The Outgasing characteristics of MgO film for protecting layer of plasma display panel

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Abstract

In this study, outgassing characteristics of MgO films, and the plasma cleaning effects of the deposited MgO films by atmospheric pressure plasma on outgassing rate were compared. The MgO layer was heated up to 350℃ and the outgassing characteristics were observed for the heated conditions. As the main impurity species H_2, H_2O, N_2, CO_2, and H_2O were released from this panel. Impurity species of plasma treatment panel were lower than non-treated panels for the heating temperature

1. Introduction

Plasma display panel (PDP) is one of the most promising candidates for large-area wall hanging displays because of simple panel structure, easy and cheap processes appropriate for large area displays, good display quality, and high speed addressing ability. As one of the dielectric materials for PDP, MgO thin film is deposited to protect the dielectric layer from sputtering by ions and to emit relatively large secondary electrons when low energy ions hit on the surface, therefore, to reduce operation and sustaining voltage[1-3]. However, MgO tends to adsorb H_2O on the surface and the impurities such as H_2, N_2, CO_2, etc. in addition to H_2O. The cell including H_2O may deteriorate the characteristics of PDP and reduce the operation time of PDP. Also, the impurities adsorbed on the surface increase the time required for the evacuation before the introduction of discharge gas, therefore, decreases the throughout of the panel production.

In this study, outgassing species and their partial pressures emitted from MgO deposited on the real AC PDP front glass were measured using a quadrupole mass spectrometer. Also, using an atmospheric pressure surface cleaning tool, the deposited MgO surface was treated and the effect of the treatment on the change of outgassing characteristics and secondary electron emission coefficient(SEEC) were investigated.

2. Experimental

In this experiment, MgO deposited by evaporation on the real PDP front glass composed of indium tin oxide(ITO) electrode, bus electrode, and PbO dielectric layer was used as the sample. Each materials including MgO were deposited on glass using the same sequence used in PDP production. The size of the MgO deposited glass sample was 14.5cm x 11cm.

For the surface treatment by the atmospheric plasma, a modified dielectric barrier discharge (DBD) equipment having a number of capillary holes drilled in the dielectric material of the power electrode has been used[4]. The capillary holes were drilled on the dielectric to induce more uniform distribution of feed gas and to have a higher plasma density. The gap between the electrodes (capillary dielectric covered power electrode and ground electrode) was 0.5cm. 30kHz and 4.5 kVrms AC power was applied to the power electrode to generate the plasma. The sample was located on the ground electrode. For the plasma treatment, a mixture of He(6slm) /O_2(20sccm)/ Ar(20sccm) was fed through the power electrode under atmospheric pressure. The plasma treatment time was 5 minutes.

Outgassing system used in this experiment is shown in Figure 1. The sample was loaded to the outgassing chamber using a load-lock system and the outgassing chamber was evacuated to 10^{-7}Torr before the loading the sample. The sample was heated from room temperature to 350℃ at 10℃/min using a halogen lamp and outgassing species and their partial pressures were measured using a quadupole mass spectrometer(Hiden Analytical Inc. HAL-201: QMS) Due to the differences in the detected partial pressures of the species at the QMS and those outgassed at the chamber, the each impurity gas detected at the QMS was calibrated using various calibration gases to

obtain quantative partial pressures of each gases. [5-6] MgO surfaces before and after the plasma cleaning were analyzed by both the X-ray photorelectron spectroscopy(XPS) and SEEC measurement to monitor the chemical and electrical characteristics variation..

