Improvement of Light Emitting Efficiency on Flip Chip LED with Patterned Sapphire Substrate

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In general, the external quantum efficiency of the Light Emitting Diode(LED) is determined by multiplication of the internal quantum efficiency and the light extraction efficiency. The internal quantum efficiency of LED was already reached to 90%. However, the light extraction efficiency is still insufficient compared to the internal quantum efficiency due to the total reflection in the interface between the LED chip and air.[1] To increase the light extraction efficiency, many studies have carried out such as chip shaping, chip structure like flip chip or vertical chip, surface texturing, patterned sapphire substrate(PSS), photonic crystal, anti-reflection layer and so on. Recently, one of the technologies that gained the most interest is PSS, is forming patterns on the sapphire surface. It brings effectiveness that reduce the probability to generate the total internal reflection(TIR) and increase probability to transmit at the interface between n-GaN and sapphire of the light spreads out in Multi Quantum Wells(MQWs). In addition, light is refracted at various angles due to the diffuse reflection effect of PSS. In conclusion it improves the light extraction efficiency.[2]

In order to check the light extraction efficiency change of the flip chip LED, we designed and simulated the flip chip LED with hemispherical PSS, the parameters for simulation are arrangement, edge spacing, radius and height using LightTools program. Also, PSS shape was designed and simulated with cone, pyramid and cylinder etc. The results show that the light extraction efficiency of 16.76% for flip chip LED without PSS waw enhanced to 56.29% by the application of the optimized PSS to the flip chip LED. In addition, SiO_2 material was applied to PSS and it's influence was checked.

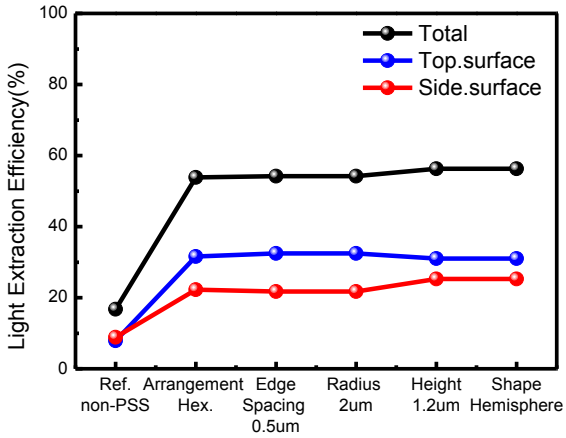

Fig. 1. Improvement of the light emitting efficiency according to PSS

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References

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