Influences of degradation in MgO protective layer and phosphors on ion-induced secondary electron emission coefficient and static margins in alternating current plasma display panels

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Abstract

The degradation characteristics of MgO protective layer and phosphors have been investigated in terms of the ion-induced secondary electron emission coefficient γ and static margin of discharge voltages, respectively, in this experiment. The ion-induced secondary electron emission coefficients γ for the degraded MgO protective layer and phosphors have been studied by γ -focused ion beam system. The energy of Ne+ ions used is from 80 eV to 200 eV in this experiment. The degraded MgO and phosphor layers are found to have higher γ than that of normal ones without degradations or aged one. Also, the static margin of discharge voltages for test panels with degraded MgO protective layer and phosphors been found to be seriously decreased in comparison with those of normal ones without degradations.

Introduction

The electro-optical characteristics of MgO protective layer [1] and phosphors are very important for the development of recent alternating current plasma display panels (AC-PDPs). The MgO protective layer and phosphor provides the required lifetime which is greater than 20,000 hours. During PDP's operation the MgO layer and phosphors are being gradually disappeared due to ion sputtering. Especially the MgO protective layer and phosphors can be damaged and degraded by long time discharges of fixed images in AC-PDPs. Degradation of MgO and phosphor layers results in so called image sticking problem, which is one of the most important topics to be solved for AC-PDPs. Up to now, unfortunately, there is not enough basic studies on degradation characteristics of MgO protective layer and phosphors in AC-PDPs. In this paper, we have investigated a electrical characteristics for degraded MgO protective layers, along with phosphors, which is related to the image sticking problem in AC-PDPs. Especially, it is of great importance to investigate the influence of degradation in MgO and phosphor layers on ion-induced secondary electron emission coefficient γ and its discharge characteristics in AC-PDPs. The ion-induced secondary electron emission coefficient γ of degraded MgO protective layer might be correlated to the ignition and sustaining voltages of AC-PDPs[2] Hence we also investigate the breakdown and sustaining voltages for AC-PDP panel with the degraded MgO protective layers and phosphors, from which the static margin characteristics of degraded AC-PDP panel could be obtained and they are compared with those of non-degraded one in this experiment. In general, large values of ion-induced secondary electron emission coefficient γ of MgO protective layer result in a low breakdown or firing voltages, Vb, defined by $Vb= A(Pd)/\ln[B(Pd)/\ln(1+1/\gamma)]$, where A and B are constants determined by gas species, and Pd is the Paschen parameter, which is defined by the product of gas pressure P and distance d between anode and cathode. The MgO thin films were prepared by using electron beam evaporation method from sintered materials. Also the phosphors on rear panel has been deposited by screen printing method. The ion-induced secondary electron emission coefficient γ of MgO protective layer and phosphors have been measured by γ - focused ion beam system throughout this experiment to investigate the degradation of MgO protective layer and phosphor in AC-PDP. The test panel for this experiment is a 3.5 inch VGA class AC-PDP with a cell pitch of 1080 mm. The number of cells used in this experiment is 58 X RGB

Experimental Configuration

Figure 1 shows the schematic γ -focused ion beam system for a measurement of ion-induced secondary electron emission characteristics from MgO thin film and phosphors. The γ - focused ion beam system is broken down into five basic components the diode consisting of