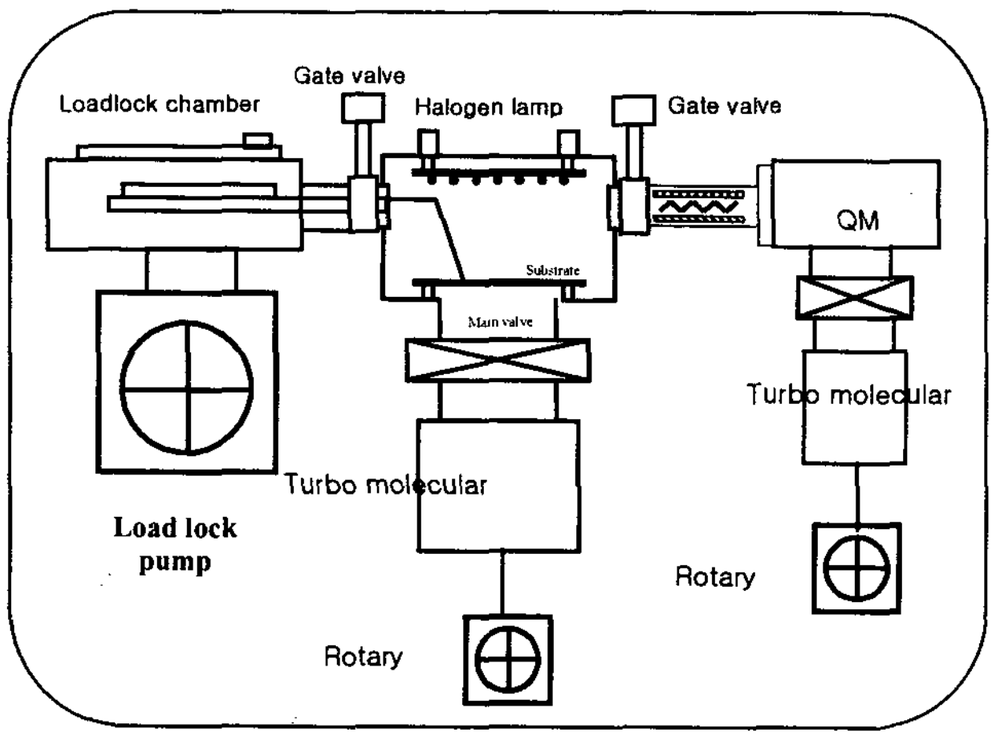

Figure 1 Outgassing measurement system

3. Results and discussion

Figure 2 shows the major outgassing species and their partial pressures measured as a function of temperature for the as-deposited MgO sample. As shown in the figure, the major outgassing species were H_2O, CO_2, CO, and H_2. Among these, H_2O showed the highest partial pressure. These impurity partial pressures possibly could be from other layers in the glass such as glass, ITO, bus electrode, and PbO. However, previous experiment[7] on outgassing impurity vapor pressures of MgO layer on glass was similar to those from the MgO deposited on the glass with ITO, bus electrode, and PbO. Glass itself did not show significant impurity vapor pressures. Therefore, the outgassing species observed in Figure 2 are believed to be mainly from MgO itself. As shown in the figure, two outgassing peaks are shown near 200-250℃ and 300-350℃. The peak partial pressure near 200-250℃ appears to be from the desorption of the physisorbed species and the further increase near 300-350C appears to be from the desorption from the chemisorbed species.

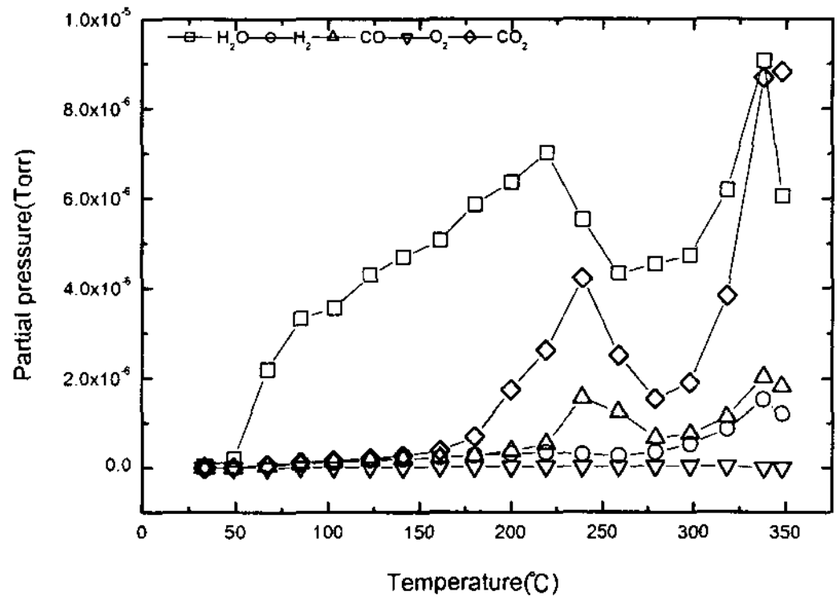

Figure 2 Major outgassing species and partial pressure as function of temperature

