AC PDP의 MgO 결정방향성과 증착조건간의 상관관계에 관한 연구

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The study of the relationships between the MgO crystal orientation and the conditions of deposition on AC-PDP

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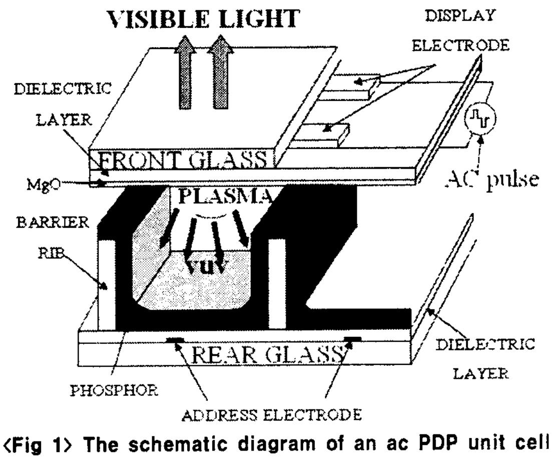
Abstract - There are several important issues in AC PDP researches such as cost reduction, reliability, and good image quality. The properties of MgO layer is thought to be one of the most important factors that affects the panel reliability through the firing voltage variation. The MgO thin film mainly has (111), (200) and (220) crystal orientation. It is reported that (111)-oriented film helps decreasing the discharge voltage, and (200)-oriented film improves the misfiring on high temperature and the image sticking[1]. In this study, we investigated the relations between the crystal orientation and e-beam evaporation process parameters such asdeposition rate, temperature of substrate, and distance between the target(MgO tablet) and the substrate.

1. Introduction

A plasma display panel (PDP) is one of the best candidates for a large-scale flat panel display using plasma technology for next generation. However there are several important issues in AC PDP researches such as lowering operating voltage for cost reduction, increasing voltage margin for stable performance, and enhancing luminance and luminous efficiency for good image quality. AC PDP is influenced by characteristics of the surface glow discharge on the MgO thin film. Because MgO thin film is practically discharge electrodes, the discharge characteristics of PDP depends on the method and process condition of MgO deposition. It has been known that a various physical and chemical properties of MgO film, such as surface roughness and crystal orientation affects the discharge properties [2~4]. However there is not enough data of relations between the crystal orientation and the condition of deposition on substrate. In this study, we investigated the relations of the crystal orientation about deposition thickness, deposition rate, temperature of substrate, and distance between the MgO tablet and the substrate.

2. Experiments

<Fig 1> is an illustration of the PDP cell. The front glass is fabricated the two sets of parallel sustaining electrodes. Addressing electrodes are placed orthogonal to the sustaining electrodes, on the opposite rear glass. In the front glass, there is a protective film of MgO to prevent deterioration of the dielectric layer caused by ionic impacts. MgO has favorable characteristics in that its discharge voltage is low, thanks to a high secondary electron emission coefficient. The rear glass has a phosphor layer for converting the VUV to visible light for color displays, and barrier ribs to control the discharge gap, which separates the cells.



<Fig 1> The schematic diagram of an ac PDP unit cell

<Table 1> shows the split conditions of the process parameters used for MgO film growth.

<Table 1> deposition condition of MgO thin film (Time : Deposition time, Tem. : temperature, Dis. : Distance between the crucible and the substrate)

condition	E-beam power	Time	Tem.	Dis.
Thickness	6 mA	(a) 5 min	200 °C	13 cm
		(b) 15 min		
		(c) 25 min		
Tem.	6 mA	25 min	(d) 150°C	13 cm
			(c) 200°C	
			(e) 250°C	
Dis.	6 mA	25 min	200 °C	(f) 11 cm
				(c) 13 cm
				(g) 14 cm
Deposition rate	6 mA	(h) 35 min	200 °C	13 cm
	8 mA	(i) 30 min		
	10 mA	(j) 25 min		

