In-situ monitoring for the role of dye structure on electrochemical decolorization

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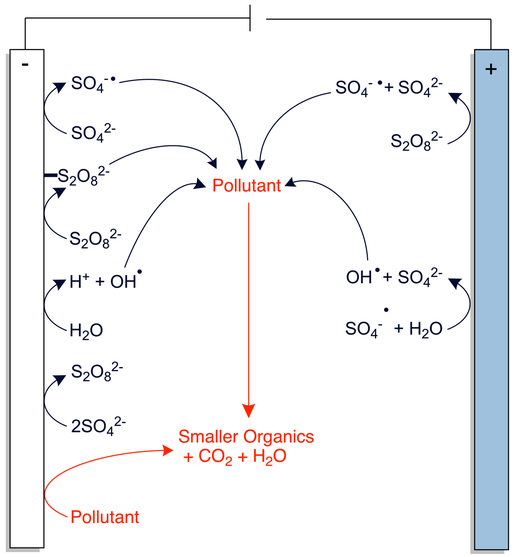
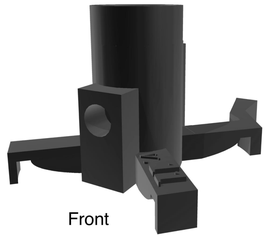
Introduction

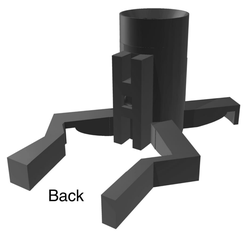
- Approximately 80% of textile wastewater is discharged without treatment
- The mutagenic and genotoxic properties of dyes can devastate entire ecosystems
- Most dyes are resistant to traditional water treatment methods
- Electrochemical advanced oxidation processes (EAOP) are promising alternatives due to their high efficiency, small physical footprint, simple operation, and capability for automation
- EAOPs like the electrochemically activated persulfate system in this work generate radicals in-situ which break down pollutants into smaller components

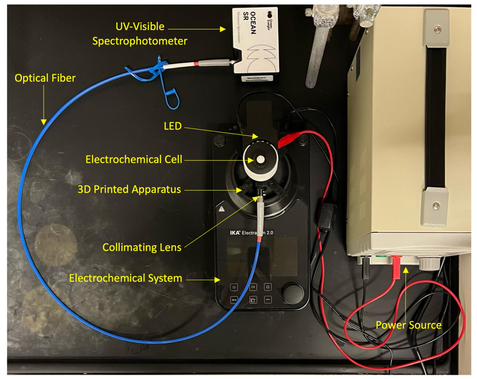


- Traditional offline UV-Visible (UV-Vis) analysis is tedious and time-consuming
- Disparate literature reports have wide-ranging variables making it difficult to ascertain how pollutant structure impacts system efficiency[1]

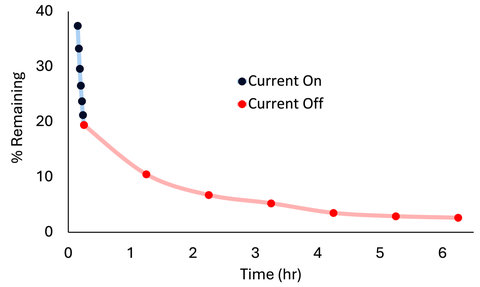
Development of an *in-situ* continuous-monitoring apparatus







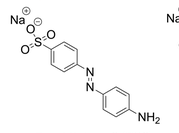
- 3D printed apparatus is constructed out of black PLA to block extraneous light
- The vertical cylinder fits snugly around the electrochemical cell
- Frog-like legs lock around the stir plate in only one possible orientation
- Ports on the front and back align an LED with an optical fiber and UV-Vis for reproducible measurements, turning the entire reaction into a cuvette[2]
- Optimized reaction conditions: boron doped diamond (BDD) anode, graphite cathode,10 mA current, 14 mM sodium persulfate as the electrolyte, 1,000 rpm stirring speed[3]

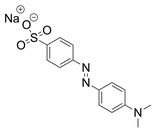


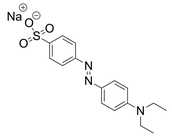
- Decolorization continues for after electrolysis is stopped
- *In-situ* monitoring is essential to obtain accurate data[2]

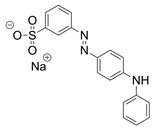
The impact of dye structure on decolorization speed

Phenyl Azo Dyes:

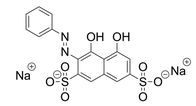

Food Yellow 6 (FY6)

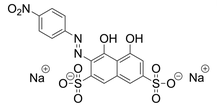

Methyl Orange (MO)

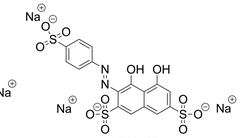

Ethyl Orange (EO)


Acid Yellow 36 (AY36)

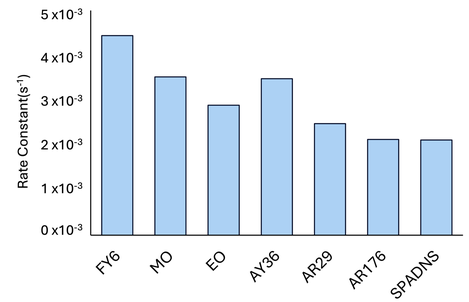
Napthyl Azo Dyes:


Acid Red 29 (AR29)


Acid Red 176 (AR176)


SPADNS

- Increasing chromophore complexity, and electron withdrawing groups decrease efficiency
- Electron donating groups can overcome the negative impact of higher molecular formulas[3,4]



References

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2. Schroeder, C. M., León Sandoval, A., Ohlhorst, K. K., Leadbeater, N. E., *Chem. Methods*, **2023**, e202300014.
3. Schroeder, C. M., Koehler, T. M., Ohlhorst, K. K., Leadbeater, N. E., *RSC Adv.*, **2023**, 13, 33559–33565.
4. Schroeder, C. M., Koehler, T. M., Leadbeater, N. E., *RSC Adv.*, **2024**, 14, 38385–38390.