Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices

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BRIEF DESCRIPTION
Hybrid growth method for III-nitride tunnel junction devices that uses metal-organic chemical vapor deposition (MOCVD) to grow one or more light-emitting or light-absorbing structures and ammonia-assisted or plasma-assisted molecular beam epitaxy (MBE) to grow one or more tunnel junctions.

BACKGROUND
Current commercially available III-nitride light-emitting diodes (LEDs), vertical cavity surface emitting lasers (VCSELs), edge-emitting laser diodes (EELDs) and solar cells, use an active region in a biased p-n junction to allow for electron and hole injection. However, p-type gallium nitride (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 traditional p-contacts and materials other than p-GaN for current spreading. Thus, there is a need for structure for improving the performance of these III-nitride devices.

DESCRIPTION
Researchers at UC Santa Barbara have developed a hybrid growth method for III-nitride tunnel junction devices that uses metal-organic chemical vapor deposition (MOCVD) to grow one or more light-emitting or light-absorbing structures and ammonia-assisted or plasma-assisted molecular beam epitaxy (MBE) to grow one or more tunnel junctions. Unlike p-type gallium nitride (p-GaN) grown by MOCVD, p-GaN grown by MBE is conductive as grown, which allows for its use in a tunnel junction. Moreover, the doping limits of MBE materials are higher than MOCVD materials, which allows for better tunnel junctions that reduces the operating voltage of these devices and increases their efficiency, while enabling new types of device structures. These tunnel junctions can also be used to incorporate multiple active regions into a single device. In addition, n-type GaN (n-GaN) can be used as a current spreading layer on both sides of the device, eliminating the need for a transparent conductive oxide (TCO) layer or a silver (Au) mirror.

ADVANTAGES
- Increased efficiency
- Elimination of a need for a TCO or silver mirror
- Simpler manufacturing process
- Reduced operating voltage

APPLICATIONS
- LEDs
- Laser Diodes
- EELDs
- VCSELs
- Solar cells

PATENT STATUS
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RELATED CASES
2015-904-0

OTHER INFORMATION
KEYWORDS
III-Nitride light-emitting diodes (LEDs), Edge emitting laser diodes (EELDs), P-GaN, Semipolar III-nitride, indfeat, indenergy, indmicroelec

CATEGORIZED AS
- Energy
- Lighting
- Other
- Engineering
- Engineering
- Semiconductors
- Design and Fabrication

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
- Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
- Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
- Nonpolar (Al, B, In, Ga)N Quantum Well Design
- Improved Manufacturing of Semiconductor Lasers
- Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN
- Etching Technique for the Fabrication of Thin (Al, In, Ga)N Layers
- Enhancing Growth of Semipolar (Al, In, Ga)N Films via MOCVD
- GaN-Based Thermoelectric Device for Micro-Power Generation
- Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
- Method for Growing High-Quality Group III-Nitride Crystals
- Growth of Planar Semi-Polar Gallium Nitride
- Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride