Research on Characteristics of MgO with Adding Hydrogen in SMPDP

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Abstract: *The MgO thin film preparation with adding hydrogen during E-beam deposition is presented in this paper. Three kinds of MgO thin film samples with different pressure ratios between oxygen and hydrogen has been studied, which were 10:1, 4:1 and 1:1, respectively. The characteristics of these MgO layers have been studied by X-ray diffraction, SEM and fluorescence spectrum. The conclusion is that the delay time for SMPDP can be shortened when adding hydrogen is applied.*

Keywords: MgO; adding hydrogen; XRD; fluorescence spectrum; SMPDP

Introduction

The modified MgO protective layer in ACPDP is one of issues for improvement PDP recently. The aim of PDP is low cost and high performance. The brightness and luminance efficiency can increase using high Xe content. However, the driving voltage is high under the standard MgO. To realize high definition display, trend of driving scheme is single scan. So, the delay time must be shortened. Research the new MgO protective layer is order to improve the working voltage and delay time for ACPDP.

There are some ways to prepare modified MgO protective layer recently. The high density MgO introduced water vapor was good effect on reducing firing voltage.[1] It is described the delay time can be improved in ACPDP with the addition of hydrogen during deposition MgO or H_2 addition to the Ne-Xe mixture gas [2, 3]. Doping Si or Ge or other element in MgO to produce electron trap is also one of way to reduce delay time.[4] The dual energy levels can be obtained by doping with electron traps and holes. The MgO will exhibit exo-emission of electrons that benefits to amend the characteristics of ACPDP [5].

The method of the addition of hydrogen during deposition MgO by E-beam is applied in this paper. Three kinds of MgO thin film samples with different pressure ratios between oxygen and hydrogen has been studied, which were 10:1, 4:1 and 1:1, respectively. The characteristics of these MgO layers have been studied by X-ray diffraction and fluorescence spectrum. The influence of the hydrogen branch pressure on the resistance is also discussed. The influence of MgO with different hydrogen processing on the delay time in SMPDP is investigated.

Experimental

Preparation of MgO samples and SMPDP test panels

The MgO thin film is deposited using E- beam evaporator. To match with the true case, the MgO film is coated on small substrate with dielectric layer and electrodes. The base pressure is and the substrate is heated 250°C. The thickness of MgO film is about 700nm. The deposited pressure is $1.2X10^{-2}$ Pa. The MgO film samples are prepared under different pressure ratios between oxygen and hydrogen, as shown Table 1.

Table 1. MgO samples with different deposited conditions

sample	1	2	3	4
O_2 :H_2 pressure ratio	No H_2	10:1	4:1	1:1
base pressure	$4.0X10^{-4}$ Pa			
heated temperature	250°C			
deposited pressure	$1.2X10^{-2}$ Pa			

Using the deposition conditions of sample 1~4 respectively, the corresponding test panels of SMPDP are made. There were panel 1~4. The opposite discharge principle is used in SMPDP and MgO film is deposited on both the front substrate and the rear substrate. The work gas is mixture gas of Ne + Xe 20% and the gas pressure is 450 Torr. In order to avoid the effect of phosphors on respond time, there is no phosphors layer in the test panel.

Experimental Tests for characteristic of MgO film and SMPDP Panel

The X-ray diffraction (XRD) and SEM tests for samples are taken to determine the effect of addition hydrogen on the surface orientation of MgO film. The fluorescence spectrum analysis for sample 1~4 are carried out to research.

Oxygen vacancies always exist in MgO. They can assume two possible charge state: F+-center and F-center. F-centers are oxygen vacancies filled by two electrons; F+-centers are ionized F-centers, and are filled by only one electron. The energy levels of both F-center and F+-center lie about 5 eV from the top of conduction band. With exciting by the light of 250nm, the emission light produces in about 540 nm (2.3 eV) for F-center and 380nm (3.2 eV) for F+-center. [6] The persistence of the F-center and F+-center phosphorescence is directly linked to the concentration of hydride ions. [7] So, under different hydrogen partial pressure, the different MgO film samples are deposited by E-beam. From analysis fluorescence spectrum with 250nm excited wavelength, the information about F-center and F+-center in MgO and influence of hydrogen concentration can be obtained.

The resistance of sample 1~4 are also measured. The MgO film is deposited to coat on the ITO glass with $1cm^2$ square. The cover is another ITO glass with same square. The resistance of MgO is measured under the same force and frequency.

The response time of SMPDP panels is measured using IR (828nm) senor. The driving wave scheme and the diagram of test delay time are shown in figure 1and 2.

