Veeco

Research Driving Down the Costs of Efficient LED Lighting

Solid state lighting (SSL), which uses light emitting diodes (LEDs), has the potential to be 10 times more energy-efficient than traditional incandescent light bulbs. Currently, 20% of energy usage in the U.S. goes to lighting. SSL technology can potentially cut U.S. lighting energy usage, reducing the electricity consumption for lighting by one-fourth.

That's why since 2003, the U.S. DOE has invested with industry partners in research and development of LED technologies. While costs are dropping and many product improvements have been made, the work continues to make LED lighting a competitive option in more lighting applications.

As part of this national effort, Veeco, a leading equipment supplier, and Philips Lumileds, a solid state lighting manufacturer, are working with Sandia National Laboratories (SNL) to drive down the cost of high-brightness LEDs (HB-LEDs) by implementing process simulation tools and by improving temperature measurement and control methods to increase metal organic chemical vapor deposition (MOCVD) yield. MOCVD is the critical enabling technology zfor the production of LEDs.

The overall objective of this two-year program
is to develop high-volume MOCVD systems that provide a four times reduction in the cost of epitaxial growth for LED devices, with the ultimate goal of a 10 times reduction in
LED costs.

Computational Fluid Dynamic (CFD) models are used by Veeco to design indium gallium nitride (InGaN) MOCVD growth systems.
The actual experimental GaN non-uniformity
is about four times greater than predicted because the model does not take into account the effects of kinetics and thermodynamics in chemical reactions. To more accurately predict MOCVD growth processes, Veeco's expertise in fluid dynamic modeling is being combined with SNL's specific experience modeling III-Nitride based chemistry.

Temperature is the primary driving force for the majority of reactions that take place in the LED growth process; therefore it is important to accurately and directly measure the GaN layer temperature. UV and mid-IR pyrometry are promising technologies to enable direct GaN layer or sapphire wafer temperature measurement on production MOCVD reactors.

SNL has provided a prototype near UV pyrometer that will be jointly developed with Veeco for use with Veeco's production MOCVD reactors. Philips Lumileds is evaluating the UV pyrometer for accuracy and repeatability in a high volume LED manufacturing environment.
A mid-IR pyrometer is also being developed by SNL to be used for direct substrate temperature measurements. Sapphire substrates, the primary substrate used for HB-LED growth, absorb mid-IR wavelengths and therefore make bare substrate pyrometry measurements possible.

Veeco has already made improvements to its high-throughput MaxBright™ multireactor MOCVD system, with more to come. This means the partnership between Veeco and SNL has already yielded results, and is well on its way to achieving its goal of driving down the cost of HB-LEDs, making them more competitive with existing lighting in order to reduce our country's energy use.

Technologist Jeff Kempisty of SNL removes an InGaN LED wafer from the Veeco MOCVD system.

Veeco's collaboration with Sandia has helped us lower MOCVD cost of ownership through improved modeling and better temperature control.

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