## Integrating Sphere Photon Flux Measurements

Calibration of the 385 nm UV-LEDs was carried out using a Thorlabs PM100D optical power meter with a S-120Z filter for relative power measurements ranging from 10 – 500 mA reported in Figure 10. The UV-LED shows a linear relationship to power. The integrating sphere was calibrated with a LS-1-Cal calibration light source with an 8036 ms integration time. Photon flux measurements were made with an ocean optics integrating sphere and operation current of the UV-LEDs at 10mA.

A graph of a calibration curve

Description automatically generated

Figure 10. Relative power calibration curve for 385 nm UV-LED

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## Determination of Photon Flux and Methyl Orange Photonic Yield

The photon flux of the 385 nm UV-LED was determined by measuring the total photons at 385 nm over an integration time of 8036 ms at 10 mA. The photon flux was calculated as follows:

A graph of a graph showing a line of led

Description automatically generated with medium confidence

Figure 12. Photon Flux Calibration Curve for 385 nm UV-LED

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The photon flux measurement at 10 mA was used with the relative power calibration curve (Figure 5) to create a photon flux calibration curve. The photon flux calibration curve illustrated in Figure 12 was used to calculate the photon flux at the current in which the methyl orange degradation kinetics measurements are made (photon flux (500 mA) = 1.81 \* 1016 photons/s). The photonic yield is calculated for USR 450 utilizing Equation 1 as follows:

(1)

\*Note: The rate in the optimal rate regime must be converted to methyl orange atoms / min.22

\* 100

114%

Table 1. Optimal Rate and Photonic Yield of USR and NG Catalysts

|  |  |  |
| --- | --- | --- |
| Catalyst | Optimal Rate (M/min) | Photonic Yield |
| USR AR | 3.96 \* 10-7 | 39.9 % |
| USR 450 | 1.13 \* 10-6 | 114 % |
| NG AR | 3.57 \* 10-7 | 36.0 % |
| NG 450 | 9.23 \* 10-7 | 93.0 % |

There is an issue with the photonic yield measurements made. The photonic yield should not exceed 100% as it is does for USR 450. This is most likely due to two experimental constraints; 1) the 385 nm UV-LED is wired in a way that the entirety of the LED cannot be inserted into the integrating sphere; 2) the UV-LED has a distribution of wavelengths above the band gap that also contribute to the reactions aside from 385 nm. Thus to measure a more physically reasonable photonic yield the photon flux of each wavelength above the band gap of the photocatalyst must be measured. Additionally, modifications to the LED wiring or integrating sphere set-up must be made to ensure all photons are measured by the detector.

To account for these issues we solved 1) by using a flat copper wiring and soldering it to the LED so that the entire LED will lay flat and can be inserted into the integrating sphere. We then solved 2) by integrating the calculated photon flux over the total distribution of wavelengths of the 385 nm LED. The updated photonic yields are presented in Table 2.

Table 2. Updated Optimal Rate and Photonic Yield of USR and NG Catalysts

|  |  |  |
| --- | --- | --- |
| Catalyst | Optimal Rate (M/min) | Photonic Yield |
| USR AR | 3.96 \* 10-7 | 1.10 % |
| USR 450 | 1.13 \* 10-6 | 3.15 % |
| NG AR | 3.57 \* 10-7 | 0.99 % |
| NG 450 | 9.23 \* 10-7 | 2.57 % |