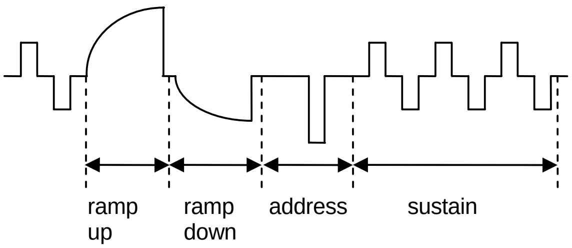


Figure 1. driving wave scheme for test address time

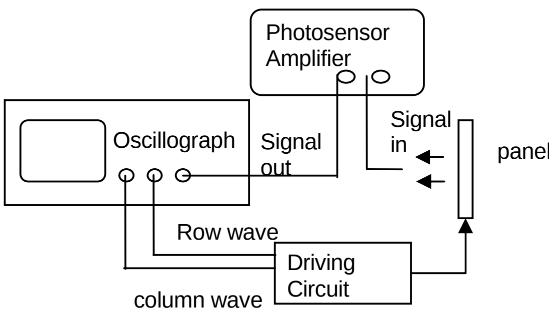


Figure 2. diagram of test set

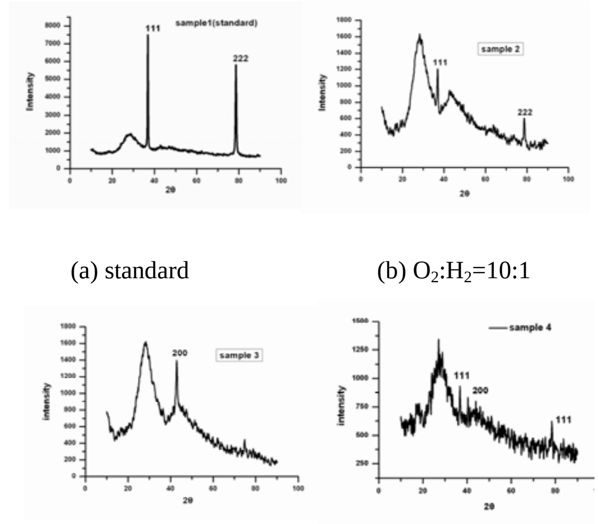
Results and Discussion

Microstructure change of of MgO film

The XRD test results show that additional H_2 can influence surface orientation of MgO. The results of sample 1~4 are shown in figure 3 (a) (b) (c) (d). In standard MgO film (sample 1), there is prominent (111) plane, see figure 3 (a). The corresponding SEM image, see figure 4 (a), shows the shape of crystal grain is regular and their sizes are lager than ones shown in figure 4 (b). When the hydrogen is added to deposition atmosphere, the (111) plane gets small. As increasing H_2 branch pressure and deceasing O_2 branch pressure, the (220) plane appears and gets strong, given in figure 3 (b) (c). When the pressure ratio of O_2 and H_2 reaches 1:1, (220) plane turns to small again, shown in figure 3 (d). Its SEM image shows the grain gets small.

Effect of addition hydrogen on fluorescence spectrum

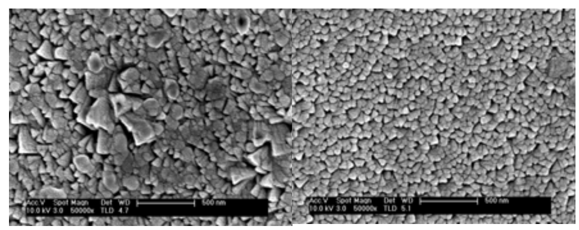
The fluorescence spectrums of samples are given in figure 5 (a) (b) (c) (d) under different concentration of addition hydrogen. For standard MgO film, no wave peak appears, shown figure 4 (a).



(a) standard (b) O_2:H_2=10:1

(c) O_2:H_2=4:1 (d) O_2:H_2=1:1

Figure 3. charts of XRD for MgO film sample



(a) sample 1(standard) (b) sample 4 (O_2 : H_2=1:1)

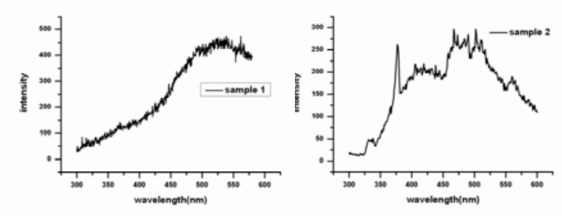
Figure 4. SEM images of MgO film

After addition hydrogen, the first wave peak about 360nm near to 380nm exists shown in figure 4 (b). As to increase hydrogen concentration, this wave peak gets strong, shown in figure 4 (c), and the second wave peak about 560nm near to 520nm also appear shown in figure 4 (d). We can suppose the first wave peak stands for F+-center, and the second wave peak stands for F-center. These results indicate that the F+-center and F-center are directly linked to the concentration of hydrogen.

