Influence of sintering temperature of MgO pellet on the electro-optical characteristics of alternating current plasma display panel (AC-PDP)

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Abstract

We have investigated the electro-optical characteristics of AC-PDP with different MgO protective layers, which have been deposited by electron beam evaporation from various sintered pellets with different temperatures. We have measured the secondary electron emission coefficient (γ) by using the Gamma Focused Ion Beam (γ-FIB) system, the static margin, and the address delay time. Also, we have investigated photoluminescence (PL) characteristics for understanding the energy levels of MgO pellets and protective layers.

1. Introduction

Magnesium oxide, MgO is a very important material in AC-PDP. In order to deposit the MgO on the PDP panel, MgO should be made in a shape of pellet by sintering process. Therefore, it is of great importance to investigate the relation of the sintering temperature to the electro-optical characteristics of AC-PDP. In this experiment, we have measured the secondary electron emission coefficient, static margin, sustain voltage, address delay time, and the photoluminescence (PL) spectrum characteristics in AC-PDP with different MgO protective layers, which have been deposited by electron beam evaporation from the various sintered pellets with different temperatures. Also we will analyze the relation of the energy level and PDP discharge characteristics in AC-PDP, in which the sintering temperature for the various pellet are different from each other.

2. Experimental

Fig. 1 shows Gamma Focused Ion Beam (γ -FIB) system. For measuring the secondary electron emission coefficient of MgO protective layer, we have used Gamma Focused Ion Beam (γ -FIB) system. It consists of the thermal electrons source part, ionized & accelerated region, electrostatic single Einzel lens for focusing ion beam, collector and copper pad for measuring the secondary electron emission coefficient of MgO protective layer. The neutral gases released from MFC are ionized by collision with the thermal electrons generated from filament source. And these ions are accelerated by the electric field formed between the anode and the ground hole and the ions obtain the kinetic energy by the applying voltage. The ion beam is focused by the electrostatic single Einzel lens. The focused ion beam induces the secondary electrons from MgO protective layer. We can measure the secondary electron emission coefficient by changing the collector voltage. When the collector voltage is the negative region the electric field forms to the collector from copper pad. At this time, the secondary electrons induced by ion beam come back to the MgO layer surface and we can measure the ion current (I_i) generated by only ion beam. On the other hand, at the positive region of the collector voltage the electric field forms to copper pad from collector. Because of the electric field, the electrons induced by ion beam are collected by the collector. At this time, we can measure total current (I_t) generated by the secondary electron and ion beam. We can measure the secondary electron emission coefficient by the following equation,

$$\gamma = \frac{I_t - I_i}{I_i} \quad (1)$$

In this experiment, we have used Ne gas and applied voltage to the anode from 80 V to 170 V. Also, we have deposited MgO pellets that have different sintering temperature each other on PD-200 glass by the electron beam evaporation system. The thickness of MgO layer is 8000 Å.

We have investigated work function of the respective MgO protective layers by using the signal that is obtained by the measurement of the secondary electron emission coefficient. The kinetic energy distribution, $E_{k\max}$, for the emitted secondary electrons from the MgO surface can be described by

$$E_{k\max} = \varepsilon_{iz} - 2\Phi_w \quad (2)$$

The Eq. (2) has been originated from the Auger neutralization theory. When the collector voltage goes to the positive region from the negative region, $E_{k\max}$ is calculated by the differentiation of the collector current signal. The work function, Φ_w, is calculated by $\Phi_w = \frac{\varepsilon_{iz} - E_{k\max}}{2}$, where ε_{iz} = 21.56eV is the ionization energy of the Ne gas whose acceleration energy is fixed to be 150eV in this experiment.

