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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ELECTROCHEMICAL STUDIES OF $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2]\cdot 5.5H_2O$, $[Cu(phen)(edda)]\cdot 5H_2O$, AND THEIR INTERACTION WITH DNA AND H_2O_2

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

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

ELECTROCHEMICAL STUDIES OF $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2]\cdot 5.5H_2O$, $[Cu(phen)(edda)]\cdot 5H_2O$, AND THEIR INTERACTION WITH DNA AND H_2O_2

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February 2012

Chairman : Assoc. Prof. Tan Wee Tee, PhD

Faculty : Science

ABSTRACT

Electrochemical characterization of the copper complexes; $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2)_5]\cdot 5.5H_2O$, and $[Cu(phen)(edda)]\cdot 5H_2O$ (phen= phenanthroline; c-mala = c-methylanaline; 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/cm^2. 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 $[Cu(phen)(c\text{-}mala)]NO_3$; $[Cu(phen)_2Cl_2)_5]\cdot 5.5H_2O$ and $[Cu(phen)(edda)]\cdot 5H_2O$ were found to be of the order of 10^{-7} cm^2/s. The interaction between copper(II) complexes and DNA and between copper(II) complexes and H_2O_2 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: $[Cu(phen)_2Cl_2]\bullet 5.5H_2O > [Cu(phen)(c\text{-}mala)]NO_3 > [Cu(phen)edda]\bullet 5H_2O > CuSO_4$.

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

PENGAJIAN ELECTROKIMIA TERHADAP $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2]\cdot 5.5H_2O$, $[Cu(phen)(edda)]\cdot 5H_2O$, DAN INTERAKSI DENGAN DNA DAN H_2O_2

Oleh

YAW CHONG WEY

Februari 2011

Pengerusi : Profesor Madya Tan Wee Tee, PhD

Fakulti : Sains

ABSTRAK

Pengajian elektrokimia ke atas kompleks kuprum; $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2]\cdot 5.5H_2O$, $[Cu(phen)(edda)]\cdot 5H_2O$ (phen= phenanthroline; c-mala = c-methylanaline; and edda = ethylenediaminediacetic) telah dijalankan dengan menggunakan voltammetri berkitar (CV), kronocolometri (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 kronocolometri (CC) telah menunjukkan kehadiran caj pada permukaan dalam lingkungan nilai 10^{-4} C/cm^2. 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); $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2]\cdot 5.5H_2O$, $[Cu(phen)(edda)]\cdot 5H_2O$ telah dijumpai dalam lingkungan nilai 10^{-7} cm^2/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;

$[Cu(phen)_2Cl_2]\bullet 5.5H_2O > [Cu(phen)(c\text{-}mala)]NO_3 > [Cu(phen)edda]\bullet 5H_2O > CuSO_4$.

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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 $[Cu(phen)(c\text{-}mala)]NO_3$, $[Cu(phen)_2Cl_2]\cdot 5.5H_2O$, $[Cu(phen)(edda)]\cdot 5H_2O$, 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.

Members of the Thesis Examination Committee were as follows:

Asmah binti Hj Yahaya, PhD
Associate Professor
Centre of Foundation Studies for Agriculture Science
Universiti Putra Malaysia
(Chairman)

Nor Azah binti Yusof, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Kamaliah binti Sirat, PhD
Senior Lecturer
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Sulaiman bin Ab Ghani, PhD
Associate Professor
Pusat Pengajian Sains Kimia
Universiti Sains Malaysia
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 21 May 2012

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Tan Wee Tee, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Tan Wen Siang, PhD
Professor
Faculty of Biotechnology & Biomolecular Sciences
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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.

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YAW CHONG WEY

Date: 17 February 2012

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