Deep Ultraviolet Light Emitting Diodes Using AlGaN Quantum Well Active Region

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Due to their potential use in solid-state white lighting, bio-chemical detection and high-density data storage the demand for high power, short wavelength (λ ~ 280-340 nm) compact UV light sources is rapidly increasing. Here we report our recent work aimed at developing deep UV III-N LEDs with emission wavelengths λ ≤ 340 nm over sapphire substrates. Our device design is based on using high Al-content AlGaN multiple quantum wells active region. A novel pulsed atomic layer epitaxy (PALE) approach is used to deposit short period n-AlGaN superlattices for the buffer and thick n⁺-AlGaN layers for the n-side contacts. This also tailors strain and reduces the number of threading dislocations. The p-contact region comprises of the p-AlGaN-GaN heterojunction that aids hole accumulation and thus allows for the devices to operate even at temperatures as low as 10-100 K.

Mesa type square geometry LED devices were fabricated with quantum well designs giving emission from 278-340 nm. The linewidths of the spectral emissions were about 10 nm. Differential resistance for 200 μm square devices ranged from 25 to 40 Ω. Room temperature powers for flip-chipped devices (on copper headers) were then measured using an integrating sphere. At 325 nm a record cw-power of 1 mw and a pulsed power of 10 mW were achieved. At 278 nm we obtained record cw and pulsed powers of 0.47 mW and 3 mW. Details of material growth and device simulation, fabrication and characterization will be discussed.