LED Sapphire Wafer Quality Control with Hyperspectral Microscopy

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Gallium nitride (GaN) based LED sapphire wafers are experiencing explosive growth as they have significant utility in the electronic display market. To meet growing demand, sapphire wafers are now being manufactured in sizes up to six inches in diameter with a trend toward even larger sizes. Uniform layering of the GaN across the wafer surface produces highly specific reflectance emission on the surface of the wafer for these light emitting diode (LED) applications.

A critical factor in the production of large sapphire wafers is maintaining consistency of the reflectance emission across the wafer, which is dictated by the homogeneity of the GaN coatings. For both product development and quality control purposes, it is important to understand that the reflectance emission is consistent with regard to color wavelength peak and the intensity of this peak. This information is often needed across the full diameter of wafer surface and at high spatial resolution. The ability to analyze the wafer for this information as quickly as possible is a critical requirement.

CytoViva's hyperspectral microscopy system has emerged as a fast and highly effective tool for quickly measuring the peak emission wavelength and wavelength intensity across GaN coated sapphire wafers. Hyperspectral imaging collects the full spectrum in the VNIR range (400nm-1,000nm) in every image pixel at high spatial resolution, with pixel sizes as small as hundreds of nanometers.

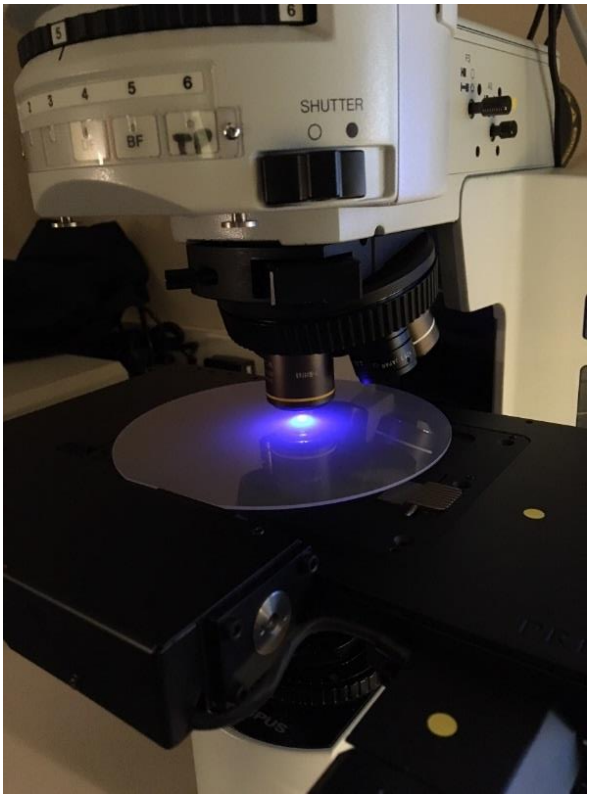

Figure 1: Six Inch Blue LED Wafer on the CytoViva Hyperspectral Microscope.

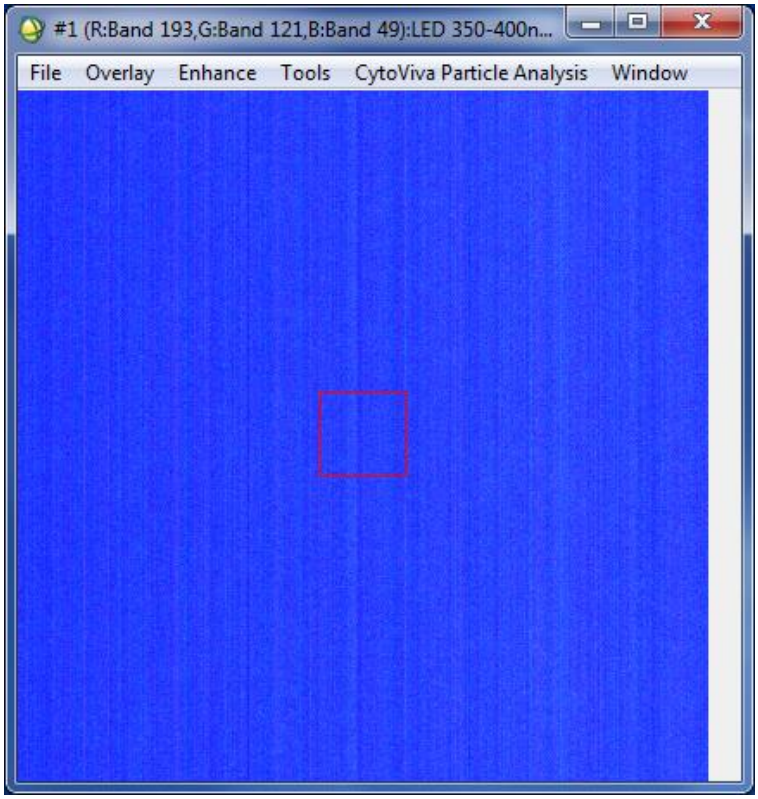

Figure 2: Example Hyperspectral Image Area of the Blue LED Wafer.

