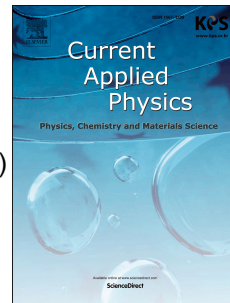


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## Growth and Characterization of Single InGaN Quantum Well in Nonpolar $a$ -plane (11 $\bar{2}$ 0) InGaN/GaN Light-Emitting Diodes

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We studied the In incorporation efficiency and composition distribution in a nonpolar  $a$ -plane InGaN ( $a$ -InGaN) quantum well (QW) layer. The In compositions decreased with increasing growth temperatures due to increased In desorption from InGaN surfaces. It was clear that the In incorporation efficiency on a nonpolar GaN surface is lower than that on a polar  $c$ -plane GaN. In addition, the In incorporation rate on an  $a$ -InGaN layer could be increased by decreasing the V/III ratio without lowering the growth temperature. In the case of the  $a$ -InGaN layer, a composition pulling effect was also observed, suggesting that the In composition of the  $a$ -InGaN layer increases along the normal growth direction from the bottom to the top of the InGaN QW layer. Using high-resolution XRD  $2\theta$ - $\omega$  scans, we found that there existed convex graded In compositions ranging from 4 to 12.7% in an  $a$ -InGaN QW layer along the growth direction. No wavelength shift with a current injection of 20 to 100 mA confirmed the absence of a polarization field. The shift in the electroluminescence (EL) peak energy was  $\sim 11$  meV between the electric field parallel and perpendicular to the  $c$ -axis components, which was caused by the valence band splitting due to the in-plane compressive strain of the 10 nm  $a$ -InGaN QW layer. The EL polarization anisotropy was clearly observed with a polarization ratio of 55%.

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