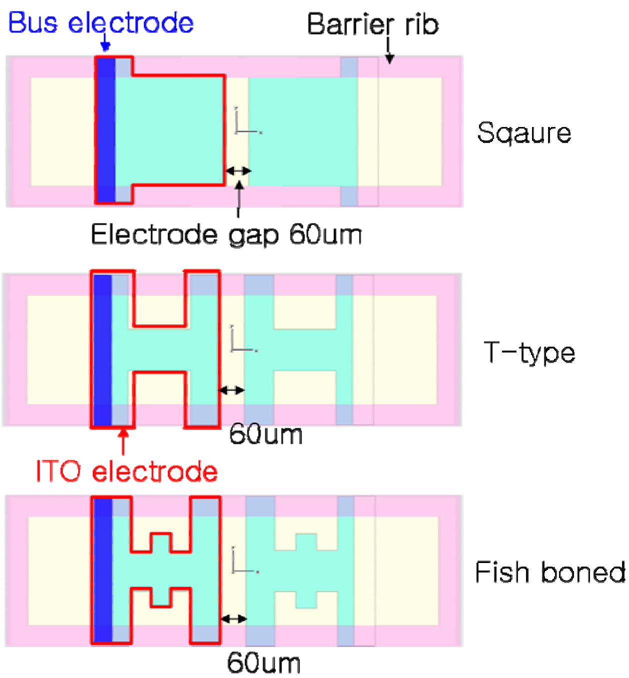


Figure 2. Various ITO electrodes

Figure 2 shows various ITO electrodes used in the simulation. Dimension of a discharge cell is 220 um x 440um. All of ITO electrodes have 60 um in gap distance. The applied voltages are +100 V to the anode and -100V to the cathode, respectively.

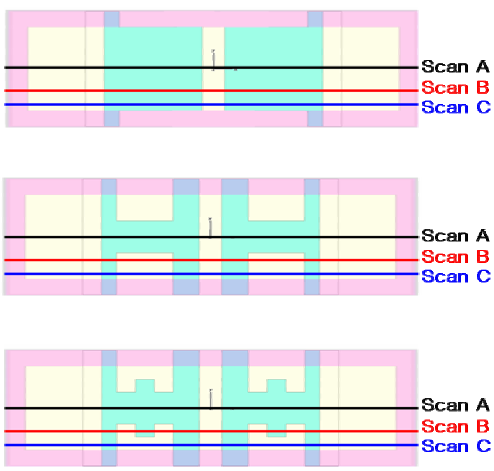


Figure 3. Scanning position by simulation for various ITO electrodes

Figure 3 shows scanning positions for various ITO electrodes in the simulation. The scanned A position is set to be 0 um, B is 72 um and C is 115 um in this study.

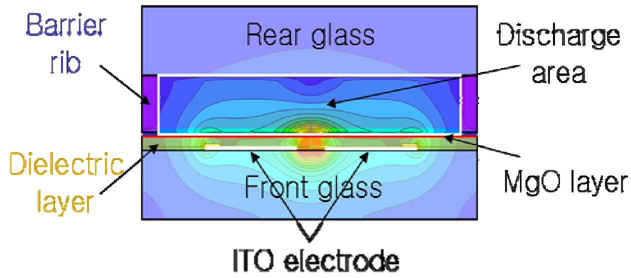


Figure 4. Cross sectional view of the scanning line

Figure 4 shows cross sectional view of the scanning line in this simulation. We have investigated the potential distribution in discharge space.

