APPENDIX

Cyclic voltammetry experiments

1. Calculation of the concentration of supporting electrolyte

1.1 Preparation of 0.1 M TEAP

TEAP has molecular weight = 229.71 g/mol.

In CH$_3$CN 50 ml, the number of grams of TEAP is

\[
\text{grams} = (229.71 \text{ g/mol}) (0.1 \text{ mol/l}) (50 \times 10^{-3} \text{ l})
\]

\[
= 1.140 \text{ g}
\]

∴ Weigh TEAP 1.140 g and dissolve in CH$_3$CN 50 ml.

1.2 Preparation of 0.1 M TBAP

TBAP has molecular weight = 387.43 g/mol

In CH$_3$CN 50 ml, the number of grams of TBAP is

\[
\text{grams} = (387.43 \text{ g/mol}) (0.1 \text{ mol/l}) (50 \times 10^{-3} \text{ l})
\]

\[
= 1.9371 \text{ g}
\]

∴ Weigh TBAP 1.9371 g and dissolve in CH$_3$CN 50 ml.

2. Calculation of the concentration of ketone and quinone compounds

2.1 Preparation of 1.0 \times 10^{-3} \text{ M Cyclohexanone in 50 ml CH}_3\text{CN}

Preparation of Cyclohexanone, the number of volume of Cyclohexanone in CH$_3$CN 50 ml is

\[
= (1 \times 10^{-3} \text{ mol/l}) (50 \times 10^{-3} \text{ l}) (98.15 \text{ g/mol})
\]

\[
= 0.947 \text{ g/ml}
\]

= 5.20 microlitre.
2.2 Preparation of $1.0 \times 10^{-3} \text{ M} \ p$-Benzoquinone 50 ml CH$_3$CN

$p$-Benzoquinone has molecular weigh $= 108.1 \text{ g/mol}$

Preparation of $p$-Benzoquinone $1.0 \times 10^{-3} \text{ M}$, the number of gram of $p$-Benzoquinone in CH$_3$CN 50 ml $= (108.1 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{ l})$

$= 5.405 \text{ mg}$

\[ \therefore \text{ Weigh } p\text{-Benzoquinone 5.405 mg and dissolve in CH}_3\text{CN 50 ml which TBAP 1.931 g (0.1M).} \]

2.3 Preparation of $1.0 \times 10^{-3} \text{ M}$ Tetrahydroxybenzoquinone in 50 ml CH$_3$CN

Tetrahydroxy-1,4-benzenequinone F.W = 208.13 g/mol

Preparation of Tetrahydroxy-1,4-benzenequinone $1.0 \times 10^{-3} \text{ M}$, the number of gram of Tetrahydroxy-1,4-benzenequinone in CH$_3$CN 50 ml is

$= (208.13 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{ l})$

$= 10.4065 \text{ mg}$.

\[ \therefore \text{ Weigh Tetrahydroxy-1,4-benzenequinone 10.4065 mg and dissolve in CH}_3\text{CN 50 ml with TBAP 1.9371 g.} \]

2.4 Preparation of $1.0 \times 10^{-3} \text{ M}$ Benzophenone in 50 ml CH$_3$CN

Benzophenone F.W = 182.2 g/mol

Preparation of benzophenone $1.0 \times 10^{-3} \text{ M}$, the number of gram of Benzophenone in 50 ml CH$_3$CN $= (182.2 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{ l})$

$= 9.110 \text{ mg}$

\[ \therefore \text{ Weigh Benzophenone 9.110 mg and dissolve in CH}_3\text{CN 50 ml with TBAP 1.9371 g (0.1 M).} \]
2.5 Preparation of $1.0 \times 10^{-3}$ M $\alpha$-Tetralone in 50 ml CH$_3$CN

$\alpha$-Tetralone F.W. $= 146.19$ g/mol

Preparation of $\alpha$-Tetralone $1.0 \times 10^{-3}$ M, the number of gram of $\alpha$-Tetralone in 50 ml CH$_3$CN $= (146.19$ g/mol)($1.0 \times 10^{-3}$ mol/l)($50 \times 10^{-3}$ l) $= 7.3095$ mg

From $D = m/V$

The number of volume of $\alpha$-Tetralone $= \frac{7.3095 \text{ mg}}{1.096 \text{ g/ml}} = 6.67 \times 10^{-3}$ ml

2.6 Preparation of $1.0 \times 10^{-3}$ M 1,4-Naphthoquinone in 50 ml CH$_3$CN

1,4-Naphthoquinone F.W. = 158.0 g/mol

Preparation of 1,4-Naphthoquinone $1.0 \times 10^{-3}$ M, the number of gram of 1,4-Naphthoquinone in 50 ml CH$_3$CN is $= (158.2$ g/mol)($1.0 \times 10^{-3}$ mol/l)($50 \times 10^{-3}$ l) $= 7.908$ mg

∴ Weigh 1,4-Naphthoquinone 7.908 mg and dissolve in CH$_3$CN 50 ml with TBAP 1.931 g (0.1 M).

