

# MOCVD trends helping to drive down LED chip costs

Veeco's **Sudhakar Raman** explains how a new generation of processing equipment is cutting the cost of manufacturing high-brightness LEDs by improving the yield and productivity of the MOCVD process.

**D**riven by the growing adoption of LED lighting for retail, commercial, industrial, roadway and residential lighting, global LED manufacturers are preparing for another LED market transition. After past LED growth from mobile devices and television backlighting, manufacturers are facing stronger pressure from their lighting customers to deliver higher-quality and lower-cost LED bulbs.

To keep pace with this growing lighting demand, LED manufacturers need efficient and productive LED chips to keep bulb costs down. That's where Veeco comes in. A new generation of processing equipment made by Veeco is cutting the costs of producing high-brightness LEDs by improving the efficiency and yield of the metal-organic chemical vapor deposition (MOCVD) process — critical to LED formation (the critical first step in LED manufacturing, depositing light-emitting chemical layers on a substrate wafer that is processed into the LED chips).

Although it is evident that solid-state lighting is increasing rapidly, production costs still stand as a significant gating factor to the widespread adoption for energy-efficient LED lighting. To help improve costs and productivity there are three key technology factors that are vital for MOCVD manufacturing and cost-efficient LED production.

## **1. Uniformity advantage — better epitaxial performance**

The growth of the epitaxial layer remains the most important technology for the manufacture of LEDs. Depositing gallium nitride (GaN) layers onto a sapphire wafer enables the conversion of an electric current into photons of light. Each layer in the GaN structure must be deposited while maintaining precise control over the thickness and composition of each layer. This is why LED manufacturers keep their deposition process and growth methodologies highly proprietary.

Deposition uniformity within the wafer, between wafers and in terms of run-to-run reproducibility is extremely important to the ultimate performance — and therefore value — of the LEDs. So, one of the most important factors for users is to operate MOCVD reactors that deliver excellent uniformity. This can be done,

in part, by ensuring that tools are designed to run a consistently clean and efficient process.

One of the most important elements in process uniformity is stringent temperature control. For example, for several years, we consistently enabled an increased rate of GaN growth by using a heated inlet flange in our reactors. This is an example of how hardware or tool design improvements that increase the control of temperature can improve within-wafer and wafer-to-wafer uniformity. Controlling repeatability and thermal transitions ensures better uniformity and faster process times, which, in turn, drives faster throughput.

## **2. Flexibility advantage — ease of use; ease of adoption**

The epitaxial processes used in the manufacturing of LEDs are largely well established. However, process revisions and innovations are essential for success. One example of this is the trend toward larger-diameter wafers.

The advantages of moving to larger substrates for manufacturing LEDs are similar to those that have driven the transitions to larger wafers for the fabrication of silicon integrated circuits. These include reduced overall manufacturing expenses, cost savings throughout the entire wafer processing cycle, and fewer steps per LED. To help shorten the time to transition to larger-wafer production, the coming MOCVD generation will incorporate capabilities that will facilitate next-generation MOCVD system adoption. These include seamless process transfer from previous generations, the ability to change wafer sizes instantly, easy service access and software upgrade capability, thereby quickly enhancing capacity for users.

## **3. Cost-of-ownership advantage — superior economic capability**

It is incumbent upon MOCVD manufacturers such as Veeco to help customers improve throughput and reduce LED chip costs. It is clear that LED manufacturers want to reduce costs, increase throughput and improve performance through:

- increased reactor capacity — enabling more wafers to be processed in fewer runs;
- optimal wafer placement — improving uniformity and

leading to higher yields;

- one-touch operating capability — minimizing the need for constant operator supervision;
- enhanced thermal and planar uniformity of wafers — contributing to improved yields;
- improved process flow and temperature control — increasing throughput and producing more quality wafers per month;
- increased uptime — allowing more continuous runs between maintenance;
- lower maintenance costs and improved system efficiency — lowering consumable use; and
- better capital efficiency — leading to stronger profitability for customers.

### Future-proofing customers

Technology is advancing rapidly and, to keep pace with steadily falling chip average selling prices (ASPs), MOCVD users need to adopt new technology and process improvements rapidly as well. To this end, Veeco is developing new technologies and capabilities with an eye toward our long-held strategy of future-proofing customers. That is, our goals ensure that customers can extend and enhance their MOCVD systems in the future by:

- continually improving performance to extend yield improvements and throughput;
- maximizing cost of ownership;
- transitioning easily to larger wafer sizes; and
- boosting their capacity while reducing tool/fab floor footprint.

These are exciting times for the LED industry. With end products from mobile devices, tablets and TVs to a wide array of lighting applications, demand for LEDs in a range of power and brightness levels will continue to escalate. To keep pace with this demand, LED makers will need to operate manufacturing equipment and

processes that deliver optimal performance in terms of uniformity, thermal stability, repeatability and cost-effectiveness. The requirements are clear, and we look forward to helping write the next chapter in this evolving LED market. ■



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