3. Results and discussion

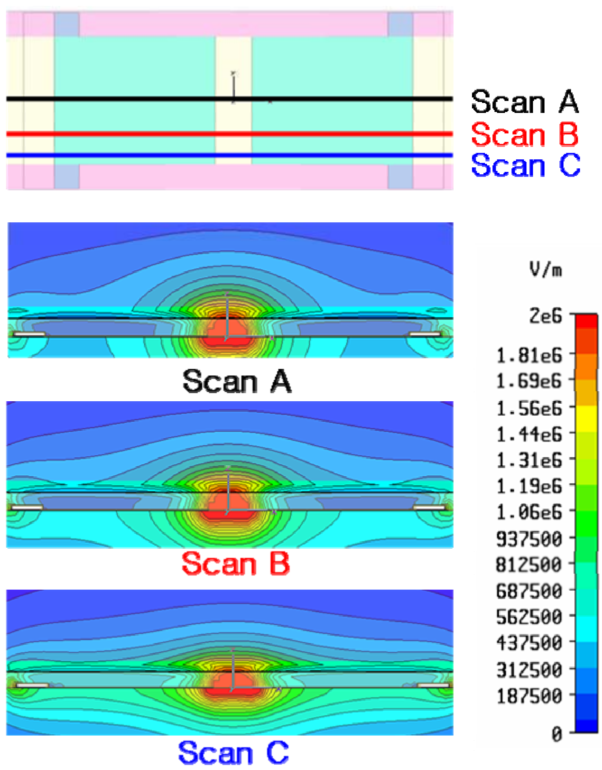


Figure 5. Potential profiles in square-typed ITO

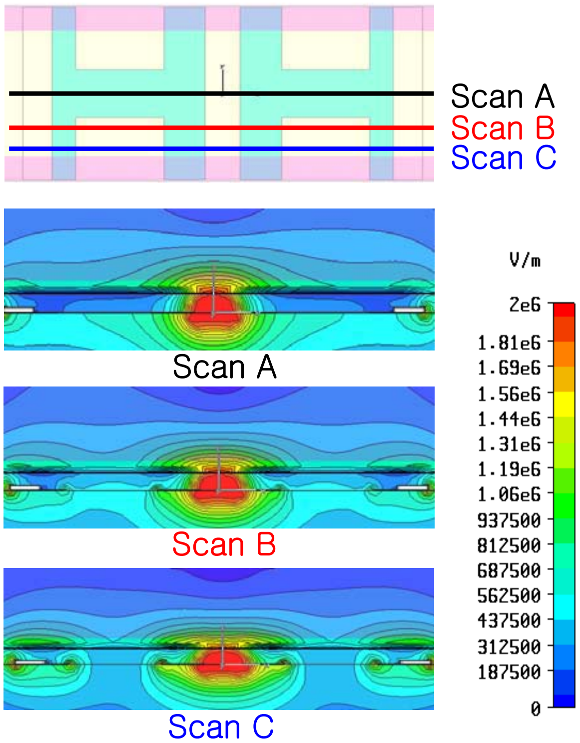


Figure 6. Potential profiles in T-typed ITO electrode

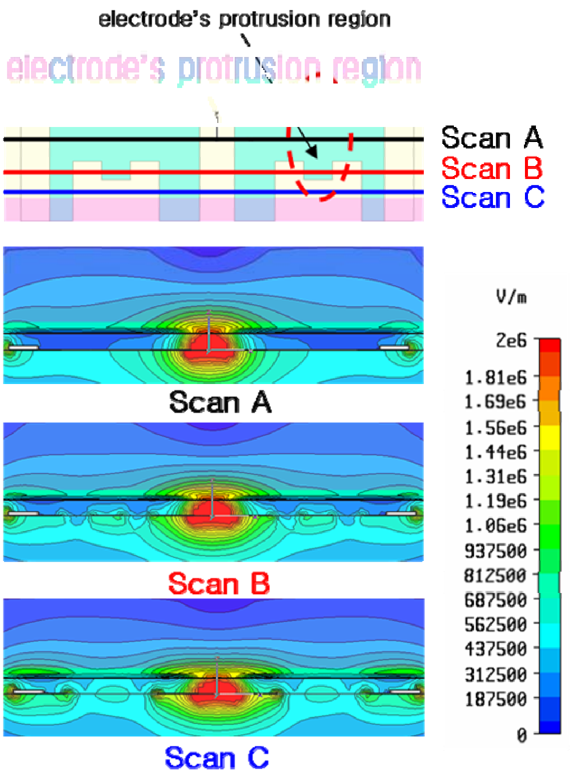


Figure 7. Potential profiles in fish boned **ITO** electrode

Figures 5-7 show the potential distribution profiles for squared, T-shaped and fish boned ITO electrodes, respectively, in each scanning position of A, B, and C. The potentials look like to be almost identical profiles especially at the electrodes gap region for all ITO electrodes and scanning positions.

