出國報告(出國類別：參加國際會議)

參加 2012 年 iCBEB 國際研討會議

會議名稱：

2012 生物醫學工程與生物技術國際研討會(iCBEB)

2012 International Conference on Biomedical Engineering and Biotechnology (iCBEB)

服務單位：國立暨南國際大學

姓名:科技學院 電機工程學系 孫台平 教授兼任院長

派赴國家：大陸 澳門

出國期間： 2012.05.28 ~2012.05.30

報告日期： 2013.04.30

摘要

參加學術研討會是學術研究重要吸收專業知識機會，每年世界各地皆會舉辦大大小小研討會，對於本人研究領域於生物感測器相關知識，研討會除了進行論文發表外，更舉辦優秀論文獎選拔、專家演講等項目進行，對於學術研究者吸收新知的場域與國際交流機會。本會議由美國電氣和電子工程師協會（IEEE）主辦，澳門大學承辦，此會議涵蓋生物信息學、計算生物學和系統生物學、生物醫學信號處理生物醫學成像和影像處理、細胞及組織工程其他相關信息等領域，會議收錄的所有文章將由美國電氣和電子工程師協會（IEEE）出版，進入美國電氣和電子工程師協會網路刊物(IEEE Xplore)，並被工程資訊有限公司(Engineering Information Inc., EI)全文核心檢索。優秀論文將推薦到科學引用文獻索引資料庫(Science Citation Index Expanded, SCI)期刊和其他國際期刊免費發表，此行會難得機會與世界各地專家學者進行交流。

目錄

目的

本會議為工作在生物醫學工程及生物技術國際會議的各學者，專家提供一個交流討論的平台，促進大陸及港澳台地區生物醫學事業的發展，對於本人研究領域生醫感測器領域有所幫助，且此會議於中國澳門舉辦，世界各地生物醫學工程及生物技術領域專家學者齊聚於會上，使本人所發表論文進行交流與探討，此次發表題目「阻抗式前列腺癌免疫生物感測器 (Impedimetric PSA Immunosensor)」，內容主要以生物感測器為主，生物感測器是一門結合眾多領域的研究，運用層面之廣範，包含了生物、醫學、環境工程、食品安全等領域，透過研討會方式與世界各地專家學者進行交流，並了解世界的脈動未來的趨勢，經評審專家將有機會收錄於國際性期刊(SCI 期刊和其他國際期刊)上。

參加會議經過及紀要

2012 生物醫學工程及生物技術國際研討會(iCBEB)會議由美國電氣和電子工程師協會（IEEE）主辦，澳門大學承辦，此會議涵蓋生物信息學、計算生物學和系統生物學、生物醫學信號處理 生物醫學成像和影像處理、細胞及組織工程其他相關信息等領域，今年於 5 月 28-30 日中國澳門麗景灣酒店(Regency Hotel, 附件照片)舉辦，會議時間為期 3 天，包含專家演講、論文發表等會議議程。2012 生物醫學工程與生物技術國際會議（iCBEB2012）討論議題廣泛，包含生物感測器、生醫設備、人工器官，生醫影像等議題。

此論文發表方式於大會會議廳內張貼海報，並接受與會人員、國際學者觀摩與互動，並討論相關生物醫學工程(BioMedical Engineering)及生物科學(Biology Sciences)領域問題，匯集他方的意見及建議，也詢問本研究相關技術與創新性，以增進未來研究之深度及廣度。

過程中國立暨南國際大學應化系傅傳博教授也參與此次會議，傅教授發表一篇關於感測器相關領域技術，題目為「利用存活分析法及時間電流滴定法評估磁性奈米粒子細胞呼吸之影响 (The Evaluation of Cell Respiratory Effect of Magnetic Nanoparticles Using Viability Assay and Chronoamperometric

Method)」，在網版印刷的碳電極上，同時使用 MTT(黃色化合物，是一種接受氫離子的染料，可作用於活細胞腺粒體中的呼吸鏈(3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide))，利用氫化鐵(Ferro cyanide)濃度為成比例的電流響應，以評估肝細胞之存活率。

