Gaseous Changes during Discharge and Thermal Treatment 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 film and phosphor have been investigated as a function of discharge, also phosphor and sealing frits have been investigated as a function of temperature. Changes of impurity generation of MgO, phosphor and sealing frits were measured by using x-ray photoelectron spectroscopy (XPS) and quadropole mass spectrometer (QMS). Impurities such as CO, CO_2, OH and H_2O were increased during discharge and heating treatment. Gaseous impurities such as carbon compounds and water deteriorated the characteristics of PDP operation during of lifetime. So metal is used to remove the impurities of phosphor and sealing frits during heating, the result that the quantity of the impurities such as carbon monoxide and water was reduced.

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].

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 lifetime [3, 4, 5].

We observed gas evolution of rear panel and sealing frits. Also in order to find out surface changes according to plasma discharges, the samples were discharged by He plasma. In this study, we tried to find out surface contaminant of panel and remove evolution gases. This study will be used for adsorption of gases and productivity improvement in PDP fabrication. Surfaces have been also examined by x-ray photoelectron spectroscopy. 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 500℃ at 15℃/min and their partial pressure was measured using a quadropole mass spectroscopy (QMS).

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 Electron Spectroscopy for Chemical Analysis (ESCA). Fig. 1 shows that the apparatus constructed

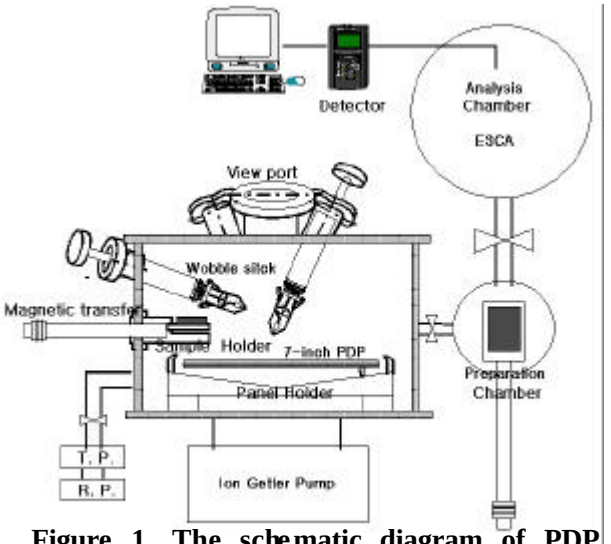

Figure 1. The schematic diagram of PDP disassembling chamber for vacuum transfer

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. 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.

3. Results and discussion

The performance of the PDP is strongly influenced by the surface glow-discharge characteristics on the MgO layer. MgO films 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.

MgO film according to aging time is shown in Fig. 2. It shows that intensity of carbon peak was decreased considerably and C, Mg and O peak were shifted according to aging by plasma discharge. In aging 12 hours, carbon compound was decreased considerably by heat effect and electron effect with plasma discharge. Phosphor layer with aging time is shown Fig. 3. It shows that intensity of carbon and oxygen peak was decreased, as aging time extended. This result shows that carbon compound and water adsorbed onto phosphor surface were desorbed by heat effect and electron effect with plasma discharge.

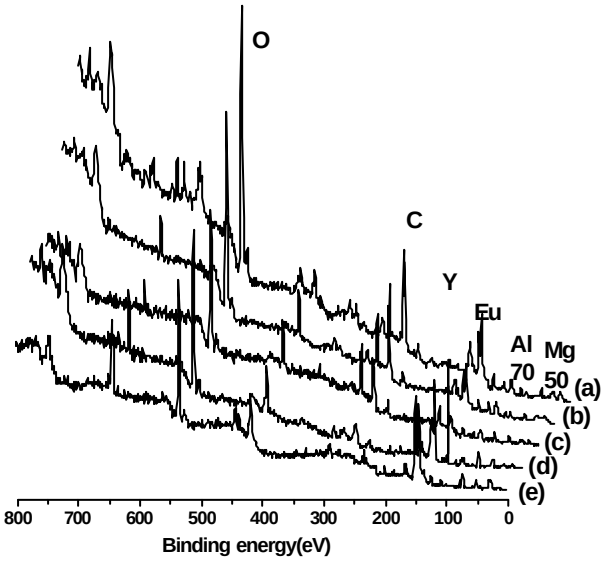

Figure 2. Surface change of rear panels at different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h and (e) 12h