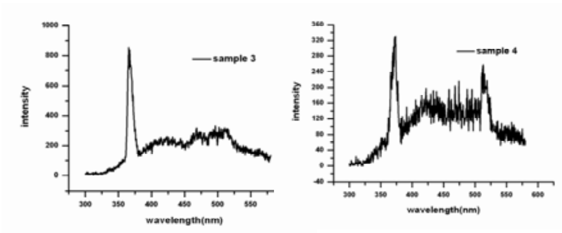
These vacancies of oxygen existed can improve the characteristic of SMPDP. After F-center and F+-center de-excitation, the electrons can also be trapped by hydride-filled oxygen vacancies which trap level is only 0.6 eV below conduction band. These trapped electrons can be thermally excited and become priming electrons which help to shorten address time and reduce firing voltage.

Improvement performance of SMPDP with addition hydrogen

The concentration of addition hydrogen has great influence on the resistance of MgO film. The relation of resistance R Vs partial pressure ratio in different



(a) standard (b) O_2:H_2=10:1



(c) O_2:H_2=4:1 (d) O_2:H_2=1:1

Figure 5 Fluorescence spectrum of MgO film λ_{ex}=250nm

frequency of 1 KHz and 100 Hz is given in figure 6.

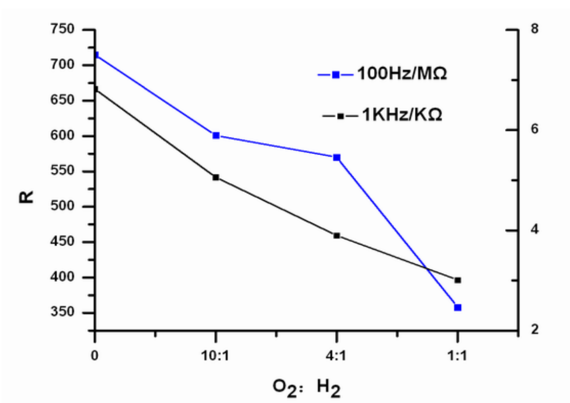


Figure 6. Relation between resistance and hydrogen content

The resistance of MgO film decreases as the concentration of addition hydrogen increases. To add much hydrogen will result in more impurity and high concentration trap level. This helps to shorten delay time.

The delay times of panel 1~4 are measured, given in figure 7. The delay time of panel with hydrogen is shorter than the standard panel. As addition hydrogen increases the delay time appears decline trend in the rough.

To compare panel 1 with panel 4, shown in figure 8, the delay time of panel 1 is about 2.2 μs and the panel 4 is only 1.65μs.

Conclusion

We can conclude that addition hydrogen is an effective way to improve the characteristics of SMPDP. The

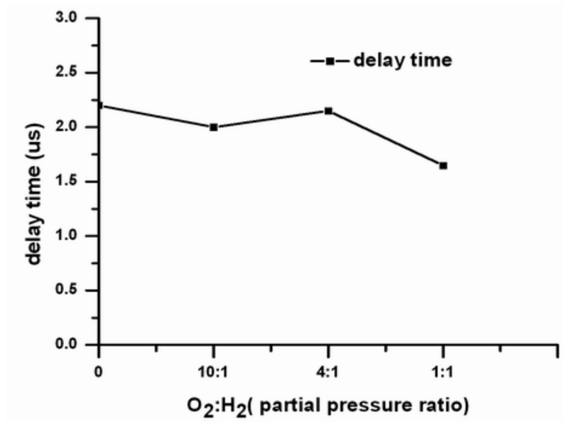


Figure 7. Relation between delay time and partial pressure ratio of O_2 : H_2

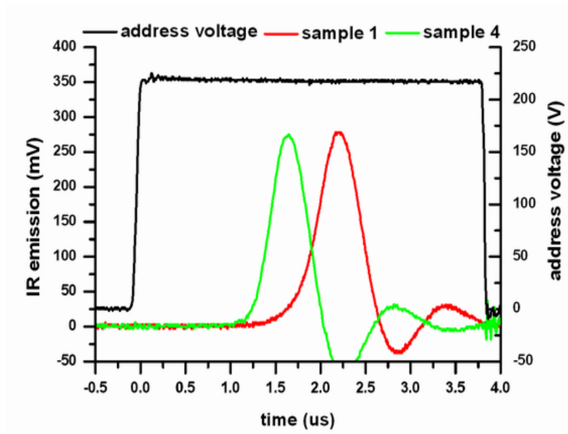


Figure 8. Compare delay time of panel1and panel4

experiment results show that the microstructure of MgO changes that (111) plane decreases and (200) plane increases. The oxygen vacancy with F-center and F+-center exists. All of these change helps to shorten the delay time. The measure data gives provability.

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