Abstract

In this thesis we investigate the degradation mechanism of AlInGaP light emitting diodes (LEDs) during encapsulation and operation. The AlInGaP LEDs are encapsulated using an injection moulding tool. The molded part acts as physical housing as well as tailors the radiation pattern. Thus a narrow light beam with a spread angle of α=10° has been observed. The LED temperature has been measured by the voltage variation of the LED which is caused by the temperature change at a constant current. Thus the thermal load of the LED chips during the encapsulation process is investigated. To verify the temperature measurement a simulation based on the finite element method has been carried out. The experimental and theoretical data are in good agreement.

The LED properties are investigated before and after the encapsulation. The results are compared and we found a reduction of the serial resistance and an enhanced luminous efficiency. The peak emission energy remained constant, but a peak broadening of ΔE=9meV has been observed. A slight polarisation of the emitted light is an indication for a polarization effect of the polymethylmethacrylat (PMMA) housing.

Accelerated degradation experiments using high forward currents are performed to estimate the lifetime of the PMMA encapsulated LEDs. A diffusion model is presented to explain the decay in luminous flux versus degradation time and degradation current. We believe that the reduction of quantum efficiency is caused by p-type dopant diffusion into the active layer where it acts as a non-radiative recombination centre. Using this model we determine the lifetime under the recommended drive current of I=20mA. The resulting lifetime is $t = 1.5 \cdot 10^6 h$ using a reduction of 50% in the luminous flux as failure criteria.