Optimization of Geometries and Optical properties in PDP Cells

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Abstract

The detailed studies regarding to the front and rear panel geometries and optical properties of composed layers were needed to improve the luminance and efficiency. 3-dimensional optical code can be used to analyze the variation of geometries and the changing of optical properties. The visible light distributions and illuminance results were simulated depending on the bus electrode position, ITO geometries and optical properties of dielectric layer. As the ITO area was decreased and the bus electrode was located at the outer part of cell, the illumination was increased. And we could find quantification which is related between dielectric layer and visible light distribution of PDP cell.

1. Introduction

Plasma Display Panel (PDP) is display device which is composed of a large number micro-discharge cell. A cell structure in a PDP is changed or designed in order to improve the luminance, luminous efficiency and addressing characteristics. Typically plasma code has been used to design and optimize the PDP cell before the real panel was made [1-2]. Recently the demand of high resolution display having more than 768 scan-lines is increased compared to the demand of common display with 468 scan-lines. It is mainly due to the start of high definition (HD) digital broadcasting. with the same size of panel, as the resolution is increased, the cell pitch is decreased. If the cell pitch is decreased, it is very hard to achieve the high luminance and high efficiency. The detailed studies regarding to the front and rear panel geometries and optical properties of composed layers, such as dielectric layer, ITO (Indium-Tin-Oxide), reflective layer, black matrix and etc. were needed to be performed.

3-dimensional optical code [3] can be used to analyze emission rays from the phosphors on the rear panel. The emitted rays can be reflected, transmitted or absorbed depending on the properties of confronted layers. The variation of geometries, such as height, shape and slope of the barrier rib, thickness of the front dielectric layer, position of the black matrix, and etc. can be simulated with the optical code. Also changing of optical properties, such as reflectance, transmittance and absorbance of each layer can be accounted. The result of optical code will be a useful data when designing Recent structure of PDP cell.

2. Model and simulation conditions

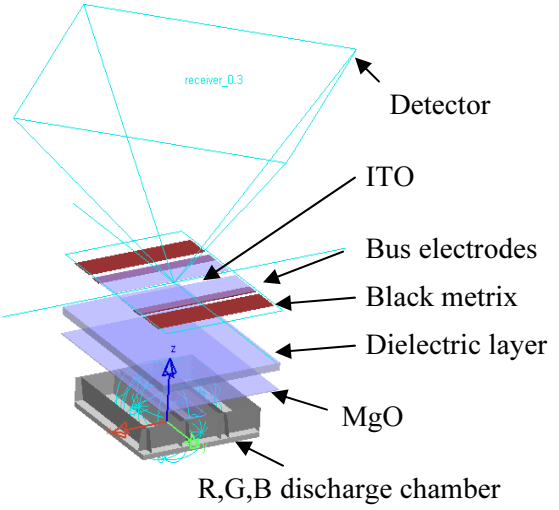


Figure 1. Geometry of Simulated PDP cell

3-dimensional optical code used in this paper is compatible with CAD, and it can be set up optical properties in the made model. It can be measured not only illuminance but also luminance, intensity, color calculation by ray trace of Monte Carlo method. By setting up the detector in the position we want, we can get the similar pattern taken by the actual Iccd camera.

Figure 1. shows a disjointed reference PDP cell used in this study. The cell pitch was selected 0.678 um (H) x 0.300 um (W), and it is same cell pitch of 42" commercial HD PDP.

Detailed geometries and optical data of PDP cell were gathered from the published paper, maker's homepage and material's data from the code library. Important geometries and optical properties are shown in Table 1. In order to minimize the cross-talk of visible rays between cells, the transmittance of barrier rib was set to 0. and a front glass (2.8 mm) is excepted because of cell' height (barrier rib' height : 120 um) is relatively low.

Components	Width	Transmittance	Reflectance
Barrier Rib	120 um	0%	75%
Electrode	0.5um	0%	98% (bottom)
ITO	1.3 um	90%	0%
MgO	0.5 um	90%	5%
Dielectric layer	38 um	85%	0%

Table 1. Material properties of simulation

For the primary light source, we designed the barrier rib having 85 degrees slope and applied phosphor by 15 um thickness to emit 550 nm visible light having 1 lm of energy.

