UV LED Measurement, Part 1: How Good is Good Enough?

Which camp are you in when it comes to home repairs or projects – “Do It Yourself-DIY” or “Call the Guy”? I always try to be camp DIY. I learned by helping my grandfather when I was young as his number one ‘gopher’ (Go for this, Go for that.).

One of the first lessons he taught me was to have the right tools so the job is done correctly. His lesson still resonates today with projects that I do.

What are your quality expectations for home repairs or projects? Does everyone in your house have the same quality expectations and pass-fail scale for the finished job? Are you happy with a repair that is functional but, as my grandfather said, “a blind man would never notice,” or do you require each finished project to look like the Sistine Chapel?

Are there parallels between home repairs or projects and the UV process? Ask yourself these questions:

1. **“How good is good enough”** for the UV-cured products that are produced? Will your customers only pay for high-quality products that meet all physical and functional requirements?

2. **“How good is good enough”** when it comes to efficiency, throughput and scrap levels? It may be ok to take 3x as long to build UV-cured, ready-to-assemble (RTA) furniture from what the instructions estimate, but it is not ok to take 3x as long to manufacture it from your established times.

3. **“How good is good enough”** when it comes to UV measurements and process control?

Your answers to these questions will vary based on whether you have:

- A critical application, such as a medical product
- A tight UV process window
- Multiple UV sources, multiple instruments and/or multiple company locations
- Quality requirements to meet and document from your customers
- To communicate with your suppliers or other company locations
- To develop a Technical Data Sheet (TDS) and communicate with your customers

Many companies already have a radiometer for broadband (mercury) sources. In most cases, this is not the right tool for measuring UV LEDs. Only you can decide if the values on a broadband radiometer are ‘good enough’ to measure UV LEDs.

This column looks at several key areas to be aware of and understand when using a broadband radiometer to measure a UV LED. In part 2, to be published in the Quarter 4 issue of *UV+EB Technology*, the column will present some actual radiometer measurements to let you decide: **“How good is good enough?”**

Dynamic Range

My Maserati does one-eighty-five,
I lost my license, now I don’t drive.
- Lyrics from Life’s Been Good by Joe Walsh

Figure 1. *A speedometer with a top-end speed of 35 mph is better suited for a golf cart than a Maserati.*

Would this song have been as catchy if Maserati used a speedometer that maxed out at 35 mph (see Figure 1)?

The dynamic range refers to the range of values a sensor on instrument can detect. Our top irradiance value for a high-power instrument designed for a broadband source is 10 W/cm^2. There is some leeway, but the peak irradiance will be truncated as shown in Figure 2 if you go too far above the 10 W/cm^2. This would lead to under-reporting the true LED value. Please confirm that the dynamic range on your instrument will support the irradiance levels (high or low) that will be measured.

LED Spectral Output

Good-quality UV LEDs for industrial curing normally are sold with a Center Wavelength (CWL) of +/- 5 nm. A 395 nm LED can be expected to have its peak output fall between 390-400 nm. We have measured the spectral output of 'less than' good-quality LEDs that fall outside this range.

Be careful and determine if there will be any impact to the final product if your LED output is not as advertised. If purchasing LEDs for multiple production lines and/or facilities, do your due diligence. The values reported by an instrument optimized for broadband sources can vary significantly based on the LED CWL.

