Transparent dielectric layer having color-filter function for PDP

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Abstract

Transparent dielectric layer having color-filter function in front panel for PDP(Plasma Display Panel) was successfully fabricated and characterized. Transparent dielectric layer in front panel was made of glass based on PbO-SiO_2-B_2O_3 ternary system. The change of properties with content variation of oxide colorants in transparent dielectric layer having color-filter function was systematically accessed. It was demonstrated that the optimized content of oxide colorants to parent glass could greatly increase up contrast ratio and color temperature without significantly degrading luminance.

1. Introduction

As shown in Figure 1, AC PDP(Plasma Display Panel) has the discharge gas such as Xe, Ne etc. in the discharge cell. The tri-primary color(R,G,B) is obtained from R, G, B phosphors excited by vacuum ultra-violet photons emitted from gas discharge[1]. However, because the orange light(at 585nm) occurred from Ne gas discharge is mixed with R,G,B color, color reproducibility characteristics are poor. In addition, reflection by external light is one of the factors decreasing contrast ratio of PDP[2), 3)].

In this paper, first, we selected the rare-earth element[4], which has sharp R,G,B spectrum but high absorption for orange light in visible range for cutting off orange light from Ne gas discharge. And then, we fabricated transparent dielectric layer having color filter function and characterized the change of properties with the concentration of oxide colorant to parent glass and the color filter function.

2. Experiment

Usally, ternary PbO-B_2O_3-SiO_2 glasses were used for transparent dielectric layer of PDP[5]. For color filter function, we added oxide colorant, Nd_2O_3 of 0 ~ 40wt% to these glass system. The glasses were prepared from mixture of reagent with given compositions. The well mixed powders were melted in Pt crucible at 1,000 ~ 1,300°C for 1 hour. Then, glasses were quenched into stainless roller to get glass flake. These glasses were grinded by ball mill to get glass powder. After special treatment to glass powder,

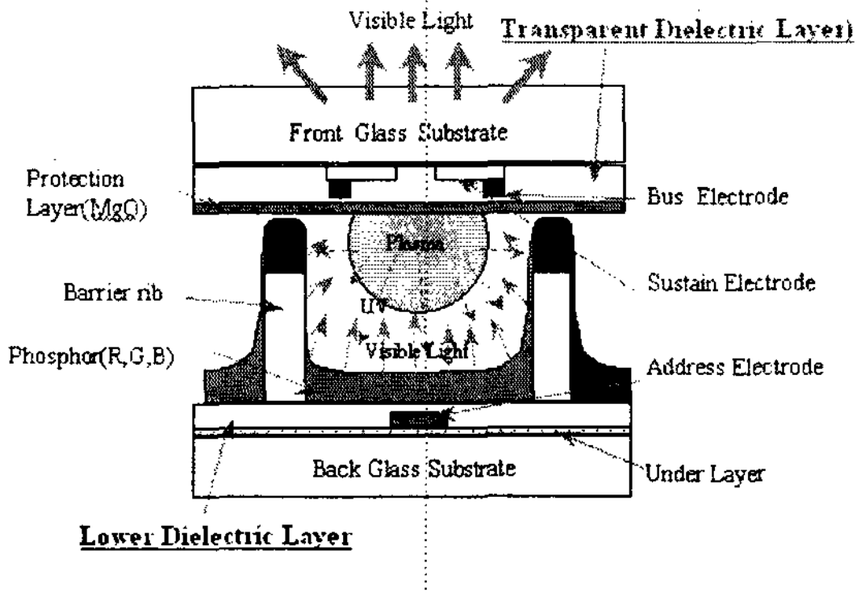

Fig. 1 Structure of AC-PDP

it was mixed with an organic vehicle which consists of ethyl cellulose, α-terpineol and butyl carbitol acetate to make paste. The glass pastes were coated onto a high stain-point glass substrate of 2.8mm thick by screen printing method and then fired at 540 ~ 600°C for 30 ~ 60minutes. Optical and electrical measurements were made on the sintered samples. Also, the small sized(7.5″ diagonal) panels were fabricated and characterized to evaluate the improvement of their color reproducibility, color temperature and contrast ratio.

