



# III-Nitride Tunnel Junction LED with High Wall Plug Efficiency

Tech ID: 31762 / UC Case 2017-131-0

## BACKGROUND

Commercially-available III-nitride light-emitting diodes (LEDs) use an active region in a biased p-n junction to allow for electron and hole injection. The p-GaN is difficult to contact electrically and has low hole concentration and mobility. This means that p-GaN cannot be used as a current spreading layer and that traditional p-contacts will add significant voltage to devices. Despite these inherent problems, all commercial light emitting devices utilize a p-contact and a material other than p-GaN for current spreading, typically transparent conducting oxides (TCO).

## DESCRIPTION

Researchers at the University of California, Santa Barbara have introduced an n-GaN layer that produces less loss than a traditional transparent conducting oxide. The favorable current spreading of the n-GaN layer also helps to reduce the droop observed in previous iterations of III-Nitride LEDs. The combined benefits of this novel current spreading layer materialize into a device with over 70% wall plug efficiency.

## ADVANTAGES

- ▶ Improved light extraction
- ▶ Improved energy efficiency (over 70%)
- ▶ No requirement for TCOs or mirrors

## APPLICATIONS

- ▶ III-Nitride LEDs

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,164,997	11/02/2021	2017-131

## RELATED TECHNOLOGIES

- ▶ [Contact Architectures for Tunnel Junction Devices](#)
- ▶ [Methods for Fabricating III-Nitride Tunnel Junction Devices](#)
- ▶ [Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide](#)

## CONTACT

Pasquale S. Ferrari  
[ferrari@tia.ucsb.edu](mailto:ferrari@tia.ucsb.edu)  
tel: .

## INVENTORS

- ▶ [DenBaars, Steven P.](#)
- ▶ [Nakamura, Shuji](#)
- ▶ [Speck, James S.](#)
- ▶ [Yonkee, Benjamin P.](#)
- ▶ [Young, Erin C.](#)

## OTHER INFORMATION

### KEYWORDS

LED, tunnel junction, GaN, III-nitride LED

### CATEGORIZED AS

- ▶ [Energy](#)
- ▶ [Lighting](#)
- ▶ [Semiconductors](#)
- ▶ [Design and Fabrication](#)

### RELATED CASES

2017-131-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- ▶ Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- ▶ III-Nitride-Based Vertical Cavity Surface Emitting Laser (VCSEL) with a Dielectric P-Side Lens
- ▶ Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
- ▶ Ultraviolet Laser Diode on Nano-Porous AlGaIn template
- ▶ Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- ▶ (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- ▶ Thermally Stable, Laser-Driven White Lighting Device
- ▶ Methods for Fabricating III-Nitride Tunnel Junction Devices
- ▶ Contact Architectures for Tunnel Junction Devices
- ▶ Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices
- ▶ A Method To Lift-Off Nitride Materials With Electrochemical Etch
- ▶ High-Intensity Solid State White Laser Diode
- ▶ Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- ▶ High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template
- ▶ III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture