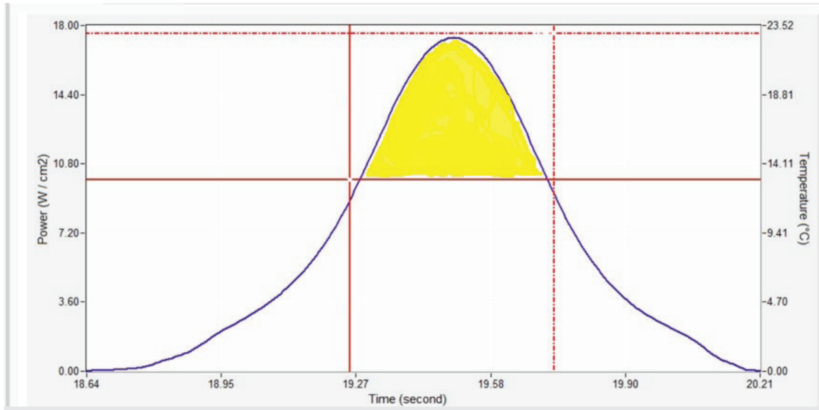

Figure 2. *Irradiance profile (W/cm² on Y-Axis, time on X-Axis) of a UV LED. The peak irradiance of 17.4 W/cm² was captured with an instrument whose dynamic range supports the higher output of UV LEDs. If using an instrument designed for broadband sources, the values above 10 W/cm² (shaded in yellow) may be missed when the instrument 'maxes' out.*

Instrument Spectral Responsivity

Variations can occur when the instrument (spectral) response does not match the UV source.

Instrument Responsivity/Bandwidth

Instrument manufacturers decide the responsivity and bandwidth (nm) of their instrument band. Some instruments have a wide band (>100 nm) approach, and others have a narrow band approach.

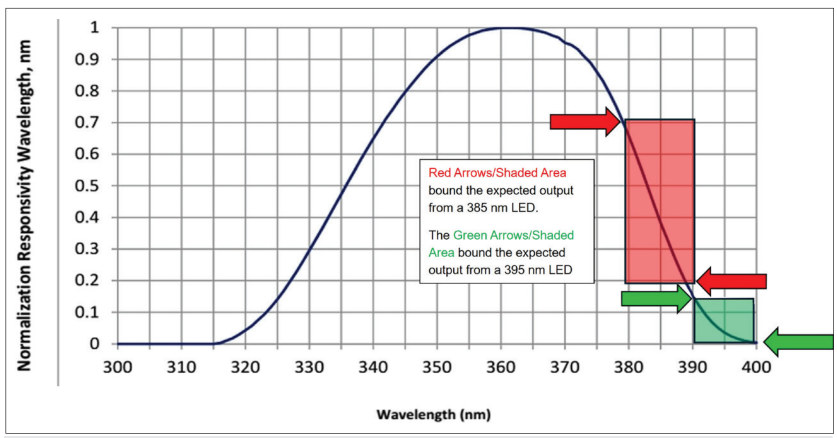

Figure 3. *When a response (EIT UVA 320-390 nm) is used to measure a 385 nm or 395 nm LED, we would expect the instrument to underreport the values. The peak output from a 385 nm LED (+/- 5 nm CWL) would be expected to fall between 380-390 nm (red arrows/shaded area). In theory, this would underreport the values by 30-85%. The peak output from a 395 nm LED would be expected to fall between 389-400 nm (green arrows/shaded area). In theory, this would underreport the values by 85-99%.*

A wide band or one-size-fits-all approach allows you to own fewer instruments. There are challenges in controlling optics and their response, especially the flatness with a wide band approach.

- Are you ok with a 20-30% variation in the optics response across the band?
- If a wide band response can cover 340-440+ nanometers and support 365, 385, 395 and 405 nm LEDs, what wavelength LED should be used to calibrate the instrument? The results will be most accurate at whatever specific point (i.e., 395 nm calibration point for a 395 nm LED) is used.

A narrow band approach requires you to either have an instrument with multiple bands or multiple instruments. A narrow band approach allows the manufacturer to have greater control of the optics and their flatness. A narrow band approach also may allow the manufacturer to design an optics stack and response that includes ALL optics in the instrument vs. just the bandpass filter, thus providing a more accurate measurement.

Figure 3 shows the expected results from a theoretical standpoint. How will an instrument (Power Puck II) optimized for broadband sources perform on different LEDs? Stay tuned for the next issue of this magazine. ◆

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