Al.25Ca.75N/GaN 高電子遷移率場效電晶體以銦錫氧化物為閘極之製作與特性研究

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摘 要

氮化鋁鎵/氮化鎵高電子遷移率場效電晶體具有高電子遷移率與高崩潰電壓等優良特性，因此本論文利用氮化鋁鎵/氮化家高電子遷移率場效電晶體之特性，將其閘極金屬用ITO取代，來製作AlGaN/GaN HEMT的光電晶體。因為ITO透明的特性，光源能穿透閘極直到氮化鋁鎵與氮化鎵接面處，產生電子電洞對，讓高電子遷移率電晶體具有光檢測器與電晶體雙重性。光訊號將會被自身放大，可取代傳統光檢測器還需搭配放大電路來增加解析度的缺點。 我們比較以ITO為閘極之HEMT在沒有照光與照光情況下，元件之特性改變，並且將ITO為閘極的HEMT與鎳/金為閘極的HEMT作為比較。 本次製作之元件ITO閘極寬度為25μm，長度1μm，在沒有照光下閘極電壓為 0 V時，最大導通電流為13.8 mA，最大轉導值為113.6 mS/mm。

關鍵詞 : 銦錫氧化物閘極 ; 氮化鋁鎵/氮化鎵高電子遷移率電晶體 ; 光控微波元件 ; 透明閘極高電子遷移率電晶體

目錄

封面內頁 簽名頁 博碩士論文電子檔案上網授權書. . . . . iii 中文摘要. . . . . iv 英文摘要. . . . . v 誌謝. . . . . vi 目錄. . . . . vii 圖目錄. . . . . x 表目錄. . . . . xii 第一章序論. . . . . 1 1.1研究動機. . . . . 1 1.2論文架構. . . . . 4 第二章氮化鋁鎵/氮化鎵高電子遷移率電晶體工作原理. . . . . 5 2.1氮化鋁鎵/氮化鎵高電子遷移率場效電晶體工作原理與介紹 . . . . 5 2.2氮化鋁鎵/氮化鎵極化效應與表面效應. . . . . 10 2.3氮化鋁鎵/氮化鎵對於光的吸收. . . . . 14 2.4閘極蕭特基接觸原理 . . . . 17 2.5歐姆接觸原理 . . . . 22 2.6傳輸線模型理論 . . . . 29 2.7銦錫氧化物薄膜理論 . . . . 32 第三章 元件製作與測試實驗 . . . . 40 3.1元件製作 . . . . 40 3.2平台隔離製作 . . . . 41 3.3歐姆接觸測試製程與量測 . . . . 43 3.4 ITO退火參數測試. . . . . 50 3.4.1 ITO穿透率量測與分析 . . . . 53 3.4.2 ITO電阻率之量測與分析 . . . . 58 3.5閘極蕭特基接觸測試製程 . . . . 61 3.6氮化鋁鎵/氮化鎵高電子遷移率場效電晶體製程. . . . . 65 3.6.1平台製作（Mesa Isolation). . . . . 65 3.6.2汲極跟源極歐姆接觸（Drain and Source Ohmic Contact） . . . . 67 3.6.3 閘極蕭特基接觸（Gate Schottky Contact） . . . . 69 第四章氮化鋁鎵/氮化鎵高電子遷移率場效電晶體電性量測結果. . . . . 71 4.1在沒照光下，傳統以鎳/金為閘極與以ITO為閘極之HEMT量測與比較. . . . . . . 71 4.2 以ITO為閘極之HEMT在照光與無照光情況下量測與比較 . . . . 75 4.3 以ITO薄膜所製之蕭特基二極體照光之特性. . . . . 79 第五章 結論 . . . . 82 參考文獻. 84

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