



Electrochemical Properties of Ferrocene Derivatives

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Introduction

Ferrocenes undergo a simple one-electron oxidation between the ferrocene and ferricinium states. This transition was measured by CV to determine the redox potential for ferrocene and two of its derivatives (ferrocene carboxylic acid and methyl ferrocenoate). These properties make ferrocene and its derivatives useful as a standard when performing non-aqueous electrochemistry, as ferrocene is soluble in most non-polar solvents.

Results and Discussion

Methyl ferrocenoate was produced from ferrocene carboxylic acid. (Yield: 0.462g, 95.8%) The product was then characterized by ^1H NMR (CDCl_3 , 400 MHz).

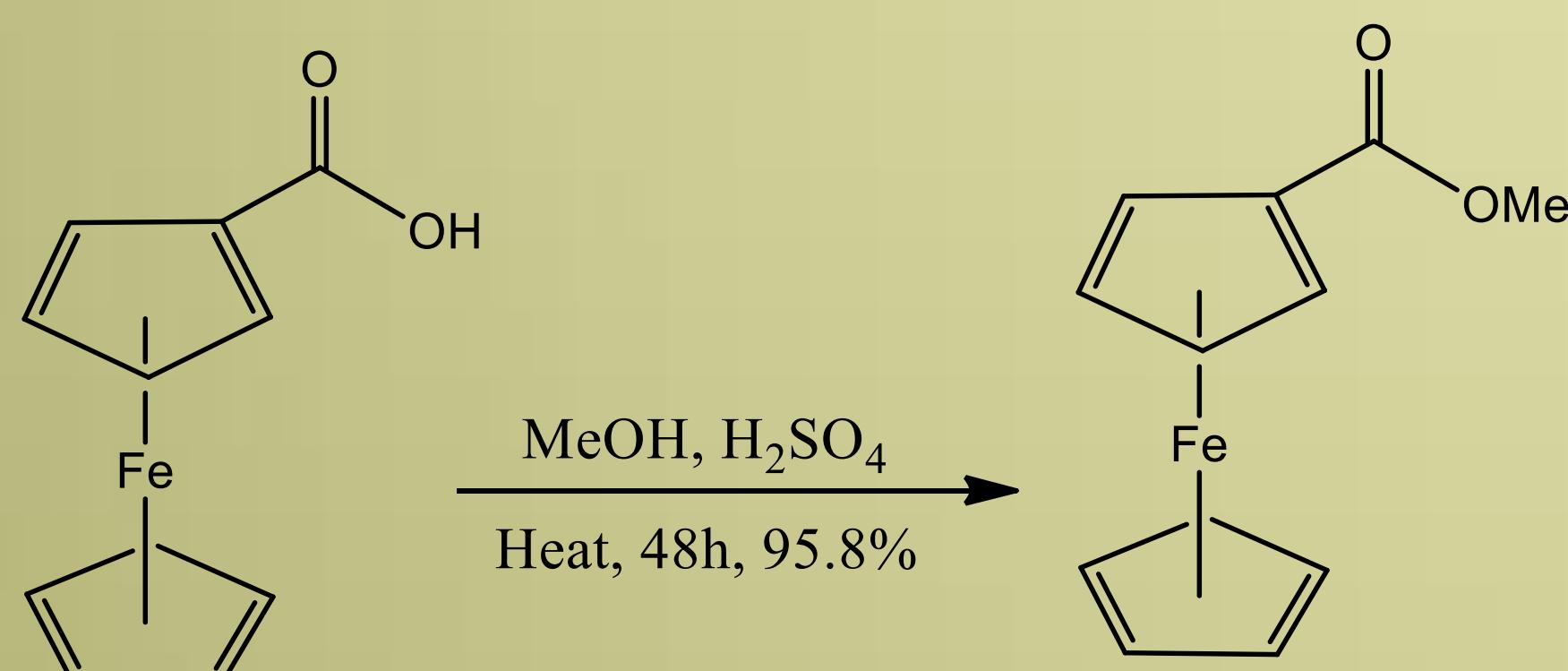


Figure 1: Reaction Scheme

Methyl ferrocenoate, ferrocene carboxylic acid, and ferrocene were then analyzed by cyclic voltammetry to determine their respective redox potentials (potential measured vs. Ag/AgCl reference electrode, 1 mM in acetonitrile containing 0.1 M sodium perchlorate) It was found that the ferrocenes substituted with electron withdrawing groups had a greater redox potentials than the unsubstituted ferrocene (Figure 3). This is because the electron-withdrawing groups make the metal center more electron-poor, and therefore more likely to be reduced.

