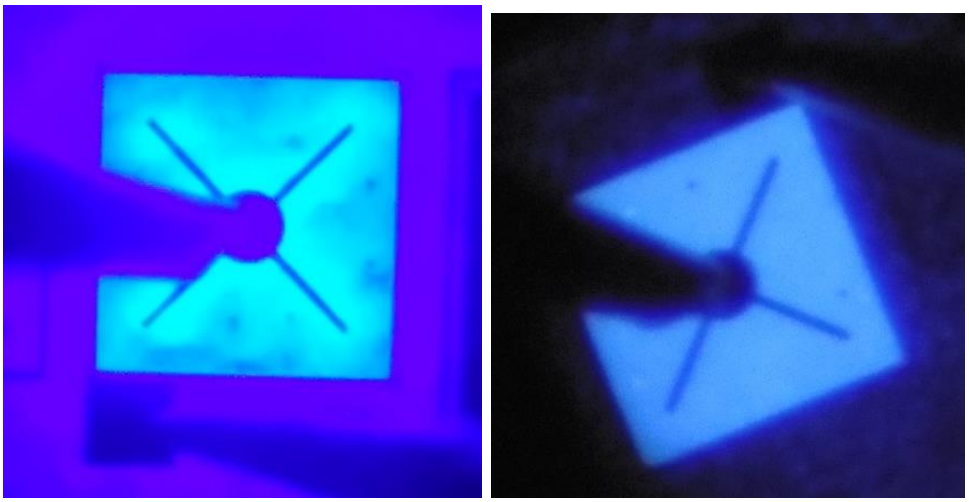
Tunnel better than holes

OPTO



Light emission from a visible (left) and UV (right) LEDs based on a tunnel junction. The tunnel junction allows for a better hole injection in the LED and provides a better current spreading, leading to a uniform emission across the device

Tunnel junctions for visible and UV diodes

The low density of holes in GaN and even more in AlGaN induces a reduced performance of nitride LEDs. First, access resistances increase the operating voltage and degrade the wall plug efficiency. Second, the carrier injection in the quantum well of the active region is unbalanced and its efficiency is reduced. When a tunnel junction is grown on top of an LED and operated in reverse bias when the LED is under forward bias, it injects holes in the p region of the LED by tunnel effect from the conduction band of the top n contact. In the frame of the DUVET and NANOGANUV projects and the GaNeX PhD work of Victor fan Arcara, we demonstrated tunnel junction based LED in GaN and AlGaN materials, for LED emitting at 440, 360 and 300 nm. Various approaches have been successfully tested, including an original all MOCVD and also MBE/MOCVD hybrid growths. The tunnel injection has been applied to active regions based on QWs, QDs and heterojunctions. Differential resistance on the order of 10^{-3} Ωcm^{-2} at 1 $kAcm^{-2}$ have been obtained.

Breakthroughs

Tunnel junctions in GaN and AlGaN for visible and UV (300 nm) LEDs based on quantum wells, quantum dots and heterojunctions

Perspectives

UVC LEDs at 275 nm based on AlGaN tunnel junction

Collaborations : LETI, IEMN

More information : V. fan Arcara et al, 2019, submitted.

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