Performance of InGaN light emitting diodes on SiC

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During the last few years, the markets for blue, green and white light emitting devices (LEDs) have experienced a strong growth. The applications range from automotive dashboards to traffic signs, displays and illumination. The high volume chips have to fulfil high brightness as well as low costs, stable color and high robustness.

Osram Opto Semiconductors is growing InGaN by metalorganic vapor phase deposition on SiC substrates. The optical power is as high as 7mW for the new generation of blue InGaN LEDs on SiC at 460 nm and 20 mA. This is the highest optical power reported on SiC based blue LEDs up to now. High qualities of the InGaN quantum wells are essential to get such high efficiencies. We have optimized the strain of the InGaN quantum wells by improvement of the buffer layers between substrate and active layer. Additionally, an increase of extraction efficiency is achieved.

Our single chip white LED generates white color by mixing two opposite colors of the chromaticity diagram: Blue light is emitted by the semiconductor chip and yellow light is generated by luminescence conversion. For many applications it is essential to have a constant color point in the color coordinate diagram at all application conditions. Therefore, a stable emission wavelength of the chip is important. However, at low currents the wavelength typically shifts to longer values at blue and green InGaN LEDs. The wavelength shift of the chips results in yellowish color of the white LED. The amount of the shift is in the order of 6 nm for blue InGaN LEDs. However, the yellow shift of our blue InGaN chips is as low as 3 nm at forward current reduction from 20 to 1 mA. The depths of the InGaN localized states are responsible for the amount of the wavelength shift.

Robustness against electrostatic discharge is important to get a low failure rate at automatically mounting of LEDs on electronic boards, for example automotive dashboards. The robustness can be achieved by two ways: (1) protection of the light emitting chip by a Z-diode or (2) controlled electrical fields inside the chips. We are going the second way: homogeneous reverse current distribution at the active layer by (a) high qualtiy of the quantum wells, (b) conductive substrate and conductive buffer technology. The local electrical fields at the pn junction are kept to low values that a robustness against electrostatic discharge of 2000V can routinely be achieved.

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