2.7 Preparation of $1.0 \times 10^{-3}$ M Anthrone in 50 ml CH$_3$CN

Anthrone F.W. = 194.23 $\text{g/mol}$

Preparation of Anthrone $1.0 \times 10^{-3}$ M, the number of gram of Anthrone in 10 ml CH$_3$CN is $= (194.23$ g/mol)($1.0 \times 10^{-3}$ mol/l)($50 \times 10^{-3}$ l) $= 9.711$ mg

∴ Weigh Anthrone 9.711 mg and dissolve in CH$_3$CN 50 ml with TEAP 0.229 g (0.1 M).
2.8 Preparation of $1.0 \times 10^{-3}$ M 9-Xanthone in 50 ml CH$_3$CN

9-Xanthone F.W = 196.21 g/mol

Preparation of 9-Xanthone $1.0 \times 10^{-3}$ M, the number of gram of 9-Xanthone in 10 ml CH$_3$CN is

$$= (196.21 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{l})$$

$$= 9.810 \text{ mg}$$

\[\therefore\] Weigh 9-Xanthone 9.810 mg and dissolve in CH$_3$CN 50 ml with TBAP 1.937 g (0.1 M)

2.9 Preparation of $1.0 \times 10^{-3}$ M Anthraquinone in 50 ml CH$_3$CN

Anthraquinone F.W = 208.22 g/mol

Preparation of Anthraquinone $1.0 \times 10^{-3}$ M, the number of gram of Anthraquinone in 50 ml CH$_3$CN

$$= (208.22 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{l})$$

$$= 10.411 \text{ mg}$$

\[\therefore\] Weigh Anthraquinone 10.411 mg and dissolve in CH$_3$CN 50 ml with TBAP 1.937 g (0.1 M).

2.10 Preparation of $1.0 \times 10^{-3}$ M 1,2-Dihydroxyanthraquinone in 50 ml CH$_3$CN

1,2-Dihydroxyanthraquinone F.W = 240.21 g/mol

Preparation of 1,2-Dihydroxyanthraquinone $1.0 \times 10^{-3}$ M, the number of gram of 1,2-Dihydroxyanthraquinone in 50 ml CH$_3$CN is

$$= (240.21 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{l})$$

$$= 12.010 \text{ mg}$$

\[\therefore\] Weigh 1,2--Dihydroxyanthraquinone 12.010 mg and dissolve in CH$_3$CN 50 ml with TBAP 1.937 g (0.1 M).
2.11 Preparation of $1.0 \times 10^{-3}$ M 1,4-Dihydroxanthraquinone in 50 ml CH$_3$CN

1,4-Dihydroxanthraquinone F.W = 240.21 g/mol

Preparation of 1,4-Dihydroxanthraquinone $1.0 \times 10^{-3}$ M, the number of gram of 1,4-Dihydroxanthraquinone in 10 ml CH$_3$CN is

$$= (240.21 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{l})$$

$$= 12.010 \text{ mg}$$

Weigh 1,4-Dihydroxanthraquinone 12.010 mg and dissolve in CH$_3$CN 50 ml with TBAP 1.937 g (0.1 M).

2.12 Preparation of $1.0 \times 10^{-3}$ M 1,8-Dihydroxyanthraquinone in CH$_3$CN 50 ml

1,8-Dihydroxyanthraquinone F.W = 240.21 g/mol

Preparation of 1,8-Dihydroxyanthraquinone $1.0 \times 10^{-3}$ M, the number of gram of 1,8-Dihydroxyanthraquinone in 50 ml CH$_3$CN is

$$= (240.21 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(50 \times 10^{-3} \text{l})$$

$$= 12.010 \text{ mg}$$

Weigh 1,8-Dihydroxyanthraquinone 12.010 mg and dissolve in CH$_3$CN 50 ml with TBAP 1.937 g (0.1 M).

