Gasification from Surface during Discharge and Thermal Processes in Plasma Display Panel (PDP)

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Abstract

PDP use the mixture of inert gases to generate a discharge inside display pixels. Inside of 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 thermal process. Impurities such as CO, CO_2, OH and H_2O in discharge region may deteriorate the characteristics of PDP operation during life time. Change of impurity generation of various MgO and phosphor surfaces were measured by using x-ray photoelectron spectroscopy(XPS) and quadropole mass spectrometer (QMS). Carbon containing species such as C, CO and CO_2 were drastically increased on the surfaces during discharge and thermal treatment. Carbon impurities on the MgO and phosphor are the 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 is one of the most promising candidates for high definition color television .[1,2]

Gaseous compounds such as H_2O, CO, CO_2, H_2, and hydrocarbon are predominant gases evolving from components such as glasses, metal and oxides. It is clear that the amount of outgassing gases has to minimize to assure a long life time.

One way to reduce the outgassing is to bake the materials at high temperature. Impurities inside plasma discharge region might increase the starting voltage of PDP and deteriorate the efficiency, thereby decreasing the life time.[3,4,5]

We observed the evolution of impure gases deteriorating PDP operation with plasma discharge and heating. In this study, we tried to find out outgassing species and surface passivation.

Surfaces and Gas species have been also examined by x-ray photoelectron spectroscopy(XPS) and quadropole mass spectrometer(QMS), respectively.

The apparatus constructed for the study of surface changes consisted of UHV(Ultra High Vacuum) system for in-situ analysis and discharge system.

Materials were loaded chamber to investigate the changes. The sample was heated from room temperature to 450℃ at 15℃/min and their partial pressure was measured using a quadurpole mass spectrometer.

This study will be used for adsorption of gases and productivity improvement in PDP fabrication.

2. Experimental

The surfaces have been mainly examined by using XPS. Fig. 1 shows 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 size panel prepared by each fabrication process. The panels were disassembled by wobble sticks and transferred plasma chambers to investigate the outgassing gas. The chemical and physical properties were characterized using x-ray photoelectron spectroscopy (XPS) of analysis chamber in the UHV-system and mass spectroscopy.

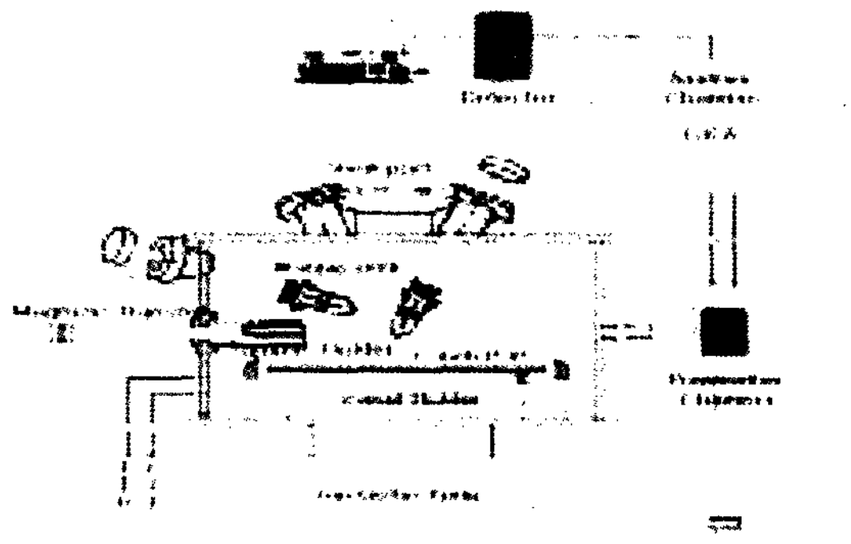

Figure 1. The schematic diagram of PDP disassembling chamber for vacuum transfer.

3. Results and discussion

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

The main contamination source of gaseous impurities can be identified inside PDP 1) the gaseous impurity content in the filling gas: 2) outgassing from internal components during the fabrication processes of the display and 3) the residual gas after the evacuation process.

