Gasification of Surface Carbon Contaminant during Discharge in Plasma Display Panel (PDP)

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Abstract

Inside of working PDP, there exist highly reactive conditions in the gap between two glass panels. MgO layer and phosphor have been investigated as a function of discharge and temperature. A drastic reduction in carbon impurity was observed on the surfaces after discharging and heat treatment. Carbon composition on the MgO and phosphor is a dominant factor for their instability

1. Introduction

Development of a large-area flat panel display which can display image and information is expected to be used for a wall-hanging television and multimedia displays. Plasma display panel(PDP) is one of the most promising candidates for high definition color television (HDTV).[1,2]

The fabrication process for a PDP composed of two glass panels is as followings. Typically, the front glass plate contains components such as ITO electrodes, bus electrodes, Dielectric layer, barrier ribs and phosphor layers. After the fabrication of the front glass panel and the rear glass panel, the two panels are sealed together by using frit sealing followed by baking under pumping. After pumping under baking for a long time, plasma mixture gases such as a He/Xe or He/Ne/We are introduced into the panel and tip-off is done. If the base vacuum level is not low enough before mixture gas filling, several impurities will exist in the plasma gas.[3]

Impurities inside plasma discharge region might increase the starting voltage of PDP and deteriorate the efficiency, thereby decreasing the lifetime. To improve the lifetime, aging process accomplished for 48 hours in PDP fabrication to stabilize the inside of panel and maintains optical performance by initial discharge.[4,5,6] We observed the evolution of impurities deteriorating the characteristics of PDP operation with plasma discharge time. In this study, we tried to find out aging effect and surface passivation. Ultimately, this study will be used for aging time reduction and productivity improvement in PDP fabrication.

2. Experimental

The surfaces have been mainly examined by using Electron Spectroscopy for Chemical Analysis (ESCA). Fig. 1 shows that the apparatus constructed for the study of surface changes of PDP panel consisted of PDP chamber, Ultra High Vacuum (UHV)-system for in-situ analysis and PDP discharge system. We designed an in-situ analysis system for 7-inch test panel prepared by each fabrication process. Test panels with various aging time (0, 0.5, 1, 2, 4, 12 and 24h) were also introduce to the UHV system. The panels were disassembled by wobble sticks and transferred analysis chambers to investigate the changes. The chemical and physical properties were characterized using x-ray photoelectron spectroscopy (XPS) and atomic force microscopy(AFM) of analysis chamber in the UHV-system.

