

Highly Color Rendering and Luminescent GaN-based White LEDs with Red InP/ZnS Quantum Dots

Tae Hoon Kim², Young Moon Yu² and Jong Su Kim¹

¹Dept. of Display Science & Engineering, Pukyong Nat'l University, Busan 608-737, Korea

Tel.:82-51-629-6416, E-mail: jsukim@pknu.ac.kr

²LED-Marine Convergence Technology R&BD Center, Pukyong Nat'l University, Busan 608-737, Korea

For the application of solid state lighting, GaN-based white light-emitting diodes (WLEDs) have attracted considerable attention due to their high luminous efficiency, low power consumption, long reliability, and strong environmental friendliness. In general, the most common WLEDs was fabricated by the combination of a GaN-based blue chip and Ce³⁺-doped Y₃Al₅O₁₂(YAG:Ce) yellow phosphor. However such a combination has a low color rendering index (CRI, Ra < 70) due to its lack of green and red spectral region. To overcome this problem, InP/ZnS quantum dots (QD) are proposed as a promising material for enhancement of high CRI because of their high quantum yield, narrow emission band, and good photostability.

In this study, in order to achieve ultra high CRI (Ra > 90) WLED, we propose a new combination of hybrid phosphor converted WLEDs by adopting YAG:Ce as a yellow phosphor, Ce³⁺-doped Lu₃Al₅O₁₂(LuAG:Ce) as a green phosphor, and InP/ZnS quantum dot as a red phosphor, respectively. Furthermore, to improve luminous efficiency, we adopt bilayer structure for phosphor coating on the LED chip as shown in Figure 1.

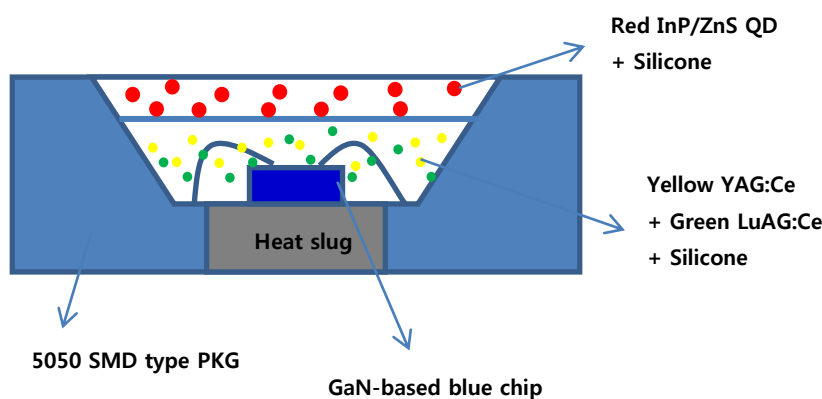


Fig. 1. Bilayer structure of hybrid phosphor converted white LED with YAG:Ce (yellow phosphor), LuAG:Ce (green phosphor) and InP/ZnS (red phosphor).

As shown in Table 1, fabricated WLED with red InP/ZnS QD exhibited high luminous efficiency of > 123 lm/W and ultra high CRI of > 90 (Ra) under operating current of 60 mA and correlated color temperature (CCT) of around 5000 K. Compared with commercial ultra high CRI WLEDs, our results indicate that hybrid phosphor converted WLEDs with red InP/ZnS QD is desirable for the application of solid state lighting.

Table 1. Results of hybrid phosphor converted white LED with YAG:Ce (yellow phosphor), LuAG:Ce (green phosphor) and InP/ZnS (red phosphor)

Sample	C _x	C _y	lm	CCT	CRI	lm/W
1	0.335	0.332	21.0	5332	92.9	123.5
2	0.337	0.335	21.1	5263	92.8	124.4
3	0.337	0.334	20.9	5281	92.9	123.2
4	0.340	0.342	21.0	5138	93.0	123.6
5	0.346	0.353	21.1	4931	91.7	124.3
average	0.339	0.339	21.0	5189	92.6	123.8