

**B**lue light-emitting diodes (LEDs) based on gallium nitride (GaN) can be used to make new lighting products that consume power much more efficiently and last many years longer than conventional incandescent light bulbs. But the price of the GaN devices will be much higher than that of traditional bulbs because, during their manufacture, throughput is reduced and costly substrate materials must be used. Here is a product that could increase throughput and lower the cost of production for blue LEDs.

## GaN-on-Sapphire Wafers

**How It Helps:** GaN-on-sapphire wafers can improve the mass production of blue LEDs. Using these wafers reduces growth time by more than 30 and allows an increase in production throughput of 30 to 50 percent—without incurring extra cost. The blue LED is grown directly on the surface of the substrate, eliminating the need for sapphire nitridization, GaN low-temperature nucleation deposition, and thick GaN buffer layer growth. The quality of the GaN LED structure is ensured by pre-growth inspection of the wafer, which is not possible with other methods of fabrication.



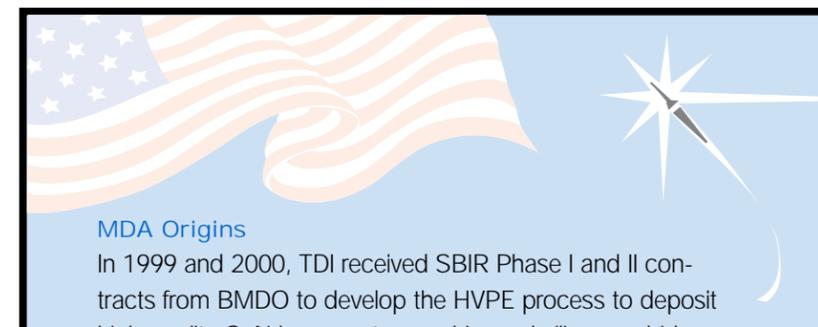
**How It Works:** GaN-on-sapphire wafers are fabricated using a technology called hydride vapor phase epitaxy (HVPE). HVPE involves reacting gallium metal with hydrogen chloride to make gallium chloride. The gallium chloride reacts with ammonia gas, and blue LED structures can be grown directly on the surface of the substrate. The HVPE process usually is carried out at atmospheric pressure in a quartz walled reactor heated by a resistive furnace.

**How Much It Will Cost:** The price of the GaN-on-sapphire wafers ranges from \$150 to \$700, depending on product specifications and purchase volume.



**When It Will Be Ready:** GaN-on-sapphire wafers are available now. These products are being manufactured at a rate of more than 1,000 per month, and that capacity is expected to increase by mid-2003. Clients include companies in the United States as well as in Japan, Korea, and Taiwan.

**Who Is Working On It:** The innovator is Technologies and Devices International, Inc. (TDI). Founded in 1997, TDI develops, manufactures, and markets bulk crystals, epitaxial structures, and devices using SiC, aluminum gallium nitride, and GaN semiconductor materials. The company employs 25 people and recently moved to a new 32,000-square-foot development and manufacturing facility in Silver Spring, Maryland. For more information, contact Dr. Slava A. Maslennikov of TDI at (301) 572 7834 or [slava@tdii.com](mailto:slava@tdii.com). The company Web site is [www.tdii.com](http://www.tdii.com).



**MDA Origins**

In 1999 and 2000, TDI received SBIR Phase I and II contracts from BMDO to develop the HVPE process to deposit high-quality GaN layers onto sapphire and silicon carbide substrates. GaN devices could significantly improve BMDO communications systems. For example, radar and satellite-communications links, which operate at frequencies of hundreds of megahertz to tens of gigahertz, often have high power-amplification requirements that can be satisfied using GaN devices. GaN transistors would work in many of these units, conferring on them the solid-state advantages of ruggedness and portability.