The most efficient way to know the characteristic and pattern of the incident ray on the flat board is to compare the illuminance. So we examined relative variation based on this. Also the declination occurs from detector's position, so we measured on the base level of 0.15 mm, 0.2 mm, 0.3 mm high above the surface.

Figure 2. is the result from setting detector and ray tracing them above cell's rear flat (0.12 mm from discharging cell's bottom), below the front glass and upper all layers (0.2 mm) and in the middle of front glass (0.3 mm).

The detector set above the cell's rear flat (0.12mm) has not yet transmitted front flat has the same value on every experiments. And by observing from the upper all layer's top (0.2 mm) that hasn't been transmitted front glass yet, the characteristic's change was the most obvious that we were able to compare.

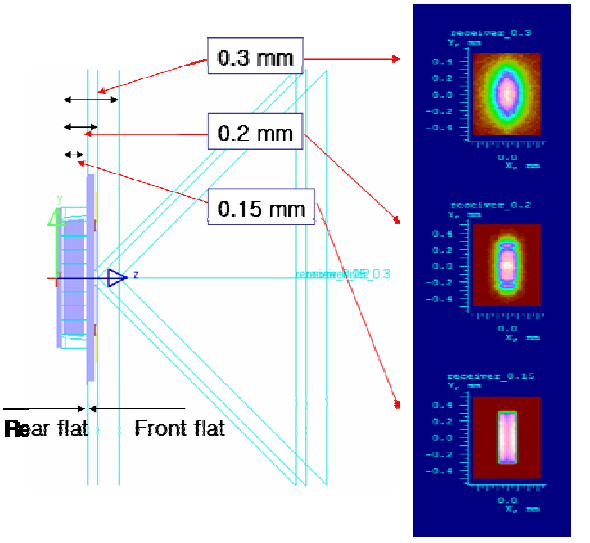


Figure 2. Illuminance chart of various detector positions

3. Results

Bus electrode at plasma display electrically applied voltage from the driving circuit. It is carrier for the electric current, it also has a character which block and reflect the light. it is used that transparent electrode which transmit visible light such as ITO to reduce loss light following the width of bus electrode. It is determined that luminance of transmitted light by bus position and ITO.

Electrode Gap (mm) / Detector pos. (mm)	0.4	0.3	0.25	0.15	0.06
0.3					
lm/mm²	1.25E+09	1.23E+09	1.22E+09	1.22E+09	1.21E+09
0.2					
lm/mm²	1.38E+09	1.36E+09	1.36E+09	1.35E+09	1.35E+09

Table 2. visible light distributions and illuminance results for the different bus electrode gaps and the different detector positions

Table 2. shows the visible light distributions and illuminance results depending on the variation of bus electrode position [4], and detector position. Due to the changing position of the detector collecting the rays from the PDP cells, the distribution and illuminance could be affected. Case of 0.4 mm bus electrode gap with the outer bus position showed the highest illuminance, 1.38E+9 lm/mm^2 at 0.2 mm detector position.

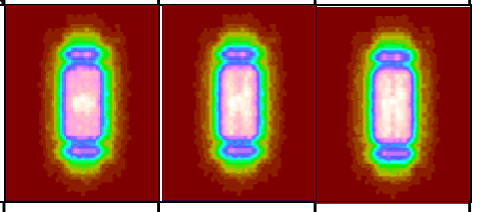
ITO width(㎜) / Detector pos.(㎜)	0.05	0.04	0.02
0.2			
lm/㎟	1.42E+09	1.46E+09	1.47E+09

Table 3. visible light distributions and illuminance results for the different ITO widths

Table 3. shows the variation of distributions and illuminance values depending on the changing of ITO width. When the ITO width was 0.1 mm, the illuminance from the cell showed the highest value of 1.47E+9 lm/mm^2 at 0.2 mm detector position.

In PDP, a transparent dielectric is formed on a front glass substrate so as to cover bus electrodes. Transmittance and thickness of dielectric layer is effected cell of visible light distribution.

Each of the Table 4. and Table 5. shows the results from changing dielectric layer's transmittance and by changing thickness. When the detector's position is 0.2mm, illuminance appears up to 1.48E+9lm/mm^2 by increasing transmittance from 70% to 100%.

