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Measuring the Wavelength of a Laser Diode as a Function of Temperature

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1 Set up

Figure 1: As shown in figure 1, we put the laser diode in the oven to heat it up. To control the temperature of the oven, we used a power supply to regulate the voltage (between 70 and 90 volts) that powered the oven so that it doesn't fully heat up since that would take us well above our temperature range. Once we reached the target temperature in the oven and waited a few minutes for the diode heat up, we opened the door to measure the wavelength of the laser using a spectrometer and measured its temperature by placing a thermocouple connected to PASCO on it.

2 Data

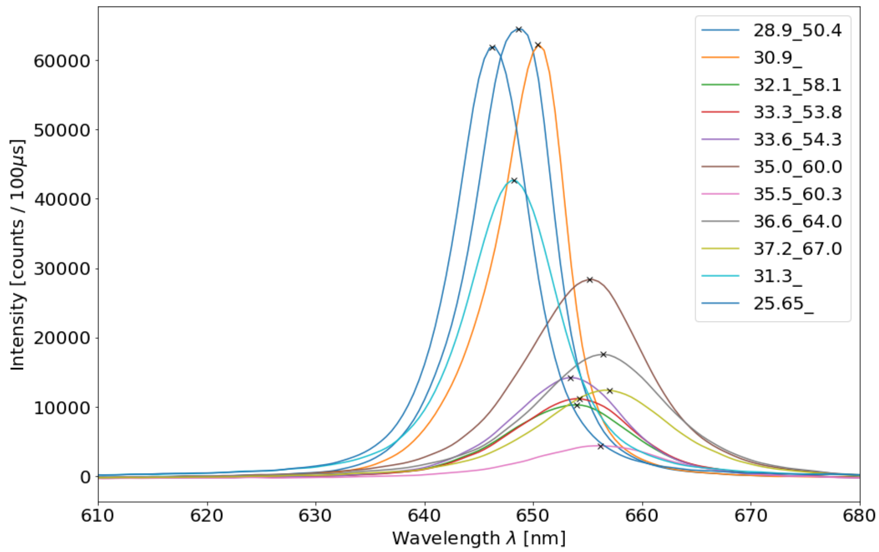

Figure 2: Spectra of LED diode emission at varying temperatures. There is a clear trend that wavelength decreases with increasing temperature.

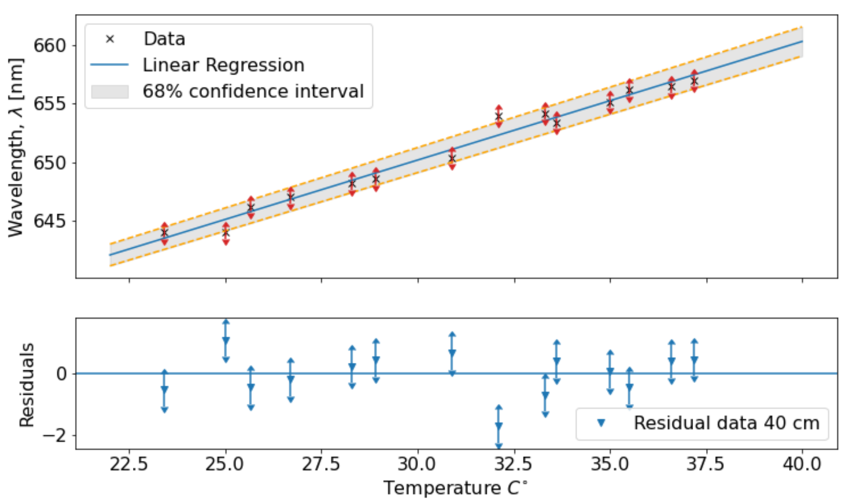

Figure 3: LED diode wavelengths at varying temperatures. There is a clear trend that wavelength decreases with increasing temperature.

3 Short Discussion

It can be seen that with increasing temperature, the peak wavelength of the emission spectrum increased. Also, we observed a significant drop in the output power of the laser diode as the temperature increased. This resulted in an observably lower intensity despite the distance of the optical spectrometer and voltage supplied remaining the same. The data so far confirms our hypothesis that with increasing temperature the wavelength increases linearly and the intensity decreases.

That aside, one observation that was outside of our expectations was that the drop in intensity was more significant than we expected. As per theory, it was expected that the shift in wavelength would cause a small drop in energy and thus intensity of the laser, but not anything this significant. Additionally, by following the change in wavelength per unit temperature ($\frac{d\lambda}{dT}$), we believe that the diode has a soft limit around 660 nm given our working temperature range (from room temperature to about 40 degrees C). As of the writing of the interim report, we don't know if this exponential decrease in intensity and thus limitation on the inducible wavelength shift presented above are fault of hardware limitations- i.e. the exponential degradation of internal components at high operating temperatures- or should expected.

From here on, we would like to see it we could push the laser diode into slightly higher temperature ranges for a more significant wavelength shift. As an aside, it may be interesting to open up the laser diode module and further investigate the consequences of the increasing temperature on its circuit board and other internal components.