The comparison and analysis on the phosphor degradation causes in ac PDP

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Abstract

In this paper, we investigated the phosphor degradation characteristics on the ultra violet ray (UV) irradiation as well as ion bombardment. We propose a novel experiment method which is related with phosphor degradation causes. The phosphor deterioration experiments were made on the UV irradiation as well as ion bombardment. To carry out the experiment and compare the results, we made up the specific experimental setup. The results show that the deterioration by ion damage is more rigorous than that by vacuum ultra violet (VUV) on the phosphor efficiency.

1. Introduction.

The plasma display panel (PDP) is a one of the flat panel devices being regarded as a good candidate for the large-sized(>40-inch), wall hanging multimedia display. However, there are many problems to be solved for the establishment as a leading device in TV market, such as luminous efficacy, cost, and image quality. Among those issues, the variation of phosphor characteristics is the one of main problems on the image quality and the lifetime of ac PDP. There are many reports on the phosphor degradation, which just deals with UV irradiation, and heat as deterioration causes[1-3]. In practical ac PDP, phosphor is directly exposed to VUV, heat as well as plasma[4]. For the improvement of image quality and lifetime of ac PDP, it is worth to know the relationship between the phosphor deterioration causes in detail.

In this research, we employed the specific experiment setup, and investigated the relationship between UV irradiation and ion bombardment which make influence on the phosphor efficiency.

2. Experimental setup

Figure 1. shows the phosphor degradation system which was composed of UV irradiation part and ion beam emission. In this experiment, we employed deuterium (D2) lamp as UV irradiation source, and fabricated 2cm×2cm-experimental sample which is paste type phosphor on the glass undergone in high-temperature baking process.

Before the aging experiment, it needs to know the relationship between the output intensity of D2 lamp and that of ac PDP. We fabricated the 3cm×3cm-size test panel which can be loaded in the chamber filled with Ne-Xe(4%) 400 torr mixture gas, and applied 240V-50 kHz pulse train to the test

