Title: Semipolar GaN lasers and SLDs for smart lighting and visible light communications

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Abstract

The past decade witnessed the rapid development of III-nitride light-emitting diodes (LEDs), superluminescent diodes (SLDs), and laser diodes (LDs), for solid-state lighting (SSL), visible-light communication (VLC), optical storage, and internet-of-things (IoT). InGaN/GaN quantum well (QW)-based LEDs have been established as the fundamental component for SSL applications while recent studies suggested that the GaN-based LDs, which is free from efficiency droop, may outperform LEDs as a viable high-power light source. Meanwhile, there are increasing potentials in using such emitters in visible-light based optical communication systems for indoor and outdoor applications as data-rate demands are exponentially growing in the near future. The unregulated visible light spectrum has recently been harnessed for energy-efficient, ultra-large bandwidth, and secure data transmission. For advancing the high-power, high-speed light-emitter architecture, compact and energy-saving laser-diode based devices are attractive for free-space and underwater visible light communication (VLC), in place of LEDs. The development of devices and components in laser-based white lighting and data communication systems will be discussed. The presentation will feature our recent investigations: 1) A small footprint integrated waveguide-modulator / laser-diode (IWM-LD) on semipolar $\left(20\overline{2}\overline{1}\right)$ GaN substrate, showing a high modulation efficiency of 2.68 dB/V. 2) Semipolar InGaN-based violet-blue superluminescent diodes (SLDs) as droop-free and speckle-free light sources, combining the advantages of both LEDs and LDs. 3) GaN-based Vertical-cavity surface-emitting lasers (VCSELs) based on nonpolar InGaN/GaN quantum-wells and a tunnel-junction intracavity contact for VLC. 4) A high-performance InGaN-based waveguide photodetector integrated LD sharing the single active region is presented with a responsivity of 0.051 A/W at 405 nm and a large modulation bandwidth of 230 MHz.

Short-bio

Chao is currently a researcher and consultant for technical innovation at KAUST. He is also affiliated with KACST Technology Innovation Center (TIC) for solid-state lighting at KAUST and KACST-KAUST-UCSB Solid-State Lighting Program (SSLP). Currently, he has co-authored 21 journal papers, including *Optics Express*, *Optics Letters*, *ACS Photonics*, *Nano Letters*, etc. In addition, he published over 20 conference papers, such as *IEDM, CLEO*, *IPC,* and *ICNS*, and has five US patents pending. He received PhD in Electrical Engineering at KAUST and BSc. in Materials Physics at Fudan University. His research interests include III-nitride photonic integrated circuit, GaN-based laser diodes, superluminescent diodes, micro-LEDs, and VCSELs, laser-based solid state lighting, free-space and underwater visible light communications.