High colour rendering dichromatic monolithic light emitting diode with tuneable colour temperature.

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LEDs emitting white light either employ phosphor to down covert a high energy photon to low energy photon or use the colour mixing (i.e. RGB or RYGB) approach. A monolithic approach employs colour mixing by exciting photons of different energies (in the visible range), typically blue and yellow/green, from different quantum wells in the same device [1]. The white emission from these state-of-art devices can find application in general illumination market only with improved quantum efficiency, colour rendering index (CRI) and correlated colour temperature (CCT) [2]. For achieving high CRI broad emission linewidth is suitable [2]. Broadened bicolour (di-chromatic) white LEDs usually have CRI in the range of 10-60 [3]. In this work we are reporting about CRI as high as 67 achieved at the normal for high power LEDs operation current 350 mA.

The structures used are the same as were used before [4]. It is a monolithic white LED chip with two quantum wells (QWs) emitting at 450-460 nm in blue and one QW emitting at 540-560 nm in green. This distinction in emission wavelength is achieved by varying the Indium composition of the InGaN quantum wells. To improve carrier injection a short-period superlattice were grown before the QW [4] on top of n-GaN layer. These bicolour structures were studied under CW and pulse regimes over the range of 30 mA to 2 A. Radiometric parameters were measured with LightMtrx software using a compact CCD spectrometer, integration sphere and DC/pulse current source.

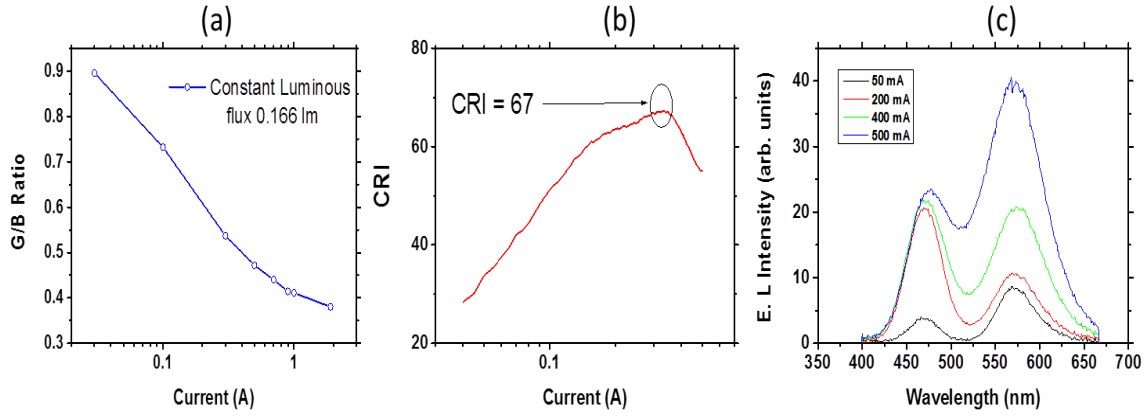

Fig. 1 (a) G/B ratio tuneability with current modulation at constant luminous flux, where white circles the experimental data, (b) Evolution of CRI with current and highest CRI measured in the range of 310- 350mA, (c) Spectrum evolution with current modulation.

The above results demonstrate warm to cool white emission with CCT varying from 3500 K to 13000 K under CW regime. Also, the green/blue ratio, and hence CCT, can be tuneable in about three times by pulse width and amplitude modulation even at the constant luminous flux (figure 1(a)). Here, also we demonstrate a very high value of CRI, Ra=67 (figure 1(b)), from one structure at 310-330 mA DC possibly for the first time. The structure with cool white can have a maximum external quantum efficiency of 6.5%.

References

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