



Introduction

In the field of chemistry, the interactions between biological compounds, such as the heme unit, and nitric oxide (NO) are thoroughly studied and researched. However, there is much more to be learned from molecules that have the ability to generate NO within a biological system. One such NO donor is hydroxamic acid – a compound utilized in the pharmaceutical industry. This project studies the interactions between molecules that donate nitric oxide, and synthetic ruthenium-metal based models of the heme unit. The focus of this research is to understand the redox behavior of the reactions between these compounds through the use of electrochemical and spectroelectrochemical techniques. It is important to understand and learn more about the interactions between organic nitric oxide-donating molecules and heme-containing biomolecules due to their abundance in biological structures. Additionally, this project may potentially provide insight to unknown side-effects of hydroxamic acid-containing medications.

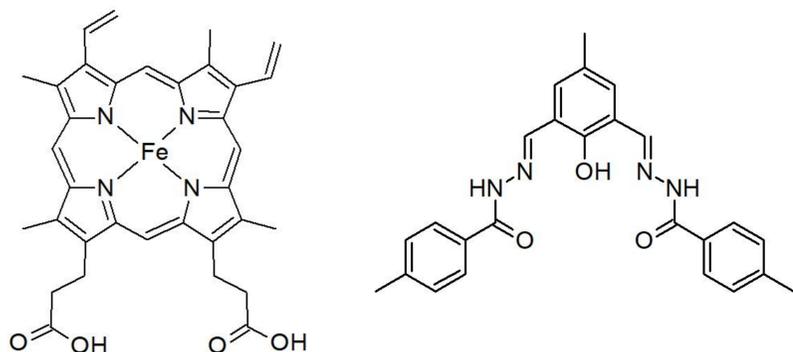


Figure 1. For the purposes of this project, a synthetic porphyrin model – henceforth referred to as the 5C ligand – is used. (Left) Molecular structure of iron protoporphyrin IX. (Right) Five-coordinate (5C) ligand.

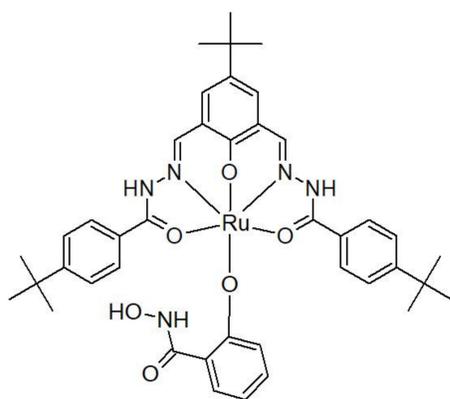


Figure 2. Proposed structure of 5C(RuHate) – the suspected NO donating compound. More spectroscopic data is required to determine exactly where the hydroxamate bonds to the ligand. Note: this ligand is the tri-t-butyl substituent variation.

Preparation

There are four basic to synthesizing the complete synthetic porphyrin model, ending with the final hydroxamate complex product. At each step, IR and NMR are taken to verify the structure of the compound. TLC may also be performed to verify that the compound is clean, and there are no remaining starting materials. Additionally, electrochemistry in the form of cyclic voltammetry (CV) is performed on each compound to monitor any redox potential changes.

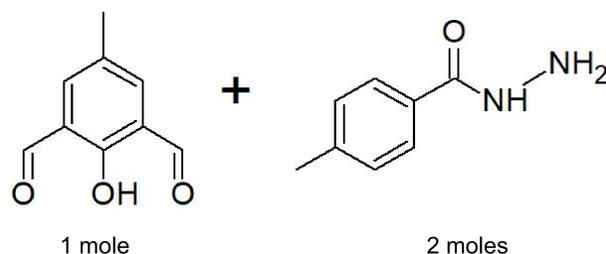


Figure 3. Synthesis of 5C ligand from one mole of a symmetrical aldehyde and two moles of a hydrazide.

Electrochemistry/Spectroelectrochemistry

A small irreversible reduction was observed on the cyclic voltammogram of the 5C(RuHate) compound at about -1.0 V.

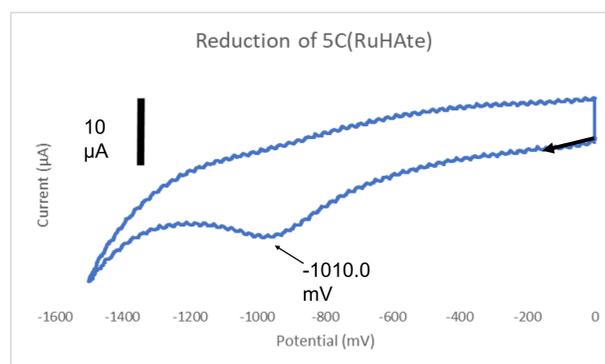


Figure 4. Cyclic voltammogram of 1.1 mM 5C(RuHate) dichloromethane solution with 0.1 M NBu₄PF₆ at 25° C. Potentials are referenced to a Ag/AgCl pseudo reference electrode. Scan rate of 200 mV/s.

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A new peak at 1885 cm⁻¹ was observed in the spectroelectrochemical difference spectrum (figure 5.) after the -1.0 V reduction of 5C(RuHate). The IR spectrum of a 5C(RuNO) complex provided evidence of an νNO stretch around 1887 cm⁻¹. This suggests that NO is being donated by the hydroxamate ligand as predicted.

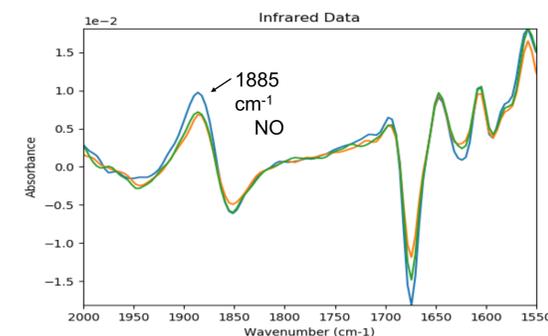


Figure 5. 5C(RuHate) difference spectroelectrochemical spectrum showing donation of NO during reduction. Three scans shown for reproducibility.

Future Work

Future research for our group includes synthesizing more iron and ruthenium hydroxamate complexes with different ligand substituents and hydroxamic acids. Additionally, we would like to further investigate the redox behavior of the compound through more electrochemistry and spectroelectrochemistry experiments.

Summary

- We have successfully synthesized synthetic ruthenium-metal based models of the heme unit.
- We have studied the electrochemistry and spectroelectrochemistry of these complexes.
- The difference spectrum (figure 5) shows the donation of NO via the compound.

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