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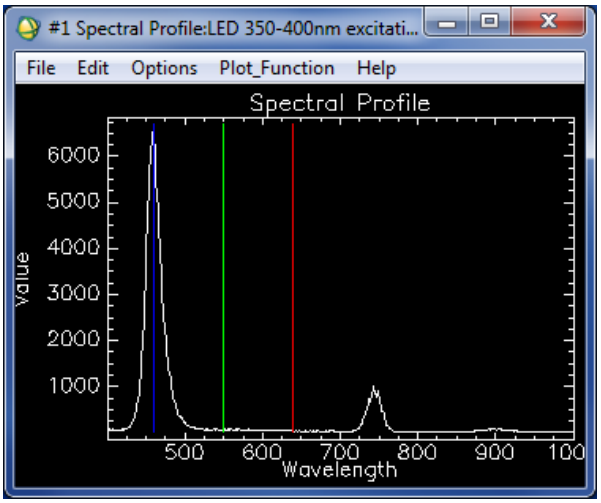

Figure 3: Example Spectrum From a Single Pixel of the Blue LED Wafer.

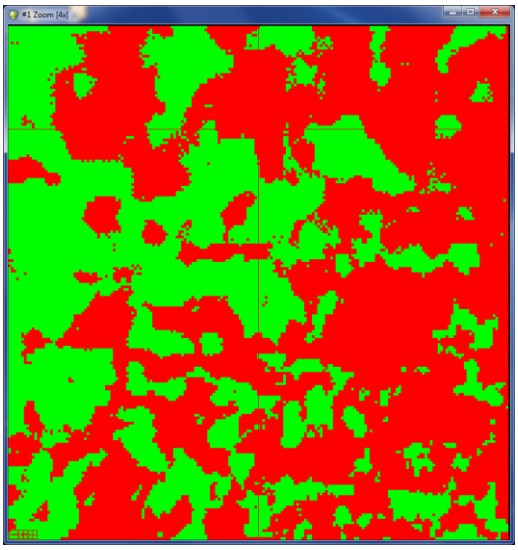

Figure 4: Mapping of the Blue LED Wafer. Areas in Red Do Not Match Peak Wavelength Threshold Requirements.

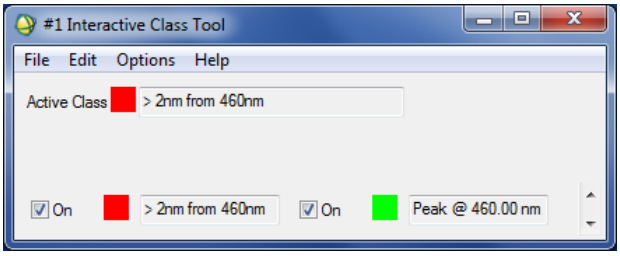

Figure 5: Peak Wavelength Threshold Parameters.

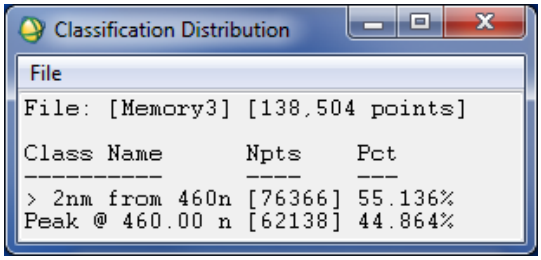

Figure 6: Class Distribution Indicating the Surface Area Not Matching Wavelength Emission Thresholds.

Figure 1 above shows a six inch wafer on the hyperspectral microscope. Using narrow band UV illumination, the wafer produces a blue reflectance emission as seen from the image. The hyperspectral image of the blue LED wafer in figure 2 is developed using a line scan approach across the selected area of the wafer, and emission data is collected as spectrum in every pixel of the hyperspectral image. In figure 3, example reflectance spectrum from a single pixel is shown. This spectrum illustrates a very narrow emission wavelength with a peak at 460nm. Figure 4 illustrates mapping of all image pixels in red that match a preset threshold for wavelength consistency around this 460nm peak. The interactive tool in figure 5 shows the parameters set for the threshold wavelength test of the wafer emission spectrum. In figure 6, the class distribution report shows the percentage of wafer area that exceeded the threshold measurement.

The illustration above is just one example demonstrating how CytoViva's hyperspectral microscopy can support both the development and quality control analysis of GaN coated sapphire wafers for LED applications. To learn more, please contact CytoViva at info@cytoviva.com. We would be pleased to discuss your work or to organize a demonstration of the system with your samples.