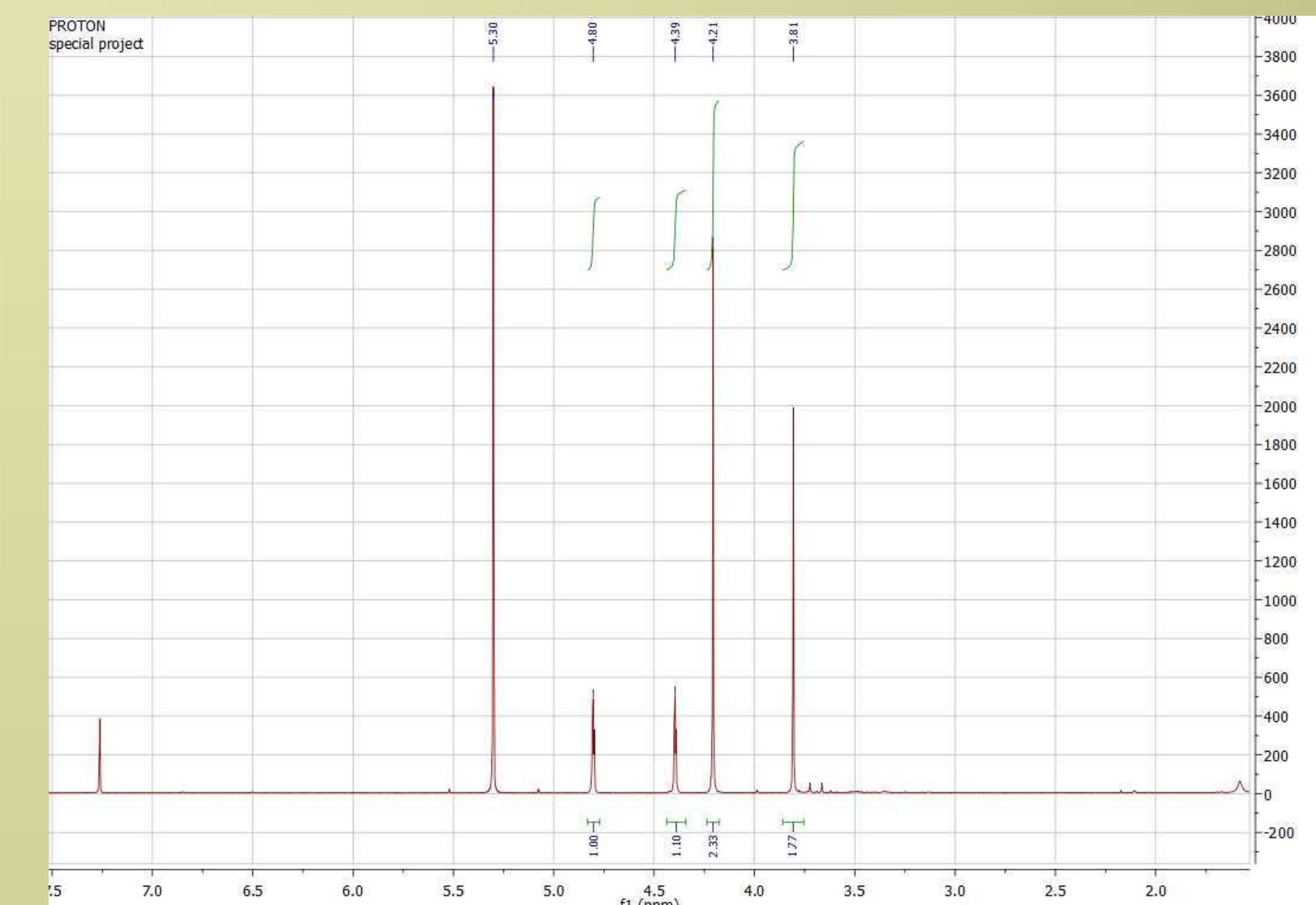


Figure 2 : NMR of Methyl Ferrocenoate

Species	E_{pa} (mV)	ΔE_p (mV)	$E_{1/2}$ (mV)
Ferrocene	401	71	366
Ferrocene Carboxylic Acid	637	70	602
Methyl Ferrocenoate	648	70	613

Figure 3 : Electrochemical Data

Conclusions

It was found that ferrocene derivatives with electron-withdrawing groups, such as ferrocene carboxylic acid and methyl ferrocenoate, had greater redox potentials than unsubstituted ferrocene.

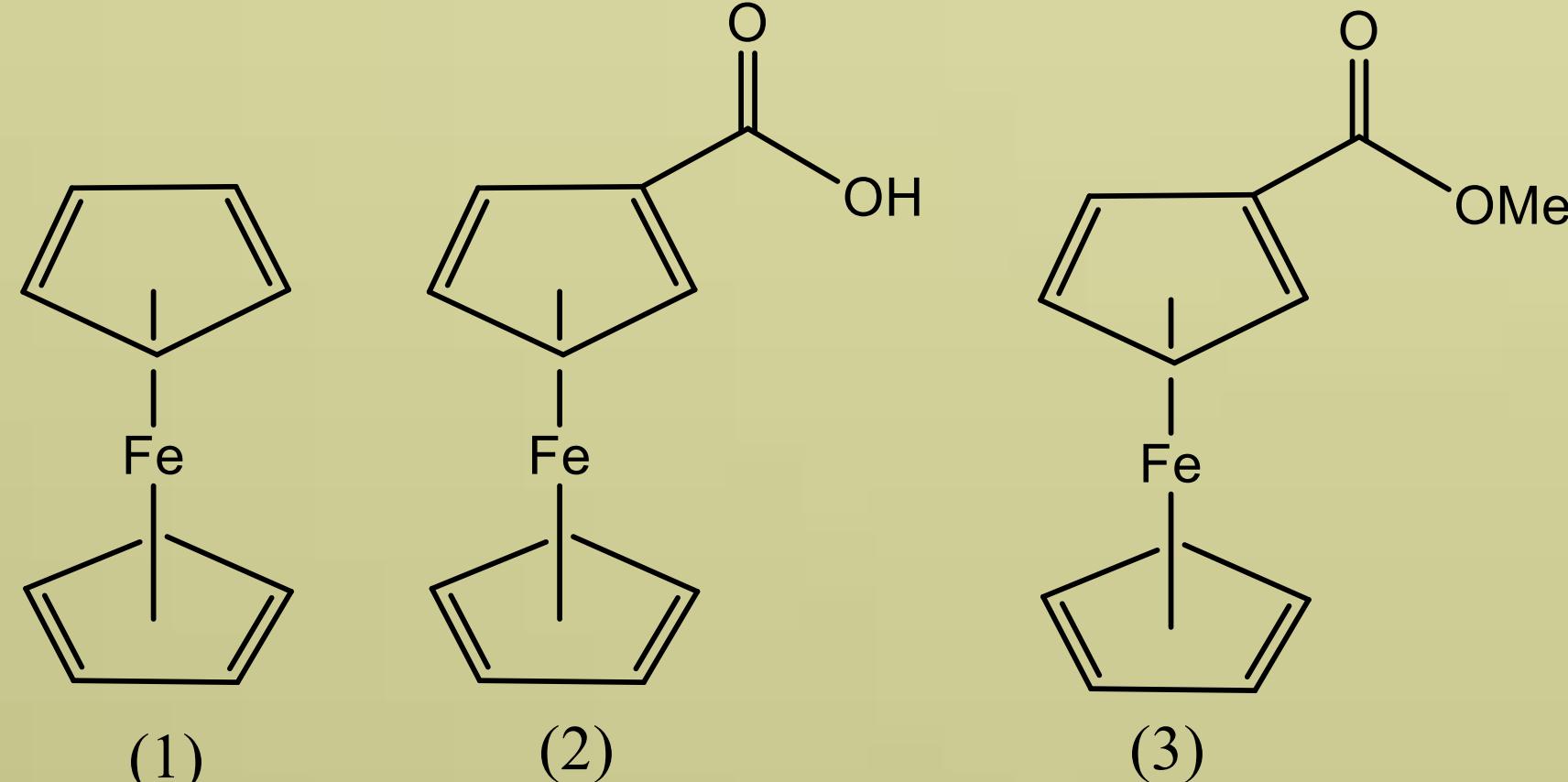


Figure 4: Ferrocene Derivatives Analyzed

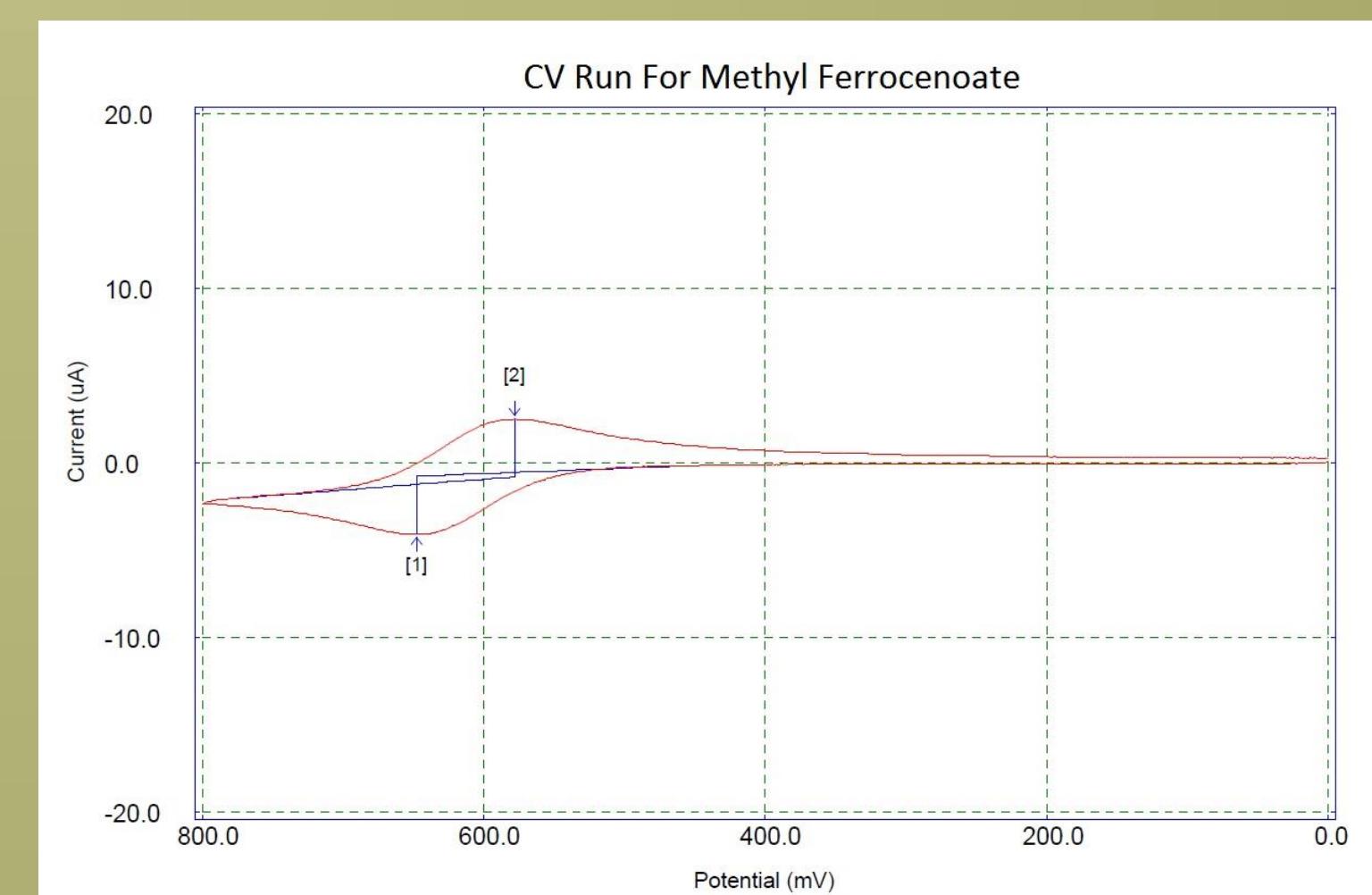
