Photocatalytic Degradation of Organic Contaminants Using Catalyst-coated Fibers

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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

Methods

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

**Catalysts**
- TiO\textsubscript{2}
- Fe\textsubscript{2}O\textsubscript{3}
- BiWO\textsubscript{3}

**Dopants**
- Graphite oxide
- Palladium
- Iron

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

Light channel

Steel plate

Coated SOFs

Organic Dye Rhodamine B

Light source (UV or visible)

Quartz tube

90 Catalyst-coated (5\% Fe-TiO\textsubscript{2}) SOFs

Peristaltic pump

RO concentrate or MF permeate

Sunlight

Solution

Rhodamine B (organic dye)
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

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

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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)