Green/Yellow/Red Emission From *m*-plane Core-shell InGaN/GaN Nanowires

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The realization of efficient LEDs using core-shell m-plane InGaN/GaN nanowires has been mainly demonstrated for the blue emission [1,2]. Green and other longer wavelength emissions still remain a challenge for this core-shell geometry due to a lower In incorporation on the *m*-plane with respect to the *c*-plane [3]. This work demonstrates a multi-color emission from self-assembled wires with InGaN multi-quantum wells (MQWs), which are used to demonstrate flexible LEDs. Self-assembled catalyst-free GaN microwires have been grown by metalorganic vapor phase epitaxy (MOVPE) with silane addition on sapphire in situ capped with SiNx mask. This was followed by the growth of seven InGaN/GaN QWs and completed with the growth of a p-GaN shell [1,4]. The electrical and optical characterization of the flexible LED device was performed using micro electroluminescence (μEL); and photoluminescence (PL) and cathodoluminescence (at 4K) respectively.

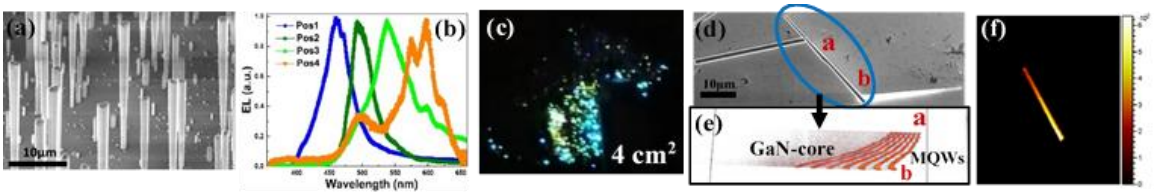

Figure 1 : (a) SEM image of virgin NWs; (b) EL spectra at four different positions; (b) Emission observed during EL measurement; (d) SEM image of NWs dispersed on Si; (e) 3D mapping of In using TOF-SIMS; (f) Color profile of secondary In^+ counts on single NW.

Fig. 1 (a) shows the SEM image of as-grown nanowires. The EL measured at injection current of 60 mA in Fig. 1(b) revealed different wavelength emission at 460 nm, 500 nm, 540 nm and 600 nm. Different color emission can be seen from the flexible LED device in Fig. 1(c) captured during current injection. Further investigations using ToF-SIMS analysis on single nanowires were also performed to quantify the indium incorporation in the InGaN/GaN core-shell structure [4]. The 'ab' section of an identified single nanowire as seen in the SEM image of Fig. 1(d) was analyzed by ToF-SIMS and the 3D profile of In present in this section can be seen in Fig. 1(e). The secondary ion count for In^+ in Fig. 1(f) shows a gradient of In-content along the length of the nanowire. These results indicate high and inhomogeneous In incorporation in the side-walls thus resulting in the variation in wavelength emission of the core-shell nanowires. This work highlights the possibility to obtain multi-color emission from blue to red from core-shell m-plane InGaN/GaN MQWs in GaN nanowire-based LEDs that opens the route for monolithic white flexible LED without phosphors.

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