金屬氧化物修飾層於有機薄膜電晶體應用之研究

碩士研究生：陳東賢　　指導教授：陳方中

國立交通大學顯示科技研究所碩士班

中文摘要

本論文探討以五環素(pentacene)為主動層的有機薄膜電晶體中，有機層與源極/汲極的接觸效應，並且以提升元件效能為目的，研究電極修飾層對元件的效果。首先我們以幾種不同導電材料作為有機薄膜電晶體的源極與汲極，並製作元件研究電極功函數的差異對電性結果的影響。之後再於原電極與五環素主動層之間加入過渡金屬氧化物作為修飾層，和未經修飾的元件作比較。我們得到了在加入過渡金屬氧化物後的元件就算搭配低功函數的金屬也能得到高效能。這是由於加入的氧化金屬於 pentacene 表面形成保護層，避免了金屬電極於沉積時對 pentacene 直接的造成破壞。此外氧化金屬在熱蒸鍍期間，也會形成不同氧化數的氧化金屬形成摻雜，使得氧化金屬層有如摻雜的半導體，因此載子自金屬注入氧化金屬層的效果也隨著摻雜濃度而改變。

我們調變不同厚度的過渡金屬氧化物，並且得到在該製程條件下使元件最佳化的厚度。由於接面電阻與通道長度的改變無關，故可以利用線性區電流電壓和通道長度的關係，來萃取出接面電阻的部份。並且證明了加入氧化金屬的元件得到效能提升是由於接觸電阻在經過修飾後有效的下降了。最後我們量測元件照光後特性的改變，以及持續偏壓下得到元件電性的衰減來探討有機薄膜電晶體可能受到環境所影響的程度。

Metal Oxides as the Buffer Layers for Organic Thin-Film Transistors

Student：Tung-Hsien Chen **Advisor：Dr. Fang-Chung Chen**

Department of Photonic and Display Institute

National Chiao Tung University

Abstract

The effect of source/drain contacts on the performance of OTFTs has been investigated using pentacene as the active material. In the first part, different metals with various work functions were used as source/drain electrode. It has been found that the device with high-work-function electrodes, for example, Au, exhibits better performance. However, after the modification of metals oxides, such as MoO_2 and V_2O_5, high performance can be still obtained, even while low-work-function electrodes, such as indium-tin-oxide (ITO) and Al were adopted. It was inferred that the metal oxides may behave like a protection layer to prevent the possible damage during the sputtering of ITO or thermally evaporation of Al. In addition, during the thermal evaporation, doping process may be induced, and the doped oxide probably behaves like a highly-doped semiconductor. Thus, the charge injection barrier is lowered due to the high concentration of free charge carriers.

The optimal device characteristics have been achieved by tuning the thickness of

metal oxides. Since the contact resistance is independent on the channel length, it can be extracted from the relationship between the current, voltage and the channel length in the linear region. By the so-called transfer-line method, it is proved that the enhancement of devices efficiency is due to the decrease of the contact resistance after one metal-oxide layer was inserted. Finally, the light-exposure effect and stress effect have been also investigated.