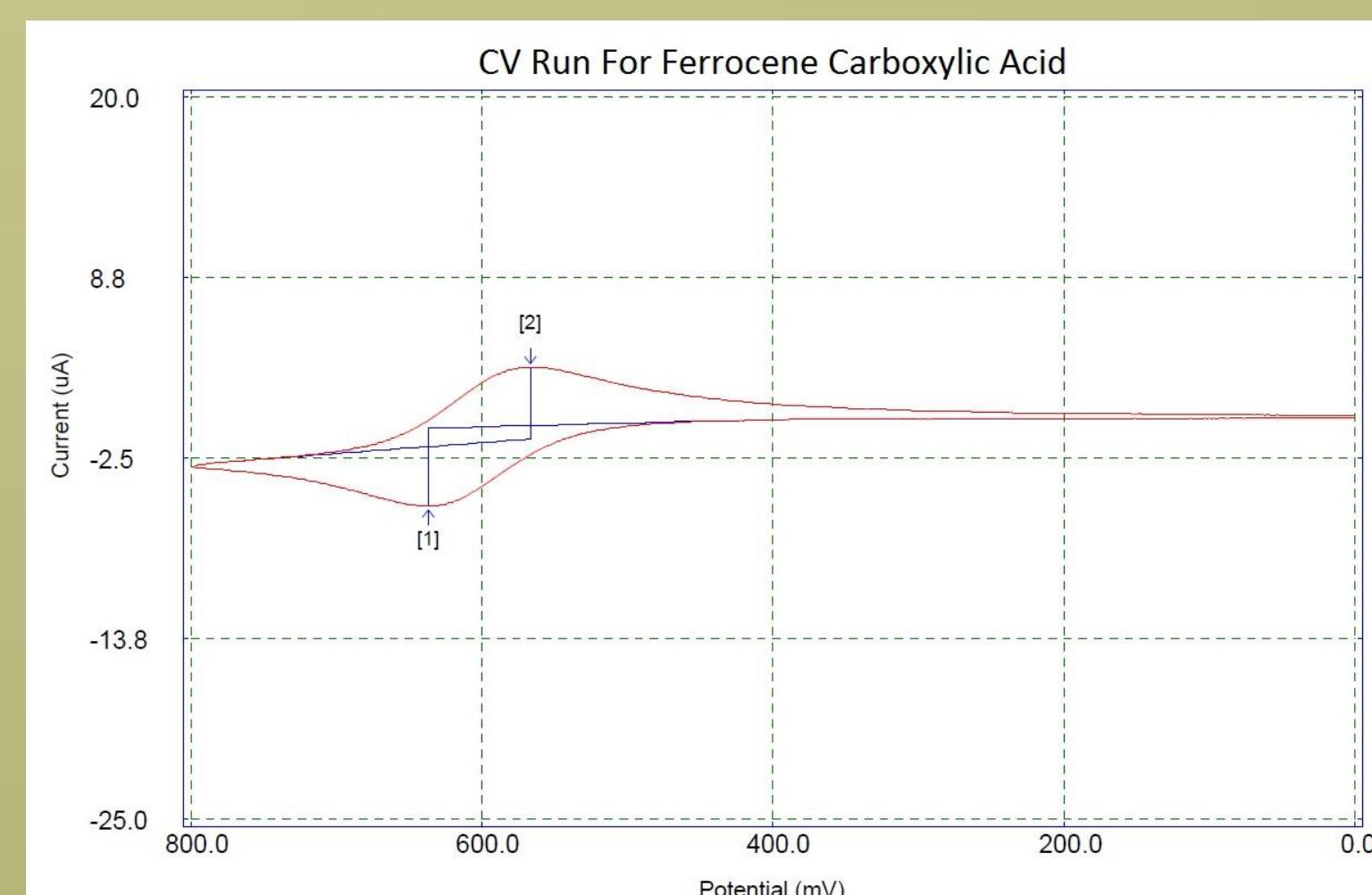
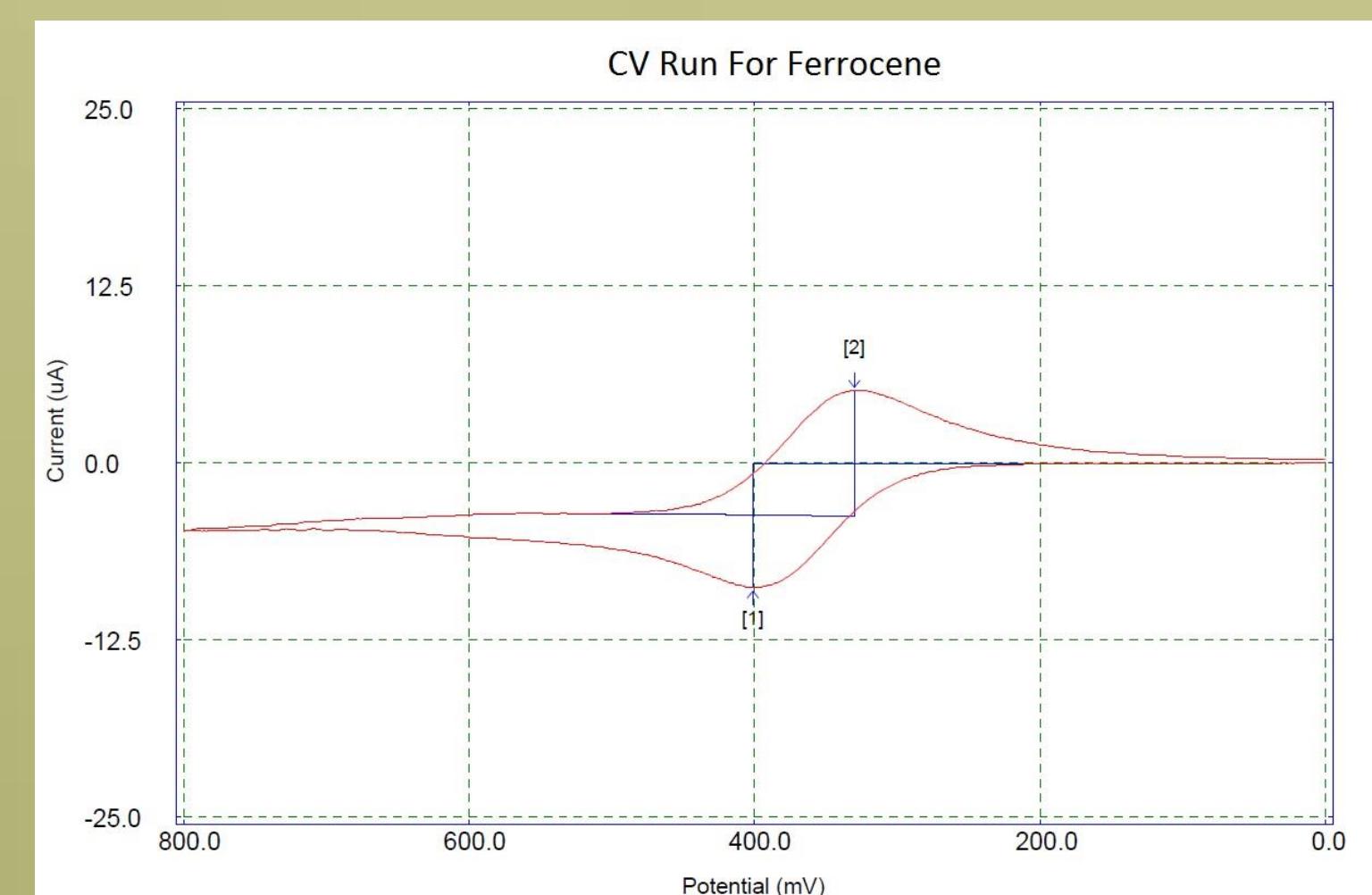


Figure 5: CV Readouts for All Compounds Studied.

References

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 - (3) Batterjee, S. *Appl. Organometal. Chem.* 2003; **17**: 291–297

Acknowledgments

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