SPECTRA OF THE MONTH

DO MORE EXPENSIVE UV INSECT TRAPS USE BETTER LEDS?

INTRO

BACKGROUND OF APPLICATION

As autumn arrives in the northern hemisphere, cooler temperatures often drive mosquitoes, flies, and other small flying insects indoors in search of warmer environments. While these pests can still be a nuisance outdoors, they can also find their way into homes and other indoor spaces, creating a need for effective insect traps.

Many insect traps use a sticky pad to capture insects and prevent them from moving or feeding. A common improvement to this design is the addition of UV light, which is particularly attractive to many species of insects. The introduction of UV LEDs made this approach even more popular by providing a compact and relatively inexpensive source of UV light.

Depending on the LED's peak wavelength, some wavelengths may be more effective at attracting certain insects than others. UV light in the 310–370 nm range, for example, has been shown to be effective for attracting insects such as flies and mosquitoes, while LEDs at higher UV wavelengths may also be used because they are often less expensive. This could help explain differences in the performance and cost of insect traps on the market—something we can easily investigate using spectroscopy.

FIGURE #1 Insect trap samples used in the experiment: a higher-cost model (left) and a more affordable model (right). Tape was added to cover branding for the figure but was not used during measurements to avoid affecting LED readings.

DESCRIPTION OF SPECTROSCOPY SETUP

The setup for this experiment (Figure 2) was based around our latest spectrometer, the AvaSpec-VRS2048CL, commonly known as the VARIUS™. This spectrometer contains patented technology and an improved optical bench design that demonstrates improved accuracy and reliability across various applications, outperforming its predecessors. The VARIUS™ offers USB3.0 and gigabit ethernet communication protocols, either a 2048-pixel or 4096-pixel CMOS linear array detector, ultra-low stray light as low as 0.1%, and a signal/noise ratio of 375:1 before spectral averaging. The instrument configuration used in this experiment was a broadband focused unit, with a range from 300-1100 nm and a 50-micron slit installed.

This configuration is ideal for measurements that only require data collection in the UV or visible spectral range, such as the present study that is measuring UV LEDs. For deeper UV applications down to 190 nm, Avantes offers a dedicated configuration of this instrument from 190-450 nm. While high resolution (as low as 0.08 nm) is possible the application of radiometry does not require high resolution thus we used the 2048 pixel detector and 50 micron slit provide for 2.5 nm FWHM resolution with this broadband grating.

Other accessories used for this experiment included a 600-micron core fiber optic cable, a cosine corrector for 180 degree field of view and a radiometric absolute irradiance calibration on the entire system to provide for absolute quantitative measurements. We used our TR-Stage for holding the samples and the cosine corrector normal to the samples. All measurements were performed at a 70 mm working distance.

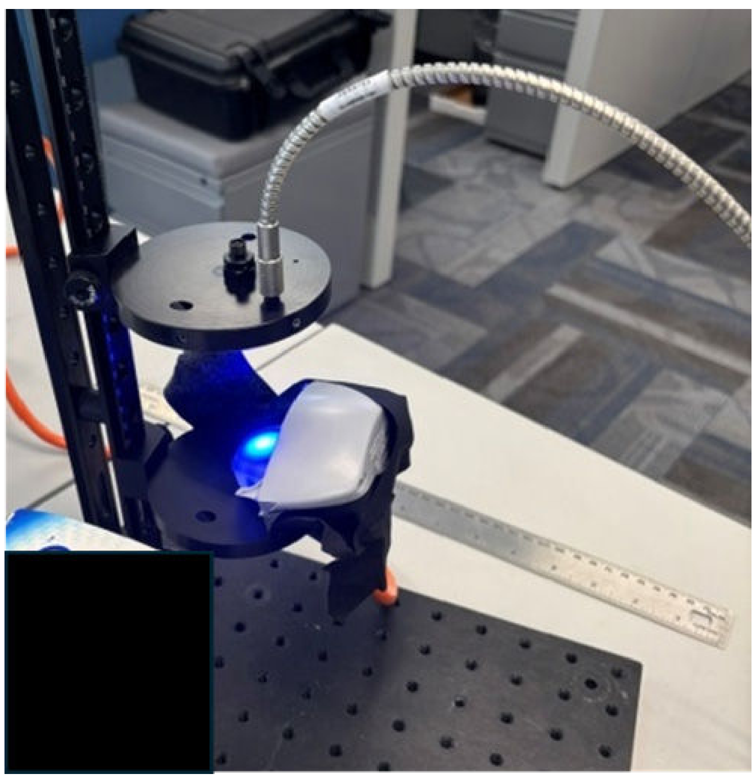

FIGURE #2 Experimental setup for insect trap measurements. The fiber optic cable was attached to the spectrometer and cosine corrector and measured normal to the samples. The cosine corrector was mounted into the U.S. TR-Stage and pointed directly down at the insect trap LEDs.