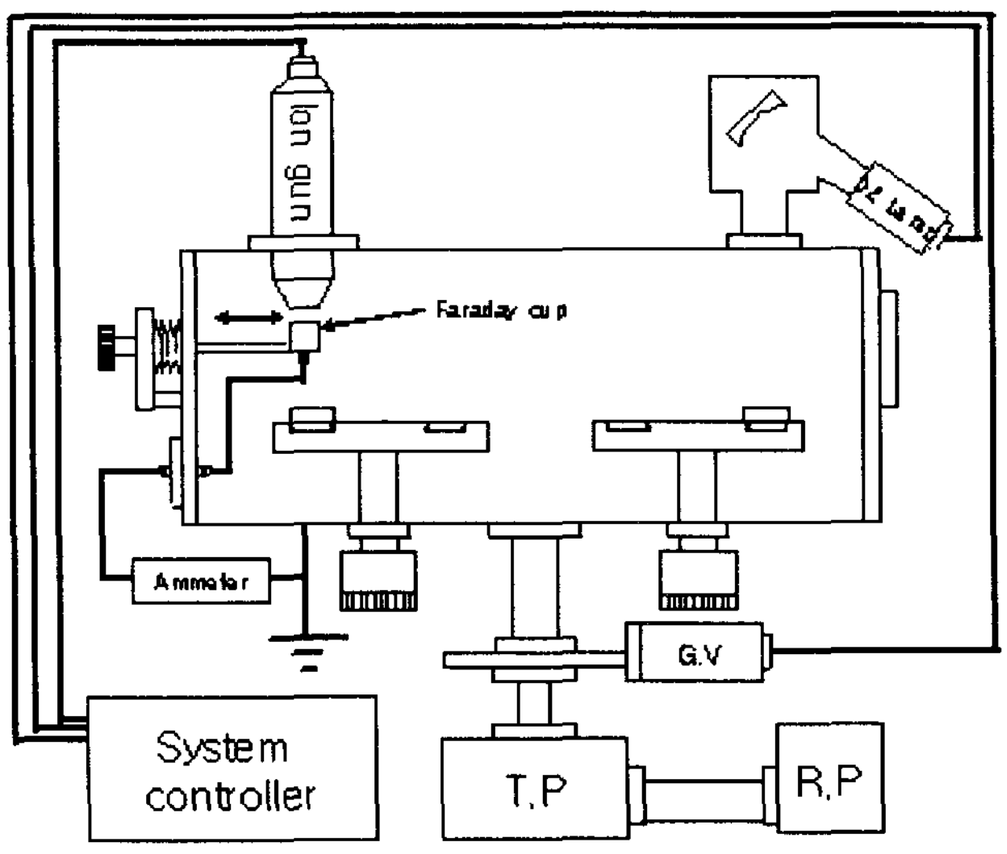


Figure 1. Schematic diagram of aging system

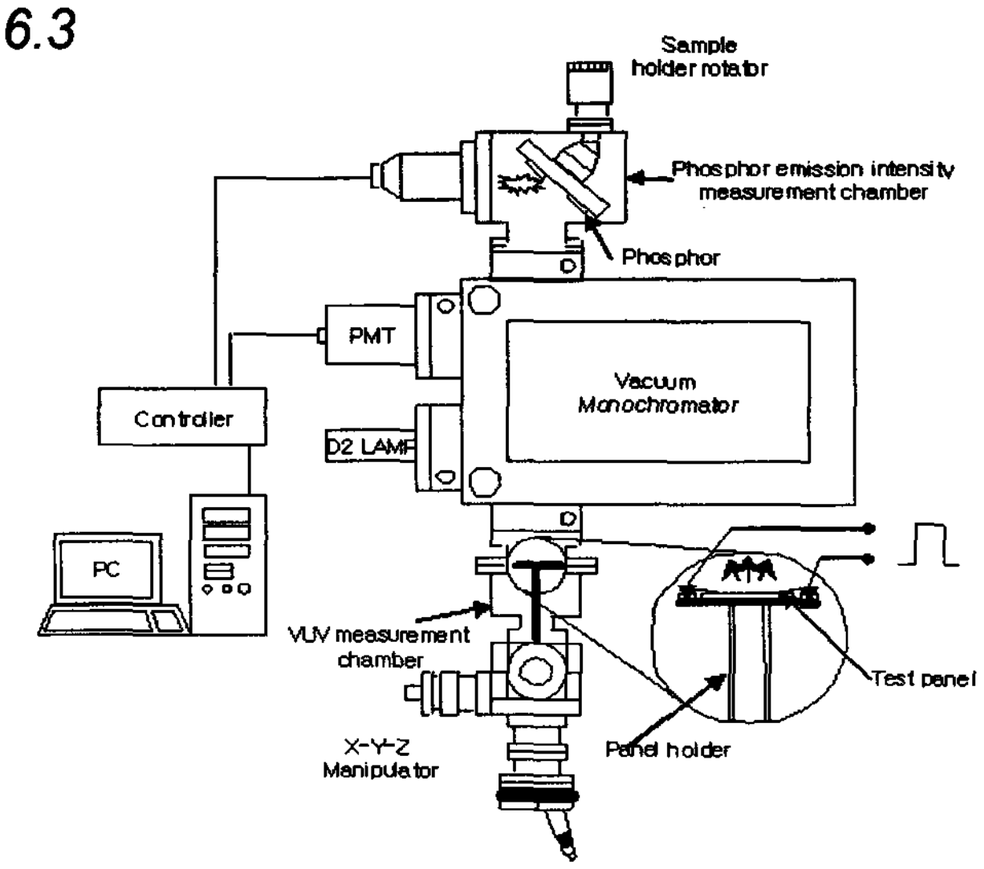


Figure 2. Schematic diagram of measuring system

panel as shown in Fig.2.
D2 lamp and the chamber were attached on the input port of vacuum monochromator respectively, and MgF_2 window was adopted for transparent isolation layer between monochromator and chamber. Figure 3. shows