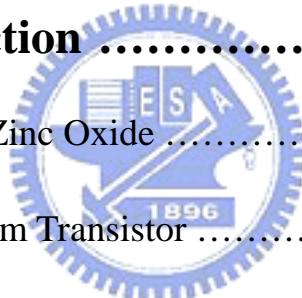


Contents

Abstract (Chinese)	i
Abstract (English)	ii
Contents	iii
Table Captions	vii
Figure Captions	ix

Chapter 1 Introduction1

1-1 Basic Properties of Zinc Oxide	1
1-2 Transparent Thin Film Transistor	2
1-3 Binary Compound TCO Materials	3
1-4 Applications of Transparent Conducting Oxide	4
1-5 Motivation	5
1-6 Thesis Organization	5



Chapter 2 Material Properties of ZnO thin films7

2-1 Introduction	7
2-2 Fabrication Techniques for ZnO Thin Films	7

2-2.1 Introduction	7
2-2.2 Sputtering Deposition Techniques	8
2-2.3 Sputtering Deposition of ZnO Films	9
2-3 Crystal Structure of ZnO Lattice	9
2-4 Influence of Deposition Parameters on the Material Properties of ZnO...	10
2-4.1 Influence on Electrical Properties	10
2-4.2 Influence on Structural Properties	10
2-4.3 Influence on Optical Properties	10
2-5 Optical Properties in Near-UV Region	11
2-6 Free-Carrier Absorption	13
Chapter 3 Experimental Details	15
3-1 Introduction	15
3-2 Preparation of the Substrates	15
3-3 Deposition Technologies	16
3-3.1 Introduction	16
3-3.2 RF Magnetron Sputtering	16
3-3.2.1 Deposition System	16
3-3.2.2 Target Preparation	17

3-3.2.3 Film Preparation	18
3-4 Characterization of Deposited Layers	18
3-4.1 Introduction	18
3-4.2 Film Thickness	19
3-4.3 Four-Point Probe	19
3-4.4 Optical Properties	20
3-4.5 Structural Characterization	21
3-4.5.1 X-ray Diffraction (XRD)	21
3-4.5.2 Scanning Electron Microscopy (SEM)	22
Chapter 4 Results and Discussion	23
4-1 Introduction	23
4-2 Effect of Argon Pressure	23
4-3 Effect of RF Power	25
4-4 Effect of Substrate Temperature	26
4-4.1 Growth Rate	26
4-4.2 Physical Properties	27
4-4.3 Electrical Properties	28
4-5 Effect of Al Content on AZO Films	28

4-5.1 Physical Properties	28
4-5.2 Electrical Properties	30
4-5.2.1 Influence of Dopant Content	30
4-5.2.2 Influence of Film Thickness	31
4-5.3 Optical Properties	33
4-5.3.1 Influence of Dopant Content	33
4-5.3.2 Influence of Substrate Temperature	34
4-5.3.3 Influence of Oxygen Atmosphere	35
4-6 Optimal Deposition Condition of AZO Flims	37
Chapter 5 Conclusion	38
References	40
Vita (Chinese)	74

Table Captions

Table 4-1 Growth rate and resistivity of the various working pressure deposited AZO films.

Table 4-2 FWHM, average grain size, and resistivity of the 1200Å AZO films deposited at various working using 2wt% Al₂O₃ target and RF power = 50W.

Table 4-3 FWHM, average grain size, and resistivity of the 1600Å AZO films deposited at various RF power using 2wt% Al₂O₃ target.

Table 4-4 Peak position of the AZO films deposited at RF power = 80W using various substrate temperature and Al₂O₃ content of target.

Table 4-5 FWHM and grain size of the AZO films deposited at RF power = 80W using various substrate temperature and Al₂O₃ content of target.

Table 4-6 Resistivity of the AZO films deposited at RF power = 80W and 1 hour of deposition time using various substrate temperature and Al₂O₃ content of target.

Table 4-7 The dependence of growth rate and Al₂O₃ content of target of the AZO films deposited at Pw = 2.5mTorr, Prf = 80W and Ts = R.T.

Table 4-8 The crystallinity parameters extracted from the XRD patterns of ~ 4000Å AZO films deposited by various Al₂O₃ content of target.

Table 4-9 Resistivity of the AZO films with different film thickness deposited at RF power = 80W using various Al₂O₃ content of target.

Table 4-10 The crystallinity parameters and resistivity of the AZO films with different film thickness deposited at RF power = 80W using 2wt% Al₂O₃ target.

Table 4-11 Resistivity of the AZO films deposited at RF power = 80W and O₂/Ar = 10% using different Al₂O₃ content of target.

Table 4-12 Optimum deposition parameters for the sputtered-deposited AZO films in this thesis.



Figure Captions

Fig. 1-1 Hexagonal wurtzite structure of zinc oxide.

Fig. 1-2 ZnO-based Transparent Thin Film Transistor.

Fig. 4-1 The dependence of growth rate and working pressure (RF power = 80W).

Fig. 4-3 The dependence of resistivity and working pressure (2wt% target, RF power = 80W)

Fig. 4-4-1 SEM image of the 2wt% grown AZO film at $P_w = 2.5\text{mTorr}$.

Fig. 4-4-2 SEM image of the 2wt% grown AZO film at $P_w = 5\text{mTorr}$.

Fig. 4-4-3 SEM image of the 2wt% grown AZO film at $P_w = 10\text{mTorr}$.

Fig. 4-4-4 XRD patterns of AZO films prepared by various working pressure. (2wt% target)

Fig. 4-5 The independence of growth rate and RF power. (2wt% target, $P_w = 2.5\text{mTorr}$)

Fig. 4-6-1 SEM image of the 2wt% grown AZO film at $\text{Prf} = 50\text{W}$.

Fig. 4-6-2 SEM image of the 2wt% grown AZO film at $\text{Prf} = 80\text{W}$.

Fig. 4-6-3 SEM image of the 2wt% grown AZO film at $\text{Prf} = 100\text{W}$.

Fig. 4-7-1 The XRD pattern of the 2wt% grown AZO film at $\text{Prf} = 50\text{W}$.

Fig. 4-7-2 The XRD pattern of the 2wt% grown AZO film at $\text{Prf} = 80\text{W}$.

Fig. 4-7-3 The XRD pattern of the 2wt% grown AZO film at $\text{Prf} = 100\text{W}$.

Fig. 4-8 The optical transmittance of 2wt% grown AZO films prepared by different RF power.

Fig. 4-9 The dependence of growth rate and substrate temperature. (2wt% target, $P_w = 2.5$

mTorr, Prf = 80W)

Fig. 4-10-1 SEM image of the 0.5wt% grown AZO film at Ts = R.T..

Fig. 4-10-2 SEM image of the 0.5wt% grown AZO film at Ts = 150°C.

Fig. 4-10-3 SEM image of the 0.5wt% grown AZO film at Ts = 250°C.

Fig. 4-11-1 SEM image of the 1wt% grown AZO film at Ts = R.T..

Fig. 4-11-2 SEM image of the 1wt% grown AZO film at Ts = 150°C.

Fig. 4-11-3 SEM image of the 1wt% grown AZO film at Ts = 250°C.

Fig. 4-12-1 SEM image of the 2wt% grown AZO film at Ts = R.T..

Fig. 4-12-2 SEM image of the 2wt% grown AZO film at Ts = 150°C.

Fig. 4-12-3 SEM image of the 2wt% grown AZO film at Ts = 250°C.

Fig. 4-13-1 SEM image of the 4wt% grown AZO film at Ts = R.T..

Fig. 4-13-2 SEM image of the 4wt% grown AZO film at Ts = 150°C.

Fig. 4-14-1 The XRD pattern of the 2wt% grown AZO film at Ts = R.T..

Fig. 4-14-2 The XRD pattern of the 2wt% grown AZO film at Ts = 150°C.

Fig. 4-14-3 The XRD pattern of the 2wt% grown AZO film at Ts = 250°C.

Fig. 4-15-1 SEM image of the 4000Å undoped ZnO film. (Prf = 80W, Pw = 2.5mTorr)

Fig. 4-15-2 SEM image of the 4000Å 0.5wt% grown ZnO film. (Prf = 80W, Pw = 2.5mTorr)

Fig. 4-15-3 SEM image of the 4000Å 1wt% grown ZnO film. (Prf = 80W, Pw = 2.5mTorr)

Fig. 4-15-4 SEM image of the 4000Å 2wt% grown ZnO film. (Prf = 80W, Pw = 2.5mTorr)

Fig. 4-15-5 SEM image of the 4000Å 4wt% grown ZnO film. (Prf = 80W, Pw = 2.5mTorr)

Fig. 4-16 XRD patterns of the 4000Å AZO films prepared by different Al₂O₃ content of target at Prf = 80W and Pw = 2.5mTorr.

Fig. 4-17 Peak position and FWHM of the 4000Å AZO films prepared by different Al₂O₃ content of target at Prf = 80W and Pw = 2.5mTorr.

Fig. 4-18 The dependence of resistivity and Al₂O₃ content of target for 4000Å AZO films.

Fig. 4-19 The dependence of resistivity and film thickness for 2wt% grown AZO films.

Fig. 4-20 The optical transmittance of Corning 1737F glass substrate.

Fig. 4-21 The optical transmittance of the 4000Å AZO films prepared by different wt% target.

Fig. 4-22 The optical bandgap of the 4000Å AZO films prepared by different wt% target.

Fig. 4-23-1 The optical transmittance of 0.5wt% grown AZO films prepared by different substrate temperature.

Fig. 4-23-2 The optical transmittance of 1wt% grown AZO films prepared by different substrate temperature.

Fig. 4-23-3 The optical transmittance of 2wt% grown AZO films prepared by different substrate temperature.

Fig. 4-24 The XRD pattern of 2wt% grown AZO films at Ar/O₂ = 10%.

Fig. 4-25 The optical transmittance of the AZO films prepared by different Al₂O₃ content of target at O₂/Ar = 10%.

Fig. 4-26-1 The optical transmittance of 0.5wt% grown AZO films at O₂/Ar = 0% and 10%.

Fig. 4-26-2 The optical transmittance of 1wt% grown AZO films at O₂/Ar = 0% and 10%.

Fig. 4-26-3 The optical transmittance of 2wt% grown AZO films at O₂/Ar = 0% and 10%.

Fig. 4-26-4 The optical transmittance of 4wt% grown AZO films at O₂/Ar = 0% and 10%.