The respective MgO pellets are e-beam evaporated to the 4-inch test panel(Ne-Xe 10%, 400Torr) that has the electrode gap of 60 ㎛ and the cell pitch of 1 ㎜. The static margin and the address delay time (jitter) are the basic discharge characteristics of AC-PDP. At the static margin voltage, when one cell of the test panel is turned on by the external applied voltage, it is called the $V_{f\min}$ voltage. When all cells of the test panel are turned on, it is the $V_{f\max}$ voltage. When one cell of the test panel of all cells turned on is turned off, it is called the $V_{s\max}$ voltage. When all cells of the test panel are turned off, it is called the $V_{s\min}$ voltage. Generally, it is called that the voltage difference from the $V_{f\min}$ to the $V_{s\max}$ is the static margin voltage. In this experiment, we have applied the sustaining pulse that has 30 kHz and 25% duty ratio to the x and y electrodes of the test panel. Fig. 2 shows the definition of jitter. We have applied the 90V to the address voltage that has 3 ㎲ pulse width. At photoluminescence(PL) spectra, we have used He-Cd laser(441 ㎚). When it has irradiated onto the MgO pellets, we have observed two strong peaks by using spectrometer at atmospheric pressure, room temperature.

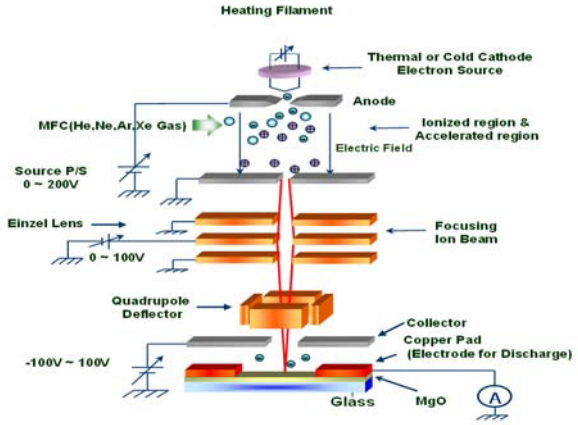

Fig. 1. Schematic of Gamma Focused Ion Beam system

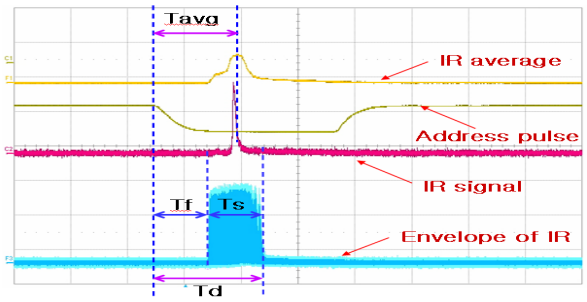

Fig. 2. Definition of jitter : T_{avg} (averaged time delay), T_f (formative time delay), T_s (statistical time delay), T_d (total delay)

3. Results and discussion

The samples of A, B, C and D were sintered by different temperatures. The sintered temperatures for the A and B are the same and the highest among them. Here the B, C and D are multi-doped MgO pellets with different doping degrees, while the sample A is close to pure MgO pellet. It is noted that the sintered temperatures for the samples of C and D are lower than those for A and B. Fig. 3 shows the secondary electron coefficient versus the ion acceleration energy for the different MgO thin film. It is noted that these MgO protective layers have been formed on the PD-

200 glass by sintered MgO pellets with different sintering temperatures. The thickness of MgO thin film is 8000 Å. This result shows that doped sample A has lower value of γ than any other samples. The samples B, C and D have the similar values of γ. Fig. 4 shows the static margin voltage versus various MgO pellets with different sintered temperatures. It shows that sample A has higher voltage than any other samples. It is noted that the higher value of γ has, the lower discharge voltage has. Fig.5 shows address delay time versus various MgO pellets with different sintering temperatures. It is noted that the formative, statistical and delay times are about 1.2 us, 0.8 us, and 2 us, respectively, for the samples of A, while the other samples of B, C, and D have similar values of 1.1 us, 0.6 us, and 1.7 us, respectively.