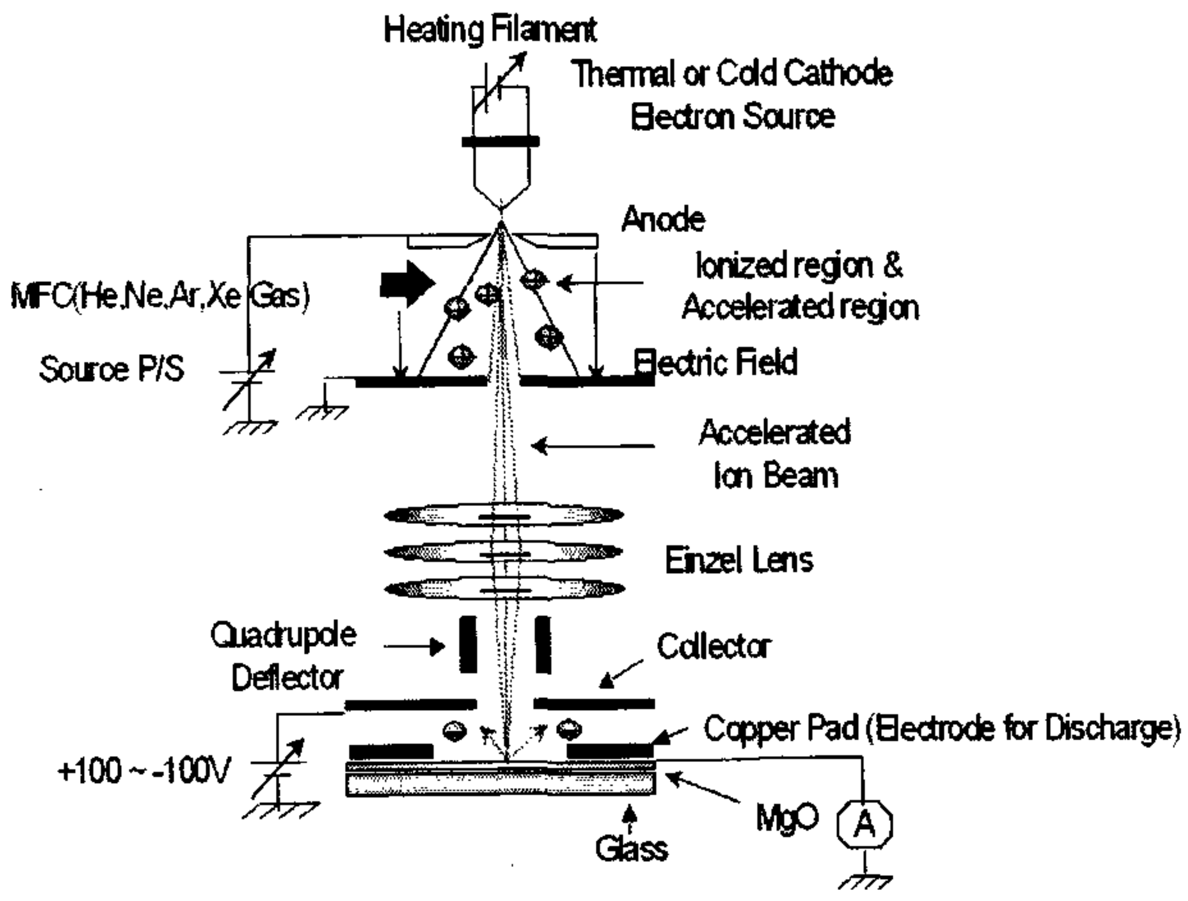

Figure 1. The schematic of□γ -FIB system

thermionic electron source and anode, electron-impact ion formation and its acceleration region, electrostatic single Einzel lens for ion beam focusing, quadrupole deflector, and substrate for γ measurement of MgO thin film, respectively. The background vacuum pressure of γ - focused ion beam system is maintained at 1.6 x 10^{-5} Torr, whereas it is kept by up 7 x 10^{-5}Torr during ion beam formation mainly at the nearby region of 2mm-diam anode hole by gas feeding. The ions are produced by impact collisions of thermal electrons emitted from filament to the He, Ne, Ar, N2, and Xe atoms. The kinetic energy of ions is depended on the ion accelerating voltage applied to the anode. The anode is positively biased and can be set from +50 up to +500V for the ion acceleration, and these ions are passed through the 0.5 mm-diam beam defining aperture along downstream of the system. The ion beam is the focused by single electrostatic Einzel lens and scanned by the quadrupole deflector onto the MgO surface and phosphor surface with fixed beam diameter of 80 μm throughout this experiment, which can be achieved by adjusting the filament heating current under the given ion acceleration energy. The MgO protective layers are deposited on the dielectric layer by electron beam evaporation method and vacuum annealed under 300℃ about 30 minutes after the deposition. The phosphors are screen- printed in this experiment. The thickness of MgO thin film and phosphors are 5000Å, and 20 μm, respectively. The deposition rate of MgO protective layer is 5A/s. In this experiment, Ne+ ions are used for the measurement of γ by varying its energy from 80eV to 200eV. Figure 2 shows a test panel in this experiment and images of normal reference cells, aging cell and degraded cells. The middle 7-lines have been aging processed for 24 hours and the below 7-lines have been degradated by more than 72 hours for sufficient degradation at both MgO protective layer and phosphors.