2.13 Preparation of $1.0 \times 10^{-3}$ M Dammacanthal in 10 ml CH$_3$CN

Dammacanthal F.W = 294.0 g/mol

Preparation of Dammacanthal $1.0 \times 10^{-3}$ M, the number of gram of Dammacanthal in 10 ml CH$_3$CN is

$$= (294.0 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(10 \times 10^{-3} \text{l})$$

$$= 2.940 \text{ mg}$$

Weigh Dammacanthal 2.940 mg and dissolve in CH$_3$CN 10 ml with TEAP 0.229 g (0.1 M).
3. Calculation of the concentration of Silver

$$AgNO_3 \text{ F.W} = 169.87 \text{ g/mol}.$$  

3.1 Preparation of silver $1.0 \times 10^{-2} \text{ M}$ in acetonitrile 50 ml with 0.1 M TEAP

The number of gram of AgNO$_3$ in 50 ml CH$_3$CN is

$$= (169.87 \text{ g/mol})(1.0 \times 10^{-2} \text{ mol/l})(50 \times 10^{-3} l)$$

$$= 0.0849 \text{ g}$$

:. Weigh AgNO$_3$ 0.0849 g and dissolve in CH$_3$CN 50 ml with TEAP 1.140 g (0.1 M).

3.2 Preparation of silver 0.1 M in acetonitrile 50 ml

The number of gram of AgNO$_3$ in 50 ml CH$_3$CN is

$$= (169.87 \text{ g/mol})(0.1 \text{ mol/l})(50 \times 10^{-3} l).$$

$$= 0.8494 \text{ g}$$

:. Weigh AgNO$_3$ 0.8494 g and dissolve in CH$_3$CN 50 ml.

3.3 Preparation of silver $1.0 \times 10^{-4} \text{ M}$ in acetonitrile 100 ml

The number of gram of AgNO$_3$ in 100 ml CH$_3$CN is

$$= (169.87 \text{ g/mol})(1.0 \times 10^{-4} \text{ mol/l})(100 \times 10^{-3} l)$$

$$= 1.699 \text{ mg}$$

:. Weigh AgNO$_3$ 1.699 mg and dissolve in CH$_3$CN 100 ml.
4. UV-Visible experiments

4.1 Calculation of the concentration of ketones

4.1.1 Cyclohexanone $1.0 \times 10^{-2}$ M in CH$_3$CN 100 ml

Preparation of Cyclohexanone, the number of volume of Cyclohexanone in CH$_3$CN 100 ml is

$$= \left(1 \times 10^{-2}\text{ mol/l}\right)\left(100 \times 10^{-3}\text{ l}\right)\left(98.15\text{ g/mol}\right)$$

$$= 0.947\text{ g/ml}$$

$$= 103.64\text{ microlite}$$

4.1.2 $p$-Benzoquinone $1.0 \times 10^{-2}$ M CH$_3$CN 100 ml

$p$-Benzoquinone F.W = 108.1 g/mol

Preparation of $p$-Benzoquinone $1.0 \times 10^{-2}$ M, the number of gram of $p$-Benzoquinone in CH$_3$CN 100 ml is

$$= \left(108.1\text{ g/mol}\right)\left(1.0 \times 10^{-2}\text{ mol/l}\right)\left(100 \times 10^{-3}\text{ l}\right)$$

$$= 0.1081\text{ g}$$

\[\text{\textbf{.\textbf{. Weigh }p\text{-Benzoquinone 0.1081 g and dissolve in CH}_3\text{CN 100 ml.}}\]

4.1.3 Tetrahydroxy-1,4-benzenequinone $(7.0 \times 10^{-5}$ M) in CH$_3$CN 100 ml

Tetrahydroxy-1,4-benzenequinone F.W = 208.13 g/mol

Preparation of Tetrahydroxy-1,4-benzenequinone $7.0 \times 10^{-5}$ M, the number of gram of Tetrahydroxy-1,4-benzenequinone in CH$_3$CN 100 ml is

$$= \left(208.13\text{ g/mol}\right)\left(7.0 \times 10^{-5}\text{ mol/l}\right)\left(100 \times 10^{-3}\text{ l}\right)$$

$$= 1.456\text{ mg}$$

\[\text{\textbf{.\textbf{. Weigh Tetrahydroxy-1,4-benzoquinone 1.456 mg and dissolve in CH}_3\text{CN 100 ml.}}\]
4.1.4 Benzophenone (2.0 x 10⁻⁵ M) in CH₃CN 100 ml.

Benzophenone F.W. = 182.2 g/mol

Preparation of Benzophenone 2.0 x 10⁻⁵ M, the number of gram of Benzophenone in 100 ml CH₃CN is

= (182.2 g/mol)(2.0 x 10⁻⁵ mol/l)(100 x 10⁻³ l)

= 0.3644 mg

∴ Weigh benzophenone 0.3644 mg and dissolve in CH₃CN 100 ml.

