산화 마그네슘 박막의 스퍼터 제조기술

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Sputtering technique for magnesium oxide thin films

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Abstract - A high rate deposition sputtering process of magnesium oxide thin film in oxide mode has been developed using a 20 kW unipolar pulsed power supply. The power supply was operated at a maximum constant voltage of 500 V and a constant current of 40 A. The pulse repetition rate and the duty were changed in the ranges of 10 ~ 50 kHz and 10 ~ 60%, respectively. The deposition rate increased with rising incident power to the target. Maximum incident power to the magnesium target was obtained by the control of frequency, duty and current. The deposition rate of a moving state was 9 nm m/min at the average power of 1.5 kW.

1. 서 론

The plasma display panel (PDP) is one of the most promising candidates for large area wall hanging displays because of its simple panel structure, superior display quality, and wide viewing angle. Although plasma display panels are now entering the world wide markets, further improvements in picture quality, life span, and lowering costs are still needed. Magnesium oxide thin films play a particularly important role in the high quality and long lifetime of PDPs. Magnesium oxide thin films have been used as a protective layer for dielectrics in the alternative current (AC)-PDP to improve discharge characteristics and panel lifetime because of their anti-sputtering property, high transmittance, and secondary electron emission coefficient [1-3].

The aim of this study is the development of a higher deposition sputtering process of magnesium oxide thin film at the oxide mode using a devised power supply. The size of plasma display panel is intended to be 30 ~ 100 inches and consist of the vertical In-Line type. Deposition conditions were pursued at the oxide mode to improve the characteristics of time delay of magnesium oxide thin film. This technique will be contributed to a magnesium oxide thin film manufacture system having superior quality, high deposition rate,, and low cost.

2. 본 론

2.1 Experiment

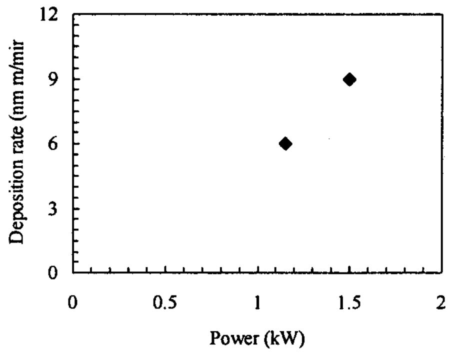
In this experiment, a unipolar pulsed power supply of 20 kW was used. The power supplywas operated at a maximum constant voltage of 500 V and a constant current of 40 A. The target voltage could not be applied between 250 ~ 300 V because of relatively low impedance (about 15 Ω) of reactive discharge. In this case, in order to increase incident power of the target, the constant current mode was used. Therefore, a maximum power density of the magnesium target was obtained by controlling a constant current mode. This function was significant for increasing the deposition rate. The deposition parameters in this experiment were as follows.

Base pressure	: 1e-5 Torr
Processing pressure	: 2.8 ~ 9.5 mTorr
Argon flow rate	: 60 sccm
Oxygen flow rate	: 40 sccm
Incident average power	: 1.5 kW
Target-substrate distance	: 70 mm
Substrate temperature	: 200 °C
Pulse repetition rate	: 25 kHz
Power duty ration	: 50 %
Carrier speed	: 30 mm/min
Number of targets	: 1 -