3. Results and discussion

According to the Beer's law[6], absorption in a certain wavelength is proportional to the concentration of added colorants and the thickness of thick film. To obtain a maximum absorption intensity, we investigated the change of absorption intensity with the concentration of Nd_2O_3 and the thickness of dielectric layer. First, the properties of parent glasses with the concentration variation of it were measured to find a appropriate concentration of Nd_2O_3 as a transparent dielectric layer.

As shown in Figure 2, 3, the more concentration of Nd_2O_3, the more increase of glass transition temperature, T_g and dilatometric softening temperature, T_d due to the reduction of PbO content and the role of Nd_2O_3 as a glass former. Absorption intensity at 585nm for orange light increases, too.

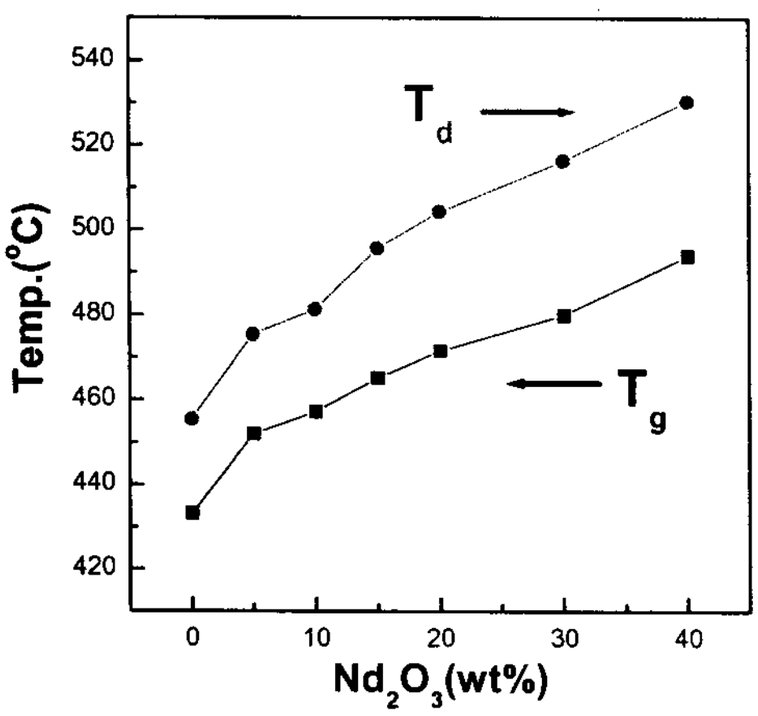

Fig. 2 The change of T_g, T_d with increasing Nd_2O_3

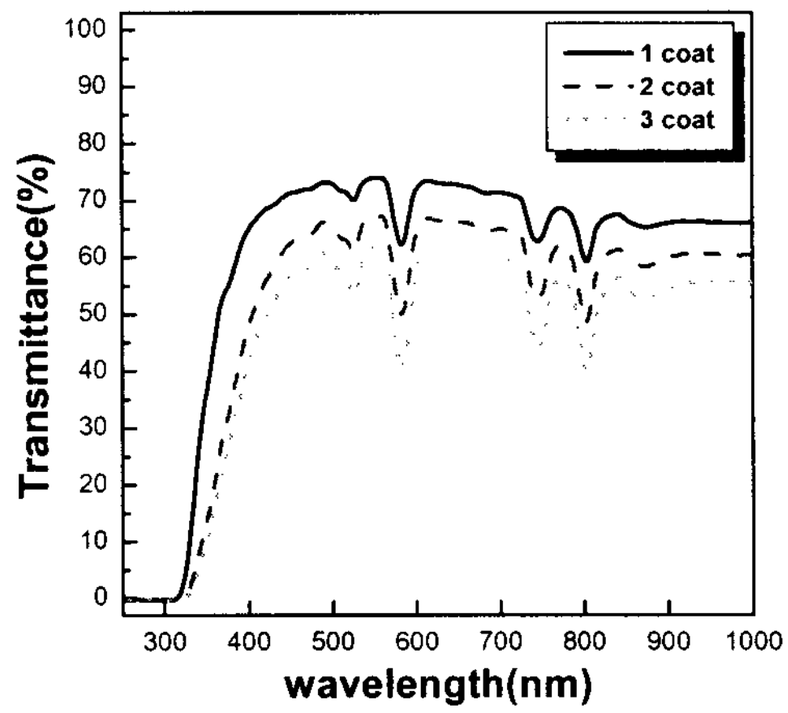

Fig. 4 The change of transmittance with thick film thickness at the same concentration of Nd_2O_3