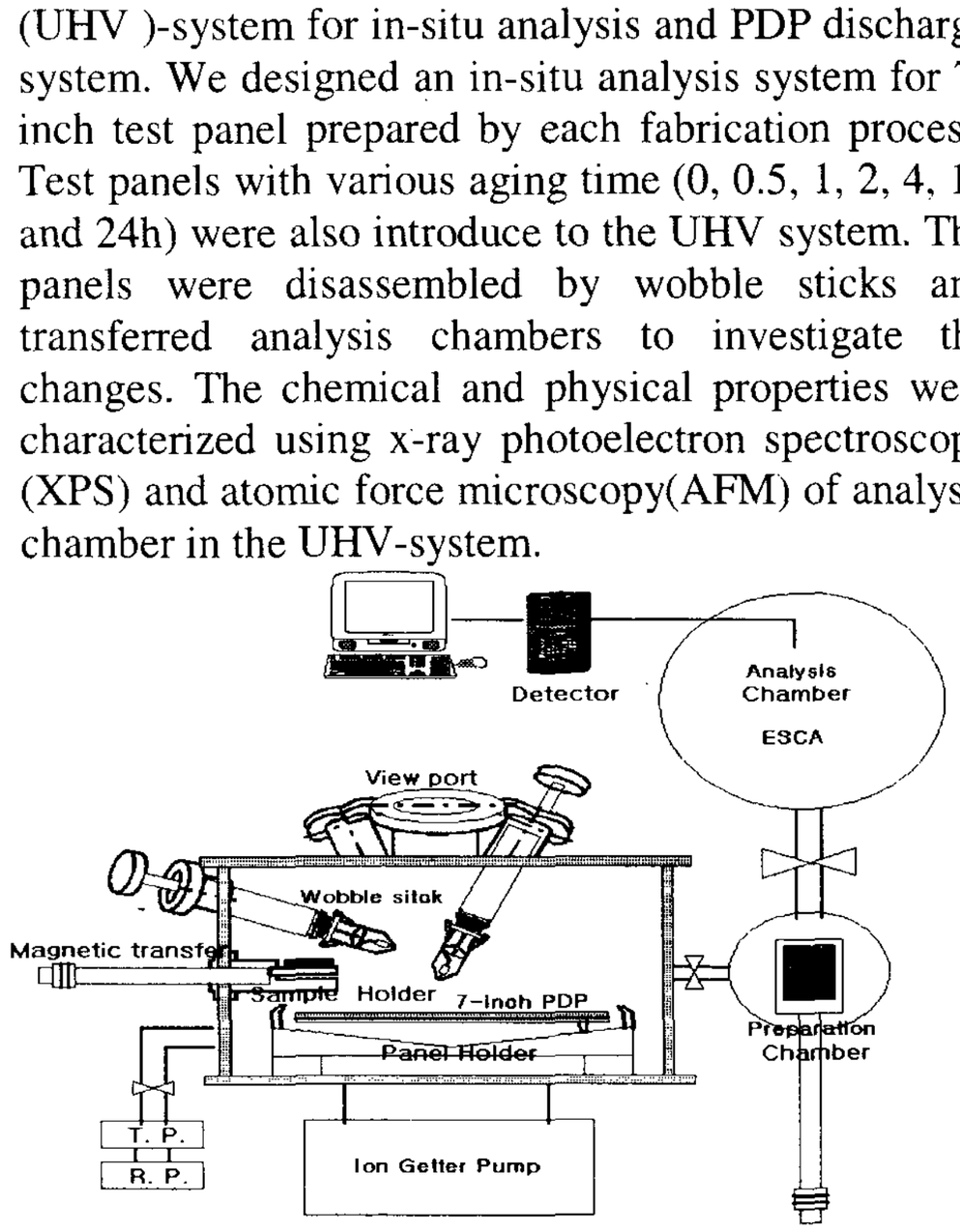

Figure 1. The schematic diagram of PDP disassembling chamber for vacuum transfer.

3. Results and discussion

The performance of the PDP is influenced strongly by the surface glow-discharge characteristics on the MgO protective film. MgO and phosphors are in contact with the free space of display pixel where it is filled with the inert gas mixture. Therefore, MgO and phosphor can be a main source of impurities.

We found out that carbon compound and water were major impurities on MgO film and phosphor. Chemical analysis indicated that there were few organics, and that chemically adsorbed carbon compound and water.

Fig. 2 shows the ESCA wide scan of MgO film according to aging time. These spectra showed that intensity of carbon peak was decreased considerably and carbon, magnesium and oxygen peaks were shifted according to aging by plasma discharge. In aging 0.5h, we could see that carbon compound which is not composition of MgO film was could see that carbon compound was decreased considerably by heat effect and electron effect with plasma discharge.[7,8]

Carbon compounds were adsorbed on the MgO. Fig. 3 shows the ESCA wide scans of phosphor layer with aging time. The wide scans of phosphor were also examined with the plasma exposure time.

Intensity of carbon and oxygen peak was decreased, as aging time extended. MgO protective layer and phosphor on each panel before aging process showed peaks of C_{1s} and O_{1s} at the binding energy of 285 and 530eV, respectively, indicating adsorbed organics and hydration compounds.

