Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs
Tech ID: 29198 / UC Case 2018-256-0

BRIEF DESCRIPTION
A way to reduce leakage current and increase the efficiency of III-Nitride microLEDs via ALD sidewall passivation.

BACKGROUND
Due to the chemical inertness of III-nitrides semiconductor materials, plasma-based dry etching is widely employed to define the mesa structure of LEDs. Due to the high-energy nature of plasma etching, the sidewall of the LED has defects which result in leakage current and reduction of internal quantum efficiency. There are currently techniques to try to minimize these problems. Sidewall passivation using dielectrics has been demonstrated and used to decrease the leakage current and plasma-enhanced chemical vapor deposition (PECVD) is the common technique for deposition dielectrics to passivate the sidewall. However, as the size of LED diminishes, it is easier for hydrogen to diffuse into LEDs, lowering the efficiency. This results in less light being extracted from the LED. MicroLEDs are used in a number of “Near-eye” display devices, which have very low current in order to avoid retina damage. As a result, microLEDs with very low leakage current are desired.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a way to reduce leakage current and increase the efficiency of III-Nitride microLEDs via ALD sidewall passivation. ALD has atomic-scale control on the deposition rate of dielectrics thin film. The dielectric film is sufficient to passivate the sidewall of LEDs and to reduce leakage current for microLEDs. Furthermore, ALD is a hydrogen-free deposition method which prevents the problem of hydrogen passivation, thus increasing the efficiency of the LEDs.

ADVANTAGES
▶ Hydrogen-free sidewall passivation
▶ No increase in resistivity for p-type layers
▶ No decrease in transparency for ITO

APPLICATIONS
▶ Smart phones
▶ Smart watches
▶ “Near eye” devices that require ultra-low current

PATENT STATUS
<table>
<thead>
<tr>
<th>Country</th>
<th>Type</th>
<th>Number</th>
<th>Dated</th>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States Of America</td>
<td>Published Application</td>
<td>21-0193871</td>
<td>06/24/2021</td>
<td>2018-256</td>
</tr>
</tbody>
</table>

RELATED CASES
2018-256-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Subtrates
▶ Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
▶ Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- III-Nitride-Based Devices Grown With Relaxed Active Region
- Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)
- Defect Reduction in GaN films using in-situ SiNx Nanomask
- Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
- Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes
- Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices
- Low Temperature Deposition of Magnesium Doped Nitride Films
- Transparent Mirrorless (TML) LEDs
- Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- Size-Independent Forward Voltage Micro-LED with an Epitaxial Junction
- Method for Enhancing Growth of Semipolar Nitride Devices
- III-Nitride Tunnel Junction with Modified Interface
- Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices
- Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
- Increased Light Extraction with Multistep Deposition of ZnO on GaN
- Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications
- High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices
- Oxyfluoride Phosphors for Use in White Light LEDs
- Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
- (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- Thermally Stable, Laser-Driven White Lighting Device
- MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
- Reduced Dislocation Density of Non-Polar GaN grown by Hydride Vapor Phase Epitaxy
- Highly Compact, High-Index Dielectric Nanostructures for Deep-Ultraviolet Devices
- Methods for Fabricating III-Nitride Tunnel Junction Devices
- Low-Droop LED Structure on GaN Semi-polar Substrates
- Contact Architectures for Tunnel Junction Devices
- Semi-polar LED/LD Devices on Relaxed Template with Misfit Dislocation at Hetero-interface
- Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures
- Semipolar-Based Yellow, Green, Blue LEDs with Improved Performance
- III-Nitride-Based Devices grown on Thin Template on Thermally Decomposed Material
- Growth of Semipolar III-V Nitride Films with Lower Defect Density
- III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
- Improved Manufacturing of Solid State Lasers via Patternning of Photonic Crystals
- High Efficiency III-Nitride Devices with Smooth Relaxed InGaN Buffer and Strain Compliant Template
- Tunable White Light Based on Polarization-Sensitive LEDs
- Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN
- Growth of High-Performance M-plane GaN Optical Devices
- Packaging Technique for the Fabrication of Polarized Light Emitting Diodes
- Improved Anisotropic Strain Control in Semipolar Nitride Devices
- High Light Extraction Efficiency III-Nitride LED
- III-V Nitride Device Structures on Patterned Substrates
- Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs
- Method for Increasing GaN Substrate Area in Nitride Devices
- Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
- GaN-Based Thermoelectric Device for Micro-Power Generation
- Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patternning
- LED Device Structures with Minimized Light Re-Absorption
- Growth of Planar Semi-Polar Gallium Nitride
- Nonpolar (Al, In, Ga)N Quantum Well Design
- UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys
- Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD