Start-up produces blue LEDs using 'dismissed' technique

The Fox Group has developed a hydride vapor-phase epitaxy technique that produces medium-brightness blue LEDs, based on AlGaN/GaN structures, at a low cost, writes Tim Whitaker.

Despite it being largely dismissed as a viable technique for the growth of GaN-based LEDs, The Fox Group - a start-up LED manufacturer headquartered in Ripon, CA - has developed a production method for manufacturing such devices by hydride vapor-phase epitaxy (HVPE).

Using technology originally developed by Technologies and Devices International (TDI), The Fox Group has established a manufacturing facility in Montreal, Canada, and shipped its first order of 460 nm "FoxBlue" LEDs in mid-May of this year. The mid-brightness devices have remarkable color consistency and are extremely low-cost, thanks to the use of the HVPE growth technique.

The devices are AlGaN/GaN structures that do not contain indium or quantum wells. As such, they are not high-brightness devices; typical intensities are around 1000 mcd for narrow-beam-angle LEDs or up to 3 mW for dies. "We are not competing with the big players such as Nichia, Toyoda Gosei, Cree, Osram and Lumileds, or anyone else making high-brightness InGaN LEDs," said Barney O'Meara, the company's vice-president.

Even so, the technology used by The Fox Group has three very strong advantages: the HVPE process is intrinsically low-cost; it is protected by a strong patent portfolio; and the LEDs have extremely good color consistency.

Color consistency

"The dominant wavelength is typically 460 ± 1 nm across each wafer, from wafer to wafer and from week to week," said O'Meara, who credits the incorporation of indium into InGaN/AlGaInN structures for the much larger variations in brightness and wavelength exhibited by these devices. "Even for such applications as Christmas tree or holiday lights, color consistency is a significant issue; for sign and message board manufacturers the problem is much worse."

The HVPE technology that is used to grow LEDs was developed by TDI, a wide-bandgap materials specialist company based in Silver Springs, MD. The Fox Group has an exclusive license for certain TDI patents relating to light-emitting devices, and the firm has advanced the technology from the research stage to a fully automated, reproducible manufacturing process.

The company is confident of its intellectual property position. "Besides the entirely different crystal growth process, Fox Group's LED structure is different and, we believe, non-infringing," said O'Meara. "We have one or more patents pending in this regard, and we do not use a buffer layer."

So what has prevented other companies from growing GaN LEDs by HVPE? Jacques Pankove and colleagues at RCA Labs grew n-type GaN by HVPE more than 30 years ago, but used a metal junction for the p-side of their device. Successfully growing p-type material was one of the key factors in developing a viable growth technology, while the other was the ability to use aluminum in a quartz-tube reactor. The Fox Group is currently using industry-standard 2 inch sapphire wafers, although other substrates can also be used.

Compared with MOCVD, which is used by all other manufacturers of blue GaN-based LEDs, HVPE is estimated to reduce the consumption of ammonia by at least an order of magnitude. Also, HVPE uses pure metals as starting materials rather than metal-organic precursors, which are around 10 times as expensive per gram of metal. The fast growth rate of HVPE (up to 1 μm/minute) and the relative simplicity of the HVPE-grown device structure also help to further reduce the overall cost of the process.

About the author

Tim Whitaker is the consulting editor of *Compound Semiconductor* magazine.