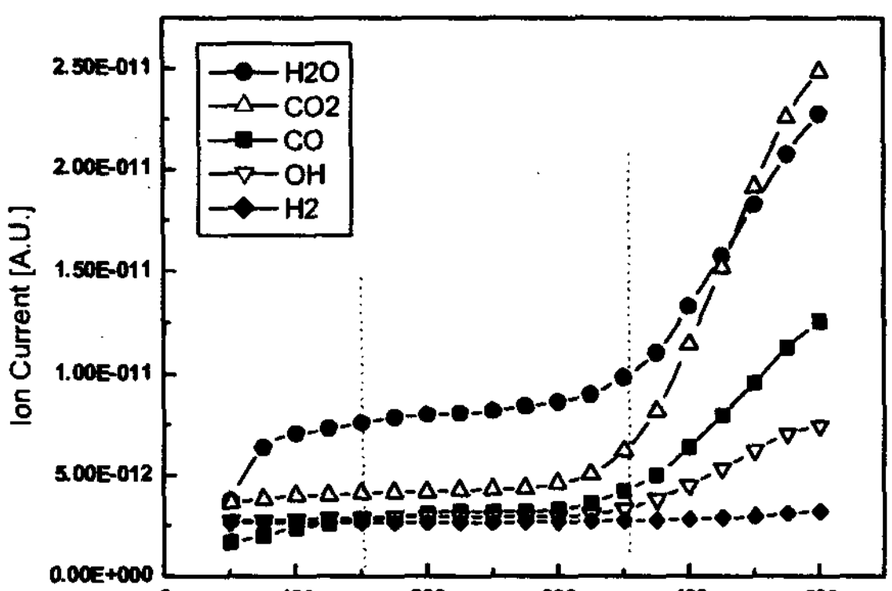

Figure 2. Gases desorbed inside PDP by heating

Physical and chemical desorption by heating process was shown in Fig. 1.

Fig.1 indicates outgassing species by heat treatment. We measured that carbon compound and water were major impurities on MgO and phosphor surfaces. Chemical analysis indicated that there were a few organics, and that chemically adsorbed carbon compound and water.

Electro-negative gas such as CO can cause the sustain pulse amplitude to rise by attaching electrons which will play an important role in the earlier stage of the discharge.

MgO layer and phosphor on each panel showed XPS peaks of C_{1s} and O_{1s} at the binding energy of 285 and 530eV, respectively, indicating adsorbed organics and hydration compounds. It can be anticipated that MgO film of front panel will exist in $Mg(OH)_2$, $Mg(CO)_3$ by chemical analysis shown in Fig. 3.

