Characterization of LEDs and a Study of their Applications

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Abstract

Light emitting diodes, otherwise known as LEDs, are an upcoming form of lighting that have many different applications. Compared to other forms of lighting, LEDs are cheaper, last longer, and are more resilient in different areas. Some of these applications include LED grow lights, photodynamic therapy, and water sterilization. The goal of this project is to examine the Color Rendering Index (CRI) of lighting devices and their emerging applications, as well as examine how LED light effects mood. A set of LEDs with varying wavelengths, from 505 nanometers to 940 nm, were characterized through a series of experiments that analyzed the spectrum and found Plank's Constant. A spectral light meter was used to analyze the spectrum, as well as analyze different units such as the Photosynthetically Active Radiation (PAR) and the actual CRI measurements. Overall, a greater understanding of LEDs properties and their certain interaction with the objects was gained.

Research Goal

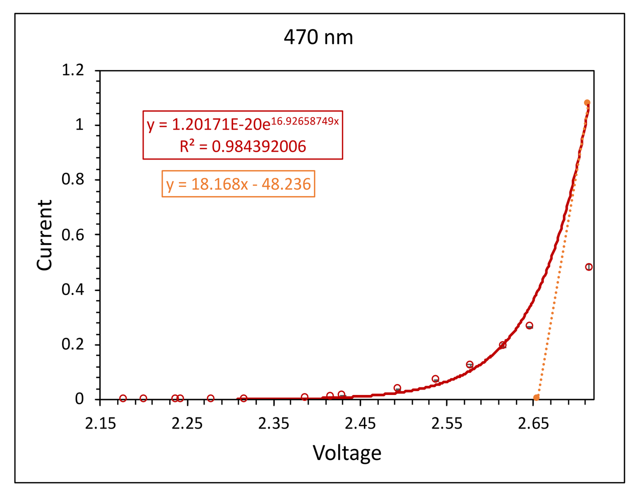
Characterization of LEDs

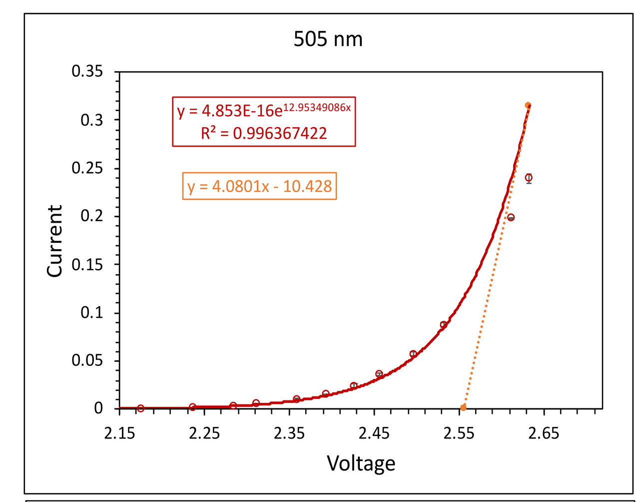
- L-I and I-V Characteristics
- Color Rendering Index (CRI)
- Emerging Applications

