LIGHT-EMITTING DIODE WITH TOP ELECTRODE AS A LAMINAR DIFFRACTION GRATING

(приглашенный доклад)

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An importance of light-emitting diodes (LEDs) as an instrumental ingredient in solid-state lighting is of common knowledge. The development of high efficiency and brightness LEDs is limited mainly due to the difficulty for light to escape from high refractive index semiconductors. Among a number of schemes considered for increasing the external quantum efficiency (based on the old idea of coupling the light out of the semiconductor by means of a high refractive index hemispherical lens), surface roughening is considered as one of the simpler method. However, the roughened surface morphology can be irregular and uncontrolled along with a significant problem to eliminate the strong parasitic absorption at the electrodes. We try to overcome the problem with electrodes.

The device studied in the present report is a LED structure grown by MOCVD on a sapphire substrate. The LED structure consists of a GaN buffer layer, a thick *n*-GaN:Si layer, an InGaN/GaN active region, a *p*-AlGaN:Mg blocking layer and a *p*-GaN:Mg contact layer. The structure is processed in order to obtain circuit devices, 10 μm in diameter, including ECR-plasma mesa-etching, passivation by silicon nitride film, e-beam lithography and precision etching to produce a p-contact. Getting LED's p-contact into shape of laminar diffraction grating promises more efficient light output. First, stripe-like grooves of grating can spatially homogeneous spread of applied current driving across the whole structure being the grating covered structure surface totally. Second, the grating itself can be resonantly transparent for the generated light (0.45 mcm). Indeed, we describe quantitatively a resonant suppression of the reflection of plane monochromatic electromagnetic waves from the grating as a function of the grating gap (inter-rulings spacer 0.35 mcm, rulings width 0.2 mcm), rulings thickness (0.1 mcm) and wave incidence angle. Mentioned optimization of p-contact allowed to increase LED light emission efficiency by 26% in comparison with 18% for LED with a conventional p-contact.