Student Research Symposium | Student Research Symposium 2024

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Photocathodes From Aerobic Oxidation of Tellurorhodamines

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Photocathodes from Aerobic Oxidation of Tellurorhodamines

BY AMELIA JELLISON

Solar Cells

Traditional solar cells: silicon semi-conductors

Large, bulky, inflexible

Alternative designs: organic photovoltaics, perovskites, and dye-sensitized solar cells

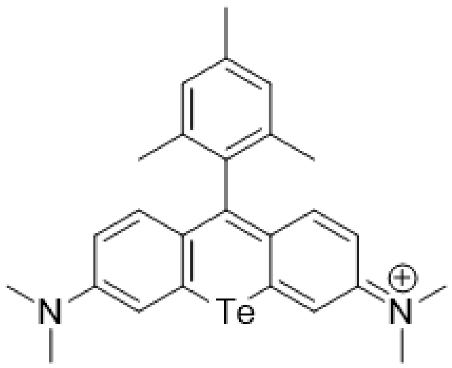
smaller, flexible, less efficient

Specific Aims

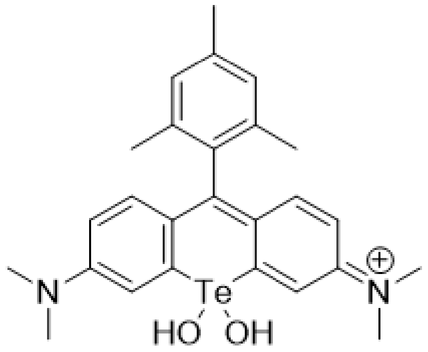
Aim 1: Develop and analyze Mesi dye sensitized photocathode

Aim 2: Develop and analyze Te-BLK dye sensitized photocathode

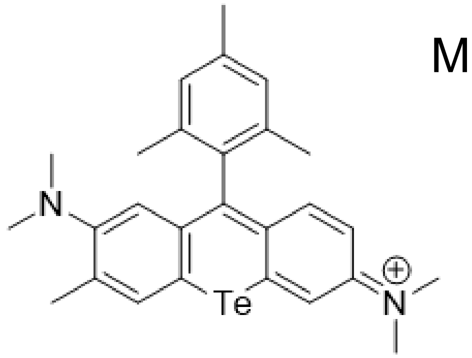
Aim 3: Analyze how altering the structure and substituents of tellurorhodamines affects the electrochemistry.



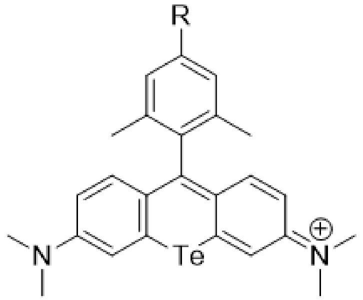
Mesi



Mesi-O



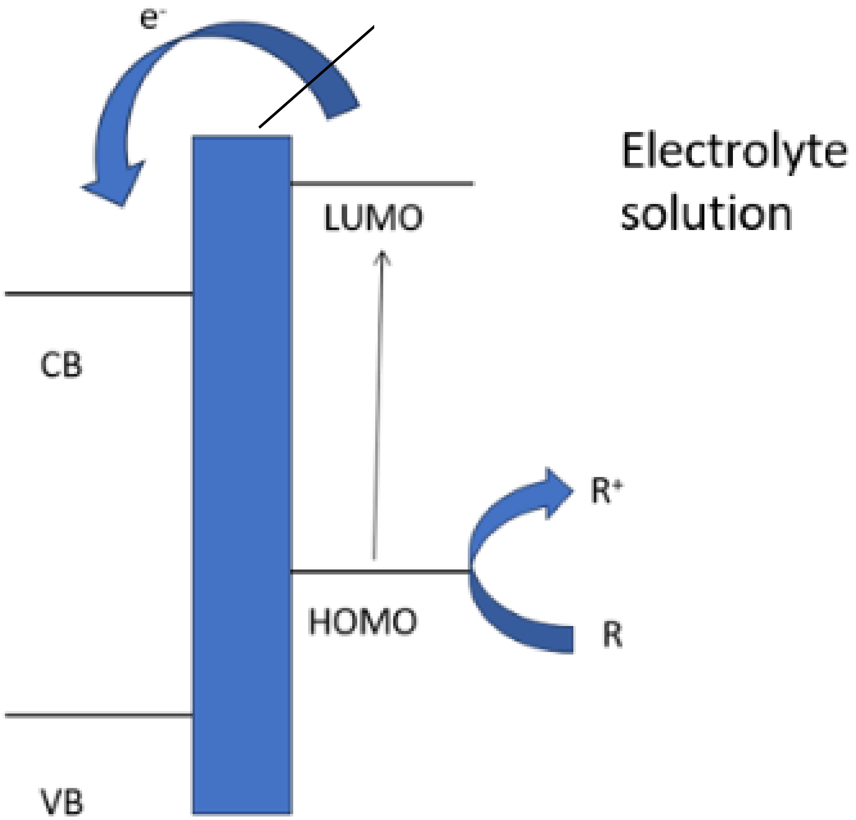
Te-BLK



Varying substituents

Photochemical cells

DSSC are made of a semiconductor and a dye



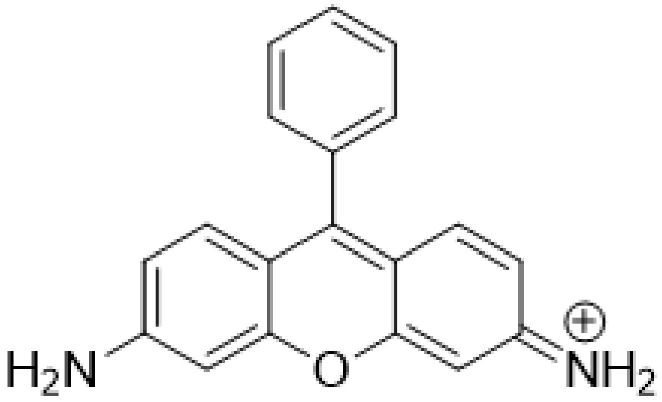
anode

Current DSSC dyes

Mainly aromatic dyes

- Focus on delocalization
- Pyrrole, phenyl, BODIPY, ruthenium, **rhodamine**

- Rhodamines have been commonly used in fluorescence chemistry, redox active



Rhodamine

Hypothesis: overall

Problem: Current cathode designs are not as efficient as they could be

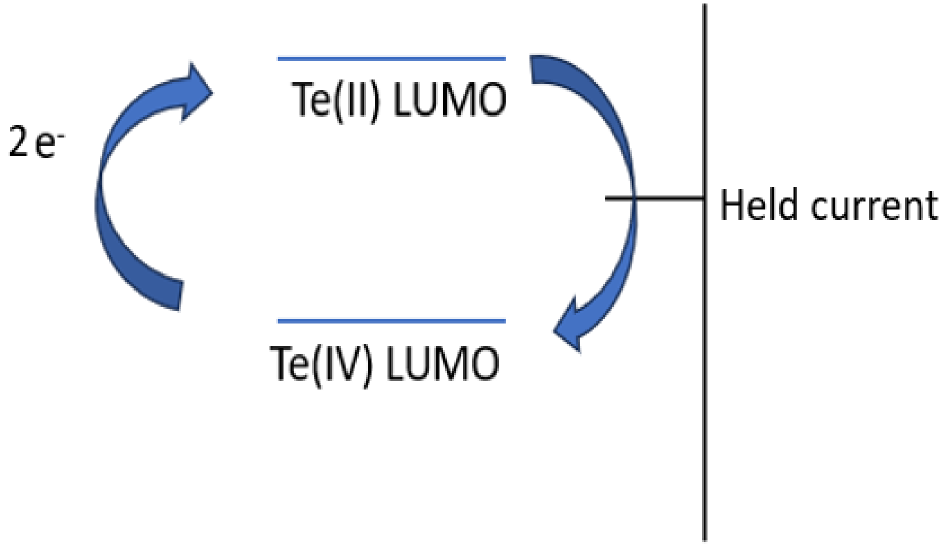
Hypotheis: Dye-sensitized cathode could lower energy level, creating more efficient system