the spectrum of D2 lamp and that of test panel. From this result, the intensity of D2 lamp is about 500 times stronger than that of test panel through the integration of each spectrum area. By the calculation referred to a general full-white driving condition whose averaging sustain frequency is about 10kHz, and 80% VUV transmittance of MgF_2, it is considered that D2 lamp has around 2000 times intense UV energy to a real ac PDP.
During the reset period, the address electrode becomes the cathode, and ions bump into phosphor layer. Even though there are several kinds of simulation methods on the analysis of ac PDP, it is difficult to know the ion energy exactly during the reset discharge.

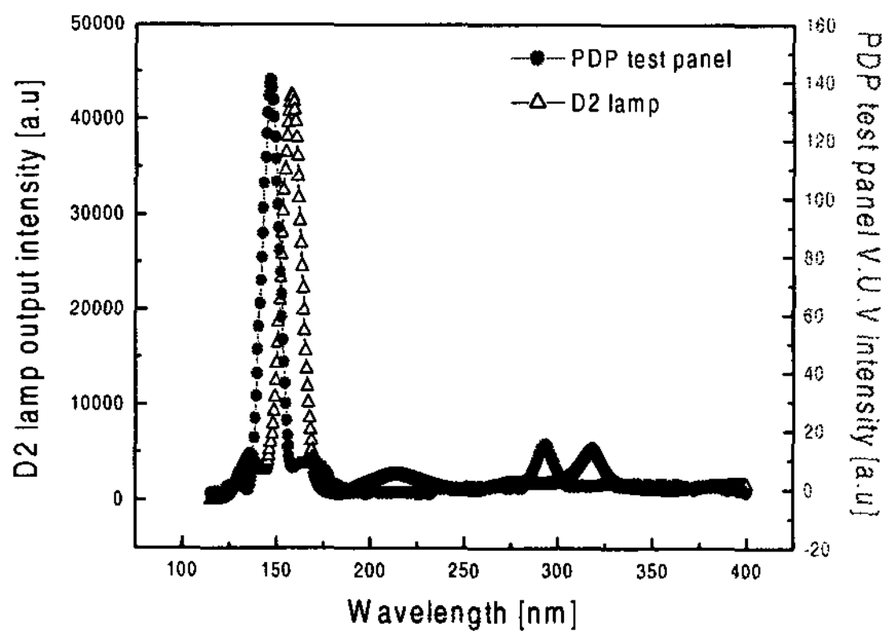
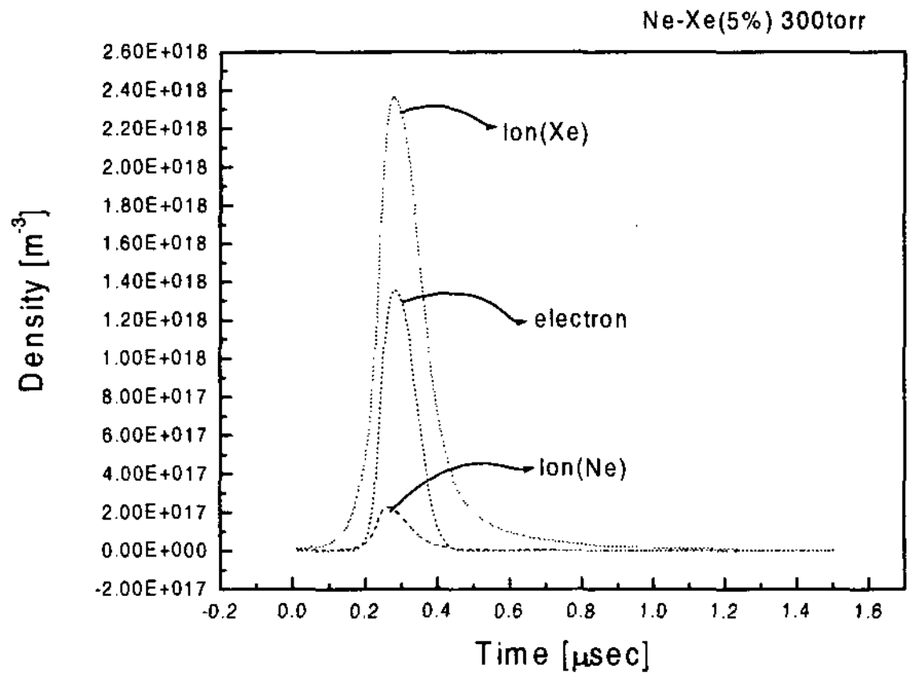
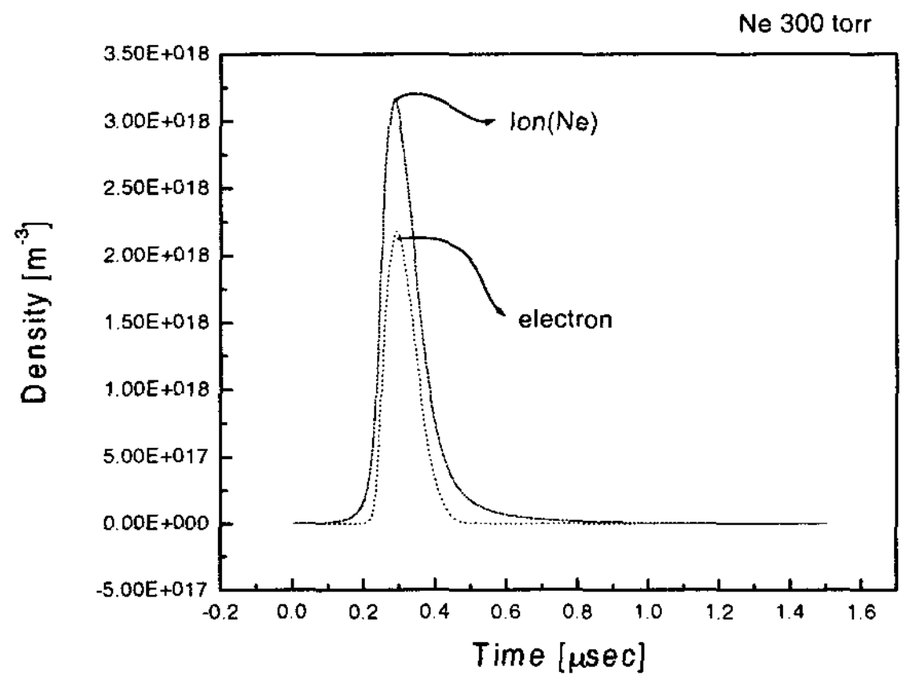


Figure 3. The spectrum of D2 lamp and test panel

Instead of ion gun as deterioration source, we used the test panel whose content of gas is only pure Ne for excluding VUV irradiation. Figure 4. shows the simulation result of ion density as to gas species during the one cycle of sustain discharge, which results in nearly same density of ion irrespective of the content of gas. We made up the experimental environment which consists of test panel loaded aging chamber with using pure Ne gas and measurement system. We fabricated phosphor-printed test panel whose electrode is 1.5cm × 1.5cm and put it in the aging chamber with setting the plates opposite each other.



(a)



(b)

Figure 4. The density of each species in an ac PDP by simulation method

(a) Ne-Xe(5%) 300 torr, (b) Ne 300 torr

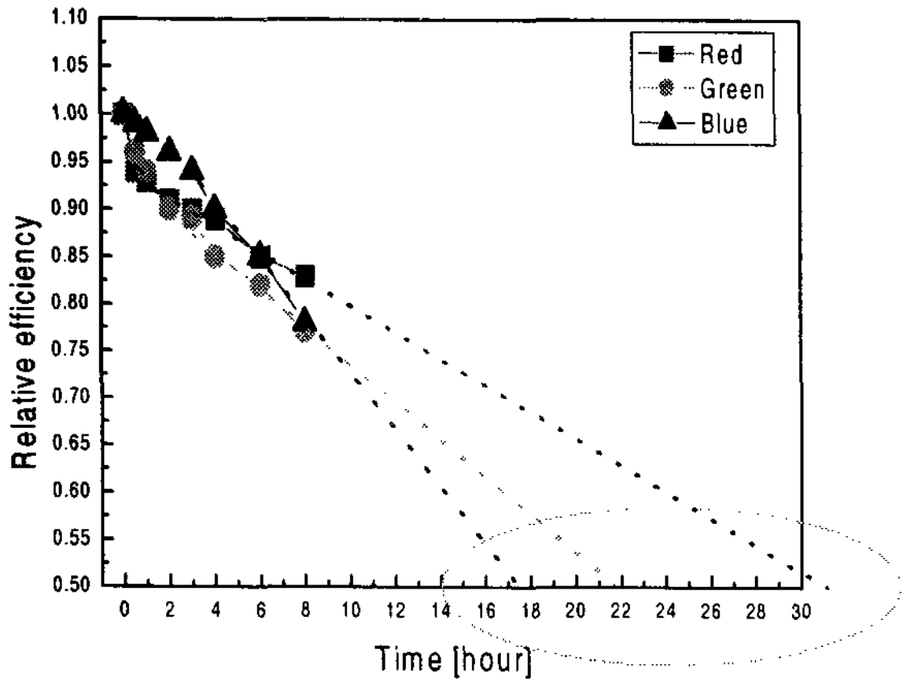


Figure 5. Relative efficiency of phosphor on the UV irradiation

3. Results & Discussion

On the basis of above results, we carried out UV irradiation experiment as a function of time. The phosphor which were employed in this experiment, are (Y, Gd)BO_3:Eu as a red component, Zn_2SiO_4:Mn(35%)+YBO_3:Tb(40%)+(Ba,Sr,Mg)OAl_2O_3:Mn(25%) as a green component, $BaMgAl_{10}O_{17}$:Eu as a blue component. Figure 4. shows the relative efficiency of each phosphor which was degraded by UV irradiation. The time to the level of 50% efficiency of each phosphor is from 20 to 30 hours, which can be translated to from 40,000 to 60,000 hours in real ac PDP by considering the relationship between the intensity of D2 lamp and that of test panel.

For the experiment on the ion bombardment, we applied ramp reset type pulse train to the Y-electrode

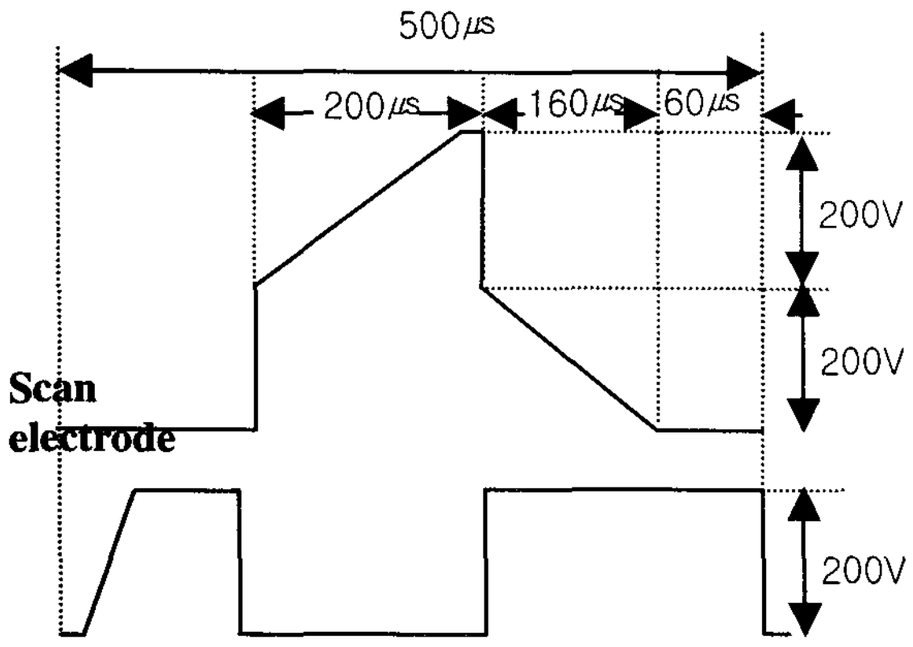


Figure 6. Applied waveform on the ion bombarding experiment

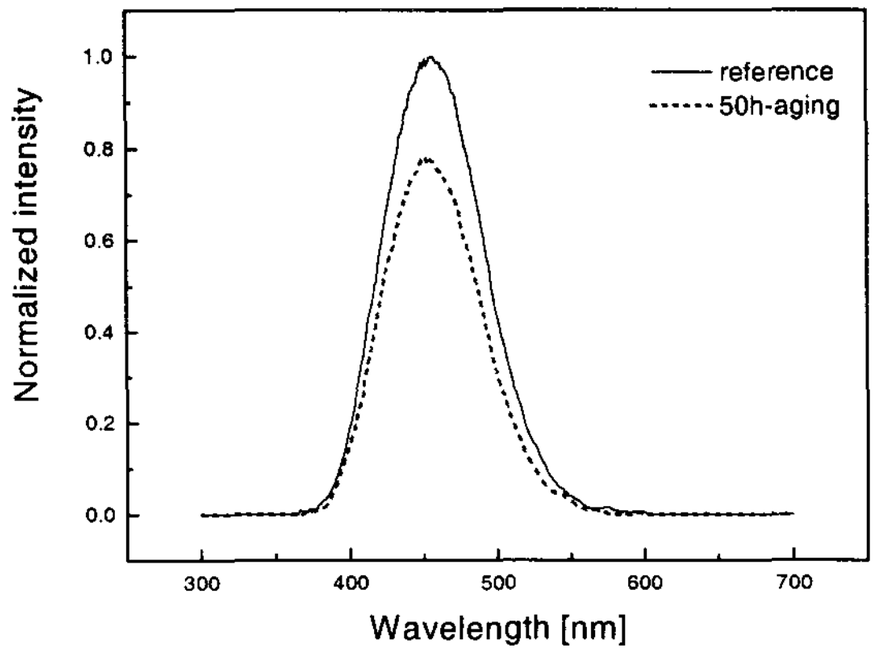


Figure 7. The spectrum of blue phosphor on the ion bombardment degradation.

and held appropriate bias level to the A-electrode as shown in Fig. 6. The peak reset voltage and frequency correspond to 400V and 2 kHz respectively. If it is assumed that the number of subfield of a commercial PDP is 8, the number of reset discharge per 1 sec is 480. Therefore, the experimental condition is about 5 times(2000/480) severer than commercial case. Figure 7 shows the spectrum of blue phosphor after 50 hour aging experiment. Relative efficiency of which sample attended to degradation process, decreased to 76% of reference one by the comparison of the integrant of each area. Through the linear extrapolation, and conversion of this result to the real ac PDP referred to the actual driving condition, the time to the level of 50% of relative efficiency of phosphor is thought to be about 500 hours.

The time to the level of 50% on the ion bombardment degradation is far shorter than that of VUV. This is due to the different phosphor area which is affiliated in phosphor degradation process. However VUV is irradiated on the whole of phosphor area, ion is bumped into restricted phosphor layer where is on the cross area of address and scan electrode.

4. Summary

We made an experiment with focusing on the comparison between the UV irradiation and the ion bombardment on the phosphor efficiency. It still needs to carry out the ion bombarding experiment on the other phosphor(Red, Green) and analyze the deterioration process of UV irradiation and ion damage.

These experimental results introduce the phosphor degradation by ion damage which has been passed over up to present. The results show that ion

bombardment gives severe damage on the phosphor compared to VUV, but on the other hand the degradation by ion bombardment is limited on the around 1/8 of total phosphor layer.

5. Reference

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