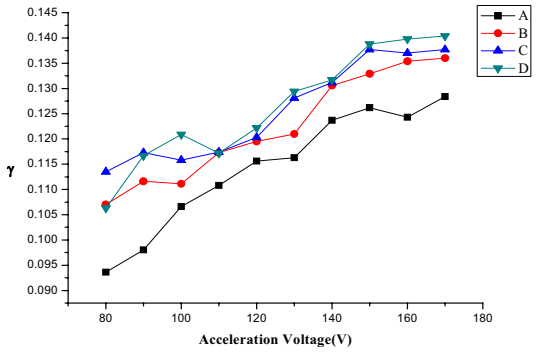

Fig. 3. Secondary electron emission coefficient versus the ion acceleration energy

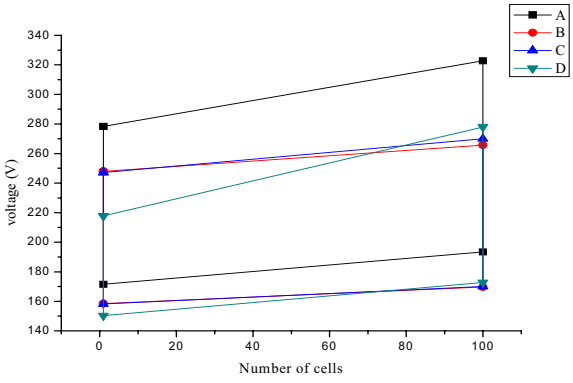

Fig. 4. Static margin voltage versus various MgO pellets with different sintered temperatures

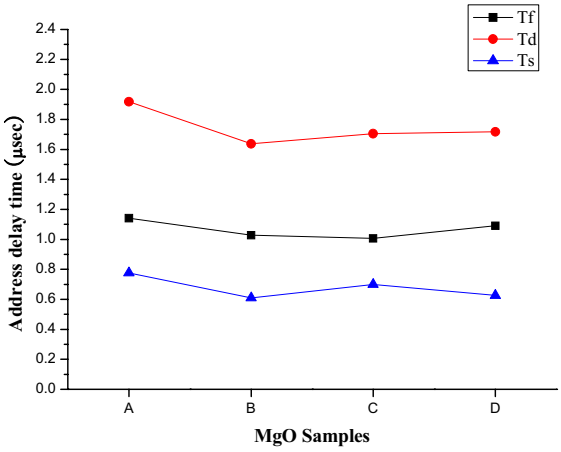

Fig. 5. Address delay time versus various MgO pellets with different sintered temperatures

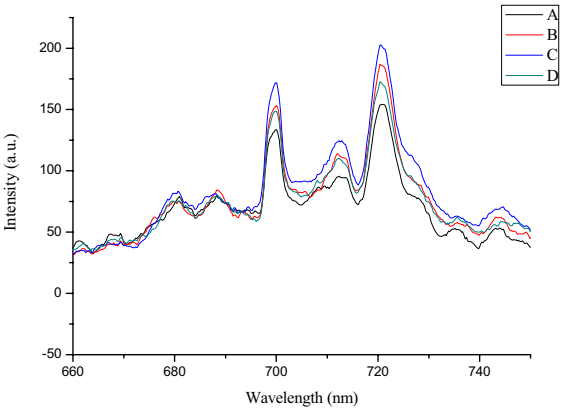

Fig. 6. Emission spectrum in MgO pellets exposed to He-Cd laser (441 ㎚)

Fig. 6 shows the PL spectrum of MgO pellets exposed to He-Cd laser (441 ㎚). we have observed the two strong peaks that are 700 ㎚ ($h\nu$=1.777eV) and 720 ㎚($h\nu$=1.727eV). This spectrum shows the sample of A has the lowest intensity among any others. This result shows that sintering temperature has an effect on the energy level of MgO pellets. Also the degree of doping materials affects on the energy level of MgO pellets. In comparison with the value of γ of MgO layer and PL spectrum from MgO pellets, even though they are in different states of thin film and bulk, the both results show similar tendency in behaviors. At the discharge characteristics like the static margin and the address delay time, the similar tendencies are also seen in this experiment.

