Colour management of InGaN/GaN based monolithic two-wavelength LEDs

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The recent advancement in the growth technology of InGaN/GaN has decently positioned InGaN based white LEDs to leap into the area of general or daily lighting. Monolithic white LEDs with multiple QWs were previously demonstrated by Damilano et al. [1] in 2001. However, there are several challenges yet to be overcome for InGaN based monolithic white LEDs to establish themselves as an alternative to other day-to-day lighting sources [2,3]. Alongside the key characteristics of luminous efficacy and EQE, colour rendering index (CRI) and correlated colour temperature (CCT) are important characteristics for these structures [2,4].

Investigated monolithic white structures were similar to that described in [5] and contained blue and green InGaN multiple QWs without short-period superlattice between them and emitting at 440 nm and 530 nm, respectively. The electroluminescence (EL) measurements were done in the CW and pulse current modes. An integration sphere (Labsphere "CDS 600" spectrometer) and a pulse generator (Agilent 8114A) were used to perform the measurements.

The CCT and Green/Blue radiant flux ratio were investigated at extended operation currents from 100mA to 2A using current pulses from 100ns to 100µs with a duty cycle varying from 1% to 95%. The strong dependence of the CCT on the duty cycle value, with the CCT value decreasing by more than three times at high duty cycle values (shown at the 300 mA pulse operation current) was demonstrated (Fig. 1). The pulse width variation seems to have a negligible effect on the CCT (Fig. 1). To account for the joule heating, a duty cycle more than 1% was considered as an overheated mode. For the 1% duty cycle it was demonstrated that the CCT was tuneable in three times by modulating input current and pulse width (Fig. 2). It has also been demonstrated that there is a possibility of keeping luminous flux independent of pulse width variation for a constant value of current pulse (Fig. 3).

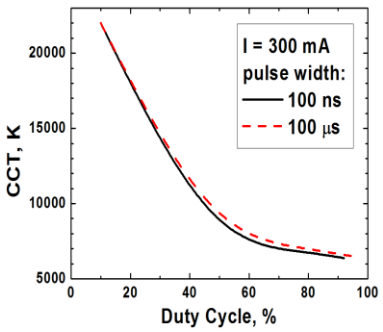

Fig.1. CCT vs. Duty Cycle of the white LED measured in the integration sphere at 100 ns and 100 µs pulse durations.

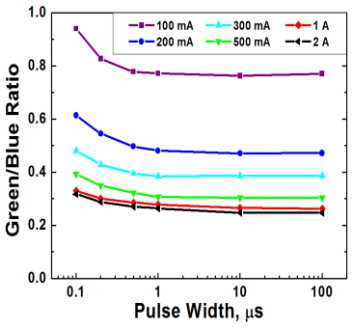

Fig.2. Green/Blue bands ratio vs. pulse width measured at different currents and 1% Duty cycle. The figure demonstrates colour mixing tunability even at non-overheated mode.

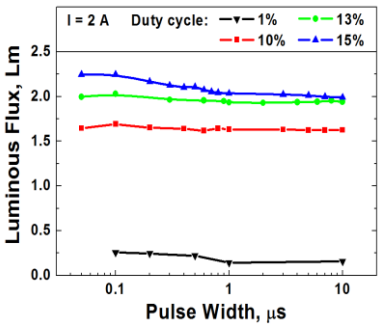

Fig. 3. Luminous flux vs. pulse width measured at different Duty cycles at 2A driving current. The figure demonstrates a possibility to keep the luminous flux independent from pulse width in the range of more than two orders.

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