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Influence of polar surface properties on InGaN/GaN core-shell nanorod LED properties

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Abstract InGaN/GaN nanorod core-shell LEDs have shown to be very promising candidates for high efficiency lighting devices. Such nanorods can be grown in different ways, leading to different device geometry and in particular to different structures near the polar Ga- and N-face nanorod surfaces. In this work the influence of the properties of the polar surfaces on the electrical device behaviour is studied qualitatively based on a semiclassical simulation model.

Keywords LED · Nanorod · Nitrides · Simulation · Surface effects

1 Introduction

Electric lighting accounts for roughly 20 % of the total electric power consumption in the USA and in Europe. Clearly, the exclusive use of highly efficient lighting devices would allow to save considerable amount of energy. Therefore, the development of very high efficiency LEDs with long lifetime has become a topic of major importance during the last decade.

Nitride-based LEDs are already widely used for lighting applications (Crawford 2009; Wu 2009). Commercially available white LEDs are usually based on a conversion process involving Phosphors, where the light of a highly efficient blue LED is partly converted to the yellow spectral range. This process, however, is accompanied by an inherent conversion loss (Stokes' loss), and the device lifetime strongly depends on the applied Phosphor. Therefore, much research effort is put into the development of phosphor-free white emission, e.g. by RGB approaches combining emission of red, green and blue LEDs (O'Donnell et al. 2012).

Two of the major problematics in InGaN/GaN LEDs are a reduction of the quantum efficiency when going from blue to longer wavelength emission and a decrease of efficiency with

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