來自南洋理工大學(Nanyang Technological University)的 Prof. Ng Yin Kwee 報告利用熱像圖在生物醫學量測應用：乳癌偵測(Thermography Measurements in Biomedical Applications: breast tumour)，提出了紅外線熱成像技術(IRT)，用以偵測人體表面溫度，以診斷乳癌、發燒及眼睛異常等疾病，更是促進自我研究專長領域啟發，讓本實驗室紅外線讀出電路設計團隊有了不同感想與看法，並針對光感測器進行系統化讀取電路研究，如紅外線、紫外光、可見光等，將單一紅外波段擴展至多波段感測器，藉由一種讀出電路架構設計變成兩種以上電路模組，此想法藉由本會議聆聽紅外線文章發表將有不同研究主題，適合與實驗室之研究群討論未來發展方向與執行策略，因此本實驗利用相關研討會參與交流，使本研究有紅外線文章產出、發表與專利申請。

感想與建議

很高興能夠參加了這次在中國澳門所舉行的會議，從會場的佈置與不同主題內容的安排，可以看出目前各地學者，專家的研究趨勢。由於，會場報告領域之廣泛，聽取過程中接觸到更多領域、啟發另類的思維，最新資訊也使我們受益良多，會議裡也有許多國際知名的教授參與，聽完他們演講後不但可以了解新的研究領域，有助於我們之後研究能有更多元的思考更廣泛的發展，並且如何有組織的去一步一步邁進，進一步也可以知道未來自己應該往哪個方向做研究，對論文內容增加了很多可以實現的空間，尤其對於本實驗室紅外線讀取電路設計團隊，在於不同感測器條件下，其光感測之讀取電路架構有所不同，如直接注入型、電容轉阻放大器、緩衝注入型等，此多重讀取電路主態，將做為高解析度、高速度下紅外線影像成像有更有發展性與未來性。

研討會為工作在生物醫學工程及生物技術的各學者，專家提供一個交流討論的平台，集結世界各地、各領域之學者對其研究，不僅提

出許多有趣的研究構想及專業性技術發展，並了解未來的趨勢，掌握世界的脈動。在準備報告的過程當中，不但可以提升世界觀，並加強及促進自己思考以後研究的方向，並且可以經由別人的發問知道自己設計的缺點或是哪個部分還有改良的空間，尤其在會場中遇到與研究領域相同的學者，他們所提供的建議尤其珍貴。

對於教職人員而言，出國參加會議以及發表文章不但可以增廣見聞，實質上對以後研究方向也有相當大的幫助。會議中可以結識許多優秀國際友人，有助於學校名氣在國際場合中的能見度，達成學校研究學習國際化目標。因此希望能夠提供更多的資源，無論在研究方面或是補助經費，如此對於學校教職人員而言將會減低負擔並增加投稿發表的吸引力。也很高興能夠參加這次的會議，以後做研究時能有更寬廣的發揮空間。

攜回資料名稱及內容

此次會議帶回來了許多有用的資料，包括了 2012 年生物醫學工程及生物技術國際研討會會議的論文集以及其他會議相關資訊，這些資料尚未公佈於網路上提供下載，因此對於我們而言可以提早閱讀到這些重要的發表增加新的想法。

附錄

會場及住宿照片

會議場地：澳門麗景灣飯店

會議場地：澳門麗景灣飯店

會議流程表

會議流程表 **Conference Schedule**	
2012/05/28~30 May 28 ~ May 30, 2012	
08:00-18:00	註冊地點：澳門麗景灣酒店 Registration Location: Regency Hotel Macau
Note: You can register at any time during the conference	
Tuesday Morning, May 29	
09:00-09:15	開幕式 Opening Ceremony
09:15-09:30	主席致詞 Welcoming Speech Prof. Vai Mang I
09:30-09:40	大會開幕合影 Pose for Photographs
09:40-09:50	茶歇 Coffee Break
09:50-10:50	邀請演說 1： Keynote Speech 1: DNA Smart Materials and Devices, Prof. Dongsheng Liu
10:50-11:50	邀請演說 2： Keynote Speech 2: Thermography Measurements in Biomedical Applications: breast tumour, fever etc, Prof. Ng Yin Kwee
Tuesday Noon, May 29	
12:00-13:00	午餐 Lunch Location: Macau Ballroom, Regency Hotel
Tuesday Afternoon, May 29	
15:00-16:00	邀請演說 3： Keynote Speech 3: Bioengineering and Global Health, Dr. Roderic I. Pettigrew
16:00-16:15	茶歇 Coffee Break
16:15-17:15	邀請演說 4： Keynote Speech 4: Magnetic Resonance Imaging for Translational and Basic Life Sciences, Professor Ed X. Wu
Tuesday Evening, May 29	

