Key Technologies for White Lighting Based on LEDs: Precise Temperature Measurement

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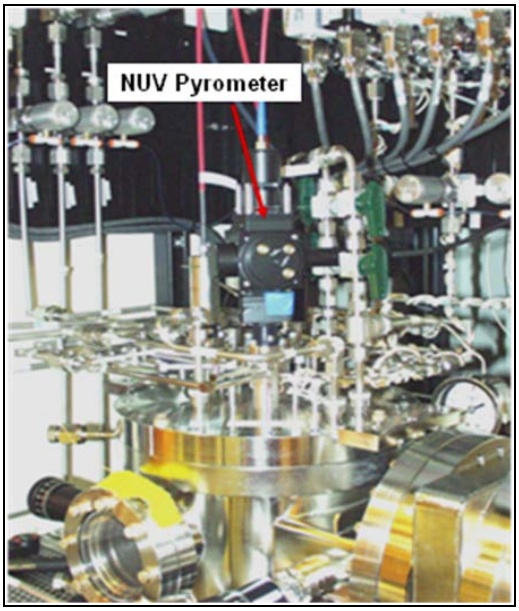
Emerging Technology

Novel Pyrometer Enables Precise Temperature Measurement during Growth of InGaN LEDs

Temperature measurement during indium gallium nitride (InGaN) metalorganic chemical vapor deposition (MOCVD) is very difficult due to the transparency of the substrates (e.g., sapphire) and epilayers at the near-IR wavelengths (e.g., 900-1000 nm) normally used for pyrometry. In fact, until recently there has been no readily-available method that measures the true wafer surface temperature during deposition. The problem is particularly severe because the InGaN composition (and therefore emission wavelength) is extremely sensitive to temperature in the 700-800°C range. Due to errors in existing temperature measurement techniques, process drifts of 10-20°C are common, leading to InGaN devices that emit light outside of the target wavelength window.

With assistance from the Department of Energy's Building Technologies Program, SNL is developing a new type of pyrometer to accurately and precisely measure the temperature during the MOCVD process. Unlike existing equipment, this pyrometer was developed based on high-temperature GaN opacity in the near-ultraviolet (NUV) wavelength range of approximately 400 nm. The ability to measure thermal radiation at wavelengths where the wafer and/or epilayer are opaque greatly enhances temperature control, which will increase the yield of InGaN epitaxial material and significantly lower the cost of the final LED products.

SNL is currently collaborating with Veeco Instruments, Inc., to further develop an in-situ pyrometer for accurate substrate temperature measurement. The next-generation NUV pyrometer will measure the wafer temperature distribution with both high-temperature resolution and spatial resolution during growth of the active region of InGaN LEDs.



SNL's NUV Pyrometer for Temperature Measurement during InGaN LED Growth

Technology History

- Developed by Sandia National Laboratories (SNL).
- Continuing work involves collaboration with Veeco Instruments, Inc., to further develop an in-situ pyrometer for accurate substrate temperature measurement.

Applications

Can be used to improve the temperature control of the MOCVD process during the growth of InGaN LEDs.

Capabilities

- Accurately and precisely measures the GaN/sapphire wafer temperature during the growth of InGaN LEDs.
- Achieves a temperature-reporting accuracy of less than 1°C.
- Enables narrower emission wavelength range for LEDs.

Benefits

Cost Savings

Reduces cost of final LED products by increasing the production yield of InGaN epitaxial material.

Product Quality

Produces InGaN devices that emit light within a target wavelength window by eliminating process temperature drifts associated with conventional measurement techniques.

Contact Information:
Dr. Robert Biefeld
Email: rmbiefe@sandia.gov
Phone: (505) 844-1556
Sandia National Laboratories
PO Box 5800
Albuquerque, NM 87185-1086
Website: http://www.sandia.gov

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