UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF BIOSENSOR FOR DETERMINATION OF Cd(II) AND Hg(II) IONS BY EXPLOITING MWCNT/PEPTIDE NANOHYBRID MODIFIED Au ELECTRODE

NADIAH BINTI ABDUL RAHMAN I

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By

NADIAH BINTI ABDUL RAHMAN

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

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Abstract of thesis presented to the Senate of University Putra Malaysia in fulfillment of the requirements for the degree of Master of Science.

DEVELOPMENT OF BIOSENSOR FOR DETERMINATION OF Cd(II) AND Hg(II) IONS BY EXPLOITING MWCNT/PEPTIDE NANOHYBRID MODIFIED Au ELECTRODE

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May 2011

Chairman : Associate Professor Nor Azah Yusof, PhD

Faculty : Science

A biosensor for simultaneous detection of Cd(II) and Hg(II) was developed by using MWCNT/peptides modified Au electrode using cyclic voltammetry (CV). It was observed that the MWCNT/peptide modified gold electrode has significant superior analytical performance in determination of Cd(II) and Hg(II) compared to the unmodified gold electrode.

The gold electrode surfaces are modified with peptides that were synthesized by self assembly of cysteine monomers in the presence of diphenylphosphoryl azide (DPPA). This self assembly approach leads to rapid access of cyclic dimer and linear tripeptide of cysteine. The yielded peptides together with the MWCNT are attached to the Au electrode for further characterization and optimization with CV. The experimental conditions such as pH, supporting electrolyte, reproducibility and scan rates of the modified Au electrode were optimized.

Modification of peptide and MWCNT on the Au electrode surface has increased the sensitivity and selectivity of the electrochemical sensor for simultaneous determination of Cd(II) and Hg(II) ion. The reproducibility of the electrochemical sensor was good with relative standard deviation (R.S.D) value of 2.52%. The linear response for Cd(II)(in presence of borate buffer at pH 3) was obtained in the range of 0.1 ppm to 50.5 ppm whereas for Hg(II)(in presence of acetate buffer at pH 2) the linear response was obtained in the range of 0.1 ppm to 50.0 ppm.

The slope value of log I_p versus log v is 0.61-0.85 demonstrate that the modified Au electrode undergoes diffusion-adsorption controlled process. The sensitivity expressed as the slope of linear region of calibration curve was 6×10^{-6} A/ppm in borate buffer (pH 3) and 8×10^{-7} A/ppm in acetate buffer (pH 2). The limit of detection (L.O.D) for Cd(II) is 2.75×10^{-8} M whereas the limit of detection for Hg(II) is 9.07×10^{-10} M. The developed electrochemical sensors were applied in analysis of electroplating and wood industrial waste water for simultaneous determination of toxic metal Cd(II) and Hg(II). The results of the waste water sample analysis based on the developed method showed a comparable result with the ICP-OES method.

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

PEMBANGUNAN PENDERIABIO UNTUK PENGESANAN Cd(II) DAN Hg(II) ION DENGAN MENGEKSPLOITASI MWCNT/PEPTIDA PENGUBAHSUAIAN Au ELEKTROD

Oleh

NADIAH BINTI ABDUL RAHMAN

Mei 2011

Pengerusi : Prof Madya Nor Azah Binti Yusof, PhD

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Satu pengesan penderiabio untuk pengesanan serentak Cd(II) dan Hg(II) ion telah dibangunkan dengan menggunakan MWCNT/ peptida Au elektrod yang dikaji dengan menggunakan teknik voltamentri siklik. Dapat dilihat bahawa pengesan elektrokimia yang telah diubahsuai dengan MWCNT/peptida Au elektrod mempunyai pencapaian yang luar biasa dalam pengesanan Cd(II) dan Hg(II) berbanding Au elektrod yang tidak diubahsuai.

Permukaan Au elektrod telah diubahsuai dengan peptida yang telah disintesis menggunakan teknik self assembly iaitu mengsintesis sisteina dengan kehadiran DPPA. Kaedah sintesis ini menjurus kepada penghasilan yang cepat gelang dimer dan rantai panjang dipeptida sisteina. Hasil peptida yang telah diperolehi bersama dengan MWCNT dilekatkan pada permukaan Au elektrod untuk diklasifikasikan dengan lebih mendalam menggunakan voltammetri siklik(CV).

Keadaan eksperimen seperti perubahan pH, jenis elektrolit penyokong yang sesuai, kebolehan penghasilan semula, kadar imbasan telah di optimakan.

Penambahan peptida dan MWCNT ke atas Au elektrod telah berjaya meningkatkan sensitiviti dan selektiviti alat pengesan elektrokimia dalam pengesanan serentak ion Cd(II) dan Hg(II). Elektrod yang telah diubahsuaikan mempunyai kebolehan penghasilan semula yang bagus dengan nilai sisihan piawai relatif 2.52%. Garis lurus penentu ukur untuk Cd(II) dengan kehadiran elektrolit penyokong asid borat pada pH 3 adalah dalam lingkungan 0.1 ppm ke 50.5 ppm manakala untuk Hg(II) dengan kehadiran asid asetik pada pH2 nilai yang diperoleh adalah dalam lingkungan of 0.1 ppm ke 50 ppm.

Nilai kecerunan log I_p melawan log v adalah 0.61-0.85 dimana ia adalah proses pembebasan-penyerapan yang terkawal. Sensitiviti yang diperoleh adalah nilai kecerunan garis lurus penentu ukur dimana nilainya adalah 6×10^{-6} A/ppm untuk kehadiran asid borat(pH 3) dan 8×10^{-7} A/ppm untuk kehadiran asid asetik (pH 2). Nilai had pengesanan (LOD) untuk Cd(II) adalah 2.75×10^{-8} M dan nilai had pengesanan untuk Hg(II) adalah 9.07×10^{-10} M. Pengesan elektrokimia yang telah dibangunkan untuk pengesanan serentak Cd(II) dan Hg(II) telah diaplikasikan di dalam sampel sebenar industri iaitu dalam sampel industri kayu dan sampel industri elektro-mendapan. Keputusan yang diperolehi dari teknik yang dibangunkan mempunyai nilai yang hampir sama dengan keputusan yang di peroleh dari teknik ICP-OES.

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I certify that a Thesis Examination Committee has met on 19 May 2011 to conduct the final examination of Nadiah Abdul Rahman on her thesis entitled **"Development of Biosensor for Determination of Cd(II) and Hg(II) Ion by Exploiting MWCNT/Peptide Nanohybrid Modified Au Electrode"** in accordance with the Universities and University Collages 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:

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

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Date:

DECLARATION

I declare that the thesis is my original work except for quotations 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 University Putra Malaysia or at any other institutions.

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NADIAH BINTI ABDUL RAHMAN

Date: 19 May 2011

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