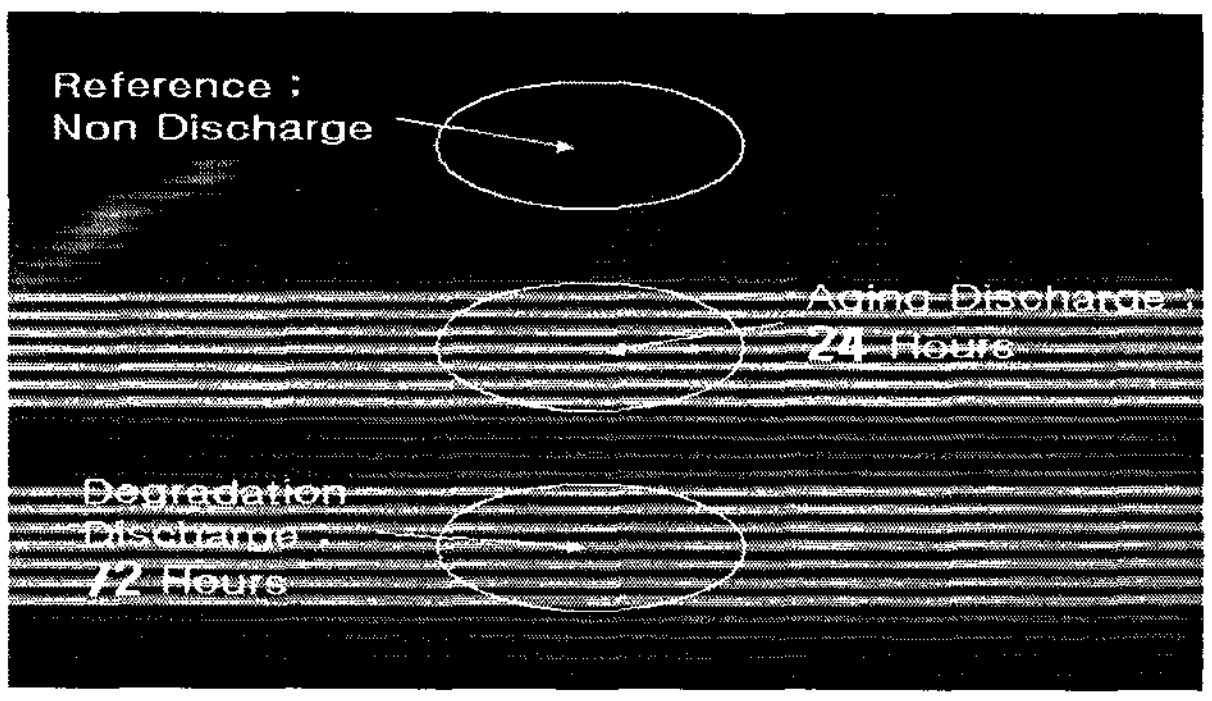

Figure 2. Test panel in experiment and discharge image

Experimental result

Figure 3 shows the ion-induced secondary electron emission coefficient γ of MgO protective layer for the normal reference, aging processed and degraded one, described by solid rectangular, open circle, and solid triangles, respectively. It is noted that the degraded MgO protective layer has the higher γ value than those of normal reference and aging processed MgO protective layer throughout the all ion energies ranged from 70 eV to 200 eV in this experiment. For a given Ne+ ion energy of 100 eV, the ion-induced secondary electron emission coefficient γ is 0.03, 0.05, and 0.09 for normal reference, aging processed and degraded MgO protective layer, respectively.

