Deep Ultraviolet Light Emitting Diodes Using AlGaN Quantum Well Active Region

M. Asif Khan, Maxim Shatalov, Vinod Adivarahan, Jian Ping Zhang, Ashay Chitnis, Grigory Simin, Jinwei Yang

Department of Electrical Engineering, University of South Carolina,

Columbia, SC 29208, U.S.A.
asif@engr.sc.edu

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 ($\lambda \sim 280$-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 $\lambda \leq 340$ 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.