4.1.5 α-Tetralone (3.0 x 10⁻⁵ M) in CH₃CN 100 ml

α-Tetralone F.W. = 146.19 g/mol

Preparation of α-Tetralone 3.0 x 10⁻⁵ M, the number of gram of α-Tetralone in 100 ml CH₃CN is

= (146.19 g/mol)(3.0 x 10⁻⁵ mol/l)(100 x 10⁻³ l)

= 0.4386 mg

From \[ D = \frac{m}{V} \]

The number of volume of α-Tetralone = \(0.4386 \text{ mg})

\[ \frac{1.096 \text{ g/ml}}{0.4386 \text{ mg}} = 400.18 \text{ microlite.} \]

4.1.6 1,4-Naphthoquinone (5.0 x 10⁻⁵ M) in CH₃CN 100 ml

1,4-Naphthoquinone F.W. = 158.2 g/mol

Preparation of 1,4-Naphthoquinone 5.0 x 10⁻⁵ M, the number of gram of 1,4-Naphthoquinone in 100 ml CH₃CN is

= (158.2 g/mol)(5.0 x 10⁻⁵ mol/l)(100 x 10⁻³ l)

= 0.791 mg

∴ Weigh 1,4-Naphthoquinone 0.791 mg and dissolve in CH₃CN 100 ml.
4.1.7 Anthrone (1.0 x 10^{-5} M) in CH\textsubscript{3}CN 100 ml

Anthrone F.W = 194.23 g/mol

Preparation of Anthrone 1.0 x 10^{-5} M, the number of gram of Anthrone in 100 ml CH\textsubscript{3}CN is

= (194.23 g/mol) (1.0 x 10^{-5} mol/l)(100 x 10^{-3} l)

= 0.1942 mg

.: Weigh Anthrone 0.1942 mg and dissolve in CH\textsubscript{3}CN 100 ml.

4.1.8 Xanthone (2.0 x 10^{-5} M) in CH\textsubscript{3}CN 100 ml

Xanthone F.W = 196.21 g/mol

Preparation of 9-Xanthone 2.0 x 10^{-5} M, the number of gram of 9-Xanthone in 100 ml CH\textsubscript{3}CN is

= (196.21 g/mol)( 2.0 x 10^{-5} mol/l)(100 x 10^{-3} l)

= 0.3924 mg

.: Weigh 9-Xanthone 0.3924 mg and dissolve in CH\textsubscript{3}CN 100 ml.

1.4.9 Anthraquinone (9.0 x 10^{-6} M) in CH\textsubscript{3}CN 100 ml

Anthraquinone F.W = 208.22 g/mol

Preparation of Anthraquinone 9.0 x 10^{-6} M, the number of gram of Anthraquinone in 100 ml CH\textsubscript{3}CN is

= (208.22 g/mol)( 9.0 x 10^{-6} mol/l)(100 x 10^{-3} l).

= 0.1874 mg.

.: Weigh Anthraquinone 0.1874 mg and dissolve in CH\textsubscript{3}CN 100 ml.

1.4.10 1,2-Dihydroxyanthraquinone (4.0 x 10^{-5}M) in CH\textsubscript{3}CN 100 ml

1,2-Dihydroxyanthraquinone F.W = 240.21 g/mol

Preparation of 1,2-Dihydroxyanthraquinone 4.0 x 10^{-5} M, the number of gram of 1,2-Dihydroxyanthraquinone in 100 ml CH\textsubscript{3}CN is

= (240.21 g/mol)( 4.0 x 10^{-5} mol/l)(100 x 10^{-3} l)

= 0.9608 mg.
Weigh 1,2-Dihydroxyanthraquinone 0.9608 mg and dissolve in CH$_3$CN 100 ml.

4.1.11 1,4-Dihydroxyanthraquinone (1.0 x $10^{-5}$ M) in CH$_3$CN 100 ml

1,4-Dihydroxyanthraquinone F.W = 240.21 g/mol

Preparation of 1,4-Dihydroxyanthraquinone 1.0 x $10^{-5}$ M, the number of gram of 1,4-Dihydroxyanthraquinone in 100 ml CH$_3$CN is

$$\text{number of gram} = (240.21 \text{ g/mol})(1.0 \times 10^{-5} \text{ mol/L})(100 \times 10^{-3} \text{ L})$$

$$= 0.2402 \text{ mg}$$

Weigh 1,4-Dihydroxyanthraquinone 0.2402 mg and dissolve in CH$_3$CN 100 ml.

