

旋塗式有機主動層薄膜電晶體的製程改善與可靠度分析

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摘要

近年來，有機薄膜電晶體廣泛的被研究使用在各種低成本、低溫、可繞式的製程應用上，本論文以” Bottom contact” 的結構， SiO_2 為絕緣層，利用旋塗的方式成長有機薄膜，成功地製作出以poly(3-hexythiophene)簡稱P3HT為有機主動層材料的有機薄膜電晶體。

在第二章當中，我們利用鉻、鎳、鉑來做為有機薄膜電晶體之源極及汲極的電極材料，此三者之功函數皆大於 P3HT，由於鉑的材料穩定性佳，可和 P3HT 形成良好的歐姆接觸，鉻和鎳則會與 P3HT 在介面產生化學反應物，使得以鎳為源極汲極電極材料的電晶體在低汲極電壓下產生 crowding effect，以鉻為源極汲極電極材料的電晶體則無正常電性，我們亦使用在鎳上鍍上極薄之鉑薄膜來改善 crowding effect。另外，我們改變附著層金屬的厚度來研究其與元件特性的關係，但實驗發現元件特性受其影響的程度不大。

在第三章當中，我們對有機薄膜電晶體進行電性可靠度測式，發現各項特性對熱載子 stress 的敏感度不高，而臨限電壓值的偏移則主要是歸因於 P3HT 的極化現象，接著我們對 P3HT 進行一些極化現象的分析，發現極化強度會在一定時間後進入飽程且與 stress 的電壓大小成正比，在移除 stress 電壓後，P3HT 內部的耦合極會回復原先的排列，但無法回到最初狀況。

在第四章當中，我們使用液相沈積法來成長 SiO_2 絕緣層，以此進行全低溫的電晶

體製程，所製成之元件除閘極漏電流外，其餘特性皆可與使用電漿沈積SiO₂ 絕緣層的元件相比，我們接著再以堆疊介電質於源極及汲極電極底下來減低閘極的漏電流，成功的將閘極漏電流降成原先的 1/10。



Process Improvement and Reliability Characteristic of Spin-On Organic TFT

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Abstract

Recently, organic thin film transistors (OTFTs) were researched widely for low-cost, low-temperature and flexible application. In this paper, organic thin film transistors based on poly (3-hexylthiophene) (P3HT) with the “bottom contact” structure, SiO₂ as insulating layer, organic active layer grown with spin-coating have successfully been demonstrated.

In chapter 2, we use Cr, Ni or Pt as S/D contact materials of OTFTs. The work function of they are all larger than the work function of P3HT. Because of the stability of Pt, it can form better ohmic contact with P3HT than others. The crowding effect was occurred at the small drain bias for Ni as S/D contact material of OTFTs. Cr form Schottky contact with P3HT because of the chemical reactivity. We improved the characteristics of OTFTs with Ni as S/D contact material by capping thin Pt film on S/D contact. We adjusted the thickness of adhesion metals and found that don't affect the performance significantly of OTFTs.

In chapter 3, we tested the electric reliability of P3HT OTFTs. The field-effect mobility and gate leakage current did not be affected significantly after hot-carrier stress. The threshold voltage shift is attributed to polarization effect. Next, we investigated the polarization

phenomenon P3HT OTFTs. Threshold voltage shift ratio saturated after a span and the last value is as large as the gate bias. The polarization will release when addition electric field remove in P3HT OTFTs but cannot return to initial characteristics.

In chapter 4, we used LPD(liquid phase deposition) method to deposit the SiO₂ as insulator in P3HT OTFTs. The performance of P3HT OTFTs with LPD SiO₂ as insulator is comparable with that with PECVD SiO₂ except the gate leakage current. We used the isolation dielectric under the S/D contact materials to reduce the gate leakage current and that is reduced about one order successfully.



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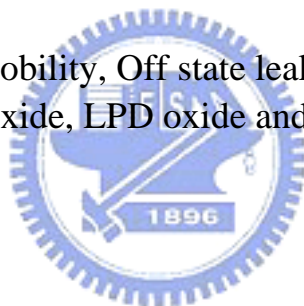


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