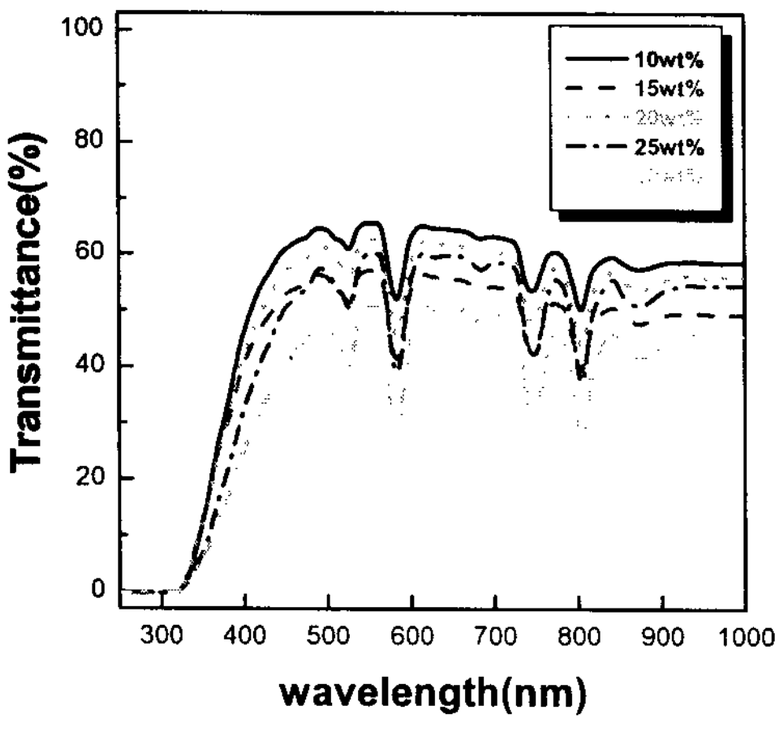

Fig. 3 The change of transmittance with the concentration of Nd_2O_3

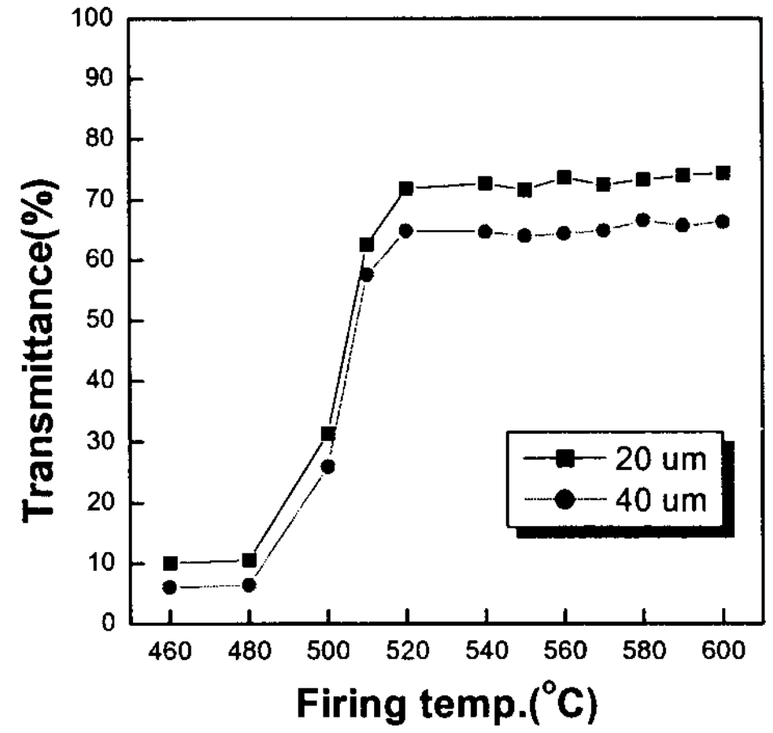

Fig. 5 The change of transmittance with thickness and firing temperature

Figure 4 shows that the change of absorption intensity with the thickness of dielectric layer of Nd_2O_3 is measured. Similarly the more thickness of thick film at the same concentration, the more increase of absorption intensity at 585nm. From these results, we determined the optimized concentration of Nd_2O_3 and the thickness of dielectric layer that could have color filter function.