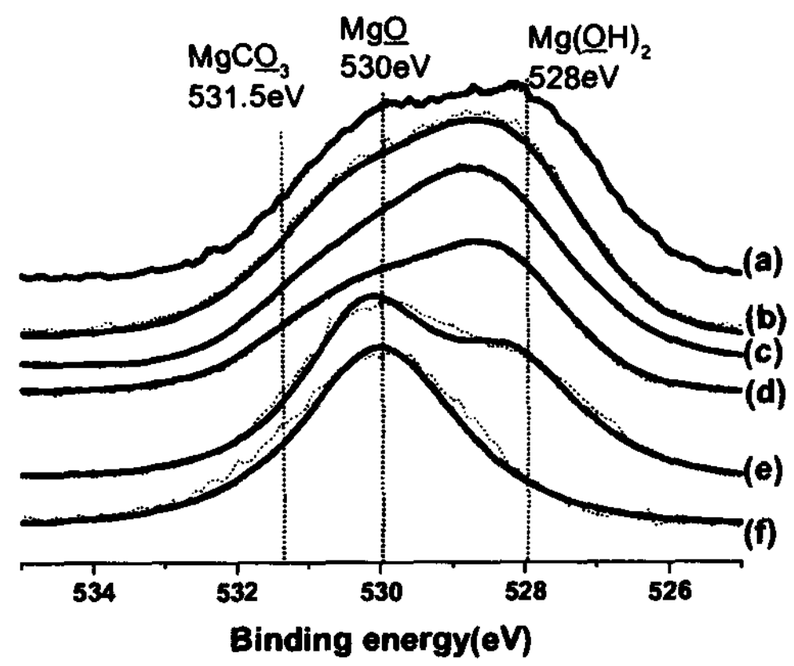

Figure 3. Chemical shifts of the binding energy of O_{1s} peak at the different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h, (e) 12h and (f) MgO single crystal.

MgO layer was used to protect the dielectric layer in PDP, and is in contact with the free space of display pixel where it is filled with inert gas mixture. MgO film can be main source of impurities.

Spectrum showed that intensity of carbon peak was decreased considerably and C, Mg and O peak were shifted by plasma discharge shown in Fig. 4. Carbon compound which is not composition of MgO

was adsorbed on MgO surface. It was decreased considerably by heat effect and electron effect with plasma discharge.

Dissimilarly the front panel, In the phosphor consisted of many compound, we could not see remarkable chemical change like the front panel. But intensity of carbon and oxygen peak was decreased shown in Fig. 5, as discharge extended. This result shows that carbon compound and water adsorbed onto phosphor surface was desorbed by heat effect and electron effect with plasma discharge.

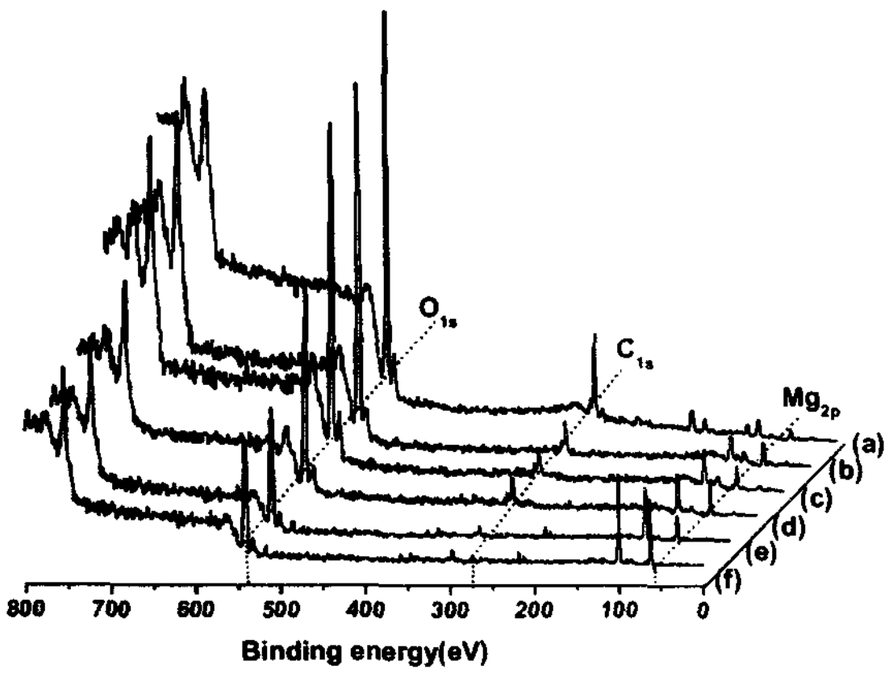

Figure 4. Surface changes of front panels at different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h, (e) 12h and (f) 24h.

