

Sapphire Substrate Processing for High-Performance GaN-Based Light-Emitting Diodes –Micropatterning of Sapphire Substrates and Its Effect on Light Enhancement in GaN-Based Light-Emitting Diodes–

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(Received December 2, 2013; accepted March 5, 2014)

Key words: light-emitting diodes (LEDs), patterned sapphire substrate (PSS), wet etching, GaN, internal quantum efficiency, light extraction efficiency

We investigated the pattern size control mechanism of patterned sapphire substrates (PSSs) fabricated by wet etching and evaluated the effect of the pattern size of the PSSs on the efficiency of light-emitting diodes (LEDs). It was found that the pattern height, top diameter, and bottom diameter can be controlled by the etching time and diameter of the etching mask. The angle of side surfaces of patterns showed a constant value, which corresponds to the $\{10\bar{1}2\}$ plane of sapphire crystals, when changing the etching time and diameter of the etching mask. On the basis of the pattern size control mechanism that we have established, PSSs with different diameters were successfully fabricated and the efficiency of the LEDs on the PSSs was evaluated. As a result, the light output of the LEDs on a PSS with the largest pattern diameter in this study was 1.2 times higher than that on planar sapphire. In addition, it was shown that the light intensity of the LEDs proportionally increases with increasing pattern diameter of the PSS, suggesting that the area of the side surface for patterns could affect the increase in the light intensity of the LEDs.

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