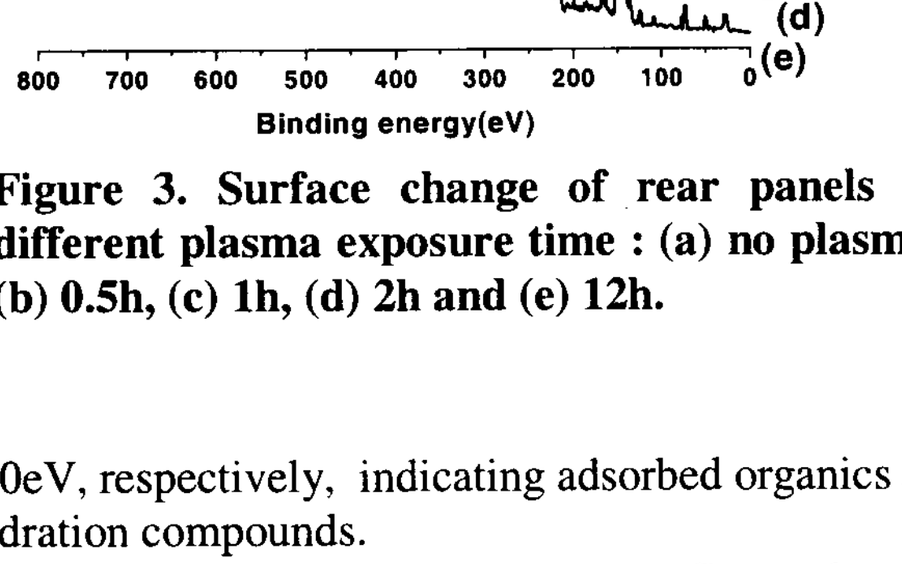

Figure 3. Surface change of rear panels at different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h and (e) 12h.

Fig. 4 shows ESCA narrow scans C_{1s} peaks. We found out that the intensity of carbon peak was decreased considerably according to aging and carbon compound were desorbed by plasma thermal effect and converted from surface to compound was chemisorbed onto MgO surfaces, the C=O binding state was more dominant than Mg-C.

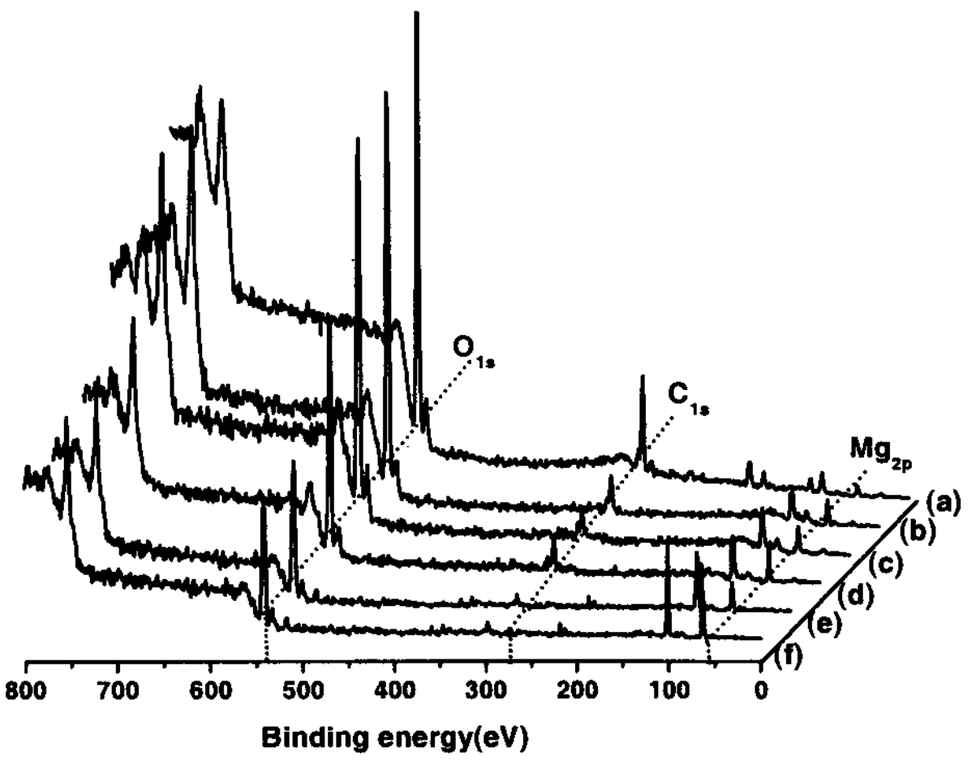

Figure 2. Surface changes of front panels at different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h, (e) 12h and (f) 24h.