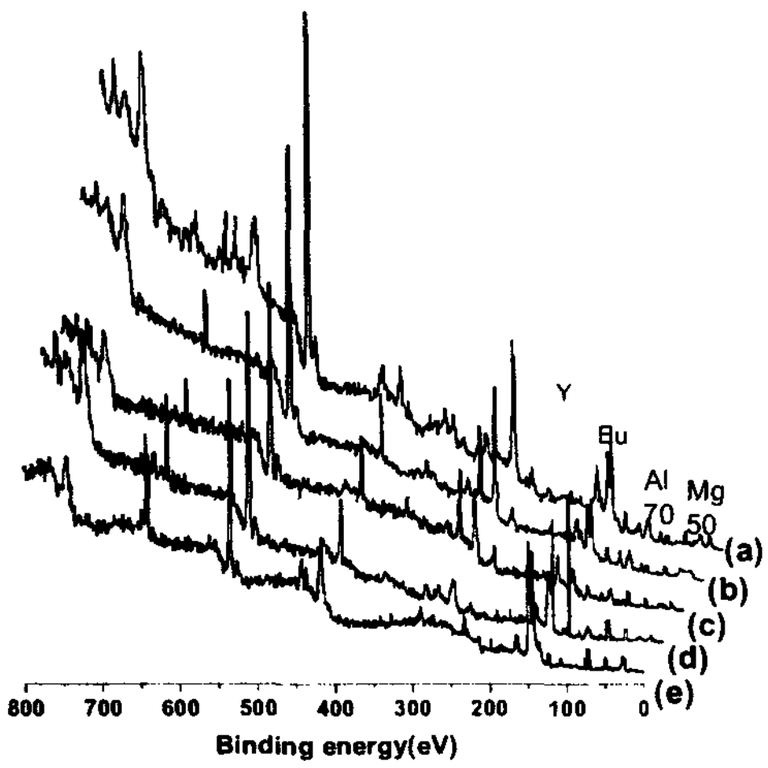

Figure 5. Surface change of rear panels at different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h and (e) 12h.

Carbon and hydration compounds were desorbed by plasma thermal effect and converted from surface to volatile gases(CO, CO_2, H_2 and H_2O). When carbon compound was chemisorbed onto MgO surfaces, the C=O binding state was more dominant than Mg-C. It could be understood that carbon compound was mainly combined with oxygen in MgO. Surface of MgO and phosphor were changing with the time and intensity of applied plasma.

Heat treatment of MgO after plasma treatment decreased the magnitude of impurity gas generation.

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. Mass spectroscopy data showed Fig. 6 and 7 that major impurities of surfaces were H_2, H_2O, CO and CO_2. We conclude that H_2O and carbon compound easily chemisorbed on surfaces are evolved at low temperature. As temperature was upto the 400 ℃, impurities such as CO, CO_2, and OH may deteriorate the characteristics of PDP operation.

This QMS data showed that major impurities of surfaces were H_2, H_2O, CO and CO_2.

Water and carbon compound easily chemisorbed onto surfaces are evolved inside discharge region by plasma discharge and thermal process. This gas evolution provides the evidence to support the above discussion. Impurities such as CO, CO_2 and OH inside discharge region may deteriorate the characteristics of PDP operation

