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Plasma Display Panel용 산화마그네슘 박막의 산화영역에서의 스퍼터 성막기술

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A sputtering technique of magnesium oxide thin film in oxide mode for plasma display panel

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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 powersupply 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 increasing 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. This technique is proposed to apply high through-put sputtering system for plasma display panel.

1. 서 론

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

The typical manufacturing methods of magnesium oxide thin films are reactive sputtering, electron beam deposition, and ion plating. Reactive magnetron sputtering for magnesium oxide thin film has been proposed by several researchers [2], with advantages of low temperature processing for polycrystalline materials and film uniformity over large areas.

The aim of this study is a development of 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 for 30 ~ 100 inches with 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 a good quality, high deposition rate, and low price.

2. 본 론

2.1 Sputtering equipment

Figure 1 shows the photograph ofthe reactive sputtering system used this experiment. The total length of this system is about 5 m. The purity of the used MgO target is 99.95 %. The target size is width of 3.5", length of 25" and thickness of 1/4". This system is designed to extend the number of the magnetron cathode targets parallel. This sputtering system is applicable to 42 inch PDP panel (height 563 mm, width 982 mm).

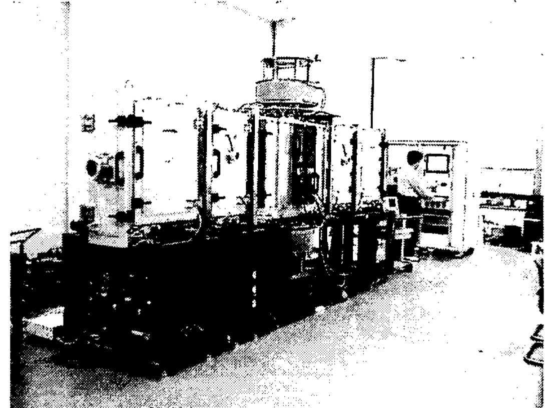

Fig. 1. Photograph of the reactive sputtering system. (Dimension of the vacuum chamber : 5000 (length) x 1000 (heigth) x 300 (width), mm)

2.2 Experiment

In this experiment, unipolar pulsed power supply of 20 kW was used. The power supply was operated at a maximum constant voltage of 500 V and a constant current of 40 A. The target voltage could not be applied 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 significantly important for increasing the deposition rate. The deposition parameters are as follows in this experiment.

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

2.3 Results and discussion

Figure 2 shows 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 increasing incident power to the target. The method which 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 3 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 4 shows the measured waveforms of voltage and current at the target. Incident power to the magnesium target was calculated using these waveforms.

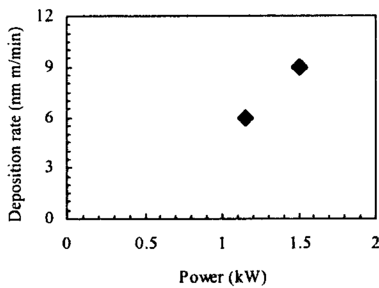

Fig. 2. Deposition rate of magnesium oxide thin film with incident power.

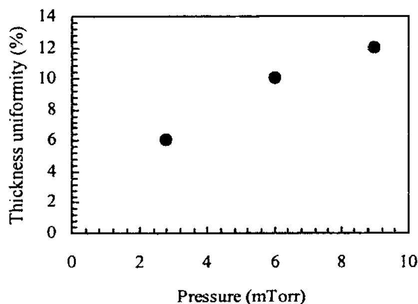

Fig. 3. The thickness uniformity over the whole subst rate area of 982 mm x 563 mm.

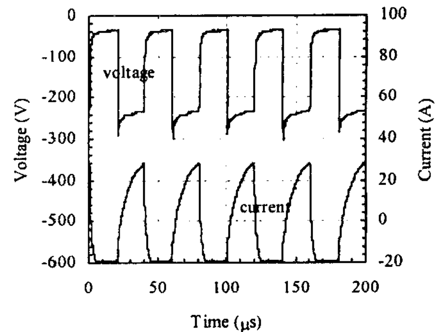

Fig. 4. Measured waveforms of voltage and current at the magnesium target. (Frequency : 25 kHz, Duty : 50 %, Average power : 1.5 kW)

The results of film analysis were described at reference [3]. 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 reason why we develop this technique at the oxide was to achieve good quality of time delay characteristics. The way to apply this technique for high through-put is to increase the number of target. On the basis of this work, in case of 15 ~ 20 targets, the through-put is estimated as 2.7~3.7 minutes with a 42 inch panel and the coating thickness of 500 nm. Figure 5 shows the diagram of magnesium oxide thin film sputtering system for high through-put.

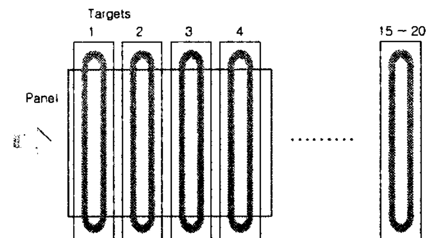

Fig. 5. Diagram for high through-put of magnesium oxide thin film.

3. 결 론

High deposition rate technique in oxide mode was developed using a devised power supply which 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 to apply high through-put sputtering system for plasma display panel. This technique needs further study for the most deposition rate and the optimal process.

[참 고 문 헌]

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