Photocathodes

Photocathodes traditionally function by hole injection

- NiO commonly used

Project aims to use tellurorhodamines as a photocathode



Dye Sensitized Cathodes

Previous researchers have focused on increasing the rate of electron transfer on photocathodes

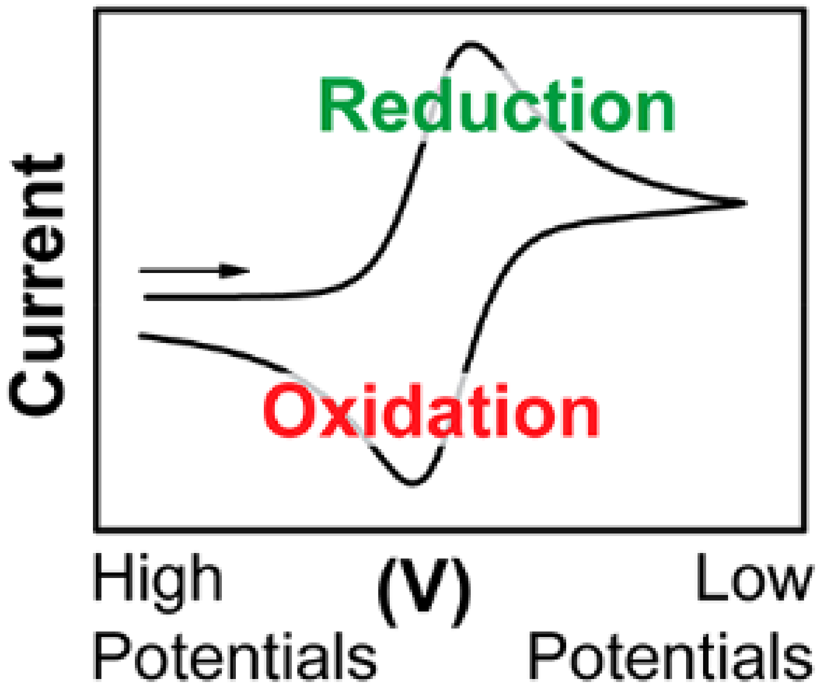
- Changing electrolyte
  - Increasing delocalization and/or changing overall electronics of the dye
  - Focus on hole injection in the cathode

Electrochemistry

Analyzes redox activity

- Major factor in DSSC
- Analyzed by cyclic voltammetry (CV: monitors redox reaction), open circuit voltage (OCV: monitors change in voltage potential across a steady current), spectro electrochemistry (SEC: monitors changes in absorption)

