

透明電極應用於III-V發光元件之研究

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摘要

本論文主要研究透明電極氧化銦錫(ITO)之製作與其特性,並應用在三五族發光元件,以改善其元件特性。論文中將ITO作為視窗層(WINDOW LAYER)與電流擴散層(CURRENT-SPREADING LAYER)應用在晶片黏貼之鏡面基板的磷化鋁銦鎵發光二極體(ALGAINP/MIRROR/SI MS LED)與氮化鎵發光二極體。藉控制製程參數之氧化銦錫薄膜具有低的電阻率($2.1 \times 10^{-4} \Omega\text{-CM}$)與高穿透率(可見光範圍 $>90\%$)。在MS LED之應用方面在其表面鍍上ITO可有效提昇光的輸出。當注入電流增加,此元件也可以表現出光的均勻分布且不會有發光飽和現象的光輸出線性增加。此外,鏡面基板發光二極體,銦錫氧化物/鏡面基板發光二極體,銦錫氧化物/銦/鏡面基板發光二極體,在外部功率效率比原始相同吸光基板的發光二極體分別增加了2.8, 3.0及3.4倍。此可歸因於加入一層銦降低了銦錫氧化物與砷化鎵接觸層之接觸電阻,且對發出的光並不會造成明顯的吸收。此實驗中,銦錫氧化物/銦/鏡面基板發光二極體可以得到最高的功率轉換效率。在寬能隙半導體氮化鎵之應用方面,當銦錫氧化物直接接觸到氮化鎵雖然無法達到歐姆接觸,但是在接面加入一適當的極薄金屬層並作適當的退火處理便可以得到特性良好的歐姆接觸。此外,此方法可以顯著的降低接觸電阻並且不會影響光的穿透。以銦/銦錫氧化物(30 NM/250 NM)接觸到N型氮化鎵($1 \times 10^{18} \text{CM}^{-3}$)在600OC熱處理之後,其特徵接觸電阻率為 $6.9 \times 10^{-4} \text{W-CM}^2$,可見光的穿透率為80%至95%。此外,以鎳/銦錫氧化物(10 NM/250 NM)接觸到P型氮化鎵($2 \times 10^{17} \text{CM}^{-3}$)在空氣中經600OC熱處理之後,其特徵接觸電阻率為 $8.6 \times 10^{-4} \text{W-CM}^2$,在波長為450至550 NM光的穿透率大於80%。論文中將會討論造成此低接觸電阻與高穿透率可能的機制。此種方法與製程可以使用在高效率的氮化鎵發光元件上。

關鍵詞: 晶片黏貼, 發光二極體, 銦錫氧化物, 鏡面基板, 視窗層, 電流分布層, 歐姆接觸, 氮化鎵。

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