Using a photocatalyst to mitigate harmful effects of cyanobacteria found in algal blooms

Meredith Leighton, 8th Grade Science Teacher (mleighton@bridge-rayn.org)
Advisors: Dr. Pratap Rao & Dr. Ceren Yilmaz-Akkaya
SYNerg-E Lab: Materials and Processes for Energy & Printed Electronics (formerly known as NanoEnergy Lab)

Motivation

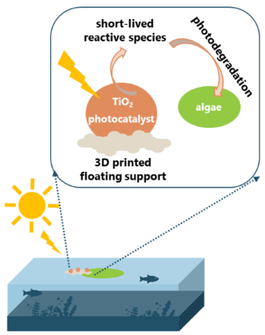
- The presence of cyanobacteria in algal blooms found in local water bodies is a serious concern for the public. [1]
- Harmful algal blooms (HABs) contain cyanobacterial genera which produce a suite of toxins across variable environments. [2]
- HABs also contribute to economic loss due to increased health-related and water treatment costs.
- This project is part of a two-year grant funded by the Environmental Protection Agency (EPA).

United Nations Sustainable Development Goals

- The aim of this project is to break down harmful algal blooms found in local freshwater by using a renewable energy source.
- After treatment, the water will be cleaner and safer for public use with no adverse effects to the local ecosystem.

Photocatalyst for Combating Algal Blooms

- Photocatalysis is a process which utilizes light energy to cause chemical reactions.
- Titanium dioxide (TiO_2) is a favorable photocatalyst it is the most active and stable.
- The photocatalyst is used to break down the cyanobacteria found in algal blooms and its associated toxins.

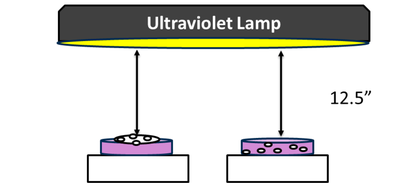


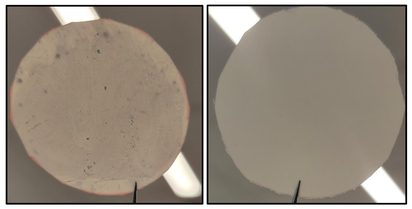
References

1. Toxic Cyanobacteria: A Growing Threat to Water and Air QualityHaley E. Plaas and Hans W. Paerl, "toxic Cyanobacteria: A Growing Threat to Water and Air Quality" *Environmental Science & Technology* 2021 *55* (1), 44-64
2. J.M. Clark, B.A. Schaeffer, J.A. Darling, et al. Satellite monitoring of cyanobacterial harmful algal bloom frequency in recreational waters and drinking water sources. *Ecol Indic* 2017, 80, 84–95.

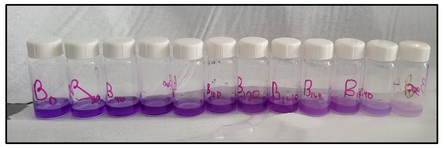
The Investigation

- Crystal violet served as a control substance to compare its performance interacting with TiO_2 particles, with the eventual interaction between the photocatalyst and algae tested.
- The amount of TiO_2 loading on thermoplastic polyurethane (TPU) paper was determined.
- TiO_2 was deployed in the artificial freshwater as mobilized particles and immobilized by smearing particles on TPU paper.
- The photocatalytic degradation of crystal violet with immobilized and mobilized TiO_2 and artificial fresh water was monitored while under an ultraviolet lamp set up to emulate solar radiation.



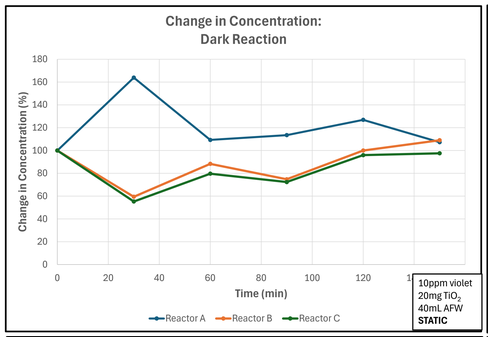


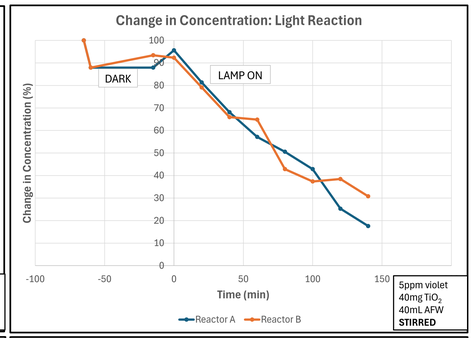
TPU coated with TiO_2 powder | Uncoated TPU

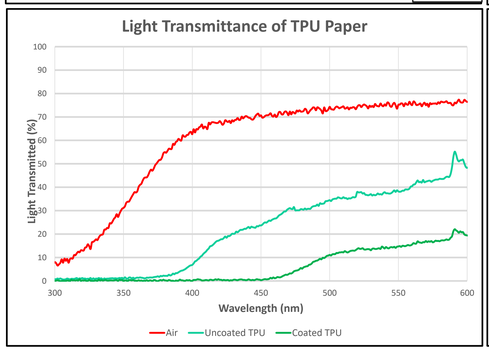


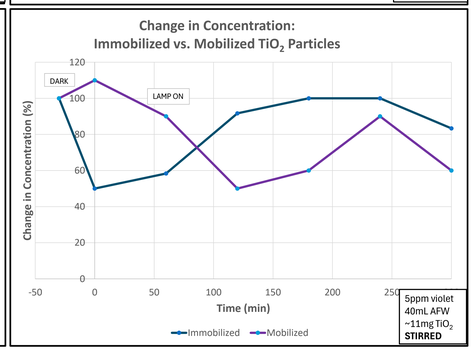
Immobilized TiO_2 particles | Mobilized TiO_2 particles

Results



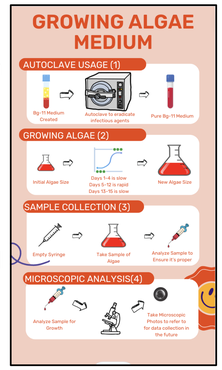






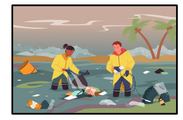
Conclusions & Future Work

- The data shows that TiO_2 degrades the concentration of crystal violet in artificial water when exposed to UV radiation when mobilized and immobilized.
- The TiO_2 is capable of immobilization on a TPU paper and suspended in the water, which will assist in 3D printing of the photocatalyst.
- The reaction with the immobilized TPU will occur on the surface of the water where algae is present.
- More focused measurements of degradation will be made at that location.
- These results will be used to compare how lab-grown algae responds to immobilized TiO_2 while exposed to UV radiation.



In the Classroom

- Take samples of local water bodies and examine their contents.
- Grow algae samples in the classroom to study the optimal growing conditions and compare them to changes in local climate.
- Investigate reactions to explain the nature of chemical versus physical changes, with indicators such as a change in color.
- Encourage a water cleanup effort in the community using evidence gained from lab experiences.



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