And with 0.019mm of layer which is twice thinner than the reference thickness of 0.038mm, the illuminance increases up to 1.408E+9lm/mm^2.

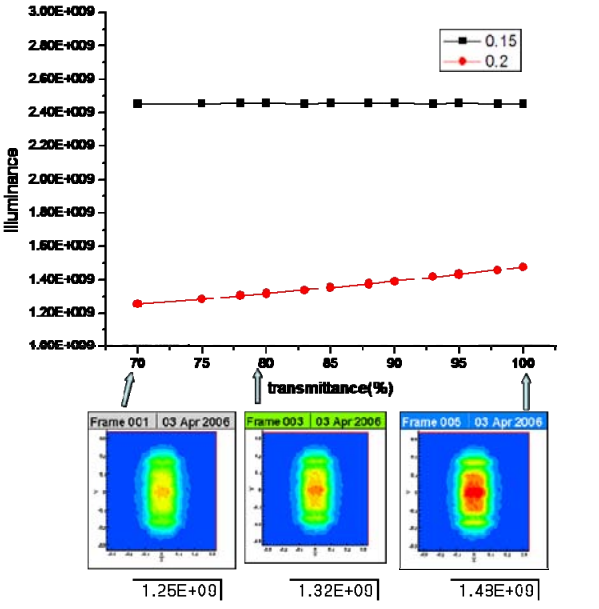


Table 4. visible light distributions and illuminance results for the different transmittance of dielectric layer.

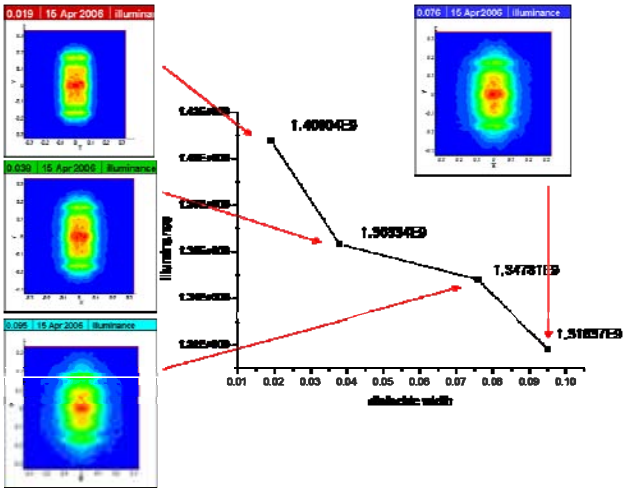


Table 5. visible light distributions and illuminance results for the different dielectric layer thickness

T-shaped ITO structure proposed by Pioneer [5] was simulated, and the visible light distribution is shown in Figure 3. The ITO shape and the location of bus electrode could be affected to the visible light distribution and luminance of PDP cell. T-shaped ITO

structure cell has value of 1.45E+09 lm/mm^2 and shows 3% enhancement than the reference PDP cell' illuminance.

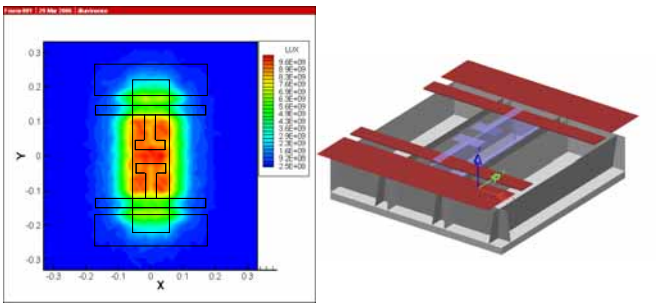


Figure 3. Structure of PDP cell in T-shape ITO

4. Conclusion

Using the 3d-optical code, we could measure visible light distributions and illuminance results by ITO shape and bus electrode position. we also found increase and decrease of illuminance and efficiency by thickness of dielectric layer and optical properties. it is needed to research for geometries or optical properties of layers which are composed of cell . This thesis shows that systematic research is possible using optical simulation.

5. Impact & Further studies

Currently we are working on the improvement of simulation accuracy by comparison with the visible light measurement of PDP cell. Number of rays from the phosphor will be differentiated depending on the UV distribution and visible light measurements.

6. Acknowledgements

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