Photoelectrochemical Etching for Chip Shaping Of LEDs
Tech ID: 23784 / UC Case 2009-157-0

BRIEF DESCRIPTION
A novel process to chip shape LEDs though photochemical (PEC) etching.

BACKGROUND
Light emitting diodes' (LEDs) external quantum efficiency is limited by light emitted into guided modes being trapped in the material. When wafers are diced, the resulting sidewalls are smooth and vertical resulting in most of the light reflecting back into the material where it is eventually lost. To counteract this phenomenon, shaping is done to modify the geometry to form non rectilinear designs, which decrease the amount of trapped light. This chip shaping involves shaping the material and substrate which may have different compositions. Moreover, the shaping is typically accomplished through crystallographic wet or dry etching or by device sawing using specialty blades.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a novel process to chip shape LEDs though photochemical (PEC) etching. This process can directly etch the material in between LEDs that are grown on III-V substrates. By varying the angle of the incident light during PEC etching, the angle of the resulting sidewalls can be controlled to create sloped sidewalls. These walls can then scatter guided modes out of the material rather than reflecting them back, to increase the external quantum efficiency.

ADVANTAGES
▶ Increased external quantum efficiency
▶ Low cost etching
▶ Rapid etching
▶ Eliminate the need of mechanical etching
▶ Possible automation of the etching process

APPLICATIONS
▶ Semiconductors
▶ LED shaping

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>Issued Patent</td>
<td>8,569,085</td>
<td>10/29/2013</td>
<td>2009-157-0</td>
</tr>
</tbody>
</table>
- Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates
- Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
- Etching Technique for the Fabrication of Thin (Al, In, Ga)N Layers
- Backside-Illuminated Photoelectrochemical (Bipec) Etching
- Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
- Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- Internal Heating for Ammonothermal Growth of Group-III Nitride Crystals
- 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
- Volumetric Hole Injection with Intentional V-Defects
- Transparent Mirrorless (TML) LEDs
- Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes
- Method for Growing Self-Assembled Quantum Dot Lattices
- 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
- Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications
- High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices
- Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
- Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
- MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
- Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
- Methods for Fabricating III-Nitride Tunnel Junction Devices
- 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
- 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
- Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN
- Growth of High-Performance M-plane GaN Optical Devices
- Improved Anisotropic Strain Control in Semipolar Nitride Devices
- High Light Extraction Efficiency III-Nitride LED
- Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration
- Method for Increasing GaN Substrate Area in Nitride Devices
- Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
- Single or Multi-Color High Efficiency LED by Growth Over a Patterned Substrate
- Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patternning
- Growth of Planar Semi-Polar Gallium Nitride
- Integration And Mass Transfer Of Microleds
- Defect Reduction of Non-Polar and Semi-Polar III-Nitrdes
- Suppression of Defect Formation and Increase in Critical Thickness by Silicon Doping