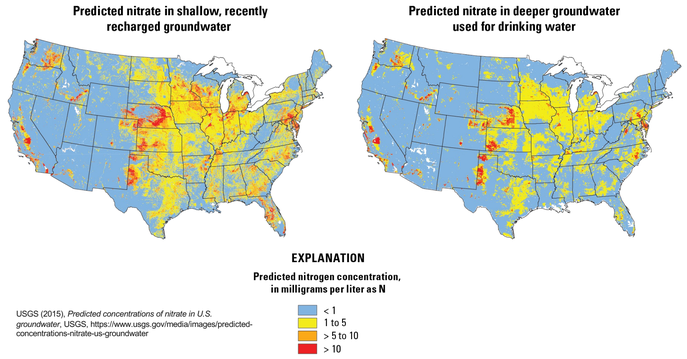
Photoelectrocatalytic Nitrate Reduction Using Nano-enabled Titanium Oxide Decorated with Metal Nanoparticles

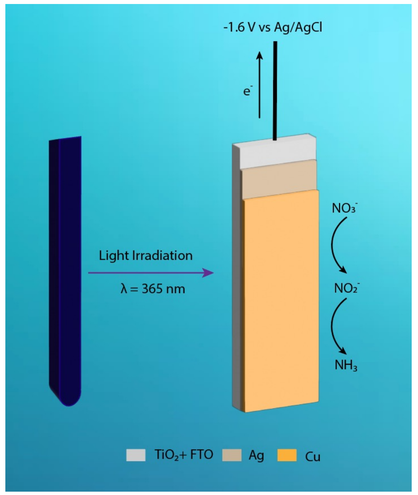
Noah Butzine, Environmental Engineering
Mentor: Gabriel Cerron-Calle, Graduate Researcher ; Prof. Sergi Garcia-Segura
School of Sustainable Engineering and the Built Environment

Background



- EPA MCL set at 10 mg/L NO_3^- –N.
- Agricultural runoff frequently exceeds 50 mg/L NO_3^- –N.
- Photoelectrochemical (PEC) processes present an opportunity to remove nitrate while creating an added-value product (NH_3).

Experimental Methods



Electrode Synthesis:

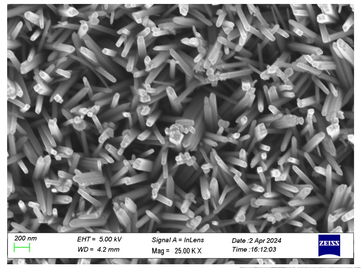
- Titanium Oxide deposited using hydrothermal deposition.
- Silver nanoparticles deposited using electrodeposition.
- Copper nanoparticles deposited using electrodeposition.

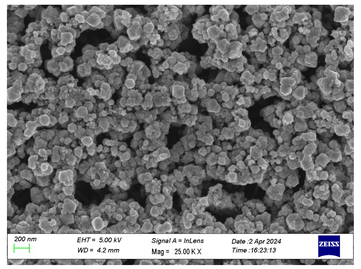
PEC Nitrate Reduction:

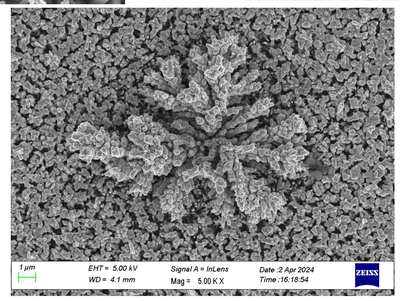
- Performed potentiostatically using Ag/AgCl reference electrode.
- 365 nm UV pen lamp provided irradiation.
- Potentials from -1.2 V to -1.8 V vs Ag/AgCl tested.

Characterization Results

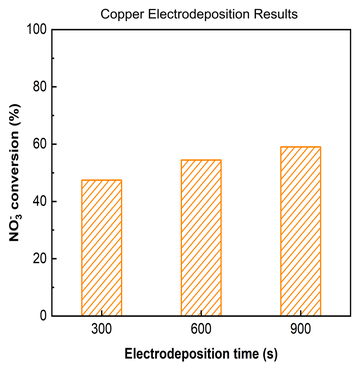
Electrode Characterization:

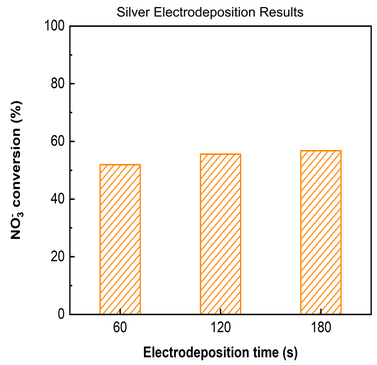






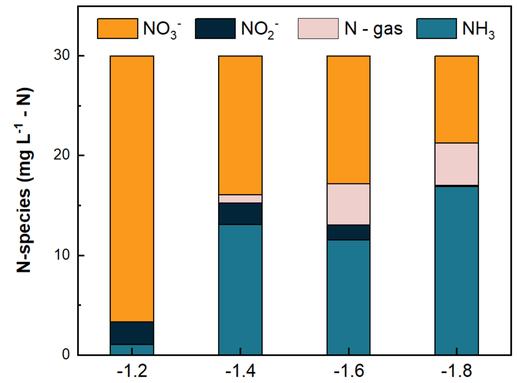
Electrode Performance:

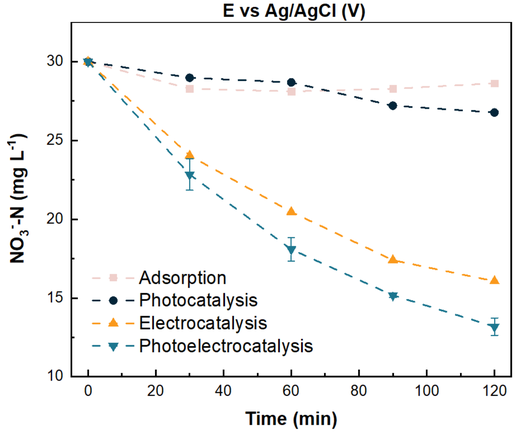




- Optimal silver concentration achieved after 120s of electrodeposition.
- Optimal copper concentration achieved after 600s of electrodeposition.

PEC Results





- 56% Nitrate Conversion in 120 minutes.
- 83% Nitrate Conversion in 240 minutes.

Conclusions

- Trimetallic photocathodes performed better than bimetallic or single metal configurations.
- Further research should focus on alternative photoactive semiconductors.

FURI

Ira A. Fulton Schools of Engineering
Arizona State University