III-N Based Material Structures and Circuit Management
Tech ID: 31884 / UC Case 2017-99F-0

BACKGROUND
Current state-of-the-art optoelectronic devices are based on either lattice-matched or biaxially strained wurtzite III-nitride materials. Their performance is limited by the low hole conductivity in group-III nitride materials, which is due in part to the high relative hole mass in nitrides, resulting in a very low hole mobility. Decreasing the holes’ effective mass results in significant performance improvements in photonic devices.

DESCRIPTION
Researchers at the University of California, Santa Barbara have incorporated strain engineering into electronic and photonic nitride heterostructures, resulting in an upward movement of the light hole band and formation of holes with a relative mass less than electrons. This technology enables significant improvement to the performance of hole-based transistors and enables the fabrication of integrated circuits combining electron and hole-based transistors. In addition, the technology enables improvements to the performance of optoelectronic devices such as LEDs, but especially lasers, through a significant reduction in the threshold carrier density. By utilizing strain as proposed by this technology, the performance of all p-type and n-type III-nitride electronic devices can be enhanced.

ADVANTAGES
▶ Hole Mobility increased by 4x in initial experiments
▶ Enables GaN based CMOS
▶ High Frequency and high current devices

APPLICATIONS
▶ III-nitride materials
▶ Materials in all polarities and crystal planes
▶ Push-pull amplifiers
▶ Wideband amplifiers
▶ Mixed signal architectures
▶ Laser diodes
▶ LEDs

PATENT STATUS
Patent Pending

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OTHER INFORMATION
KEYWORDS
strain management, circuit modules, transistors, laser diode, LEDs, amplifiers

CATEGORIZED AS
▶ Optics and Photonics
▶ All Optics and Photonics
▶ Semiconductors
▶ Design and Fabrication

RELATED CASES
2017-99F-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ Achieving “Active P-Type Layer/Layers” In III-Nitride Epitaxial Or Device Structures Having Buried P-Type Layers
▶ High-Quality N-Face GaN, InN, AlN by MOCVD
▶ Defect Reduction in GaN films using in-situ SiNx Nanomask
▶ Device Structures Utilizing Barrier Enhancement Conductive Materials on N-polar III-N
▶ Laser Diode With Tunnel Junction Contact Surface Grating
▶ High Mobility Group-III Nitride Transistors with Strained Channels
▶ A Structure For Increasing Mobility In A High-Electron-Mobility Transistor
Fabrication of Relaxed Semiconductor Films without Crystal Defects
Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices
Methods for Locally Changing the Electric Field Distribution in Electron Devices
Incorporating Temperature-Sensitive Layers in III-N Devices
Controlling Linearity in N-Polar GaN MISHEMTs
Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
Enabling Epitaxial Growth On Thin Substrates
(In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
N-polar III-N Semiconductor Device Structures Enabled by Wet Chemistry
GaN-based Vertical Metal Oxide Semiconductor and Junction Field Effect Transistors
Novel Current-Blocking Layer in High-Power Current Aperture Vertical Electron Transistors (CAVETs)
III-N Transistor With Stepped Cap Layers
Polarization-Doped Field Effect Transistors with Increased Performance
Wafer Bonding for Embedding Active Regions with Relaxed Nanofeatures