18:00-19:00	晚餐 Dinner Location: Macau Ballroom, Regency Hotel
Wednesday Morning, May 30	
09:00-11:50	口頭形式發表 1：生物醫學工程 Oral 1: BioMedical Engineering Guia Room
	口頭形式發表 2：生物科學 Oral 2: Biology Sciences Taipa Room
	口頭形式發表 3：環境工程 Oral 3: Environmental Engineering Drawing Room
Wednesday Noon, May 30	
12:00-13:00	午餐 Lunch Location: Macau Ballroom, Regency Hotel
Wednesday Afternoon, May 30	
15:00-17:30	海報形式發表 1：生物醫學工程 Poster 1: BioMedical Engineering
	海報形式發表 2：生物科學 Poster 2: Biology Sciences
	海報形式發表 3：環境工程 Poster 3: Environmental Engineering
Wednesday Evening, May 30	
18:00-19:00	晚餐 Dinner Location: Macau Ballroom, Regency Hotel
Thursday, May 31	
09:00-09:30	Please gather at Regency Hotel
09:30-16:00	Have a nice trip at Macau

2012 International Conference on Biomedical Engineering and Biotechnology

Impedimetric PSA Immunosensor

Prostate Specific Antigen Biosensor

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***Abstract*—Regular check of blood prostate specific antigen (PSA) level is very important as it is related to prostate cancer. Hence, this study aims to build up a novel impedimetric PSA immumosensor (PSA-IMS) for accurate measurement of PSA. The impedimetric PSA-IMS was fabricated with PSA antibody immobilized on screen-printed carbon electrodes. Impedance measurement at a specific frequency ranges (22.80 Hz – 2.57 kHz) showed that the PSA-IMS has an excellent response range (6.25 – 400 ng/mL), with r^2>0.9, which covers the normal physiological and pathological ranges of blood PSA levels. Intraclass correlation coefficient (ICC) showed that the PSA-IMS has excellent reliability and validity (ICC>0.95). In conclusion, a simple and reliable PSA-IMS was developed and it is capable of precisely determining blood PSA levels in the range of pathological and normal physiological regions.**

in both the normal physiological and pathological ranges.

Keywords-Prostate specific antigen; Immunosensor; Impedance

I. INTRODUCTION

Prostate cancer is a global health problem that presents one of the 21st century's biggest medical challenges. It caused primary man death all over the world (3rd position) [1] and in Taiwan (7th position) [2]. In Taiwan, the youngest person suffering from prostate cancer is less than 30 years old [3], and many Taiwan people has a poor prevention concept of prostate cancer. About 50% of prostate cancer is in an advanced stage by the time the patient or clinician detects them.

The biomarker for the prostate cancer is prostate specific antigen (PSA) [4]. Regular check of this biomarker can reduce the incidence or mortality rate for the people who are at the high risk of prostate cancer. However, routine blood PSA level can only be assayed in hospital or clinic but not at home. Although there are some published PSA biosensors papers, many of them are complicated in their fabrication procedures [5,6]. Hence, this study aims to build up a novel impedimetric PSA immumosensor (PSA-IMS) for accurate measurement of PSA.

II. MATERIALS AND METHODS

A. Reagents and Solutions

Commercial reagents, with no additional purification, were used in this study. Phosphate-buffered saline (PBS), glutaraldehyde and bovine serum albumin (BSA) were bought from Sigma Chemical Company (St Louis, MO). PSA and PSA antibody was bought from Enzo Life Sciences (Farmingdale, NY) and Novus Biologicals (Littleton, CO), respectively. Deionized water (resistivity ≥ 18MΩcm), purified by a Millipore Milli-Q UFplus System (Bedford, MA), was used for all solutions preparation.

B. Equipments

All impedance spectrum measurements were conducted by the use of an impedance analyzer (Precision Impedance Analyzer WK6420C, Wayne Kerr Electronics Ltd, UK).

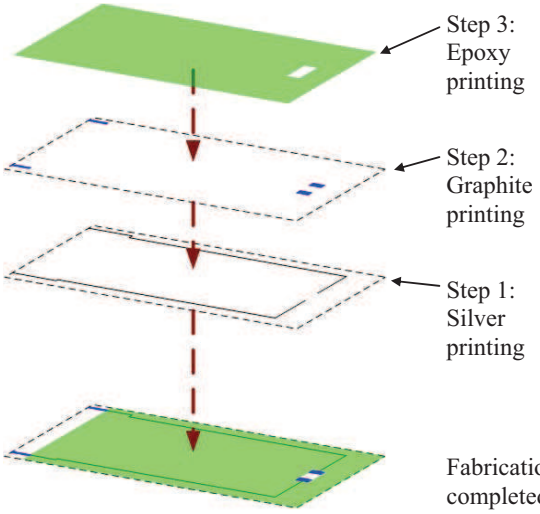

Figure 1. The fabrication steps for the PSA immumosensor. The substrate is polyethylene terephthalate. After each layer screen printing, it is placed at 80 °C for 30 minutes in order to dry the layer before the next layer screen printing.

