GaN-Based Thermoelectric Device for Micro-Power Generation
Tech ID: 21830 / UC Case 2009-389-0

BRIEF DESCRIPTION
A novel, highly-customizable device architecture for GaN thermoelectric micro power generators.

BACKGROUND
Currently practical thermoelectric technology consists mainly of Bi2Te3 based materials. These materials however are not only toxic and scarce, but have a maximum operating temperature of roughly 150°C. The current material used for high temperature applications is SiGe, but low efficiencies and limited room for improvement necessitate the search for an improved high temperature thermoelectric material. Wide bandgap GaN and its family of alloys are promising candidates to fill this role because they are non-toxic and very stable at high temperatures.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a novel, highly-customizable device architecture for GaN thermoelectric micro power generators. The device structure consists of only n-type GaN with gold interconnections. Several measurements performed on this device proved the suitability of GaN at high operating temperatures for this application. For example, a maximum average temperature of 825K was achieved with no sign of device or contact degradation. This was the highest temperature tested due to limitations in the testing apparatus, not by device performance.

ADVANTAGES
▶ Very stable at high temperatures (>825K)
▶ Low thermal conductivity
▶ Electrical conductivity maintained at the same level as standard nitride films

APPLICATIONS
▶ Thermoelectric Devices

This technology is available for licensing. See below for a selection of the patents and patent applications related to this invention.

Please inquire for full patent portfolio status.

PATENT STATUS

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<tr>
<th>Country</th>
<th>Type</th>
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<td>United States Of America</td>
<td>Issued Patent</td>
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OTHER INFORMATION

KEYWORDS
thermoelectric, energy efficiency, GaN, indaltenergy, indthermo, cenIEE, indfeat, indadvmat

CATEGORIZED AS
▶ Energy
▶ Other
▶ Semiconductors
▶ Design and Fabrication

RELATED CASES
2009-389-0

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▶ Sztein, Alexander
Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates

High Efficiency LED with Optimized Photonic Crystal Extractor

Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation

Lateral Growth Method for Defect Reduction of Semipolar Nitride Films

Flexible Arrays of MicroLEDs using the Photoelectrochemical (PEC) Lift-off Technique

Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation

Retaining Injection Efficiency and Optical Properties of Laser Diodes with Built-in Polarization Fields

Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)

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

Phosphor-Free White Light Source

Distributed Feedback Laser with Transparent Conducting Oxide Grating

Control of Photoelectrochemical (PEC) Etching by Modification of the Local Electrochemical Potential of the Semiconductor Structure

Low Temperature Deposition of Magnesium Doped Nitride Films

Transparent Mirrorless (TML) LEDs

Improved GaN Substrates Prepared with Ammonothermal Growth

Laser Diode With Tunnel Junction Contact Surface Grating

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes

Method for Enhancing Growth of Semipolar Nitride Devices

III-Nitride Tunnel Junction with Modified Interface

Growth of Polyhedron-Shaped Gallium Nitride Bulk Crystals

Nonpolar III-Nitride LEDs With Long Wavelength Emission

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

Method for Manufacturing Improved III-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected III-Nitride LEDs

High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices

Method for Growing High-Quality Group III-Nitride Crystals

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

MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride

Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy

Heterogeneously Integrated GaN on Si Photonic Integrated Circuits

Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs

Methods for Fabricating III-Nitride Tunnel Junction Devices

Planar, Nonpolar M-Plane III-Nitride Films Grown on Miscut Substrates

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

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 Patterned of Photonic Crystals

Solid Solution Phosphors for Use in Solid State White Lighting Applications

Multifaceted III-Nitride Surface-Emitting Laser

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
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 Patterning
Improved Manufacturing of Semiconductor Lasers
LED Device Structures with Minimized Light Re-Absorption
Growth of Planar Semi-Polar Gallium Nitride
Nonpolar (Al, B, 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
Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-150)
Suppression of Defect Formation and Increase in Critical Thickness by Silicon Doping
Wafer Bonding for Embedding Active Regions with Relaxed Nanostructures
Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD