

Surface spherical crown arrays structure increases GaN-based LED efficiency

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Received: 27 September 2012 / Accepted: 3 December 2012 / Published online: 15 December 2012
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Abstract To increase the light extraction efficiency of GaN-based light-emitting diode (LED) with nano-spherical hexagonal arrays, the finite-difference time-domain method was used to optimize the structure parameters such as radius and height of GaN, SiO₂ and ZnO spherical crown. The light extraction efficiency (LEE) of the GaN spherical crown hexagonal arrays with a radius of 473 nm and a height of 250 nm over the LED surface exhibited 5.7 times the enhancement compared with that of the planar LED, and better than the LEE of the same type of structures with other parameters.

Keywords LED · FDTD · Light extraction efficiency

1 Introduction

With the development of the recent III–V semiconductor industry, a great energy-saving impulse is now the driving force of GaN-based light-emitting diode (LED) research. With attributes of long life, high reliability and energy saving, the GaN-based LED plays an important role in daily life such as medical application, traffic lights, back lighting, outdoor advertisements and so on.

However, the vertical light extraction efficiency (LEE) of the GaN-based LED is poor. The reduction (droop) of the internal quantum efficiency (IQE) with increasing injection current also hampers the enhancement of LEE (Piprek and Li 2010). Because of the total internal reflection (TIR) at the interface of the semiconductor and the outer medium (commonly air), not all the power emitted from the active region is emitted into free space. Due to Fresnel

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