

Abstract Submitted  
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**High efficient LEDs having columnar structure surface fabricated by block copolymer lithography** AKIRA FUJIMOTO, KOJI ASAKAWA, Corporate Research and Development Center, Toshiba Corporation — Recently, the internal quantum efficiency of LEDs has improved, but the external efficiency remains low due to the high refractive index of semiconductors. To extract more light, a columnar structure with sub-micron period was fabricated on the LED surface by block copolymer lithography. Since the desired pattern is relatively larger than the block copolymer microdomains, a super-high molecular weight block copolymer was used. The polystyrene (PS) - polymethyl methacrylate (PMMA) diblock copolymer was used in this study since the PMMA has a much faster etch rate than the PS by reactive-ion etching (RIE). The PMMA was removed by RIE, and the gallium phosphide (GaP) substrate was etched by chlorine-based inductively coupled plasma RIE using the remaining PS dots as a mask. The optical extraction efficiency of the patterned substrates improved 2.6 times compared to unprocessed flat GaP substrates; the pillars' height was 450 nm, diameter was 100 nm, and pitch was 150 nm. We also prototyped a real LED and increased light emission volume 1.8 times compared with conventional LED at the same energy consumption.

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