The outgassing species observed during the heating of the MgO glass are believed to be from impurities adsorbed during the deposition and exposure to the air after the deposition. Therefore, surface cleaning of the MgO surface was carried out using an atmospheric pressure plasma cleaning equipment. The use of atmospheric pressure plasma cleaning equipment enables us to clean the contaminated surface at lower cost by avoiding expensive vacuum generation and measurement tools. Also, if a reasonably high cleaning rate could be obtained, high processing throughput can be also obtained because of no time delay in vacuuming the chamber is required. The MgO glass was cleaned with these plasmas for 5minutes and the change of outgassing vapor pressures observed before and after cleaning with these plasmas was measured. The results are shown in Figure 3 (a) for H_2O, (b) for CO, (c) for H_2, and (d) for CO_2. As shown in the figure, no noticeable change of vapor pressure was observed for the temperature range from 200 to 250℃, however, there was a significant decrease of vapor pressures of H_2O, CO, H_2, and CO_2 for the temperature range from 300 to 350℃. No significant change of vapor pressure for the temperature range from 200 to 250℃ appears to be from the air exposure of the treated MgO samples before the measurement, therefore, due to the re-adsorption of impurities from the air. However, the decrease of vapor pressures from the outgassing species such as CO, CO_2, and H_2 appears to be from the removal of organic materials chemisorbed on the MgO surface by the reaction with oxygen in the plasma.

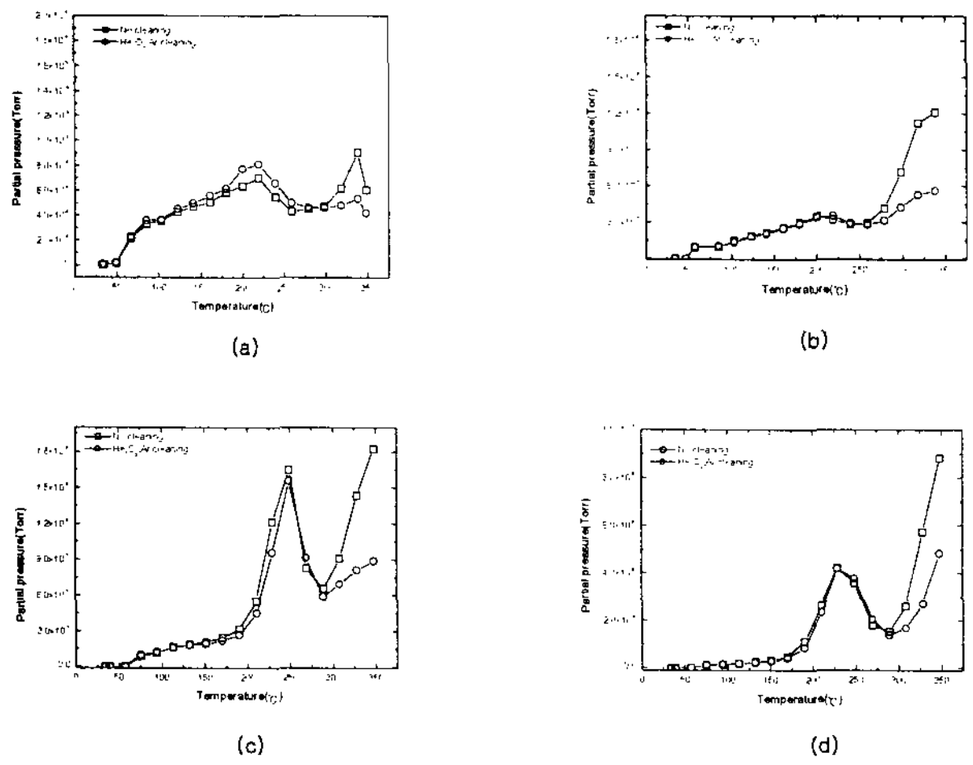

Figure 3 With/without plasma treatment Outgassing result (a) H_2O, (b) H_2, (c) CO, and (d) CO_2