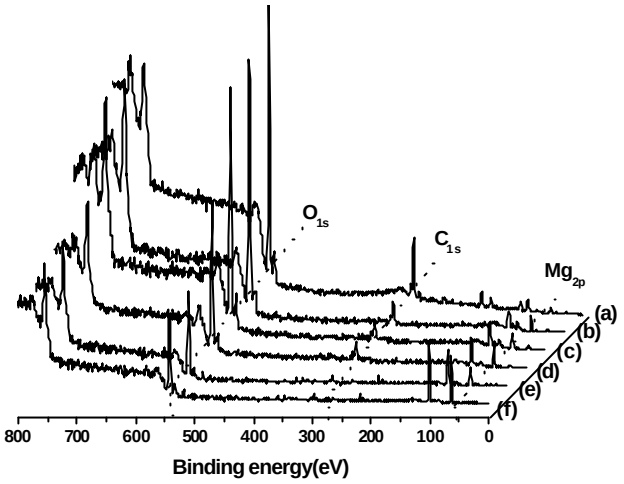

Figure 3. Surface changes of front panels at different plasma exposure time : (a) no plasma, (b) 0.5h, (c) 1h, (d) 2h, (e) 12h and (f) 24h

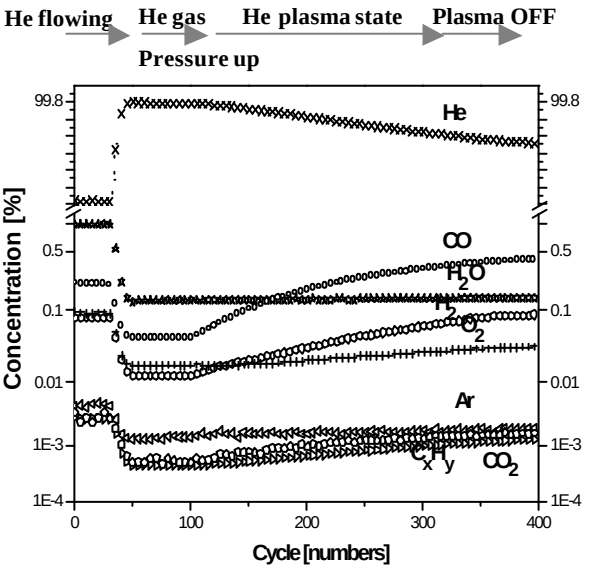

Figure 4. Gas evolution of rear panel with He^+ plasma

In order to find out gases evolved during discharge, a sample disassembled in the PDP chamber was discharged in the PDP discharge chamber by in-situ transfer. Fig. 4 shows gases evolution of aged panel for 30 minutes discharged by helium plasma, RF 100W, for 10 minutes using Mass Spectroscopy (QMS). This QMS data showed that major impurities from the surface were CO, H_2O, OH and CO_2. From this data, carbon compounds and water easily chemisorbed onto surfaces are emitted to the discharge gases by plasma discharge. Gaseous impurities such as CO, CO_2 and OH inside discharge region may deteriorate the characteristics of PDP operation. Especially electronegative gas such as CO can cause the sustain pulse amplitude to rise by attaching electron which will play an important role in the earlier stage of the discharge.

In order to find out gases evolved during the heating treatment, outgassing species and their partial pressure were measured as a function of temperature by using Mass Spectroscopy. Fig. 5 shows the evolution of gaseous impurities when phosphor is heated by 500℃. This QMS data showed that major impurities of phosphor were H_2O and CO. Fig. 6 shows gases evolution of sealing frits. This QMS data shows major impurities of sealing frits similar to the Fig. 5 were CO and H_2O. This is the same gases evolution of aged panel discharged by helium plasma of Fig. 3.

