

# Defect-Free Gallium Nitride Nanowires Fabricated with Superior Properties

Supporting/Contributing Agencies: NIST, DARPA, NASA

NIST researchers have fabricated unique, defect-free gallium nitride (GaN) nanowires that are superior to materials used in commercial light-emitting diodes (LEDs). Gallium nitride films grown conventionally contain structural defects and strain, reducing the efficiency of electrical-to-optical power conversion in the LEDs used in current video displays, and in those being developed for future solid state lighting applications that could dramatically reduce the Nation's energy consumption. The NIST nanowires, 50 to 500 nm wide and up to 20 micrometers long, exhibit laser action when optically pumped and have been fabricated into a variety of prototype devices, including photodetectors, light-emitting diodes, transistors, and nanoresonators. The nanowire growth technique developed at NIST overcomes the prior material deficiencies, as proven by x-ray and transmission electron microscopy measurements, combined with first-ever optical measurements of the surface losses. The nanowire shape itself holds great potential for increasing light extraction efficiency compared to commercial planar film devices. In addition to their use in devices, the nanowires can be used as novel transducers for sensitive measurements; for example, the optical emission can be used to measure externally applied strain or to perform ultra-high-resolution optical microscopy. Future applications of these GaN nanowires are expected to include nanoscale oscillators for cell phones, high-efficiency solar cells, and microscopic sensors and lasers for healthcare applications.

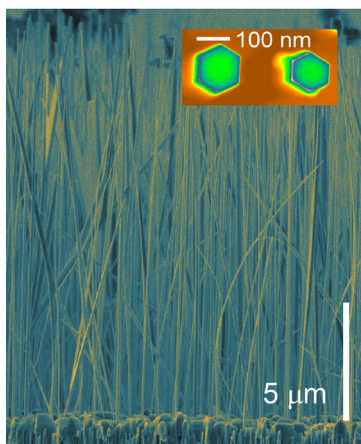


Figure 1. Electron microscope image of gallium nitride nanowires, with insert showing nanowire tips.

## References/Publications/Patents

- K.A. Bertness, A. Roshko, L.M. Mansfield, T.E. Harvey, N.A. Sanford, "Mechanism for spontaneous growth of GaN nanowires with molecular beam epitaxy," *J. Cryst. Growth* 310, 3154-3158 (2008).
- J.B. Schlager, K.A. Bertness, P.T. Blanchard, L.H. Robins, A. Roshko, N.A. Sanford, "Steady-state and time-resolved photoluminescence from relaxed and strained GaN nanowires grown by catalyst-free molecular-beam epitaxy," *J. Appl. Phys.* 103, 124309 (2008).