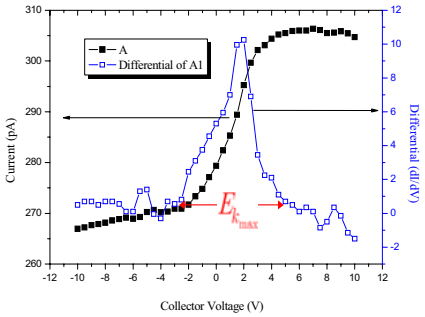

Fig.7. Kinetic energy distribution of the sample A

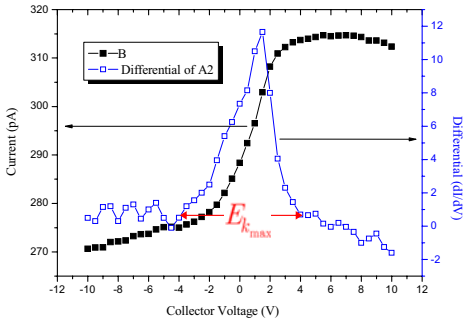

Fig.8. Kinetic energy distribution of the sample B

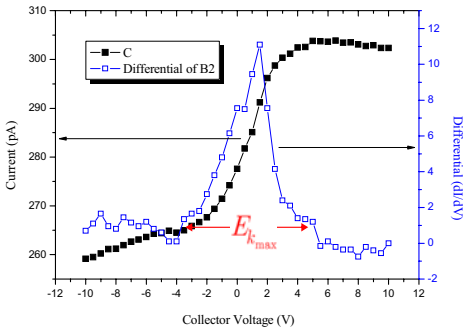

Fig.9. Kinetic energy distribution of the sample C

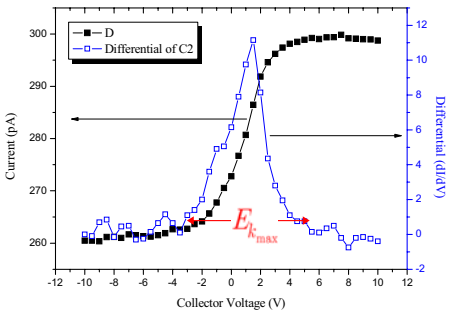

Fig. 10. Kinetic energy distribution of the sample D

TABLE 1. Kinetic energy distribution($E_{k\max}$) of the doped samples

	A	B	C	D
$E_{k\max}$	8.454eV	9.958eV	10.152eV	10.055eV

TABLE 2. Work function of the doped samples

	A	B	C	D
Work function	6.553eV	5.801eV	5.704eV	5.752eV

Fig. 7-10 show that Energy distribution ($E_{k\max}$) of the samples (A-D). Table 1 shows the kinetic energy distribution of the samples. This result shows that the kinetic energy distribution of the sample A has the lowest value, 8.45eV. In comparison with the kinetic energy distribution and the secondary electron emission coefficient, the smaller secondary electron emission coefficient has the smaller kinetic energy distribution. Table 2 shows the work function of the samples. This result shows the sample A has the highest value, 6.55eV among the other samples.

4. Summary

In this experiment, we have known that the sintering temperature of MgO pellet gives an influence on the electro-optical characteristics such as static margin, delay time, and kinetic energy distribution of secondary electrons emitted from MgO protective layer of AC-PDP. Especially PL spectrum is related to the value of γ and work function.

The kinetic energy distribution of the secondary electrons for the sample A with the highest sintering temperature and lowest degree of doping has the smallest value of 8.45 eV, while the its work function of MgO thin film A has the highest value of 6.55 eV in comparison with other samples with lower sintering temperatures and higher degree of doping. We can see in this experiment that the smaller kinetic energy distribution has the higher value of work function and lower secondary electron emission coefficient.

5. References

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