

# Growth and annealing effect of the ZnO thin film on c-sapphire by Atomic Layer Deposition

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## Abstract

Structural characteristics of the ZnO epitaxial films grown on c-plane sapphire by atomic layer deposition method were thoroughly studied. The morphology of thin film is smooth. The in-plane axes of the c-plane oriented ZnO layers are predominantly aligned with that of the sapphire substrate, yielding the relationship of  $\{10\bar{1}0\}_{ZnO} \parallel \{10\bar{1}0\}_{Al_2O_3}$ . The minor orientation with a  $30^\circ$  in-plane twist configuration, i.e.  $\{10\bar{1}0\}_{ZnO} \parallel \{11\bar{2}0\}_{Al_2O_3}$ , which is more commonly observed in ZnO films grown by metal organic chemical vapor deposition, pulsed laser deposition and other methods, only amounts to less than 3% and can be eliminated by thermal annealing. The structure of the ZnO epi-films exhibits significantly improvement upon thermal annealing and intrinsic types of basal plan stacking faults are the predominant structural defects in the ZnO after thermal treatment.

# 利用原子層磊晶術成長氧化鋅薄膜於藍寶石基板上及其退火效應

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## 摘要

利用原子層磊晶術成長在藍寶石基板的氧化鋅薄膜被我們詳細的研究與了解。薄膜的表面是十分得平坦的。在薄膜的成長中，沿著C軸堆疊在藍寶石基板的氧化鋅占了絕大多數。而氧化鋅和藍寶石基板之間比較沒有像利用脈衝雷射蒸鍍製程和有機金屬化學氣相沉積法成長的氧化鋅那樣，介面之間有旋轉了三十度。而是直接向上成長 $\{10\bar{1}0\}_{ZnO} \parallel \{10\bar{1}0\}_{Al_2O_3}$ 。占少部分大約百分之三的有旋轉的部分，經過退火處理之後，這種結構幾乎可以完全消除。氧化鋅的晶體結構可以在退火處理大大的改善。經過退火之後，壘層缺陷是氧化鋅薄膜最主要的結構缺陷。

## 致謝

光陰似箭，咻一聲。七百多個日子，就這樣一下子過去了。不免俗的，在這激動又高興的時刻，回想起這兩年的辛苦和歡樂，發表一些心中的感想與感謝。

我覺得相由心生。一個人的外貌氣質，往往會與他的所思所想有很大的相關性；一個實驗室的風格和氣氛往往也和這間實驗室的老闆有很大的關連性。我很慶幸自己能夠在謝文峰老師的實驗室，度過我二年的碩士班生活。因為我覺得老師博學又很有涵養，待人和處事都很寬厚，也使得實驗室充滿平和與互助的氣氛。在這樣的氛圍下，雖有做研究的壓力，但也不會繃得太緊，壓力過大。回想起來也是充實快樂的日子。

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