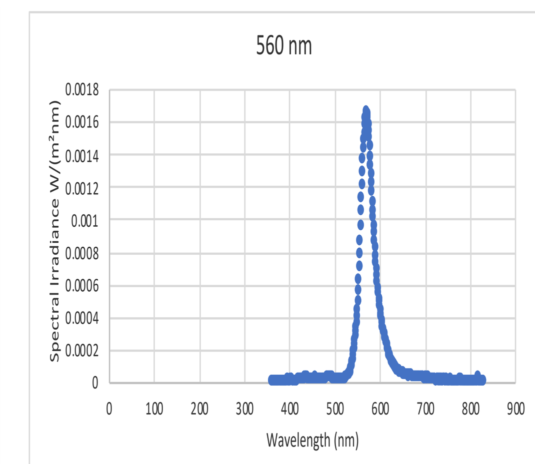
Methods

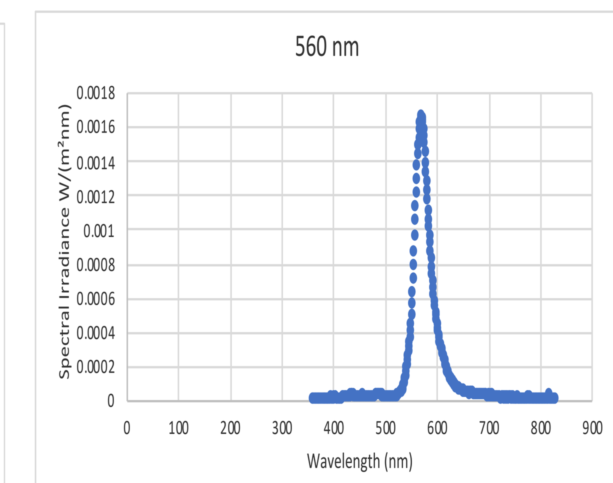
1) Connect an LED according to the circuit below. The series resistor (100 Ω) is necessary to limit the current through the diode. It is also used to measure the current passing through the LED.
2) Record the frequency (f =c/l) and the maximum current of the diode that was provided by the manufacturer.
3) Slowly increase the forward bias voltage until the diode lights up, with moderate brightness.
4) For each point record the diode voltage and the corresponding diode current.
5) Use computer software to plot a graph of I (vertical axis) against V(horizontal axis).
6) Draw a tangent to the curve to intersect the horizontal axis at V=Vd .
7) Repeat procedure 2-5 for all of the 6 diodes.
8) Make a graph of diode light frequency f (vertical) against Vd (horizontal).
9) Use computer software to determine the slope of the best straight line fits the data points.
10) Determine Plank's constant h = (slope) x (e) Compare the value of Planck's constant with the standard value and compute the percent error in your experiment .