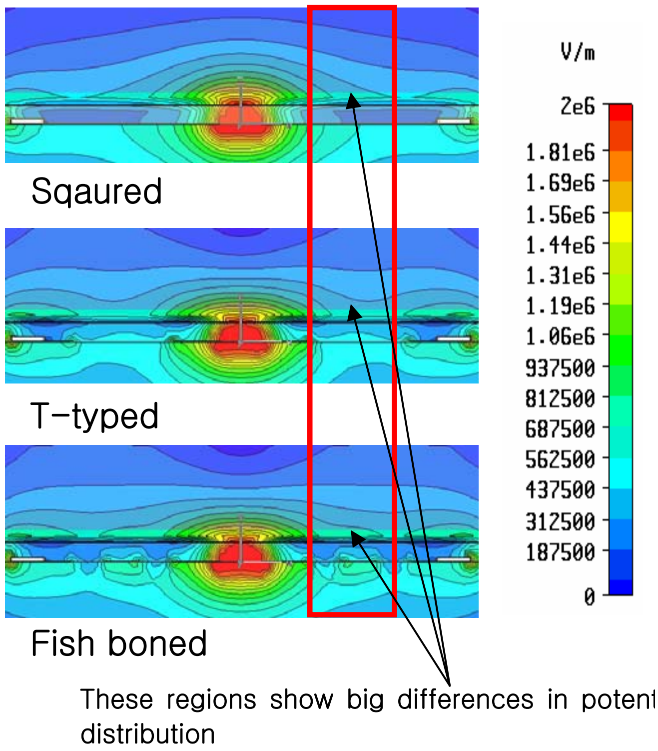
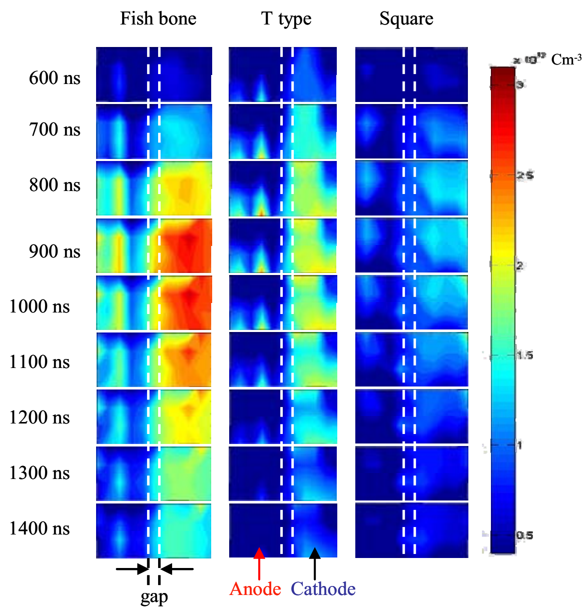


Figure 8. Potential distribution for various ITO electrodes at the scanning position B

Figure 8 shows the potential distribution for each of various ITO electrodes along the scanning position B. Especially the potential profiles at the electrode's protrusion region are denoted by the red rectangular box for the various ITO electrodes. It is noted that the potentials around this electrode's protrusion region are seen to be remarkably higher than those for the other shapes of ITO electrodes.



Sustain voltage 200V

Figure 9. Spatiotemporal distribution of excited Xe atoms density in the 1s5 state in accordance with the various ITO-electrodes in AC-PDP

Figure 9 shows spatiotemporal distribution of excited Xe atoms density in the $1s_5$ state, which have been obtained by the laser absorption spectroscopy, in accordance with the various shapes of ITO-electrodes in AC-PDP. In comparison with the conventional squared ITO, the fish-boned has wider and higher excited Xe atom density than those for the T-shaped and squared ITO electrode. It is noted that the excited Xe atom density of 3.01×10^{13} cm^{-3} for the fish boned electrode is almost the two tiles of that for the squared one. This wider and higher density profiles for this fish boned ITO electrode might be caused by the electric field distribution around the electrode's protrusion region, which is remarkably higher than those for the other shapes of ITO electrodes.

4. Summary

The wider and higher density profiles for the fish boned ITO electrode might be caused by the electric field distribution around the electrode's protrusion region, which is remarkably higher than those for the other shapes of ITO electrodes. It is concluded that the fish-boned ITO structure has the best performances of excited Xe density and VUV efficiency in AC-PDPs[3].

5. References

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