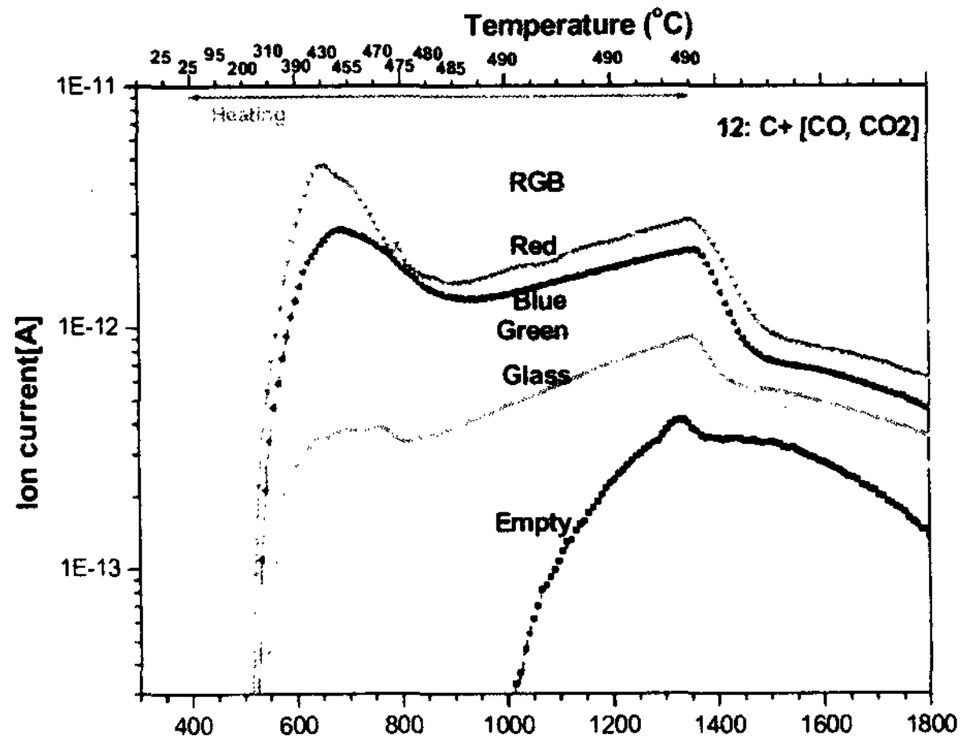

Figure 6. C^+ gas evolution on rear panel by heating.

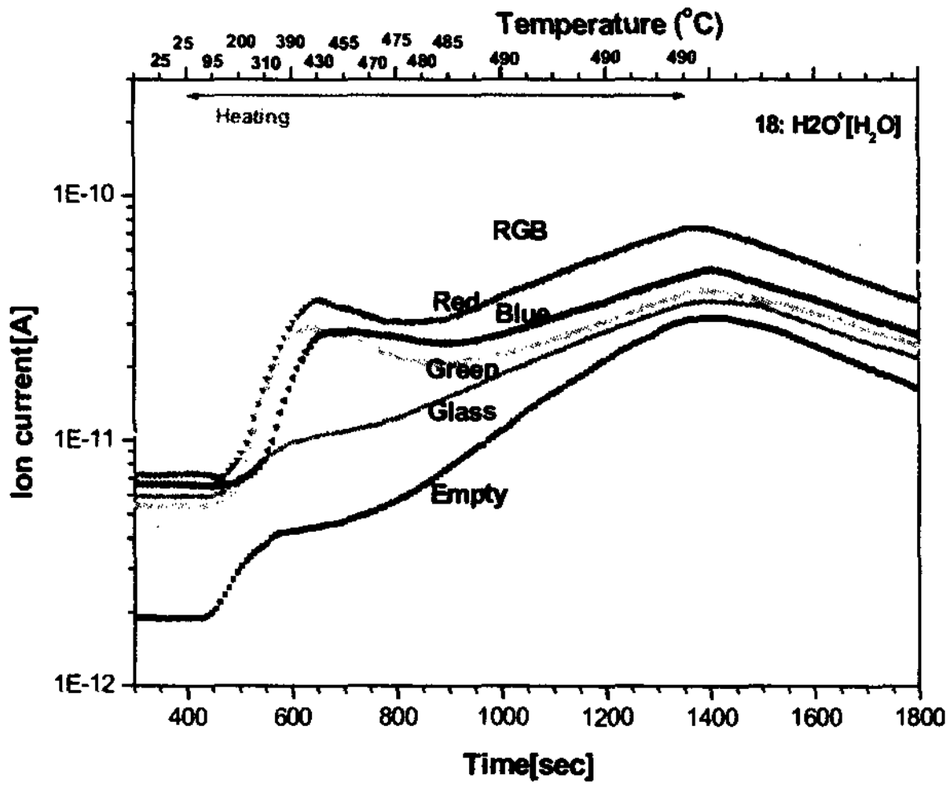

Figure 7. H_2O gas evolution on rear panel by heating.

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 discharge and thermal effect. Impurities such as CO, CO_2 and OH inside discharge region may deteriorate the characteristics of PDP operation.

In present, evacuation 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. Acknowlegements

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6. References

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