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Non-polar M-plane AlGaN Multiple Quantum Well Light-Emitting Diode

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Although AlGaN-based deep-ultraviolet (deep-UV) light-emitting diodes (LEDs) have already been demonstrated [1-2], the emission efficiency is still low especially at emission wavelengths (λ) below 250 nm, in contrast to that of InGaN-based visible LEDs [3]. One reason for the low efficiency is the low light extraction from the C-plane (0001) AlGaN growth surface due to the optical polarization anisotropy. Additionally, the strong internal electric field in the polar (0001) plane quantum well (QW) causes a spatial separation of electron and hole wave functions along the <0001> growth direction (quantum confined stark effect [QCSE]) and therefore reduces the radiative recombination. To circumvent this drawback, non-polar plane QW was proposed for InGaN-based LEDs [4]. Here, we report a first demonstration of non-polar M-plane AlGaN multiple quantum well (MQW) LED.

The M-plane AlGaN LED structure (Fig. 1) was grown on M-plane (10-10) AlN substrate by MOVPE. The layer structure consists of an AlN buffer layer, an n-AlGaN layer, an AlGaN/AlGaN MQW, a p-AlGaN electron blocking (eB) layer, a p-AlGaN superlattice (SL) and a p-GaN contact layer. A mesa structure was defined by dry etching to expose the n-AlGaN surface. Ti/Al/Ti/Au and semitransparent Pd/Au metals were used for n- and p-type contact, respectively. Electroluminescence (EL) spectra were acquired from the LED surface. For polarization measurement, the EL spectra were obtained through a linear polarizer.

Figure 2 shows the EL spectra from M-plane AlGaN MQW LED at different forward currents. The deep-UV light emission was observed at λ~248 nm. There was no blue-shift of EL peak with increasing current, which indicates the absence of QCSE. Moreover, the polarization property of the EL shows stronger emission for ***E***//*c* polarization than for ***E***⊥*c* polarization (Fig. 3), which indicates the high light extraction from M-plane LED surface. Thus, these results suggest that high emission efficiency can be obtained by non-polar M-plane AlGaN MQW LED due to the ***E***//*c* polarization in addition to the absence of QCSE.

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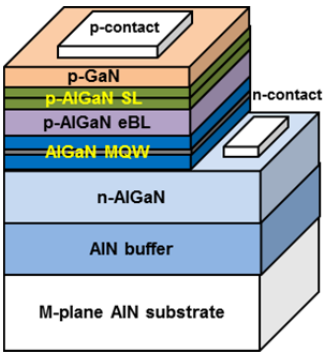

Fig. 1: Device structure of M-plane AlGaN MQW LED.

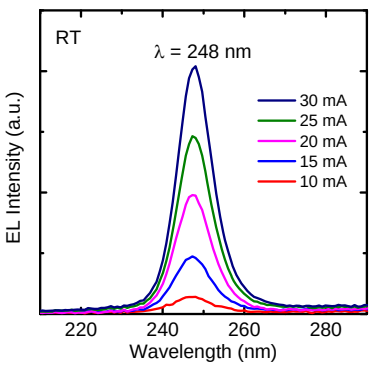

Fig. 2: EL spectra of M-plane AlGaN MQW LED at different currents.

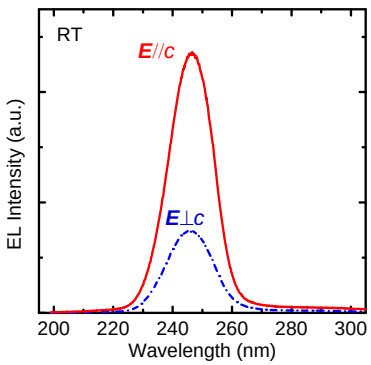

Fig. 3: Polarization property of M-plane AlGaN MQW LED.