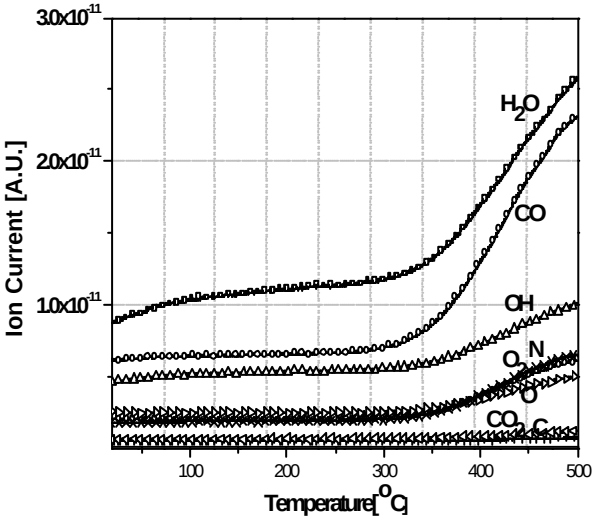

Figure 5. Gases evolution from rear panel

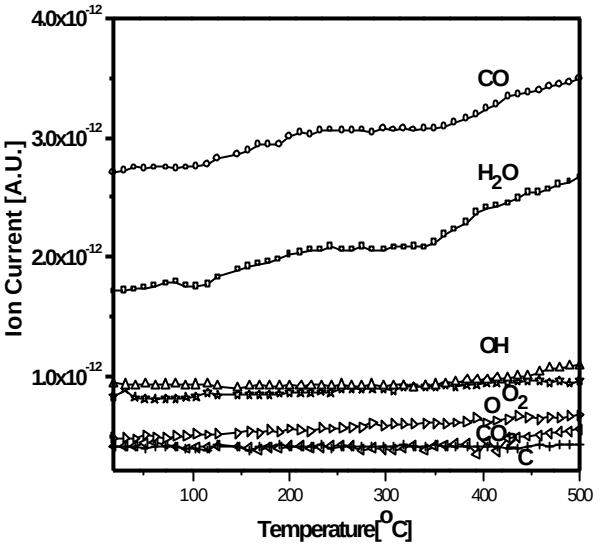

Figure 6. Gases evolution from sealing frits

We measured that carbon compounds and water were major impurities on phosphors and sealing frits. Chemical analysis indicated that there were a few organics, and that chemically adsorbed carbon compounds and water.

Sealing process is accomplished over 400℃ in the industry, therefore generated impurities by sealing process can be deposited to MgO film, phosphor and barrier ribs. During discharge, the residual gaseous impurities of inside panel are desorbed at the free space between MgO film and phosphor so they are able to decrease the efficiency of PDP.

In order to reduce gaseous impurities at the same temperature for the sealing process, we measured impurities of phosphor and sealing frits with metal. Fig. 7 and Fig. 8 show that carbon monoxide and water are desorbed during the heating by 500℃. The amount of generated carbon monoxide and water from phosphor and sealing frits decreases by metal during heating.

Therefore overall efficiency and performance of PDP will be increased by the use of metal as adsorbent of gaseous impurities.

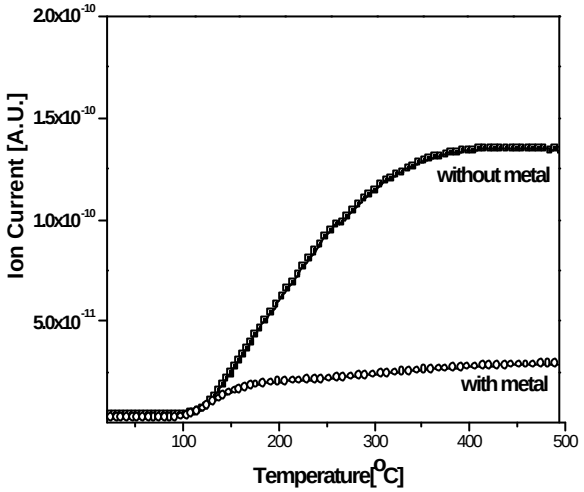

Figure 7. Desorption of carbon monoxide on metal by heating phosphor and sealing frits

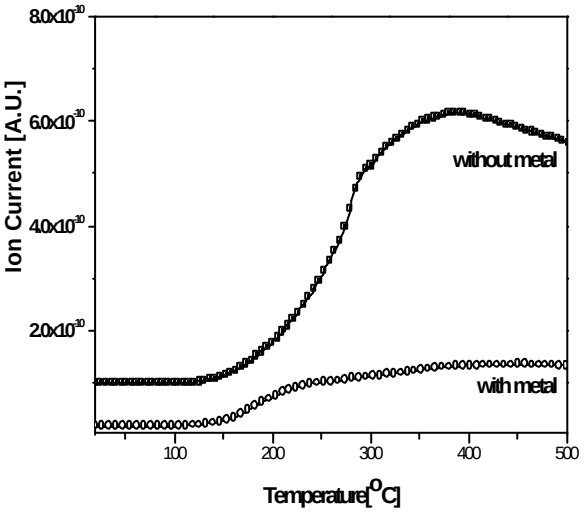

Figure 8. Desorption of water on metal by heating phosphor and sealing frits

4. Conclusion

In present, evacuation process for the purpose of surface stabilization is understood. Gaseous impurities of inside panels increase the starting voltage of PDP and decrease the lifetime.

In summary, carbon compounds and water were major impurities on MgO and phosphor surfaces. Chemical analysis indicated that there were few organics, and that chemically adsorbed carbon compounds and water. Impurity gases from sealing frits contaminate the inside surface of PDP.

In order to reduce impurity gases, the experiment progressed by using metal. The result is that the amount of carbon monoxide and water decreased during heating. Gaseous impurities inside panels are reduced by using metal therefore t will be able to improve overall efficiency and performance of PDP.

5. Reference

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