$P_{max} = V_{oc} I_{sc} FF$



Tellurorhodamines

Tellurorhodamines absorb longer light wavelengths

- Allows dye to absorb more solar light
- Te captures more red-shifted light

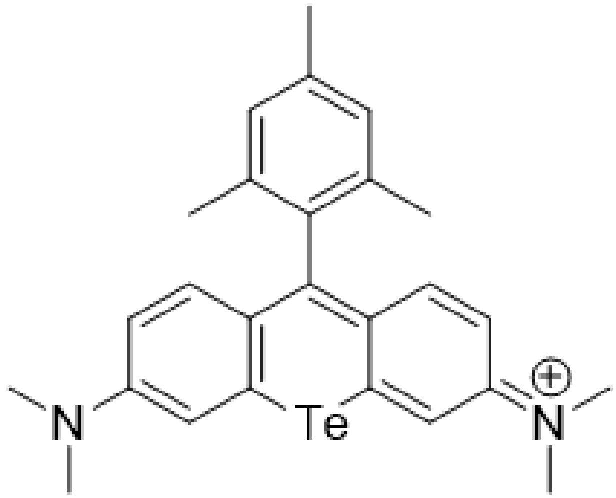
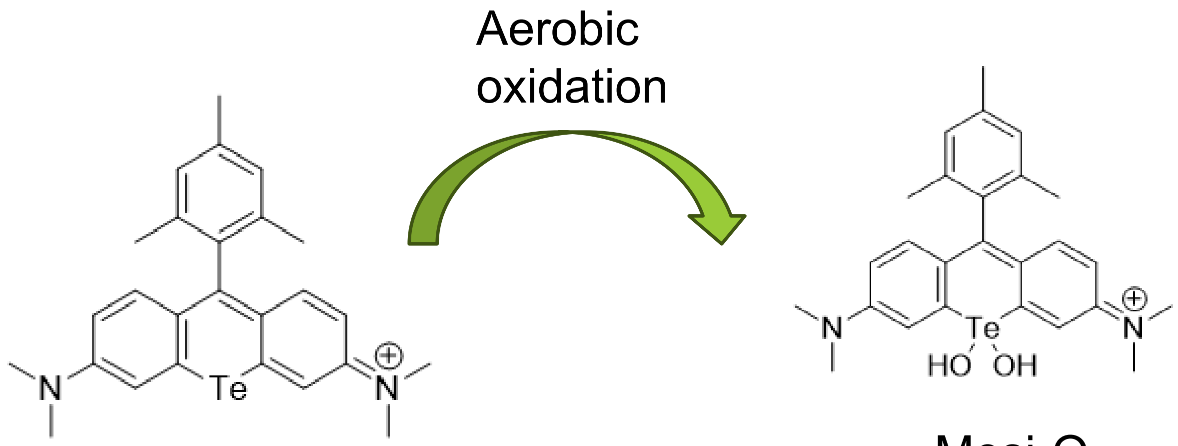


Photo-oxidxation

Mesi aerobically oxidizes under light

absorbance is red-shifted



Mesi

Mesi-O

Hypothesis: mesi dye

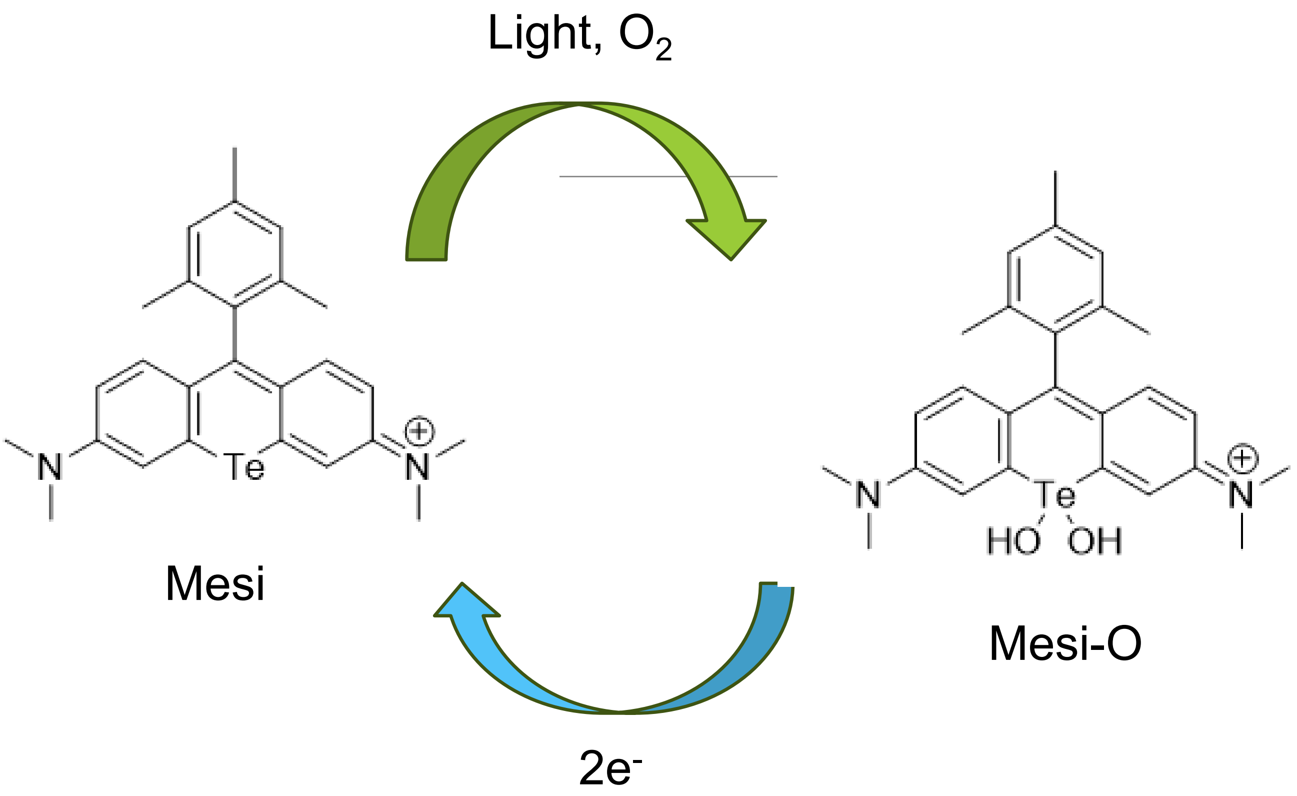
Red-shifted absorbance creates a more efficient photocathode