Transmittance and breakdown voltage are one of the most important properties of transparent dielectric layer of PDP. Because of pores in the dielectric layer, transmittance and breakdown voltage rapidly decrease. In order to remove pores in the thick film, we did special treatment to glass powder. As a result, there is remarkable improvement of transmittance and breakdown voltage of dielectric layer. On the basis of these results, the transmittance and the internal structure of dielectric layer with firing temperature and the thickness of dielectric layer are observed.

Figure 5 shows the change of transmittance with firing temperature and thick film thickness. Figure 6 shows the sintering behavior of dielectric layer with firing temperature. As Figure 5 indicates, with increasing firing temperature, the transmittance of dielectric layer increases up to the first maximum at a certain temperature and it becomes nearly constant. Therefore, the sintering of glass powder begins above T_g, and more and more progresses up to glass softening point, Sp. At this time, the behavior of pores is in figure 6. And then, above Sp, it doesn't follow the normal ceramic sintering behavior, but viscous flow occurs. Although it doesn't observed here, as a results, maybe pores in the film are combined one another, grow and rise to the surface as

temperature increases. Finally, maybe it becomes a pore-less structure, the transmittance of dielectric layer will be rapidly increased.

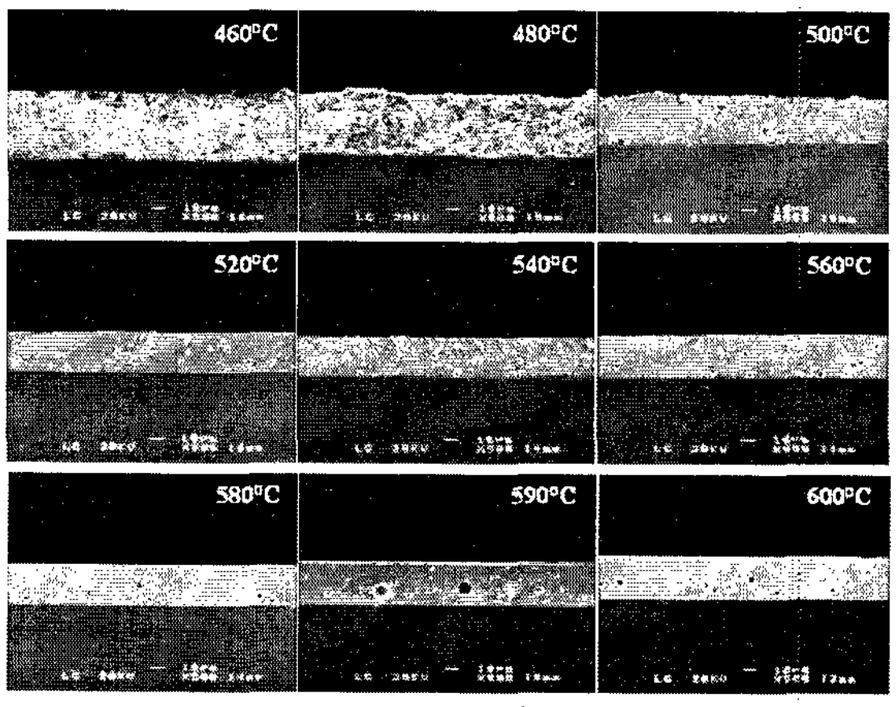

Fig. 6 Sintering behavior with firing temperature

We actually fabricated small-sized(7.5″ diagonal) panels and characterized their color filter function. Table 1 shows the properties of 7.5″ panels. As shown in Figure 7, the orange light at 585nm is considerably removed in the panel using color filter dielectric. Figure 8 indicates that using the color filter dielectric, its color reproducibility, color temperature and contrast ratio are improved than those of using normal dielectric.