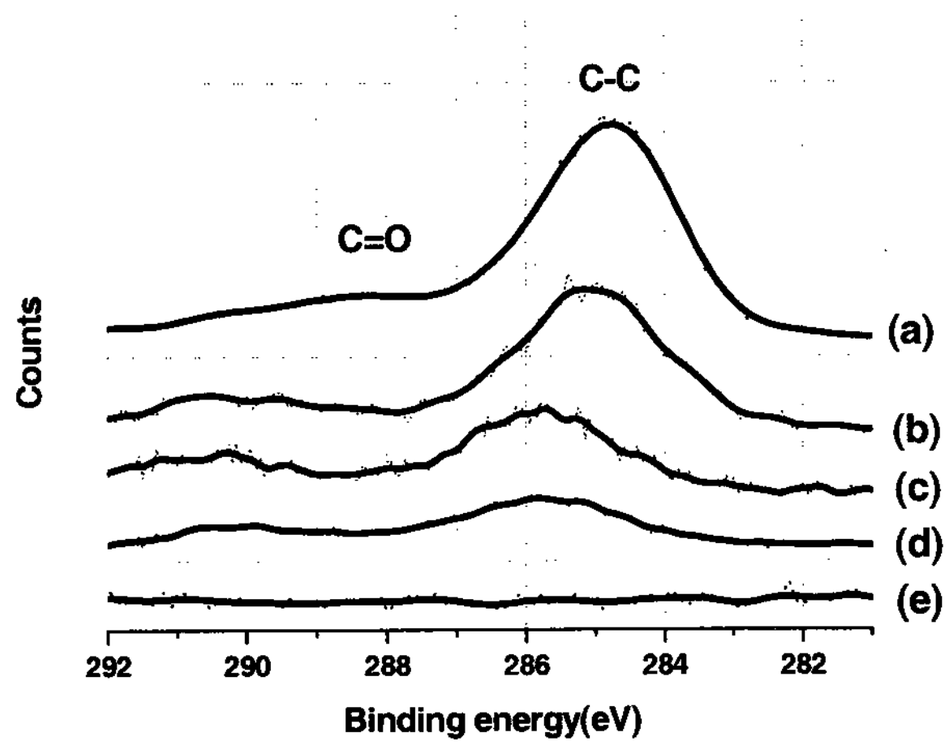

Figure 4. Chemical shifts of the binding energy of C_{1s} peak at the different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h and (e) 12h .

As H_2O molecules were desorbed onto MgO surface by aging, the influence of electron donor group such as OH^- disappears.[9] The O_{1s} peak of MgO film was shifted to O_{1s} peak of MgO(100)single crystal shown in Fig. 5.