The samples of (a)~(c) have the different thickness of MgO layer obtained from controlling the deposition time. The film thickness of each case is 1,000Å, 3,500Å, and 6,500Å. The process parameters of the sample (c) are used for reference conditions of other samples.
The (d), (c), and (e) samples have the different substrate temperature, which has 150°C, 200°C and 250°C respectively. The temperature of the glass substrate is controlled throughout the e-beam process.
The samples (f), (c) and (g) have the different working distance of 11cm, 13cm and 14cm. The case of (h), (i) and (j) have the difference of deposition rate. The deposition rate of each case is (h)200Å/min, (i)350Å/min and (j)440Å/min. The deposition rate is controlled by the E-beam power.
Measurements of the X-ray diffraction (XRD) and scanning electron microscope (SEM) were performed to analyze the crystal orientation and surface morphology of the MgO thin film.

3. Results and Discussion

3.1 The Effects of the MgO thin film thickness

<Fig 2> shows the surface images and XRD patterns for the sample (a), (b) and (c).
Measured thickness of each sample corresponds to 1,000Å, 3,500Å and 6,500Å. Surface roughness increases with thickness. There is no conspicuous change of crystal orientation with thickness variation.
The XRD intensity grows up linearly when the thickness is increased. Each increasing rate of (111), (200), and (220) is 0.005counts/Å, 0.026counts/Å, and 0.015counts/Å.
Therefore, it can be concluded that preferred crystal orientation is not much changed during the film growth.

3.2 The Effects of Substrate temperature

<Fig 3> shows the SEM images and XRD patterns for the MgO layers grown with different substrate temperature. The thickness of all MgO films is about 6,500Å,which means that the growth rate is almost same within our temperature variation range. The surface morphologyis nearly same for all samples. It is expected that crystalinity is improved with substrate temperature since higher surface energy helps movement of adtoms and there crystal bonding. Experimental results show that these tendency. One interesting point is that (200) orientation is almost

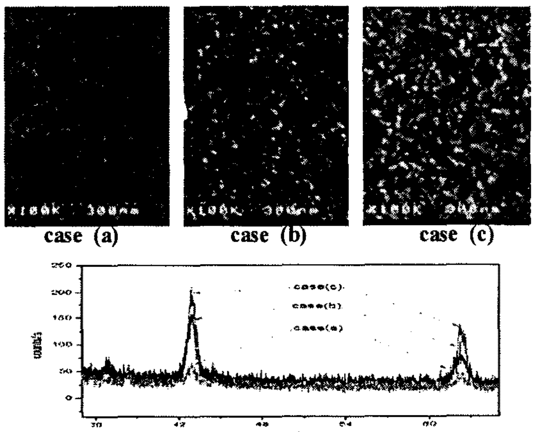
exclusively enhanced at high substrate temperature. As a result, we may concluded that substrate temperature is effect tool for controlling crystal orientation of MgO thin film.

3.3 The Effects of Working Distance

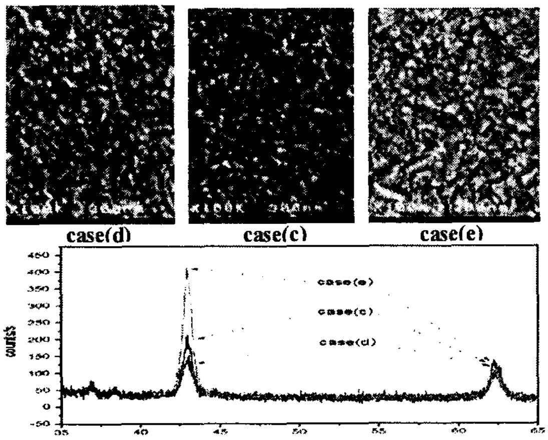
The distance between crucible and substrate is one of the parameters that can control deposition rate through particle flux density under constant evaporation rate of source materials. The energy of impinging source particle can also be affected by working distance due to collision in line of flight. The latter effect can be neglected since base pressure of chamber is 10-5 torr range. Due to limitations of our chamber size, we can vary the distance only about 20%. XRD date show that there are small amount of increment in relative intensity of (200) direction with increment of working distance. However, measured deposition rates are almost same for three samples.
Although it is difficult to say that controlling the working distance is an effective way for crystal orientation, the results sow that it can be one possible method.