Table 1 The properties of 7.5″ panels

	Full White				Voltage Margin (ΔV)	Discharge Voltage(V)	Reflection by external light
	x	y	Luminance (cd/m^2)	Color Temp.(K)			
Normal Dielectric	0.311	0.317	226.23	6690	67.5	175	18.49
Color Filter Dielectric	0.300	0.297	160.63	7850	80.6	175	15.27

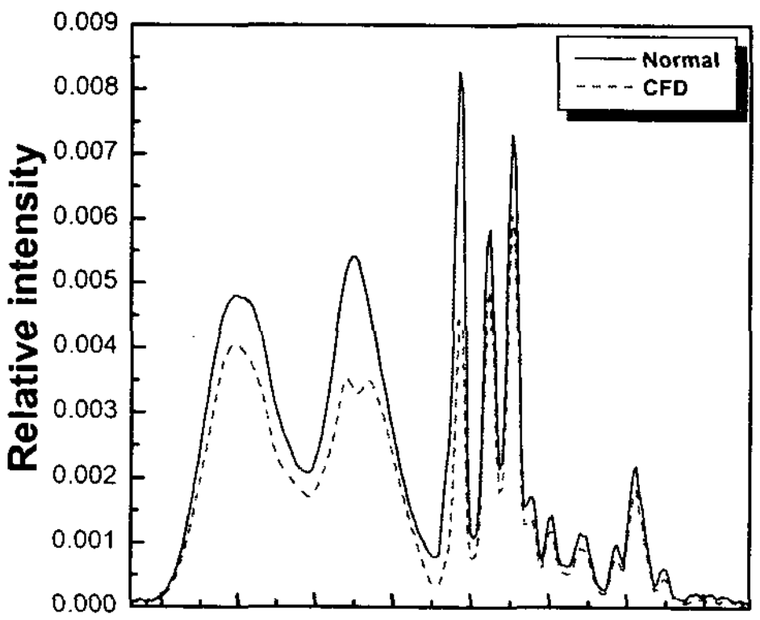

Fig. 7 The spectra of 7.5″ panels.

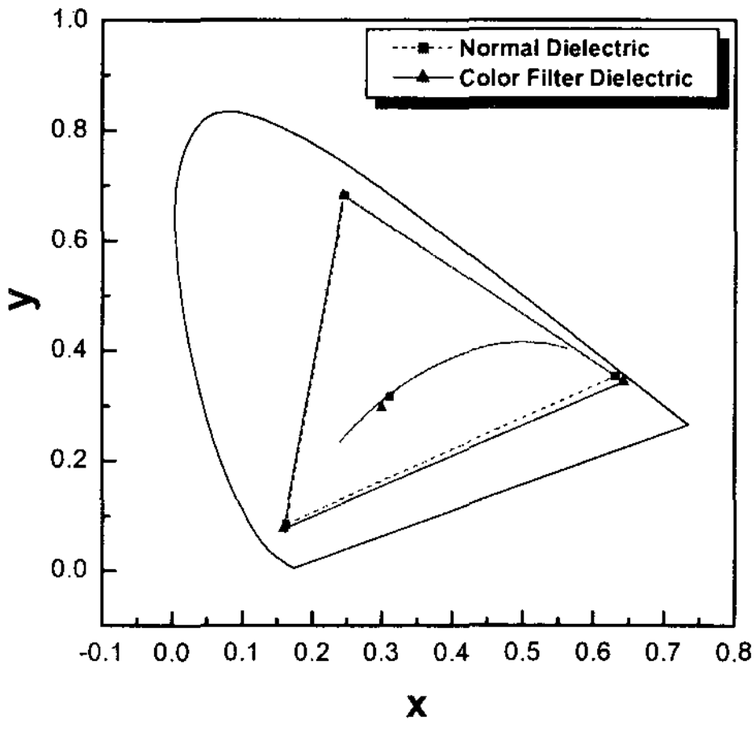

Fig. 8 The chromaticity of 7.5″ panels

4. Conclusion

We fabricated and characterized the rare-earth element added transparent dielectric layer having color filter function for PDP. By means of special treatment to glass powder, we have remarkably improved transmittance and breakdown voltage of dielectric layer. Simultaneously the absorption at 585nm for orange light and reduction of external light reflection owing to the optimized concentration of Nd_2O_3 led to improve color reproducibility, color temperature and contrast ratio than those of using normal dielectric.

5. Reference.

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