Method for Growing High-Quality Group III-Nitride Crystals
Tech ID: 21909 / UC Case 2005-339-0

BRIEF DESCRIPTION
A novel method for growing group III-nitride crystals in supercritical ammonia.

BACKGROUND
The growth of a bulk crystal of a group III-nitride (such as GaN, AlN, and LiN) presents some difficulties, since group III-nitrides have a high melting point and high nitrogen vapor pressure at high temperature. Some methods, such as high-pressure high-temperature synthesis and sodium flux, have been used to obtain bulk group III-nitride crystals. However, the crystal shape obtained by these methods is a thin platelet because these methods are based on a melt of group III metal, in which nitrogen has very low solubility and a low diffusion coefficient.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a novel method for growing group III-nitride crystals in supercritical ammonia. The group III-nitride bulk crystal is grown in an autoclave in supercritical ammonia using a source material or nutrient and a seed crystal. The supercritical ammonia provides for high solubility of the source materials and high transport speed of dissolved precursors. This method uses an internal chamber equipped with a pressure releasing device that enables the safe filling of ammonia and an exact balancing of the pressure inside and outside the internal chamber. The present invention suppresses the generation of particles from the source material and prevents the adhesion of the particles from the source material on the seed crystals. Thus, this invention produces high quality group III-nitride crystals and reduces production costs, since the source materials and nutrients are recyclable.

ADVANTAGES
▶ Allows the production of high-quality group III-nitride crystals
▶ Impurities are prevented from being incorporated into grown crystals
▶ Lower production costs (source materials and nutrients can be recycled)

APPLICATIONS
▶ Production of group III-nitride crystals

This technology is available for a non-exclusive license.

PATENT STATUS

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<th>Country</th>
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<td>United States Of America</td>
<td>Issued Patent</td>
<td>9,551,088</td>
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RELATED CASES
2005-339-0

CATEGORIZED AS
▶ Engineering
▶ Energy
▶ Materials & Chemicals
▶ Other
▶ Optics and Photonics
▶ All Optics and Photonics
▶ Semiconductors
▶ Design and Fabrication

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ 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
▶ Lateral Growth Method for Defect Reduction of Semipolar Nitride Films

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KEYWORDS
III-Nitride, ammonothermal, indssl, indbulk, indammono, cenIEE
Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
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
Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes
Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices
Phosphor-Free White Light Source
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
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
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
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
Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
Incorporating Temperature-Sensitive Layers in III-N Devices
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
Heterogeneously Integrated GaN on Si Photonic Integrated Circuits
Growth of Group III-Nitride Crystals using Supercritical Ammonia and Nitrogen
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
Semi-polar-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
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
Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs
Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration
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 Patterning
Improved Manufacturing of Semiconductor Lasers
LED Device Structures with Minimized Light Re-Absorption
Growth of Planar Semi-Polar Gallium Nitride
UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys
III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture
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

Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD