

透明氧化鋅之薄膜電晶體技術開發研究

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中文摘要

本研究論文成功地發展出一套新式具有高透光性(**Highly transparent**)、高載子移動率(**High mobility**)的氧化鋅(**Zinc Oxide**)透明薄膜電晶體(**ZnO-Transparent Thin Film Transistors**)，可應用於主動式顯示面板(**Active Matrix Liquid Crystal Display**)技術及搭配有機發光二極體面板(**Organic Light Emitter Diode Panel**)作為驅動電路，以增大顯示電晶體元件的效能與顯示畫素開口率，並減緩光漏電(**Photo leakage current**)對元件造成這影響。亦可推廣應用至驅動電路，達成系統面板整合技術(**System On Panel**)的遠景。在研究中，我們利用交大半導體中心之直流濺鍍機台(**DC Sputter**)，使用 4 吋金屬鋅(**Zinc**)的靶材(**Target**)，改變不同的直流濺鍍功率，於矽晶元基板上形成最具均勻性之薄膜，並藉由調配不同鋅原子與氧原子的組成比例，來形

成具備透明與半導體特性之氧化鋅薄膜；藉由在濺鍍過程時，改變通入氧氣的流量及製程完成後的後續退火處理，我們成功建立一個得以在室溫環境之下，均勻氧化鋅薄膜的沈積且具有最佳薄膜電晶體電性表現的半導體層(**Semiconductor layer**)沉積條件。在本論文中，我們也利用各種材料分析技術與儀器，如紅外線光譜儀(**FTIR**), X 光薄膜繞射儀(**XRD**)等 ... 來針對氧化鋅半導體薄膜之結晶性(**Crystallization**)、晶格尺寸(**Grain size**)、薄膜厚度(**Thickness**)和薄膜表面(**Surface morphology**)等特性進行分析與研究，並對氧化鋅薄膜製程電晶體元件，進行電晶體元件電性特性的分析與探討。



Investigation on Thin-Film-Transistors with a Transparent Material Zinc-Oxide Layer

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Abstract

In this thesis, we have successfully developed a transparent thin film transistors (TTFT) using a novel material Zinc Oxide (ZnO) as semiconductor layer, with high carrier mobility and optical transparency. The use of ZnO-based material can increase the field-effect mobility of TFT devices, the aperture of AMLCD panel and release the issue of photo-excited leakage current. In this work the ZnO film was deposited on a silicon substrate by sputtering Zinc metal target in DC glow discharge plasma of an argon/oxygen mixture. We changed the power of DC sputter to adjust the uniformity of the ZnO film. Also, the conductivity and carrier concentration were controlled by adjusting the flux of the mixture oxygen during film deposition and thermal annealing temperatures. An optimal ZnO film deposition condition was finally established at room temperature for the ZnO TFTs. The benefit of using the DC sputter system possesses the feasibility and varieties to easily adjusting the optimal rate of Zn/ZnO mixture, $Zn_{1+x}O$, and ZnO for TFTs.


Several material analysis techniques, such as FTIR, XRD, and etc. were

utilized to discussing the crystallization, grain size, and surface morphology of ZnO films. Electrical characteristics and conduction mechanisms of ZnO TTFT devices were also investigated by I-V characteristic analysis.



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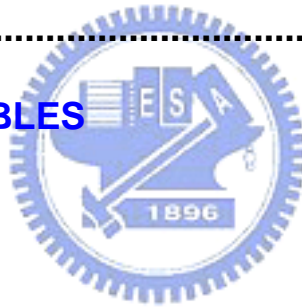


Table Caption

Chapter 1

Table 1 There are some properties of Transparent Conducting Oxides at room temperature

Chapter 2

Table 2 Experimental Flow Path

Table 3 Conditions of the DC power we applied

Table 4 Experimental conditions of different (Argon / Oxygen) mixture ratio

Table 5 Etching solution list



Figure Captions

Chapter 1

Figure 1-1 Motivated Transparent Thin Film Transistor device

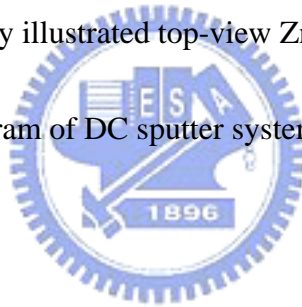
Chapter 2

Figure 2-1 Assumed band structure of (a) un-doped and (b) Tin-doped In_2O_3

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Figure 2(b) Schematically illustrated top-view ZnO-based TFTs

Figure 3 Schematic diagram of DC sputter system



Chapter 3

Figure 3 Shows the system of DC sputter.

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