Photocatalytic Degradation of Organic Contaminants Using Catalyst-coated Fibers

Theresa Chu[1], Lu Lin[2], Pei Xu[2]

[1]ReNUWIt REU Participant

[2]Department of Civil Engineering, New Mexico State University, 3035 South Espina Street, Las Cruces, NM 88003

Background

- Conventional water treatment processes for organic contaminants are expensive and energy-intensive
- Photocatalysis uses freely available sunlight for oxidation/reduction reactions
- Side-glowing optical fibers (SOFs) distribute light throughout all sides and ends of the fibers

Objectives

- Implement photocatalyst-coated fibers to degrade pollutants in solution
- Develop and optimize photocatalyst coating and fiber medium
- Quantify degradation of organic contaminants
- Test effectiveness of catalyst for different pollutants

Methods

Reactor	Batch	Continuous Flow
Purpose	Catalyst coating development	Industrial application
Light	UV (3 hr) Visible (8 hr)	Sunlight (48 hr)
Solution	Rhodamine B (organic dye)	Microfiltration (MF) permeate Reverse osmosis (RO) concentrate

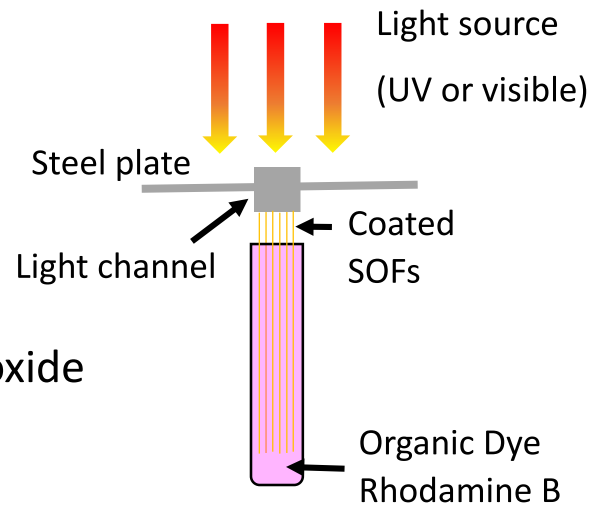
Materials

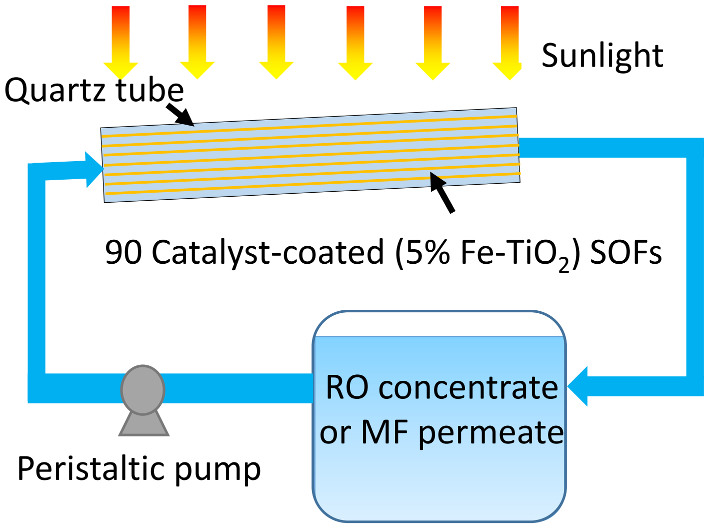
Catalysts

- TiO_2
- Fe_2O_3
- $BiWO_3$

Dopants

- Graphite oxide
- Palladium
- Iron





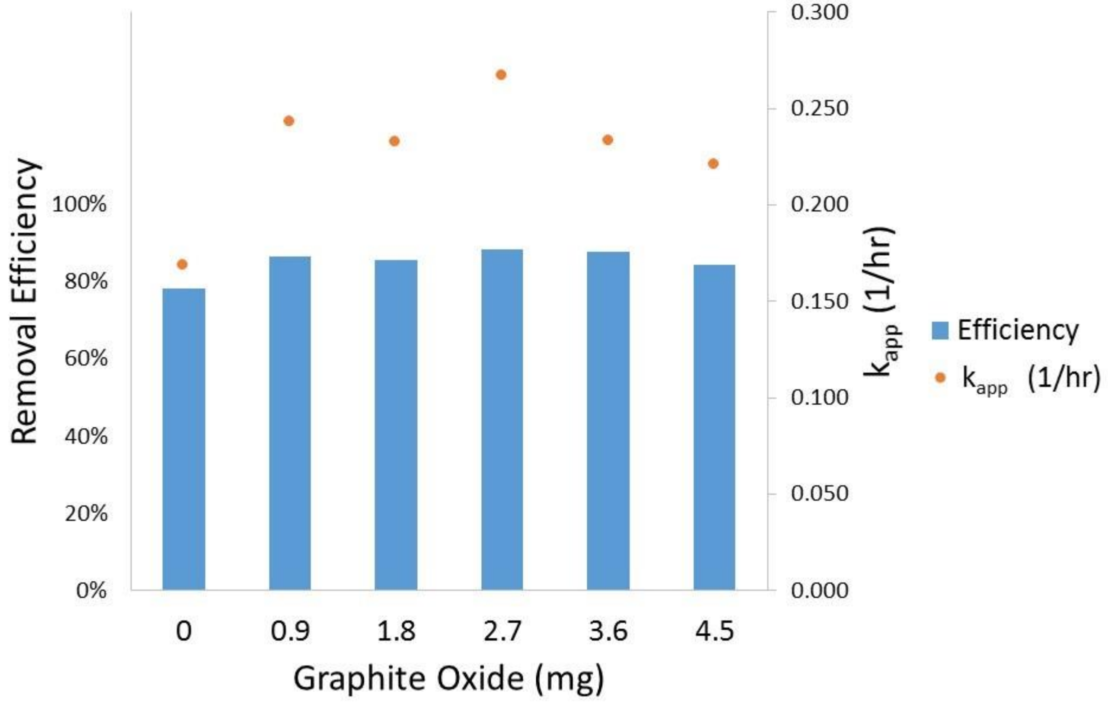
Results

Batch Reactor

- Graphite oxide doped $BiWO_3$ is the most effective group of catalysts tested (78%-89% removal of Rhodamine B)
- Graphite oxide dopant does not significantly affect removal rates
- Degradation rates fit the Langmuir-Hinshelwood model

$$r = \frac{dC}{dt} = \frac{kKC}{1+KC}, \text{ where } k_{app} = kK$$

Graphite Oxide doped $BiWO_3$ Efficiency and Degradation Rate



Continuous Flow Reactor

UV/Vis spectrophotometry

- Reactors perform similarly for each solution with or without fibers present
- RO concentrate: decrease in double bonds
- MF concentrate: increase in double bonds due to complex bonds degrading

Fluorescence Excitation Emission Matrix

- RO concentrate: fiber removes humic-like peaks

Removal Efficiency of Double Bonds (254 nm)