

Flip-Chip White LEDs Fabricated by Model Conformal Coating

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Up to present, the blue LED with the conformal phosphor is widely used to form the white LED due to its higher angular correlated color temperature (CCT) uniformity [1]. Although the pulsed spray coating (PSC) method is a common technique for the fabrication of conformal phosphor on LED chip [2], there is still room for improvement in the CCT uniformity of this white LED. In our work, the white LEDs were fabricated via the combination of flip-chip device and conformal phosphor layer. To enhance the CCT uniformity of white LEDs, the model conformal coating (MCC) technique has been presented to form the phosphor layer. For the MCC technique, a model with a square hole was designed to place the chip, and the phosphor slurry was injected into the hole. In addition, the white LED with the PSC-prepared phosphor layer was prepared as the contrasted sample.

Based on the angular-dependent CCT results (Fig. 1), the CCT deviations (with the light extraction angle range of $-80^{\circ}\sim 80^{\circ}$) of the white LEDs contained with the PSC- and MCC-prepared phosphor layers were 396 and 429 K, respectively, under a CCT value of 5100 K. This reveals these white LEDs have similar CCT deviation (@5100 K). Moreover, by adjusting the CCT to 5800 K, the CCT deviations of these two devices were 800 and 460 K, as the phosphor layers were formed by PSC and MCC techniques, respectively.

According to the observations by scanning electron microscopy, the MCC-prepared phosphor layer has smoother surface than that of the PSC-prepared phosphor layer. The smoother surface of phosphor layer would induce more uniform phosphor conversion efficiency, which leads to a better CCT uniformity in the device. Nevertheless, at a lower CCT value of 5100 K, the CCT deviation is reduced spontaneously because of the higher phosphor concentration in the phosphor layer. Therefore, the surface roughness of the phosphor layer cannot influence the CCT deviation obviously in this case. The results indicate the phosphor layer formed by the MCC technique is helpful for improving the CCT uniformity of white LED, especially at high CCT.

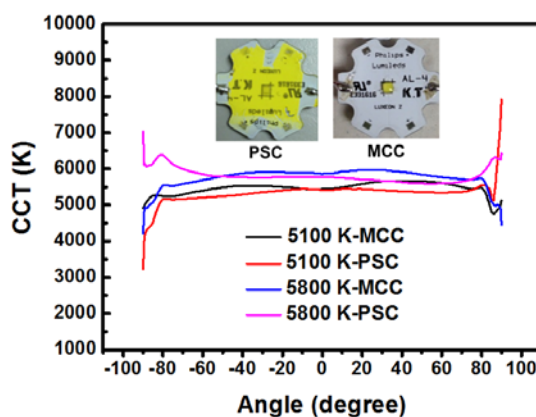


Fig. 1. Angular-dependent CCTs of the white LEDs contained with the PSC- and MCC-prepared phosphor layers. The photographs of these two devices are displayed in the inset.

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References

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