DESCRIPTION OF METHODOLOGY

The insect trap samples used for this experiment were purchased at a local supermarket. The "expensive" model was purchased for around $26 (excluding tax) and included three replaceable sticky pads, while the "affordable" model was purchased for around $15 (excluding tax) and included two replaceable sticky pads. The pads were removed from both samples to limit their potential effect on the LED measurements, but no further sample preparation was done. To perform the measurements, a dark measurement was taken and saved to account for any ambient light, and the LEDs of each insect trap were measured at approximately the same distance through the collimating lens. The distance was adjusted until it was sufficiently strong but not saturating the spectrometer detector.

For data analysis, we used the absolute irradiance (Ia) mode in AvaSoft, our proprietary custom software package. At the start of each measurement, the dark spectrum was taken with the LEDs disengaged but overhead light still on to remove (subtract) this ambient light from the reported measurements. We used an integration time of 34 ms and averaging of 10.

TEST DATA AND RESULTS

Upon plugging each sample in, it was visually apparent that the LEDs emitted different wavelengths of light (Figure 3). This was a strong indicator that the affordable insect trap likely used an LED that was cheaper to manufacture, and therefore potentially not as effective in attracting certain insects. The more expensive insect trap had a deeper blue appearance, indicating that the light wavelength may be deeper in the UV. The higher priced trap also had a second LED on the side which was without a diffusing cover and emitted at a lower UV wavelength. This was quantitatively determined through spectroscopic measurements.

FIGURE #3: LED appearance of expensive insect trap sample (left) and affordable insect trap sample (right). The expensive insect trap LED appears to be a deeper shade of blue, potentially indicating a peak wavelength deeper in the UV region.

TEST DATA AND RESULTS

Displayed below are the spectral measurements of the plastic samples, reported in reflectance in the NIR range visible in AvaSoft:

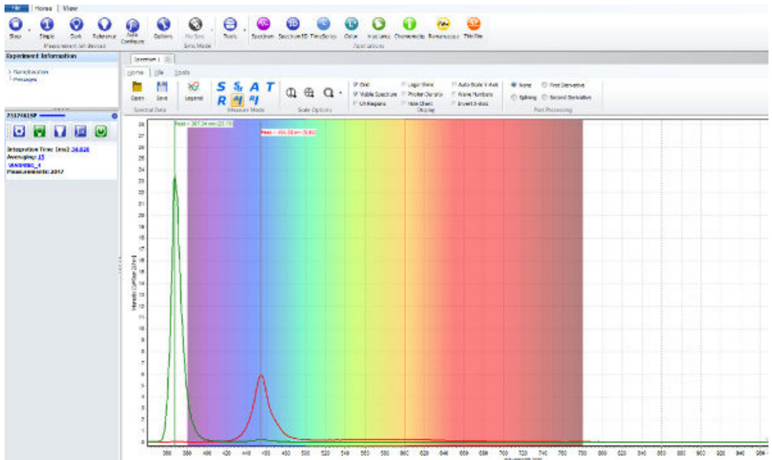

FIGURE #4: Spectrum of expensive version's two wavelengths emitted from insect trap LED. The front diffused LED is 454.68 nm and side undiffused (bare) LED is 367.34 nm

