



### 器件制备及器件物理

#### 位错形态与GaN外延薄膜电阻率之间的关系

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摘要：利用金属有机化学气相沉积(MOCVD)，通过改变生长过程中成核层退火阶段的反应室压力，在蓝宝石衬底上制得了不同阻值的GaN外延薄膜。利用原子力显微镜(AFM)、X射线衍射(XRD)和透射电子显微镜(TEM)对所生长的GaN薄膜的表面形貌、位错密度和位错形态进行了研究。结果表明，GaN的电阻率与位错形态之间存在密切联系，由此建立了模型来解释两者之间的关系。由于刃型位错附近存在负电荷，因此可为电子提供传导通道。在低阻GaN中，绝大多数位错发生弯曲和相互作用，在平行于基底方向上形成负电荷的导通通道，GaN薄膜的电导率较高。在高阻GaN中，位错生长方向垂直于基底，负电荷很难在平行于晶片方向上传导，GaN薄膜的电导率很低，由此得到高阻GaN。

关键词：氮化镓 位错形态 高阻 金属有机物化学气相沉积

#### Correlation Between The Morphology of Threading Dislocations and The Origin of High-resistivity GaN

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Abstract: The high-resistivity (HR) GaN is the basis of GaN-based electronic devices. The HR-GaN films were grown by metal organic chemical vapor deposition (MOCVD) on c-plane sapphire substrates, using trimethyl gallium (TMGa) and NH<sub>3</sub> as precursors and high purity H<sub>2</sub> as carrier gas. GaN samples with different resistivity were prepared at various annealing pressures between 10 000 Pa and 54 200 Pa. Surface morphology, dislocation density of different resistivity of the GaN films were characterized by atomic force microscopy (AFM) and X-ray diffraction (XRD). The resistance of GaN increases rapidly with the annealing pressure reducing. The high-quality GaN epitaxial films have been achieved by the experimental method. With the annealing pressure reducing, the edge dislocation density significantly increases by several times, and the screw dislocation density changes. The correlation between the morphology of threading dislocations (TDs) and the origin of HR GaN films was investigated using transmission electron microscopy. It is observed that the morphology of TDs can lead to different resistivity in GaN film, and the edge-type TDs are more sensitive to the sheet resistivity than the screw-type TDs. The sheet resistivity increases by seven orders of magnitude with the increase in the edge-type TDs. The morphology of TDs determines the movement of the negative charges which leads to different resistivity of the GaN film. The TDs can work as the electronic conduction channels. In the low-resistivity GaN, almost all TDs are bent and interactive, and the electrons also move along with the channels formed by the bent TDs. In the HR-GaN, TDs are all straight and perpendicular to the sapphire, and the electrons are difficult to move in the lateral direction.

Keywords: GaN morphology of threading dislocations high-resistivity MOCVD

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