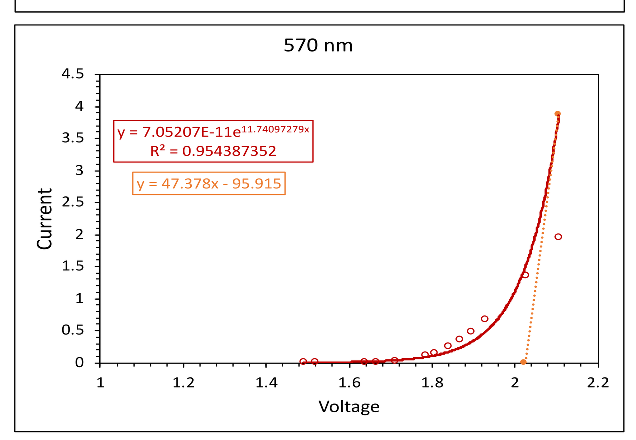
Results

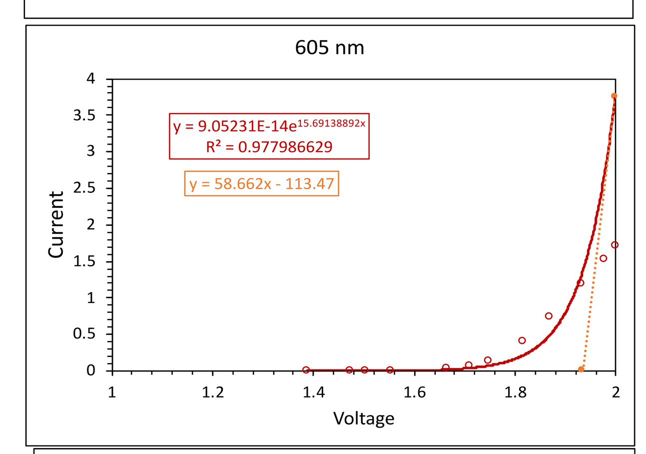


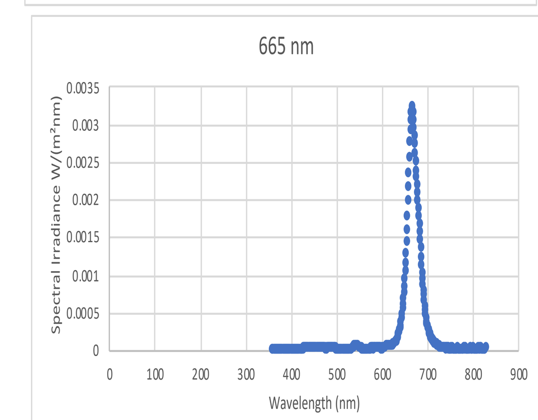


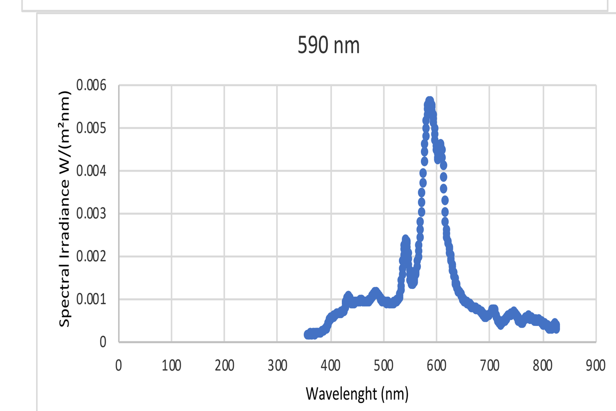


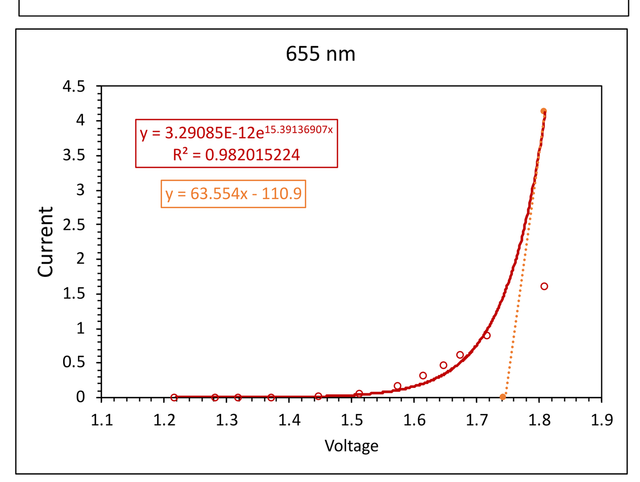


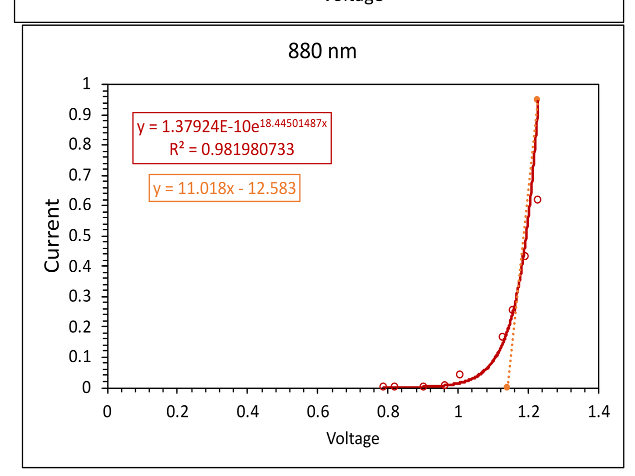


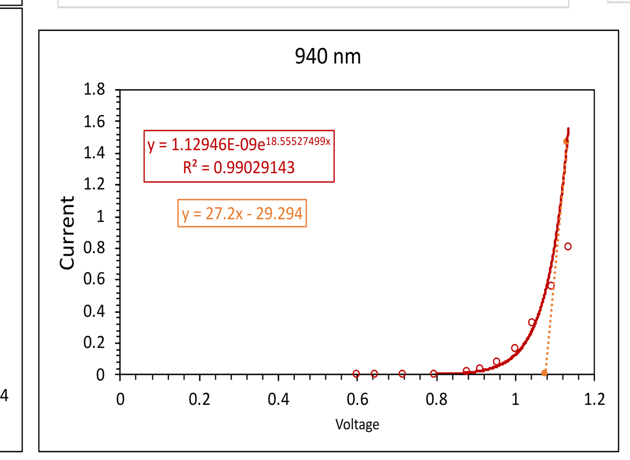


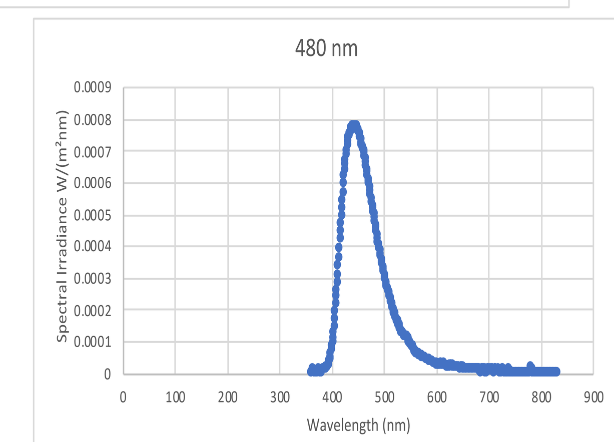






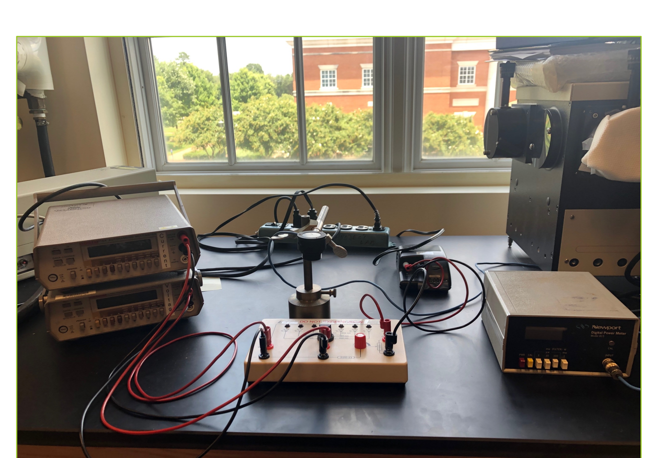


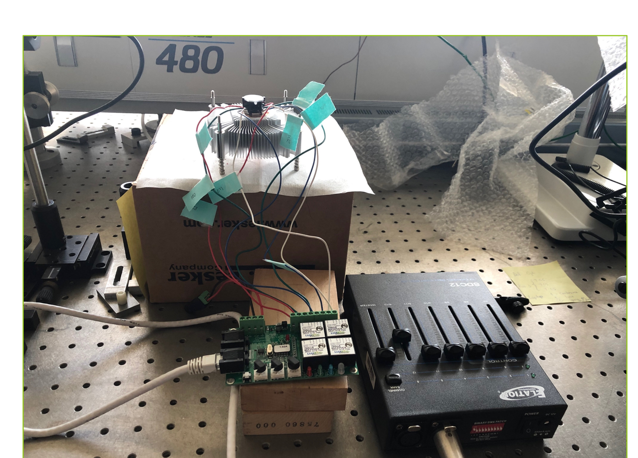




Application: Photodynamic Therapy

Acne vulgaris is a common disorder, that many people have struggle in treating properly. However, there have been a lot of development in using LEDs as a treatment for this condition. Photodynamic therapy is the use of light to activate photosynthesizes. When this occurs, a single oxygen and reactive radicles are formed. This in turn leads to bacterial destruction. The organic molecules in our skin that are the cause of acne successful achieve photoexcitation under blue LED light. Red LED light has anti-inflammatory properties as it promotes the release of cytokines, which are proteins that effect the interactions between cells.





Application: Water Sterilization

Sterilization is an important procedure in many applications, including in food and water. Heat and UV rays are some of the most commonly used methods to sterilize items. However, it is also possible for UV LEDs to carry out the same processes more efficiently. LEDs with wavelength of 365 nanometers are UVA, and can be successfully used to sterilize water sources. In a recent study conducted in 2007, it was found that the UVA-LED was successful in inactivate dangerous pathogens like E. Coli and Samonella. Normally, UV lamps have mercury in them, which can be harmful for the environment. On the other hand, UV- LEDs are more efficient and don't harm the environment. The first UV LED was created in 2000, and have since exploded in application. UV curing with LEDs, biomedical equipment and backlights