The MgO sample surfaces were analyzed by XPS to investigate the change of surface composition after the plasma cleaning. Figure 4 shows the XPS narrow scan data of the MgO surfaces for (a)C1 peak and (b)Mg2p peak measured before and after the atmospheric pressure plasma cleaning with the $He/O_2/Ar$ gas mixture. As shown in the figure, after the cleaning, the atomic percent of Mg was increased from 33.7% to 48.7% (close to stoichiometric percent of Mg in MgO) and that of carbon was decreased from 33.7% to 23.2%. The decrease of carbon by the atmospheric plasma cleaning appears to be from the removal of chemisorbed organic contaminants on the MgO surface, however, the remaining carbon after the plasma cleaning appears to be from the physisorbed carbon during the air exposure after the plasma treatment and before the XPS measurement. The decrease of carbon contaminants on the MgO surface by the plasma cleaning is related to the decrease of vapor pressures of CO, CO_2, and H_2 during the heating from 300 to 350℃ as observed after the plasma cleaning in Figure 3.

MgO is deposited on PDP glass not only to protect the cell from sputtering but also to increase SEEC. To investigate the effect of the plasma cleaning of MgO on the SEEC, the SEEC was measured for the MgO deposited samples[8] before and after the atmospheric pressure plasma cleaning and the result is shown in Figure 5. The plasma cleaning condition was the same as the condition in Figure 4. As shown in the figure, the SEEC was increased after the plasma cleaning possibly due to the decrease of impurity species chemisorbed on the MgO surface during the deposition and air exposure after the deposition. Therefore, the atmospheric pressure plasma cleaning of MgO deposited PDP glass appears to not only decrease the outgassing species but also improve the discharge characteristics by decreasing the firing voltage and sustaining voltage of PDP [9].

