Sandia National Laboratories

Energy, Climate & Infrastructure Security

Increase Building and Industrial Efficiency

Microsphere Templated Gallium Nitride Growth and Liftoff

Sandia's surface patterning method for GaN reduces crystal defects by over 95% and allows for easy removal of the substrate for highest thermal performance.

Current production methods that grow Gallium Nitride (GaN) on low cost Silicon or Sapphire substrates suffer from a large number of defects which limit LED efficiency and lead to early device failure. A technique developed at Sandia National Laboratory enables higher quality, lower cost GaN devices.

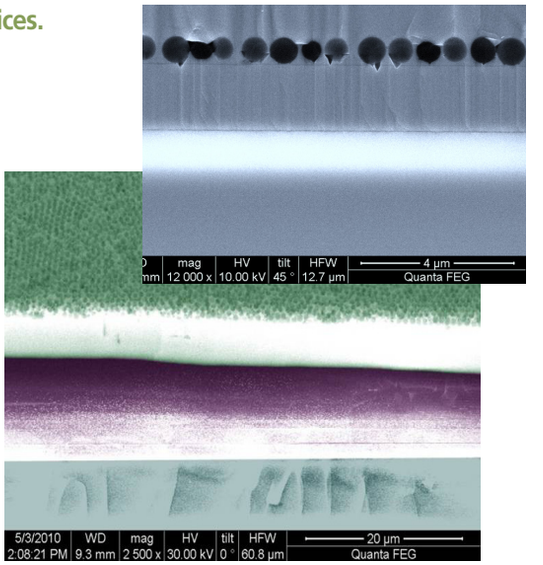
GaN for LED Lighting Displays and High Power Electronics

The LED market is one of the fastest growing worldwide, driven by demand for clean solid state lighting, LED displays, and mobile devices. GaN-based materials are essential for white LEDs used in solid state lighting and flat panel displays as well as high power electromics where GaN transistors are emerging as the high power device of choice for military communications and cell phone base stations. Current GaN devices are typically grown on sapphire wafers, which limits their performance and lifetime due to the poor resulting material quality and increases their cost.

Reduced Defects in GaN Enable Higher Quality and Lower Cost

Sandia has developed a patent pending surface patterning technology for the growth of GaN and related semiconductors which enables higher quality material for applications in visible LEDs for solid state lighting and displays, and for high power transistors. The technology may also enable the use of inexpensive, large area silicon substrates instead of sapphire for lower cost devices.

In this technique, a layer of silica microspheres is inexpensively dip-coated onto the growth wafer to act as a defect-filtering template. GaN that is grown through these templates has drastically reduced defect densities, which may enable higher performance and higher lifetime devices. The improved GaN-based device can then be bonded to a thermally conductive material host for superior heat sinking, and then released from the original wafer by selective etching of the microspheres. The etch process is less expensive and works on a greater variety of substrates than current laser liftoff methods. The substrate may then potentially be reused for further cost recovery.



Commercial Readiness

Microsphere templated GaN growth is routine on 2-inch sapphire and has been demonstrated on 2-inch silicon wafers. Sandia seeks commercial partners to explore and evaluate the benefits of the technology with respect to their own products, to scale the technology to larger substrates, and to conduct joint research and development activities. Licensing opportunities are available.

Based on investments and progress thus far, $1–3 million may be needed to transition to manufacturing, with a smaller investment for exploratory efforts.

US Patent Applications

- 12/388,103: non provisional—defect blocking method
- 61/347,586: provisional—liftoff method

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For more information please contact:

George Wang
E-mail: gtwang@sandia.gov
Phone: (505) 284-9212
Website: www.sandia.gov

U.S. DEPARTMENT OF ENERGY

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