https://www.advanced-uv.de/en/uv-basics/uv-leds-for-water-disinfection/

Application: LED Grow Lights

Plants rely on light to grow, as they use it as energy to produce sugars to survive. However, there has been developing research on ways to create light that could elicit the same response. These are particularly viable in greenhouse environment or laboratories where natural light is not available. Things like microalgae are being mass- produced as a potential way to create synfuel. Thus, finding cheaper are more efficient methods of producing it is important. LEDs have a long life, a high luminous intensity and are efficient, which is why they are so viable for use in photo bioreactors. Photosynthetic Active Radiation, otherwise known as PAR, is the light emission in the range of 400- 800 nanometers. Plants use this wavelength of light to grow, so when constructing growthights, it is important to ensure that the light falls in this wavelength. In a recent study, it was found that red LED light was effective in producing more cells for microalgae and blue LED light was the most effective at increasing cell size. Therefore, it is important to look at the PAR of photobioreactors and see if more efficient systems can be produced.

https://www.dhgate.com/product/full-spectrum-led-grow-light-bulbs-18w-30w/432256920.html

Conclusions

- A set of 7 LEDs, with the wavelength range of 460 to 940 nm were characterized.
- Future goals include characterizing and studying UV LEDs.
- Test the effectiveness of LEDs in different applications Design a LED grow light prototype and test on microalgae found in North Carolina

Acknowledgements

- Dr. Yasin Raja
- Dr. Shagufta Raja
- Mrs. Sarah Smith
- Ms. Lorena Hatcher
- STEM Pre-College Program
- Wanseok Oh, Kenan Darden, Justin Bennett
- REAP/AEOP