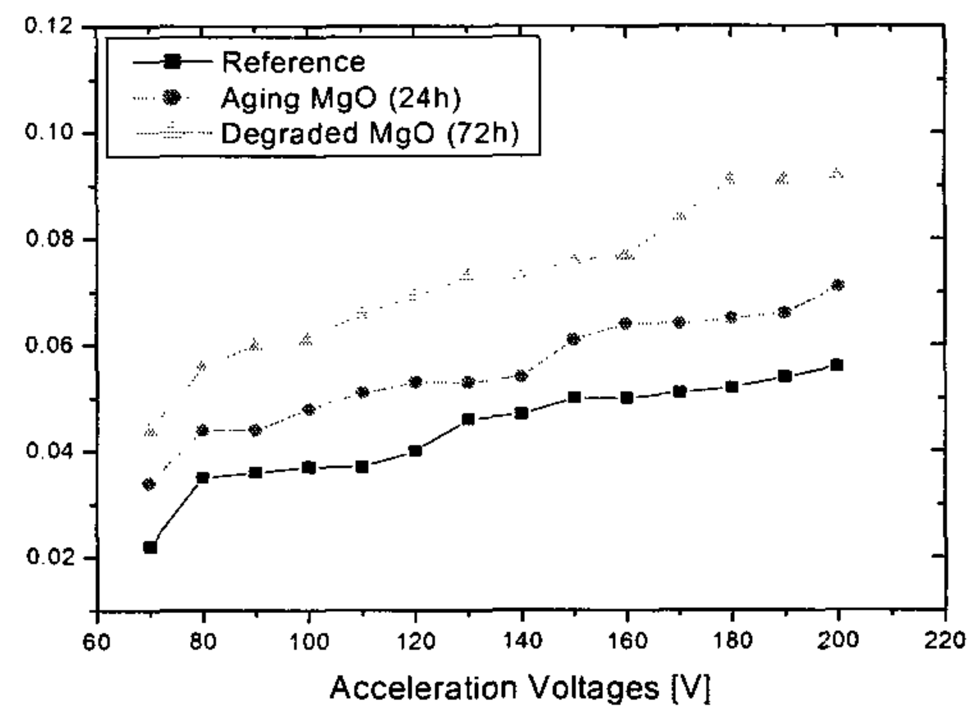

Figure 3. Secondary electron emission coefficient according to the MgO protective layer has degraded or not

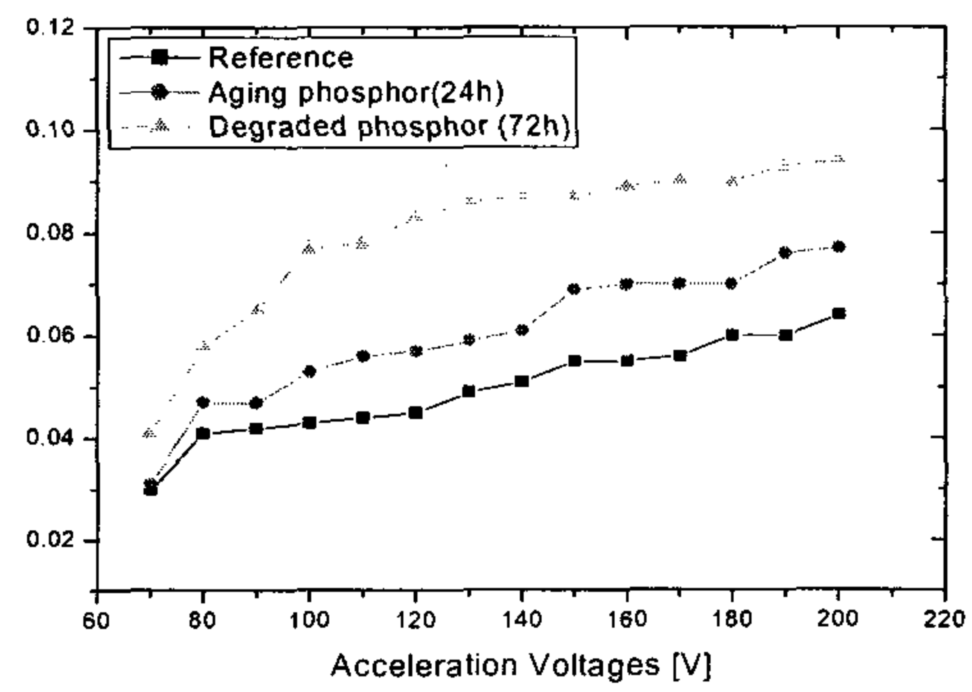

Figure 4. Secondary electron emission coefficient according to the phosphor has degraded or not

described by by solid rectangular, open circle, and solid triangles, respectively. Degraded phosphor has been found to have the higher γ values than those of normal and aging processed one throughout the all ion energies ranged from 90 eV to 200 eV in this experiment. For a given Ne+ ion energy of

120 eV, the ion-induced secondary electron emission coefficient γ is 0.02, 0.04, and 0.07 for normal reference, aging processed and degraded phosphors, respectively. Figures 5 show the static margin characteristics of normal reference, and degraded AC-PDP test panels, respectively. It is noted in this experiment that the firing minimum and sustaining maximum voltages after degradation are lowered by about 28 V and 20 V, respectively, when they are in comparison with those for normal AC-PDPs. It is found that the discharge static margin for firing minimum and sustaining maximum are reduced by amount of about 10 V from 82 V for normal MgO protective layer and phosphors to 72 V for degraded ones in AC-PDPs.

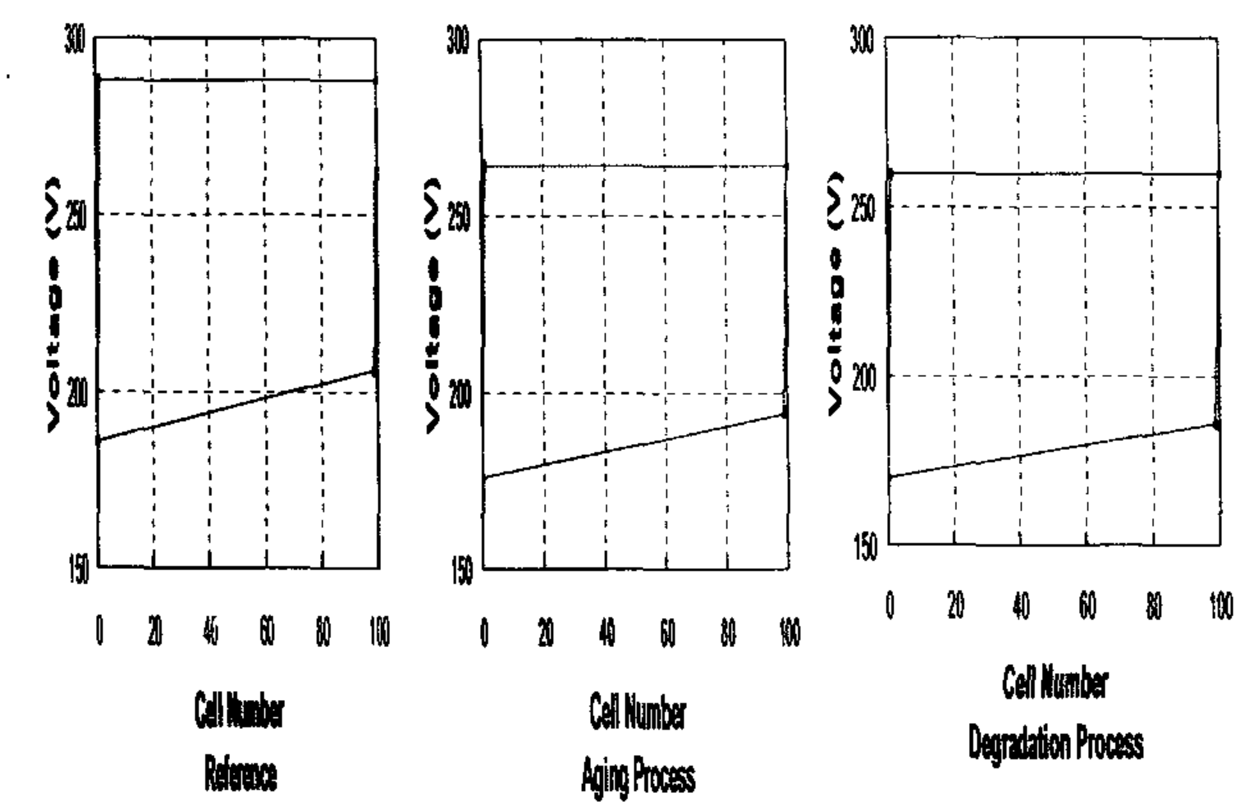

Figure 5. Static margin of test panel normal and aging, degradation process

Conclusion

We have measured the ion-induced secondary electron emission coefficient γ and basic discharge characteristics for the degraded MgO protective layer and phosphors by γ-focused ion beam system and AC-PDP test panel, respectively. The firing and sustaining voltages of test panel with degraded MgO protective layer and phosphors have been lowered by about 28V and 16V, respectively, in comparison with those of normal ones. And it is found that both degraded MgO protective layer and phosphors have higher γ values than those of normal MgO protective layer and phosphors. These results also indicate that the firing and sustaining voltages of the AC-PDP test panel might be dependent on the degradation characteristics of MgO protective layer and phosphors. It is found in this experiment that the discharge static margin is seriously reduced by amount of about 10 V from 82 V for normal MgO protective layer and phosphors to 72 V for degraded ones in AC-PDPs.

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