

# 氮化鎵之金屬歐姆接觸及其MOS光檢測器特性之研究

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## 摘要

本論文的研究目標係以電漿濺鍍沉積的方式；製作出具有低電阻及高穿透率的Ti/GaN、ITO/Ti/GaN 歐姆接觸(ohmic contact)。其次；我們使用低溫的液相沉積(liquid phase deposition；LPD)方法，將二氧化矽沉積於n型氮化鎵(n-type GaN)基材上，形成阻障層並製造出MOS的光檢測器，用以探討MOS的暗電流機制及其光學特性。最後；利用兩階段快速退火的方式於純氧氣或空氣中，進行p型氮化鎵之鎂(Mg)原子活化，以提高其摻雜濃度和提高導電率。本論文內容分為四大部份，分別敘述如下：第一部份(第一章至第二章)：以電漿濺鍍沉積的方式，分別將鈦(Ti)及鈦/氧化錫(ITO)沉積於n型氮化鎵基材上形成良好的歐姆接觸，其特定接觸電阻(specific contact resistance)分別為 $8.7 \times 10^{-7} \text{ } \Omega\text{-cm}^2$ 和 $3.2 \times 10^{-6} \text{ } \Omega\text{-cm}^2$ 。在我們的研究裡，係採用射頻濺鍍系統將ITO沉積於n型氮化鎵基材上；形成良好的電流-電壓線性關係。這種方法有別於其他學者使用電子束蒸鍍沉積ITO，在他們的研究裡ITO與n-type GaN 的接觸具有能障高度(barrier height)為0.68 eV，形成蕭特基接觸。第二部份(第三章)：利用低成本的液相沉積方法，將二氧化矽有效地沉積於n型氮化鎵基材上，我們以超飽和六氟矽酸( $\text{H}_2\text{SiF}_6$ )為沉積二氧化矽的源頭，硼酸( $\text{H}_3\text{BO}_3$ )做為控制沉積速率的溶液並獲得最高的二氧化矽沉積速率為50.5 nm/hr。第三部份(第四章)：以液相沉積法來製作MIS的阻障層並應用在Al-gate/20nm LPD-SiO<sub>2</sub>/n-GaN和ITO-gate/LPD-SiO<sub>2</sub>/n-GaN之MOS紫外線光檢測器。Al-gate MOS的界面電荷密度(Dit)於未退火前為 $8.4 \times 10^{11} \text{ cm}^{-2} \text{ V}^{-1}$ 。於真空中800 °C退火1小時後，其界面電荷密度降為 $1.75 \times 10^{10} \text{ cm}^{-2} \text{ V}^{-1}$ 。電場強度為(4 MV/cm)時，暗電流(dark current)密度為 $4.41 \times 10^{-6} \text{ A/cm}^2$ 。在照射波長為366nm的紫外線時，其響應度(responsivity)是0.112 A/W。對我們的ITO-gate MOS而言，其光-暗電流比可達到10<sup>4</sup>以上，其響應度(responsivity)為0.65 A/W。第四部份(第五章)：使用兩階段快速退火(rapid thermal annealing；RTA)來活化p型氮化鎵薄膜的鎂雜原子濃度，並與使用一般爐管退火方式(conventional furnace annealing；CFA)來做比較。兩階段快速退火為，第一階段是在氧氣或空氣中，於750 °C下退火1分鐘。第二階段是在600 °C下退火5分鐘。我們發現採用兩階段快速退火方式，可獲得較高的電洞濃度及較低電阻的p型氮化鎵薄膜。

關鍵詞：氮化鎵；光檢測器；光電流

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