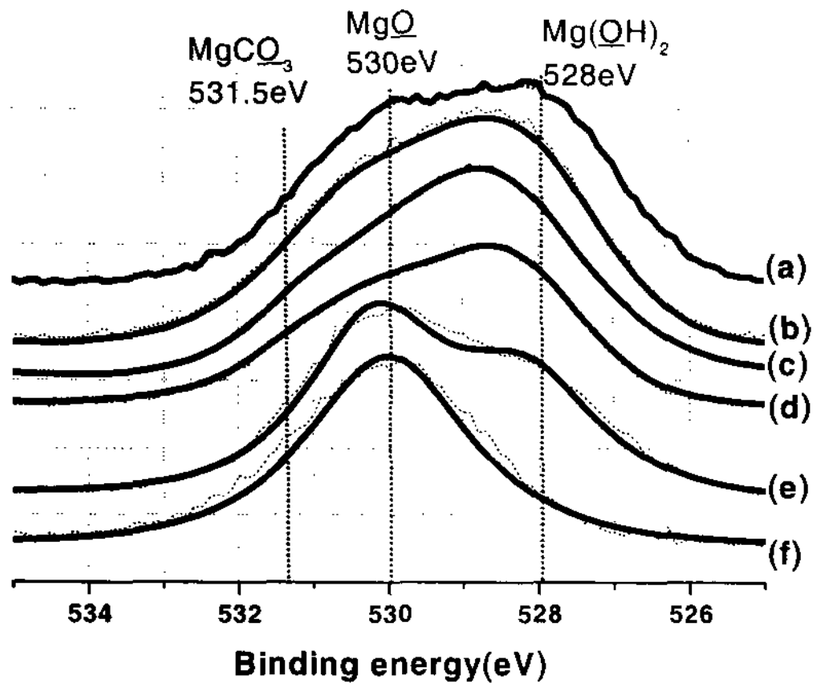

Figure 5. Chemical shifts of the binding energy of O_{1s} peak at the different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h, (e) 12h and (f) MgO single crystal.

The Mg_{2p} peak of MgO film shifted to the lower binding energy by OH^- group of H_2O molecules was returned to Mg_{2p} peak of MgO(100) single crystal shown in Fig. 6. It can be anticipated that MgO film of front panel will exist in $Mg(OH)_2$, $Mg(CO)_3$ by surface analysis data. To examine the physical change of MgO film, we have analyzed the surface of MgO film with the progress of PDP manufacturing processes. Surface morphology measured by 12hours of aging time could be flat for removal the carbon components on the panels.

In order to find out evolved gases during heat treatment, outgassing species and their partial pressure were measured as a function of temperature by using mass spectroscopy. Fig. 7 showed that major impurities of surfaces were H_2, H_2O, CO and CO_2. We found that H_2O and carbon compound easily chemisorbed onto surfaces are evolved at low temperature. As temperature was upto the 350□, impurities such as CO, CO_2 and OH was observed.

The increased signals near low temperature is from the desorption of physisorbed species and the further increase near high temperature appears to be from the desorption from the chemisorbed species.

The heat treatment and discharge aging are of great importance in stabilizing the operation characteristics of a PDP and that the effect of those processes is to reduce the surface contamination of the MgO and phosphor.