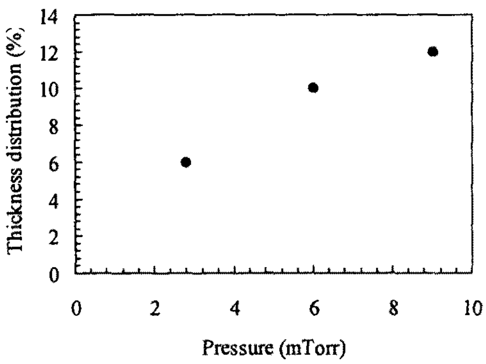
2.2 Results and discussion

Figure 1 presents the results of deposition rate. The deposition rates were 6 nm m/min and 9 nm m/min at the average power of 1.1 kW and 1.5 kW, respectively. Deposition rate increased with rising incident power to the target. The method that delivers maximum power to the target was pursued by adjusting frequency, duty and current at the pulsed power supply. From this, higher deposition rate was achieved. Figure 2 shows the results of thickness uniformities at the processing pressure of 2.8 ~ 9.5 mTorr. We found that thickness uniformity was improved at the lower processing pressure. Figure 3 depicts the measured waveforms of voltage and current at the target. Incident power to the magnesium target was calculated using these waveforms. The results of film analysis were as follows [7]. The texture of the sputtered magnesium oxide thin film was characterized by X-ray diffraction. The intensity of (111) texture was detected two times as much as the reference intensity. This means that the (111) texture has a relatively large portion in the deposited magnesium oxide film. The other peaks show the reference intensity of magnesium oxide film property. Secondary electron emission coefficient was measured to be 0.1 at 100 V of ion acceleration voltage. The transmittance was observed to be approximately 90% at the wavelength of 300 800 nm. The density and hardness were measured as 93.2%, and 800 900 kg/mm2, respectively. When the prepared magnesium oxide film was applied to the six-inch plasma display panel, discharge phenomena of the plasma display panel occurred at 200 V. The grain size of crystal magnesium oxide had a diameter of approximately 30 60 nm. The RMS roughness of the magnesium oxide film was measured to be 1 nm at a substrate temperature of 200C. The luminance and the luminance efficiency were 650 cd/m2 and 1.53 lm/W, respectively. Characteristics of the time delay were measured to be about 1 s.

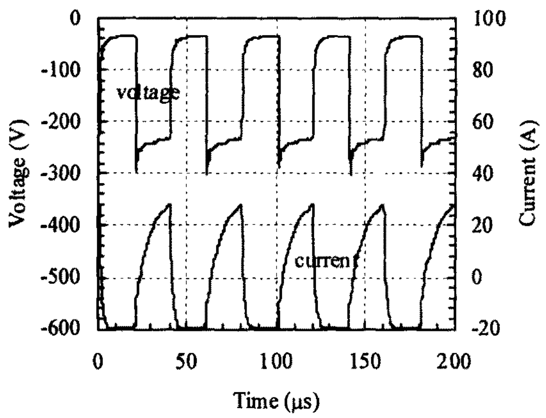
From this work, we obtained higher deposition rate than any other previous work of reactive sputtering at the oxide mode, at which the magnesium target is covered with the oxide. The reas on why we developed this technique at the oxide mode was to a chieve superior quality of time delay characteristics. The way to apply this technique for high through-put is to increase the num ber of targets. On the basis of this work, in the case of 15 ~ 20 targets, the through-put is estimated as 2.7 3.7 minutes with a 4 2 inch panel and a coating thickness of 500 nm. Figure 4 indicat es the diagram of the magnesium oxide thin film sputtering syst em for high through-put



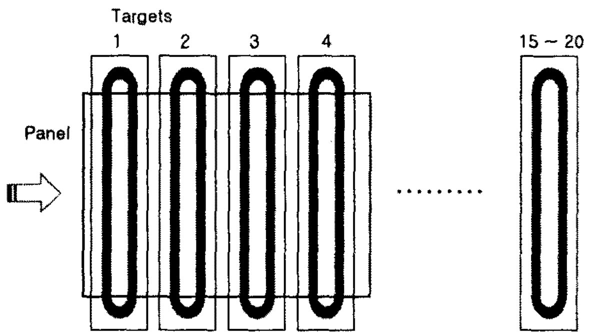
<Fig. 1> Deposition rate of magnesium oxide thin film with in cident power.



<Fig. 2> Thickness uniformity over the entire substrate area of 982 mm x 563 mm.
(2.8 mTorr : 6%, 6 mTorr : 10%, 9.5 mTorr : 12%)



<Fig. 3> Measured waveforms of voltage and current at the magnesium target.
(Frequency: 25 kHz, Duty: 50%, Average power: 1.5 kW)



<Fig. 4> Diagram for high through-put of magnesium oxide thin film.

3. 결 론

The high deposition rate technique in oxide mode was developed using a devised power supply that has the function of a constant voltage and a constant current mode. This technique shows higher deposition rate than any other previous work. This fundamental technique is proposed for application to a high through-put sputtering system for plasma display panels. It requires further study to determine the greatest deposition rate and the optimal process.

[참 고 문 헌]

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