

# Using Kinetics to Study the Stabilization of Reactive Hydrosulfide by Supramolecular Receptors

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## Introduction

- Hydrosulfide (HS<sup>-</sup>) is a highly reactive anion with biological implications as the third endogenously produced gasotransmitter
- This project is a kinetics study of hydrosulfide performed within organic solvent with the assistance of a supramolecular receptor
  - The Pluth lab at the University of Oregon presented a simple way to synthesize an organically soluble source of HS<sup>-</sup> with a breakdown of the solubility in various organic solvents
  - The Roberts group obtained 2nd order rate constants, under pseudo-first-order conditions, from S<sub>N</sub>Ar reactions with pyrimidines in aqueous media
- Even though HS<sup>-</sup> is extremely reactive, it has been found bound by non-covalent interactions in proteins
  - We want to study the supramolecular chemistry of HS<sup>-</sup> to see how non-covalent interactions can stabilize this anion

## Research Question

- In this work, we aim to analyze how the presence of stabilizing forces from a supramolecular receptor influences the kinetics of HS<sup>-</sup> in a nucleophilic aromatic substitution (S<sub>N</sub>Ar) reaction within organic media
- We hypothesize that the non-covalent interactions from the supramolecular receptor will stabilize and reduce the reactivity of HS<sup>-</sup>
- This study can provide insight into how our bodies might stabilize HS<sup>-</sup> through non-covalent interactions and give us a better understanding of the behavior of this species in biological systems

## Methods

- Given that HS<sup>-</sup> is a highly nucleophilic, easily oxidized, air, and water sensitive molecule, work must be done in an inert glove box to assure air-free techniques throughout the experiments
- Once solutions are made in the glove box, the kinetics information is obtained through UV-vis spectroscopy
- These are then used to create non-linearized plots to obtain kinetic information

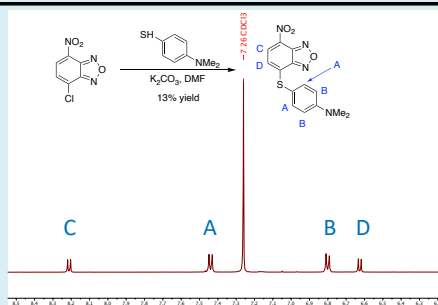
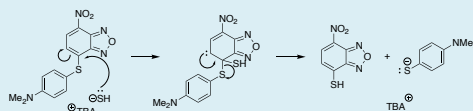
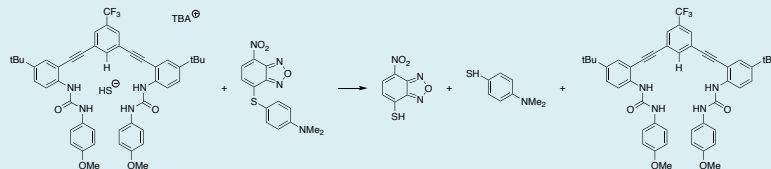


Figure 1 <sup>1</sup>H NMR of pure NBD thioether intermediate and synthetic scheme

## Project Scheme



Scheme 1 Synthetic mechanism of S<sub>N</sub>Ar reaction without the addition of the supramolecular receptor



Scheme 2 Synthetic scheme of S<sub>N</sub>Ar reaction with the addition of the supramolecular receptor

## Kinetics Data

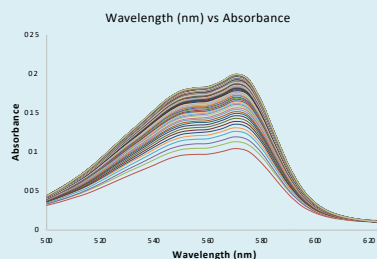


Figure 2 Wavelength (nm) vs Absorbance graph without receptor, 200 scans obtained over 3 min

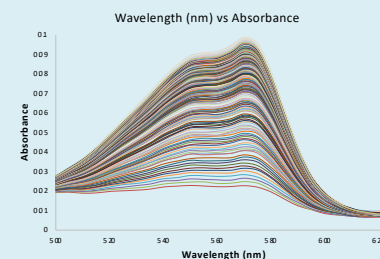


Figure 3 Wavelength (nm) vs Absorbance graph with receptor, 350 scans obtained over 5.5 min

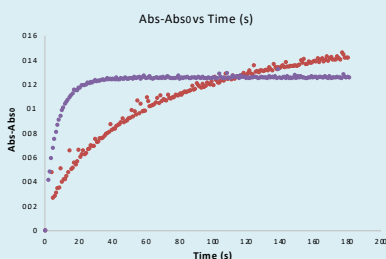


Figure 4 Absorbance vs Time (s), red line indicates with receptor while purple line indicates no receptor

- Preliminary data from Figures 2-4 indicate that the receptor slowed the reaction
- The close succession of scans and number of scans preceding the peak showed in Figure 3 compared to Figure 2 indicates a slower reaction when the receptor is present
- The graphs in Figure 4 show that there is, visibly, a more gradual slope with the receptor in the reaction mixture compared to the reaction without the receptor present, indicating a slower rate of reaction

## Conclusions

- The preliminary data shows that the supramolecular receptor slows down the reaction
  - Work is being done to replicate the data and obtain quantitative rates
- HS<sup>-</sup> is an extremely reactive molecule and nature must be stabilizing it somehow
  - We see that the noncovalent interactions in our receptor can be utilized to stabilize and reduce the rates of HS<sup>-</sup>
- This study can help us understand how nature might be stabilizing HS<sup>-</sup> and it will give us a better understanding of the behavior of HS<sup>-</sup>

## Future Directions

- We hope to see if by decreasing the concentration of receptor – which in turn would increase the concentration of unbound HS<sup>-</sup> – influences the rate kinetics
  - We would run experiments at various receptor equivalence to directly compare the rate kinetics to see if the concentration of host and guest influence the speed of the reaction
- We also hope to use a deuterium labelled receptor to see if we can observe an equilibrium isotope effect through the rate kinetics

## Acknowledgments

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