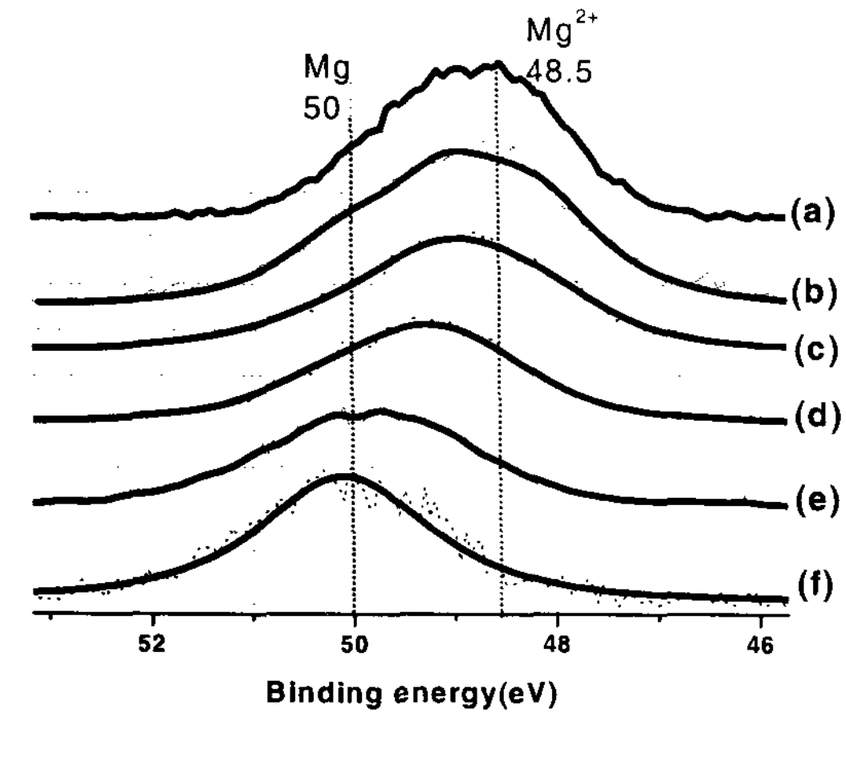

Figure 6. Chemical shifts of the binding energy of Mg_{2p} peak at the different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h, (e) 12h and (f) MgO single crystal.

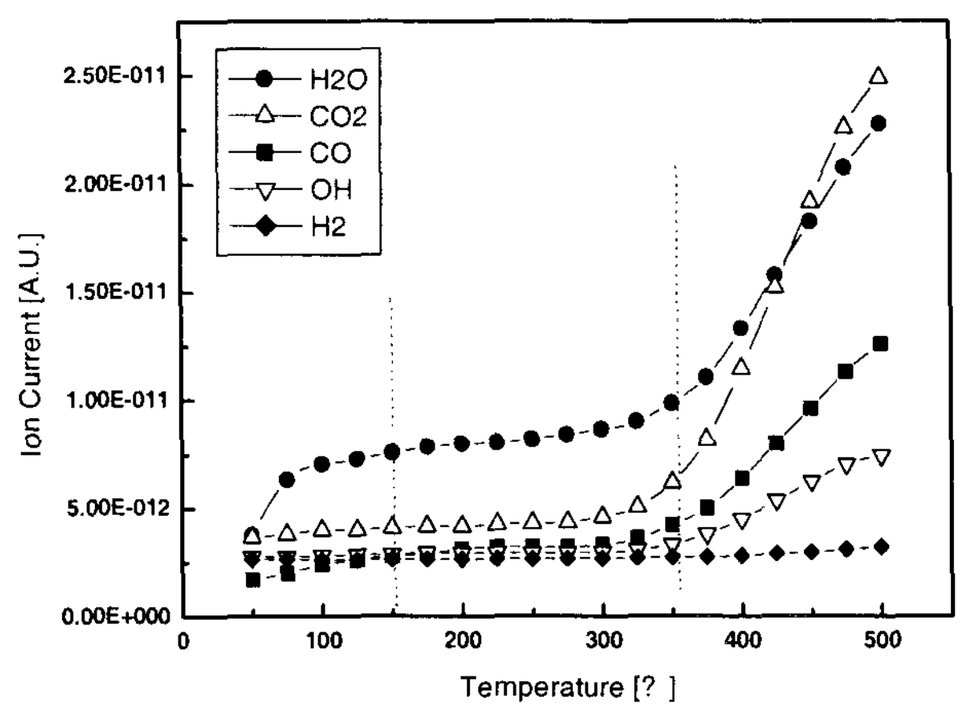

Figure 7. Gases desorbed inside PDP by heat

4. Conclusion

In summary, we found out that carbon and water were major impurities on surfaces. Chemical analysis indicated that there were few organics, and that chemically adsorbed carbon compound and H_2O. From data analysis, Mg_{2p} and O_{1s} peak of MgO film were shifted to MgO(100) single crystal state by aging process. Also, when aging process was not proceeded, we could see that the peak area of oxygen and carbon was in large presented by the effect of carbon and oxygen. But, as aging process was proceeded, we could see that peak area of oxygen and carbon was considerably decreased by the desorption of carbon and oxygen. Impurities such as CO, CO_2 and OH inside discharge region may deteriorate the characteristics of PDP operation. In present, aging process of long period time for the purpose of surface stabilization is understood. Gaseous impurities inside panels increase the starting voltage of PDP and decrease the lifetime.

5. References

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