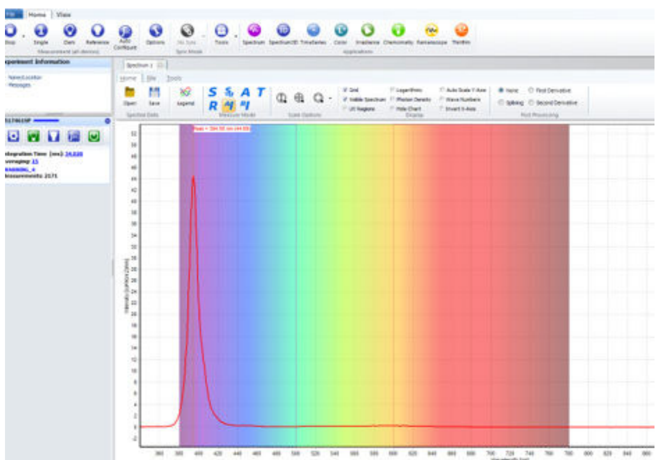

FIGURE #5: Spectrum of affordable insect trap LED (394.56 nm)

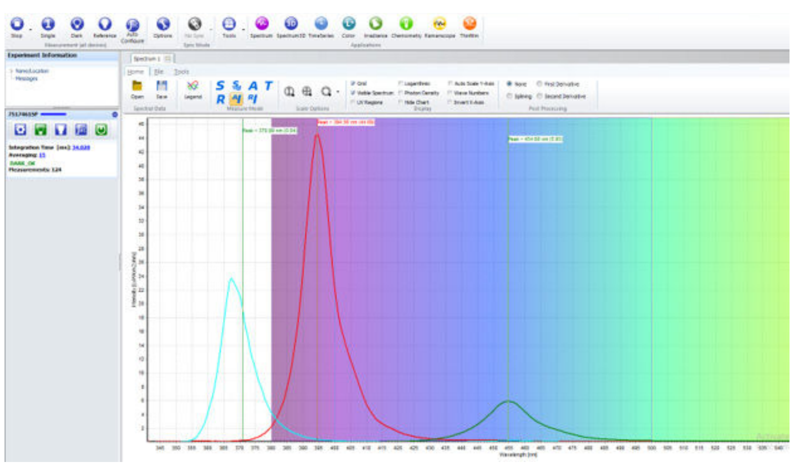

FIGURE #6: Spectra of expensive insect trap LED (Light blue and Green) and affordable insect trap LED (red), shown together for comparison.

ANALYSIS

The spectral data for each insect trap LED showed clear peaks for each sample. For the expensive model, the peak wavelengths measured at 367.34 (side) and 454.68 (front) nm (Figure 3), while the affordable model had a peak wavelength at 394.56nm (Figure 4). Each LED measured at different irradiance counts as shown in the graphs. The more expensive trap had a front facing diffused LED which showed the lowest spectral power (ca. 5 microwatts/cm2) as expected and a secondary undiffused side emitting LED which showed significantly higher spectral power (ca. 24 microwatts). The lower cost unit had a single undiffused LED which showed the highest overall spectral power at nearly 44 microwatts/cm2).

Further analysis of the data can be done in terms of wavelength efficacy in attracting bugs. Some previous studies have shown that both wavelengths are effective in attracting bugs due to them being in the UV, though 370nm is more effective in attracting what may be considered more common household pests, such as flies and mosquitoes. Interestingly, 390nm light has been shown to be more effective in attracting agricultural pests (such as beetles) and moths. Generally, 370nm light seems to be more effective in attracting smaller flying insects, which may be deemed more effective for indoor needs. With that reasoning, it seems that the expensive insect trap model is indeed more effective due to its LED peak wavelength. To truly compare the efficacy, both traps could be set up in regions with similar amounts of small flying insects and

CONCLUSION

In conclusion, the present experiment highlights the use of our spectrometers to measure LED using quantitative radiometric units (microwatts/cm2/nm). The measurements showed that the less expensive insect trap used a single LED while the more expensive emitted at two distinct wavelengths which certainly explains some of the cost difference. It is likely that the dual emitters attract a wider variety of insects. Further analysis could be done to compare the insects caught for each trap to see if the efficacy difference is made up with the difference in cost. The AvaSpec-VRS2048CL is an ideal instrument for a broad range of applications and industries, including LED measurements and our U.S. TR stage highlights the capabilities of our engineering team to provide custom assemblies and solutions for customer needs. Please contact Avantes for more information on the configuration that is best suited for your data collection..

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Curious how spectroscopy can help you reveal answers by measuring all kinds of material in-line, at your production facility, in a lab, or even in the field? Visit our website or contact one of our technical experts. We are happy to help you.

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