Section IV: Discussion

Analyzing the data finds that the relationship between the ratio and light intensity rises, peaks, then rapidly drops off. As seen in the peak between the 1:50 and 1:100 graphs from figure 2, the 1:100 ratio has a 2.52 times increase in light intensity from the 1:50 ratio, though the annihilator has only doubled from 10.4 to 20.9 µL. This disproves the idea that doubling the amount of annihilator would simply double light intensity, rather the relationship is not one-to-one. Furthermore, the 1:175 ratio graph is only slightly higher at its peak at 303040 CPS. Between 1:150 and 1:175 the increase in light intensity slows down as it hits its peak ratio at 1:175. Meanwhile, adjusting the ratio to 1:200 results in no light intensity emitted as seen in figure 3. Both the control (from figure 1) and 1:200 ratio fluctuated around 3400 CPS, which is extremely low and undetectable to human eyes. Though the control emits no light due to no annihilator present, the 1:200 sample emits no light for the opposite reason. The 1:200 sample is affected by self-quenching where extra annihilator molecules are reabsorbing emitted light so that no light escapes the sample.

An ANOVA test was run on the data from figure 1 to confirm that each sample of different ratios were statistically different. It resulted in a p-value of 3.8*10^(-46), confirming that each ratio is different.

Meanwhile, trials of the same ratio were significantly similar. A paired T-test found that two trials of a 1:100 ratio were significantly similar to a p-value of 5.83*10^(-20).

Graphing the peak light intensity from each sample, as seen in figure 4, shows a curve-like shape, starting at 0, peaking at 303040, and ending at 0 CPS. A regression analysis was performed on the data and found that the quartic function y = -0.002x4 + 0.5742x3 - 51.2x2 + 3738.3x – 1677 most closely matches the data to an R^2 value of 0.9031. However, the model predicts the peak light intensity at 1:146.21, though the data show that the peak light intensity is at 1:175.

Overall, the data collected supports the objectives and hypothesis of the project. Modeling various annihilator-to-sensitizer ratios in a TTA-UC system utilizing Perylene and PdTPBP demonstrates an increasing light intensity as the ratio increases until the optimal ratio is reached, and light intensity begins to decrease due to self-quenching. This is seen from the function that models the data.

A potential limitation of this project is the limited number of trials, 6, used to develop the model. Having a greater number of trials would help solidify the model.

This project fits into current research in the field by aiding scientists in understanding TTA-UC and better designing TTA-UC solutions. This research improves upon the understanding in the field.

Future Research

Some future steps include replicating the experiment with different TTA-UC pairings, other than PdTPBP and Perylene. Additionally, continue to collect data to strengthen the model's precision. On the other hand, study the effect of concentration on light intensity rather than the ratio can provide further insight. Overall, using the model in designing TTA-UC experiments and noting its utility will confirm its use in aiding researchers in the field.

Section V: Conclusion

In conclusion, this project's objectives were to test various ratios of a TTA-UC system and model the peak light intensity from each resulting in a function that scientists can use to estimate light intensity. To do this, TTA-UC samples ere created by micropipetting amounts of PdTPBP, Perylene, and THF into a cuvette, degassing with argon, and measuring light intensity with a spectrofluorometer. This resulted in data showing that both the control (1:0) and 1:200 samples emitted no light, while 1:175 emitted the most light. This data was able to be modeled by a quartic function to an accuracy of $R^2=0.9031$. With this project, scientists better understand the behavior of TTA-UC and can use my model to design solutions for TTA-UC in solar energy.