4.1.12 1,8-Dihydroxyanthraquinone (1.0 x $10^{-5}$ M) in CH$_3$CN 100 ml

1,8-Dihydroxyanthraquinone F.W = 240.21 g/mol

Preparation of 1,8-Dihydroxyanthraquinone 1.0 x $10^{-5}$ M, the number of gram of 1,8-Dihydroxyanthraquinone in 100 ml CH$_3$CN is

$$\text{number of gram} = (240.21 \text{ g/mol})(1.0 \times 10^{-5} \text{ mol/L})(100 \times 10^{-3} \text{ L})$$

$$= 0.2402 \text{ mg}$$

Weigh 1,8-Dihydroxyanthraquinone 0.2402 mg and dissolve in CH$_3$CN 100 ml.

4.1.13 Dammacanthal (2.0 x $10^{-5}$ M) in CH$_3$CN 100 ml

Dammacanthal F.W = 294.0 g/mol

Preparation of Dammacanthal 2.0 x $10^{-5}$ M, the number of gram of Dammacanthal in 25 ml CH$_3$CN

$$\text{number of gram} = (294.0 \text{ g/mol})(2.0 \times 10^{-5} \text{ mol/L})(100 \times 10^{-3} \text{ L})$$

$$= 0.5880 \text{ mg}$$
.
.
. Weigh Dammcanthal 0.5880 mg and dissolve in CH\textsubscript{3}CN 100 ml

5. The chemically modified carbon paste electrode experiments

5.1 Preparation of HNO\textsubscript{3} 0.2 M

M.W. of HNO\textsubscript{3} is equal to 63.01 g/mol

Preparation of HNO\textsubscript{3} 0.2 M in distill water 500 ml, the number of gram of HNO\textsubscript{3} in 500 ml distill water is

\[ = (63.01 \text{ g/mol})(0.2 \text{ mol/l})(500 \times 10^{-3} \text{l}) \]

\[ = 6.301 \text{ g} \]

But it was prepared from HNO\textsubscript{3} 65% w/w

Calculation of HNO\textsubscript{3} 65% w/w is

HNO\textsubscript{3} 65 g in solution 100 g

HNO\textsubscript{3} 6.301 g in solution = (100 g x 6.301 g)/(65 g)

\[ = 9.693 \text{ g} \]

From \( D = m/V \)

\[ V = (9.693 \text{ g})/(1.42 \text{ g/ml}) \]

\[ = 6.83 \text{ ml} \]

So HNO\textsubscript{3} 0.2 M was prepared by pipett 6.83 ml of HNO\textsubscript{3} 65% w/w mixed with distill water 500 ml.

5.2 Preparation of 1.0 x 10\textsuperscript{-3} M silver ion in HNO\textsubscript{3} 0.2 M

Preparation of Silver 1.0 x 10\textsuperscript{-3} M in 500 ml of 0.2 M HNO\textsubscript{3}, the number of gram of AgNO\textsubscript{3} in 500 ml of 0.2 M HNO\textsubscript{3} is

\[ = (169.87 \text{ g/mol})(1.0 \times 10^{-3} \text{ mol/l})(500 \times 10^{-3} \text{l}) \]

\[ = 0.0849 \text{ g} \]

.
.
. Weigh AgNO\textsubscript{3} 0.0849 g and dissolve in 500 ml of 0.2 M HNO\textsubscript{3}. 
PRESENTATION OF THIS THESIS

1. This research was poster presented by Mr. Chanwit Photicunapat. In the topic of the electrochemical behavior of some ketone and quinone compounds in 55th Annual Meeting of the International Society of Electrochemistry, 19-24 September 2004, THESSALONIKI, GREECE.

2. This work was orally presented by Mr. Chanwit Photicunapat in The Postgraduate Education and Research Program in Chemistry Congress III, 9-12 May 2004, Jomtien Palm Beach Resort Pattaya, Chonburi, Thailand.

3. It was orally presented in The 2nd PSU Symposium on Graduate Research Conference, 12 March 2004, Graduate School, Prince of Songkla University, Thailand which presented by Mr. Chanwit Photicunapat.

4. The presentation about electrochemistry of 29th Congress on Science and Technology of Thailand, 20-22 October 2003, Golden Jubilee Convention Hall, Khon Kean University, Thailand which was poster presented by Mr. Chanwit Photicunapat. In the topic of the electrochemical behavior of some aromatic ketone compounds and their application to silver ion analysis.

5. The poster presentation of 30th Congress on Science and Technology of Thailand during 19-21 October 2004 at Impact Exhibition and Convention Center, Muang Thong Thani, Bangkok, Thailand which was poster presented by Mr. Chanwit Photicunapat. In the topic of the electrochemical behavior of some ketone and quinone compounds and their application to silver analysis.