

HRTEM을 이용한 비극성 GaN의 구조적 특성 분석

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Structural characterization of nonpolar GaN using high-resolution transmission electron microscopy

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Abstract : GaN-based nitride semiconductors have attracted considerable attention in high-brightness light-emitting-diodes (LEDs) and laser diodes (LDs) covering from green to ultraviolet spectral range. LED and LD heterostructures are usually grown on (0001)-Al₂O₃. The large lattice mismatch between Al₂O₃ substrates and the GaN layers leads to a high density of defects (dislocations and stacking faults). Moreover, Ga and N atoms are arranged along the polar {0001} crystallographic direction, which leads to spontaneous polarization. In addition, in the InGaN/GaN MQWs heterostructures, stress applied along the same axis can also give rise to piezoelectric polarization. The total polarization, which is the sum of spontaneous and piezoelectric polarizations, is aligned along the [0001] direction of the wurtzite heterostructures. The change in the total polarization across the heterolayers results in high interface charge densities and spatial separation of the electron and hole wave functions, redshifting the photoluminescence peak and decreasing the peak intensity. The effect of polarization charges in the GaN-based heterostructures can be eliminated by growing along the non-polar [11 $\bar{2}$ 0] (a-axis) or [1 $\bar{1}$ 00] (m-axis) orientation instead of the commonly used polar [0001] (c-axis).

For non-polar GaN growth on non-polar substrates, the GaN films have high density of planar defects (basal stacking fault BSFs, prismatic stacking fault PSFs), because the SFs are formed on the basal plane (c-plane) due to their low formation energy. A significant reduction in defect density was recently achieved by applying blocking layer such as SiN, AlN, and AlGaIn in non-polar GaN.

In this work, we were performed systematic studies of the defects in the nonpolar GaN by conventional and high-resolution transmission electron microscopy.

Key Words : Non-polar GaN, TEM, Stacking faults, Dislocations