CNST Center for Nanoscale Science & Technology

Nanoscale-Structured Gallium Nitride Pillars for Light-Emitting Diodes (LEDs) and Photodetectors

PROJECT LEADER: Abhishek Motayed (University of Maryland) and Albert Davydov (NIST)

COLLABORATORS: Sergiy Krylyuk, Dipak Paramanik, Jong-Yoon Ha, Geetha Aluri, John Bonevich, Alec Talin (NIST); Gavin Liu (University of Maryland), Matt King (Northrop Grumman)

GOAL

To develop gallium nitride (GaN) nanopillar LEDs and photodetectors using core-shell homojunctions combining etching and chemical vapor deposition.

KEY ACCOMPLISHMENTS

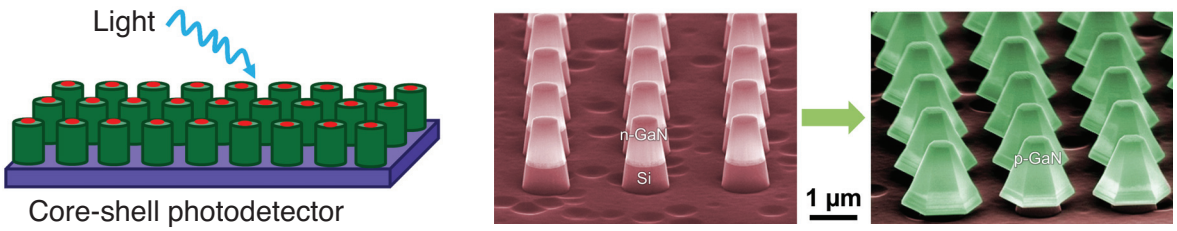
Fabricated *n*-type GaN nanopillar arrays by selective plasma-etch process followed by epitaxial overgrowth of GaN shells to produce *p-n* junctions for LEDs and *p-i-n* junctions for photodetectors.

Demonstrated microstructural uniformity, electrical *p-n* junction behavior, and electroluminescence on regular arrays of GaN core-shell pillars.

KEY NANOFAB PROCESSES

Electron beam and optical lithography, and inductively coupled plasma (ICP) etching of GaN epilayers that were grown by halide vapor phase epitaxy in the NIST Material Measurement Laboratory.

Left: *Schematic of a p-i-n photodetector based on GaN core-shell nanopillars. By using high aspect ratio nanopillars, the surface area of an array of semiconductors is increased, compared to planar architectures. In addition, higher photocurrent is expected because light can directly access the exposed p-i-n junction area.* **Middle and right:** *False color scanning electron micrographs showing the fabrication process: ICP etching of n-doped GaN pillars is followed by epitaxial overgrowth with p-doped GaN pyramidal shells.*



REFERENCE

Formation of large-area GaN nanostructures with controlled geometry and morphology using top-down fabrication scheme, D. Paramanik, A. Motayed, G.S. Aluri, J.-Y. Ha, S. Krylyuk, A.V. Davydov, M. King, S. McLaughlin, S. Gupta, and H. Cramer, *Journal of Vacuum Science & Technology B* **30**, 05220 (2012).