Photo-oxidized redox reactions in alternating light and dark conditions should create a working cathode

Mesi dye

Prove reproducibility

- UV-vis, CV, OCV
- Study dye performance range



Hypothesis: Te-BLK

Efficiency is partly determined by amount of available light absorbed

Increasing red-shift should increase efficiency

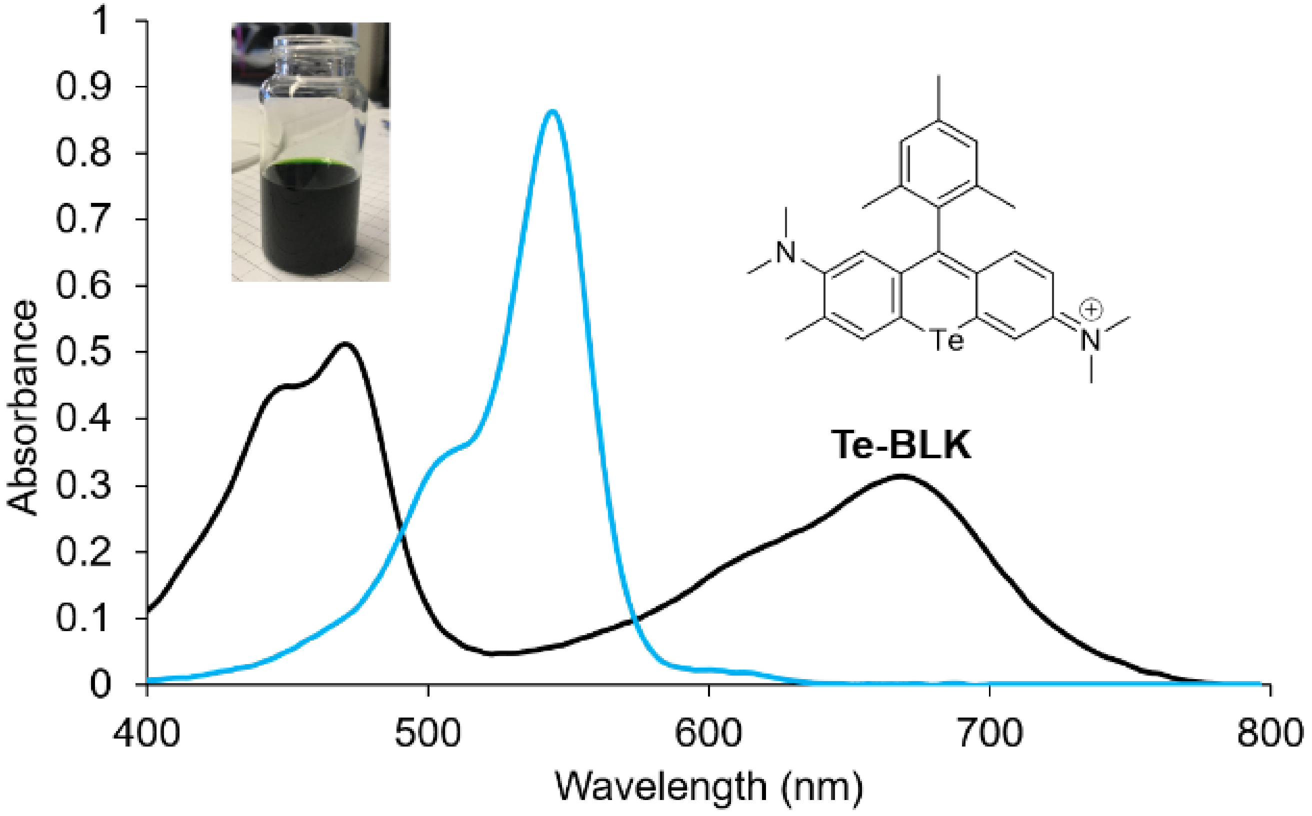
Te-BLK

Red-shifted absorbance

Electrochemistry unknown

Photophysical and electrochemical analysis

Red-shifted absorbance -> better light harvesting?



Hypothesis: varying substituents

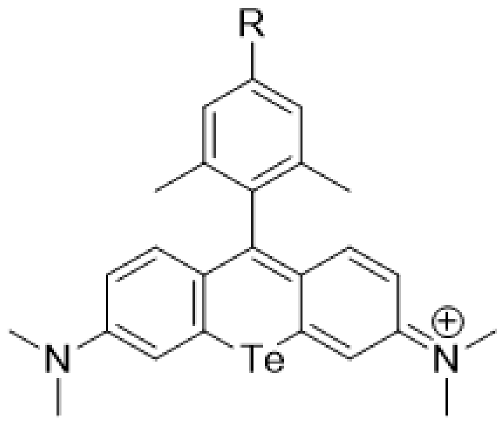
Smaller HOMO-LUMO gap leads to red-shifted absorbance

Adding electron donating substituents should increase efficiency by decreasing HOMO-LUMO gap

Varying Substituents research

Study varying substituents and structural design

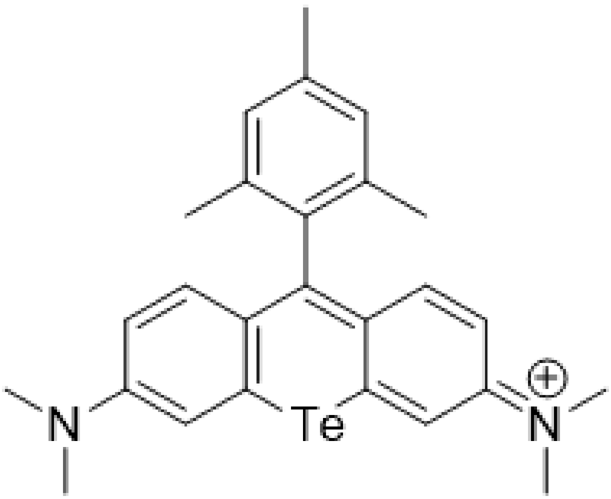
Smaller HOMO-LUMO gap could improve performance



What we hope to learn

Could potentially create a self-oxidizing dye-sensitized photocathode

- Tellurorhodamine dye to improve efficiency through changes in the dye structure



Questions?

Thank you for your time