



UNIVERSITI PUTRA MALAYSIA

**ELECTROCHEMICAL STUDIES OF [Cu(phen)(c-mala)]NO₃,
[Cu(phen)₂Cl₂]·5.5H₂O, [Cu(phen)(edda)]·5H₂O,
AND THEIR INTERACTION WITH DNA AND H₂O₂**

YAW CHONG WEY

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By

YAW CHONG WEY

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirements for the Degree of Master of Science**

February 2012

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirement for the degree of Master of Science

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[Cu(phen)(c-mala)]NO₃, [Cu(phen)₂Cl₂] \cdot 5.5H₂O, [Cu(phen)(edda)] \cdot 5H₂O,
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February 2012

Chairman : Assoc. Prof. Tan Wee Tee, PhD

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ABSTRACT

Electrochemical characterization of the copper complexes; [Cu(phen)(c-mala)]NO₃, [Cu(phen)₂Cl₂] \cdot 5.5H₂O, and [Cu(phen)(edda)] \cdot 5H₂O (phen= phenanthroline; c-mala = c-methylaniline; and edda = ethylenediaminediacetic) have been carried out using cyclic voltammetry (CV), chronocoulometry (CC), and chronoamperometry (CA). These copper(II) complexes were found to be electroactive as shown by its well defined redox waveforms during cyclic voltammetry.

The results of double potential steps chronocoulometric (CC) studies show the

presence of surface charge to be in the order of 10^{-4} C/cm². A linear plot of log I versus log scan rate with slope of near 0.5 was obtained indicating the presence of a diffusion controlled process. The monotonic rising current transient observed during chronoamperometric studies provides another evidence of the diffusion controlled process. Based on hydrodynamic voltammetry studies, the diffusion coefficients of [Cu(phen)(c-mala)]NO₃; [Cu(phen)₂Cl₂]₅•5.5H₂O and [Cu(phen)(edda)]•5H₂O were found to be of the order of 10⁻⁷ cm²/s. The interaction between copper(II) complexes and DNA and between copper(II) complexes and H₂O₂ were also investigated using cyclic voltammetry. The above electrochemical interaction was evident as their CV results revealing a slight shift in peak potential and a significant decrease in redox peak currents of Cu(II) complexes in the presence of DNA. It indicates that the interaction between the copper(II) complex with DNA molecule is via intercalation process. On the other hand, gel electrophoresis showed evident of deformation of DNA by the copper complexes. The “chemical nuclease” activity follows the order: [Cu(phen)₂Cl₂]₅•5.5H₂O > [Cu(phen)(c-mala)]NO₃ > [Cu(phen)edda]•5H₂O > CuSO₄.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**PENGAJIAN ELECTROKIMIA TERHADAP
[Cu(phen)(c-mala)]NO₃, [Cu(phen)₂Cl₂].5.5H₂O, [Cu(phen)(edda)].5H₂O,
DAN INTERAKSI DENGAN DNA DAN H₂O₂**

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YAW CHONG WEY

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ABSTRAK

Pengajian elektrokimia ke atas kompleks kuprum; [Cu(phen)(c-mala)]NO₃, [Cu(phen)₂Cl₂].5.5H₂O, [Cu(phen)(edda)].5H₂O (phen= phenanthroline; c-mala = c-methylalanine; and edda = ethylenediaminediacetic) telah dijalankan dengan menggunakan voltammetri berkitar (CV), kronokolometri (CC), dan kronoamperometri (CA). Semua kompleks kuprum(II) tersebut didapati berkelakuan secara elektroaktif seperti yang telah ditunjukkan oleh gelombang yang ditakrifkan sebagai redoks sepanjang kitaran voltammetri. Keputusan dalam pengajian dwipotensi dalam langkah kronokolometri (CC) telah menunjukkan kehadiran caj pada permukaan dalam lingkungan nilai 10^{-4} C/cm². Satu graf linear dengan

logaritma terhadap arus dengan logaritma terhadap kadar imbasan berbanding telah diplotkan dan mempunyai nilai kecerunan yang berhampiran dengan 0.5 serta ia menunjukkan kehadiran proses resapan terkawal. Ekanada meningkat semasa transien telah diperhatikan dalam kajian kronoamperometrik dan ia telah membuktikan proses resapan terkawal. Berdasarkan pengajian voltammetri hidrodinamik, pekali resapan kompleks kuprum(II); $[\text{Cu}(\text{phen})(\text{c-mala})]\text{NO}_3$, $[\text{Cu}(\text{phen})_2\text{Cl}_2] \cdot 5.5\text{H}_2\text{O}$, $[\text{Cu}(\text{phen})(\text{edda})] \cdot 5\text{H}_2\text{O}$ telah dijumpai dalam lingkungan nilai $10^{-7} \text{ cm}^2/\text{s}$. Interaksi antara kompleks kuprum(II) dengan DNA dan antara kompleks kuprum(II) dengan H_2O_2 juga telah disiasat menggunakan voltammetri kitar. Keputusan voltammetri berkitar telah menunjukkan sedikit anjakan dalam puncak potensi dan penurunan ketara dalam puncak arus redoks Cu(II) kompleks dengan kehadiran DNA. Ia menunjukkan bahawa interaksi antara kompleks kuprum(II) dengan molekul DNA adalah melalui proses interkalasi. Tambahan pula, elektroforesis gel juga membuktikan terdapat perubahan dalam bentuk DNA disebabkan oleh kompleks kuprum tersebut. Aktiviti terhadap nuklues kimia adalah seperti berikut;



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I certify that a Thesis Examination Committee has met on 17 February 2012 to conduct the final examination of Yaw Chong Wey on his thesis entitled “Electrochemical Studies of $[\text{Cu}(\text{phen})(\text{c-mala})]\text{NO}_3$, $[\text{Cu}(\text{phen})_2\text{Cl}_2]\cdot 5.5\text{H}_2\text{O}$, $[\text{Cu}(\text{phen})(\text{edda})]\cdot 5\text{H}_2\text{O}$, and Their Interaction with DNA and H_2O_2 ” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

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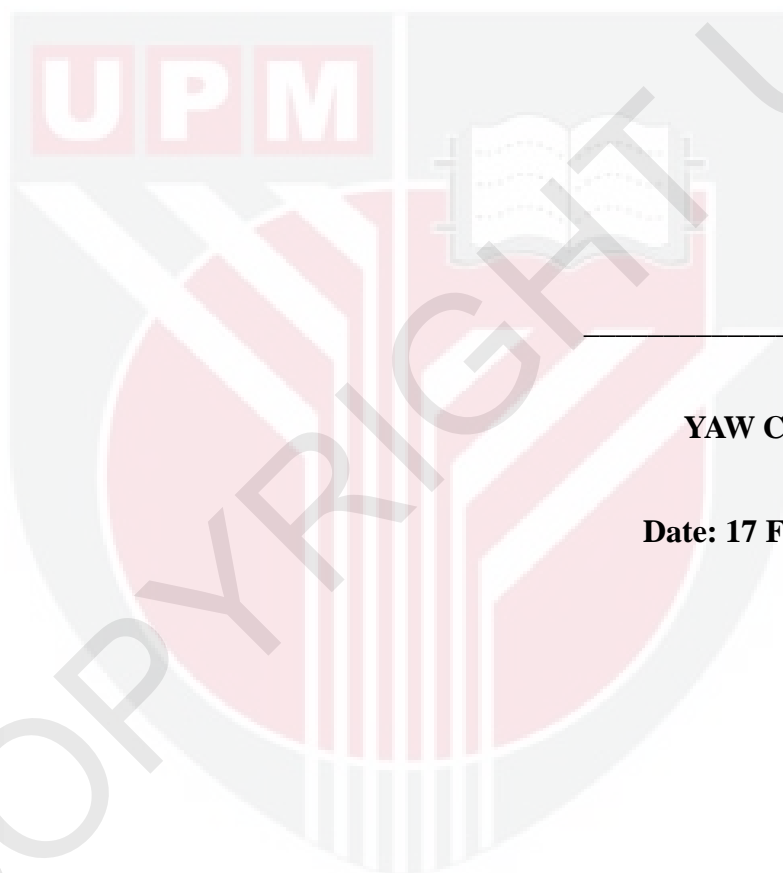
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DECLARATION

I declare that the thesis is my original work except for quotation and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



YAW CHONG WEY

Date: 17 February 2012

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