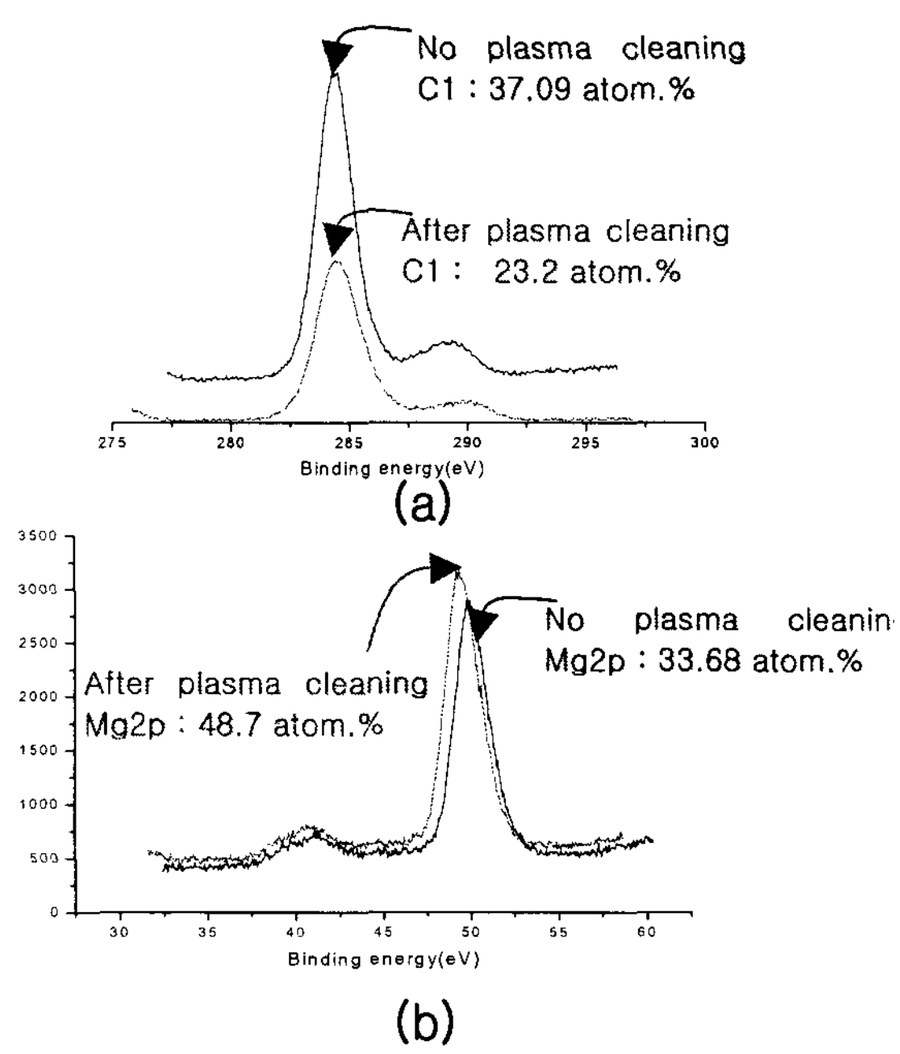

Figure 4 MgO surface analysis by XPS, (a) C1 peak , (b) Mg2p peak.

4. Conclusion

In this study, the effect of an atomospheric pressure plasma cleaning on the outgassing and secondary electron emission characteristics of MgO deposited PDP glass has been studied. As the plasma cleaning gases, mixture of $He/O_2/Ar$ has been used.

The MgO deposited PDP glass showed outgassing species such as H_2O, CO_2, CO, H_2, and O_2 when the glass was heated up to 350℃ and outgassing peaks were observed from 200 to 250℃ and also from 300 to 350℃ possibly due to the release of physisorbed species and chemisorbed species from the MgO surface, respectively. By an atmospheric pressure plasma cleaning of the MgO deposited PDP

glass using $He/O_2/Ar$ for 5minutes, the decrease of outgassing peaks from 300 to 350℃ could be observed possibly due to the removal of organic materials incorporated on the MgO layer during the deposition. The outgassing peaks from 200 to 250℃ did not show any significant change after the plasma cleaning possibly due to the re-adsorption of impurity species during the air exposure after the cleaning. The plasma cleaning increased the secondary electron coefficient of the MgO layer by removing the organic material on the MgO surface and by improving the surface stoichiometry of MgO layer.

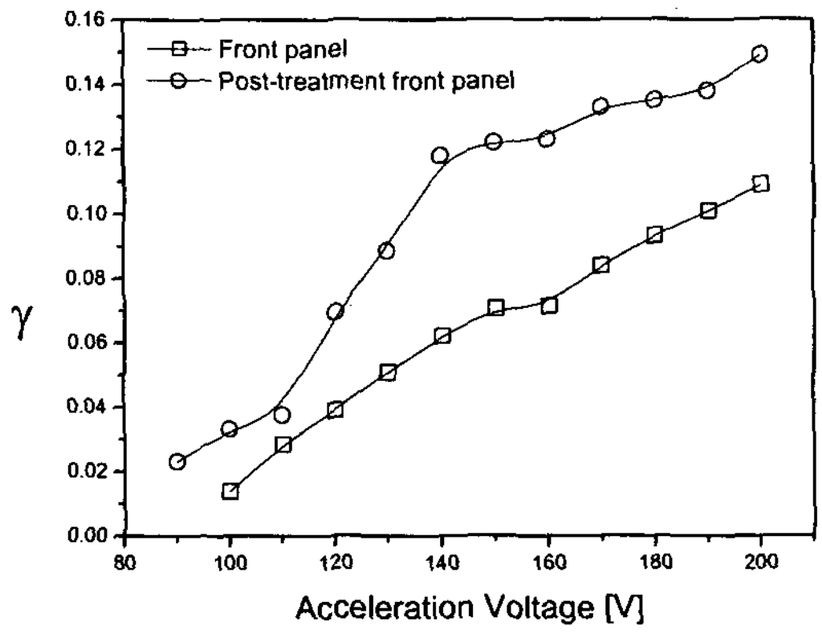

Figure 5 The SEEC measurements show the improvement of MgO film characteristics

5. Acknowledgements

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