3.4 The Effects of Deposition rate controlled by e-beam cur rent

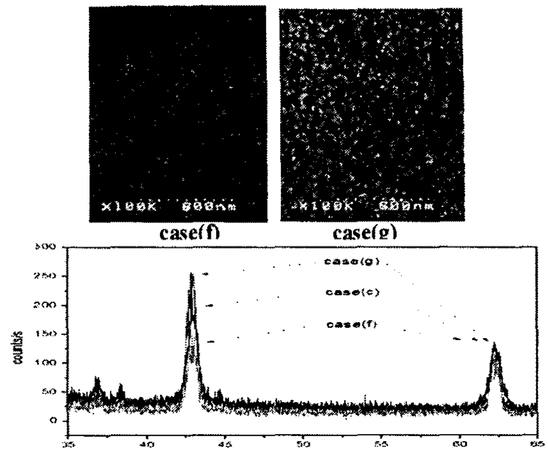
<Fig 5> shows the surface images and XRD patterns of the samples growth in different e-beam power conditions. E-beam power determines the deposition rate primarily. The deposition time is controlled to have same film thickness. Measured thickness of MgO film is 7,000Å, 10,500Å, and 11,000Å. Corresponding deposition rate of each case is (h)200Å/min, (i)350Å/min and (j)440Å/min.
The MgO film surface of case(J) is rougher than case(h).
Each XRD intensity of (111) and (220) is increased 33% and 69% in case(j) than case(h). The XRD intensity of (200) is decreased 51% in case(j) than case(h).
The XRD intensity of (200) is stronger in case(h) than case(j). The XRD intensity of (220) is weaker in case(h) than case(j). (111) intensity is detected weakly but it grows up a little at case(j) than case(h).



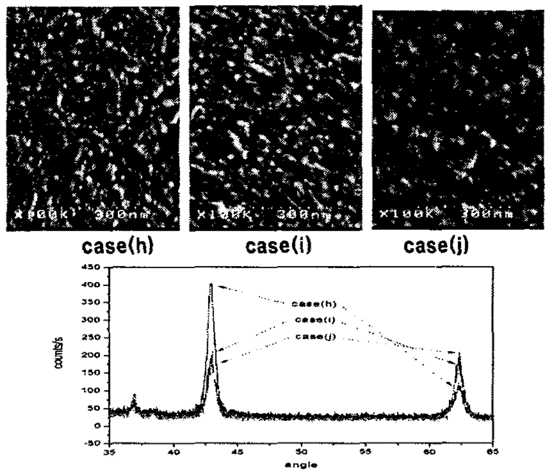
<Fig 2> Front section SEM image and XRD patterns of MgO thin film on the glass substrate about thickness.



<Fig 3> Front section SEM image and XRD patterns of MgO thin film on the glass substrate about temperature.



<Fig 4> Front section SEM images and XRD patterns of MgO thin film on the glass substrate about distance between the target and the substrate



<Fig 5> Front section SEM images and XRD patterns of MgO thin film on the glass substrate about deposition rate.

4. Conclusion

In this paper, we investigated the relations between the crystal orientation and the condition of deposition on the substrate.
Thetemperature of substrate and evaporation rate of source material, or deposition rate of the film, are definitely related to the crystal orientation of the MgO thin film. The distance between the target(MgO tablet) and the substrate is possible change the crystal orientation. However, the crystal orientation is not much affected by the thickness of MgO thin film.
To produce the MgO thin film of (200)-crystal orientation, we suggest the high temperature of the substrate, the long distance between the target and the substrate, and the low deposition rate.

[Reference]

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