978-0-7695-4706-0/12 $26.00 © 2012 IEEE
DOI 10.1109/iCBEB.2012.247

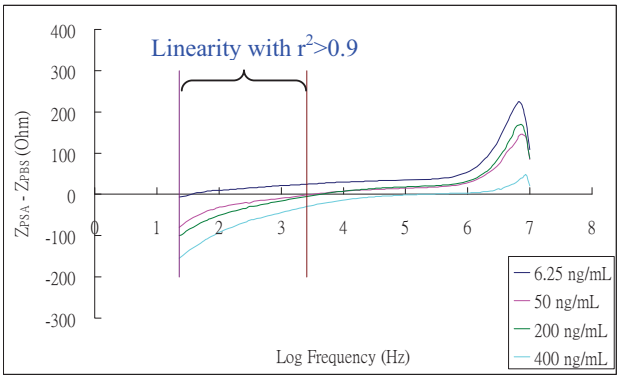

Figure 2. The PSA-IMS impedance response to PSA at various concentrations (6.25, 50, 200 and 400 ng/mL) within the frequency range of 20 Hz – 10 MHz. At a specific frequency range (22.80 Hz – 2.57 kHz), an excellent linear response range (6.25 – 400 ng/mL), with r^2>0.9, was observed.

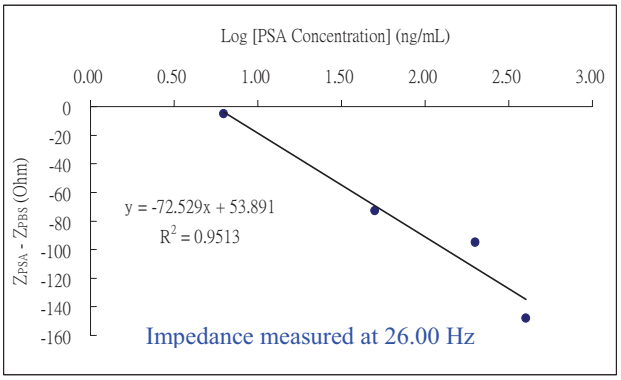

Figure 3. Calibration curve of the PSA-IMS on measuring PSA (6.25 – 400 ng/mL) at 26 Hz, within the specific frequency range (22.80 Hz – 2.57 kHz). The PSA-IMS has excellent linear response, with r^2=0.95 and sensitivity of -72.53 Ω/Log(ng/mL).

C. *PSA-IMS fabrication*

Screen printing technique is employed to construct the sensor with screen mesh size and screen emulsion thickness equal to 390 counts per inch and 25 μm, respectively. Fig. 1 shows the construction steps. Each sensor has 3 different layers: 1st layer of silver conducting tracks, 2nd layer of graphite pads and the 3rd layer of epoxy insulating shroud. The substrate is polyethylene terephthalate (PET) sheet. After each layer screen printing, it is placed at 80 °C for 30 minutes in order to dry the layer before the next layer screen printing.

For PSA antibody immobilization, glutaraldehyde (2.5%, 4 μL) was dropped onto the graphite pads of the sensor. Subsequently, a mixture of PSA antibody (4 μg, 2 μL) and BSA (0.1 M, 1 μL) was dropped again onto the graphite pads of the sensor and kept at 4 °C overnight.

D. *Measurements of the PSA-IMS impedance response to PSA*

All impedance spectrum measurements were carried out at room temperature and recorded over the frequency range of 20 Hz – 10 MHz. Within this frequency range, there was 100 frequency points per logarithmic decade. The amplitude of the perturbing wave was limited to 100 mV.

To perform the measurement, the PSA-IMS was connected to the impedance analyzer. PBS (10 μL, 25 mM, pH 7.0) was pipetted onto the PSA-IMS. After waiting for 60 seconds, impedance spectrum of the PBS (Z_{PBS}) was then recorded. After that, the PBS was removed and 5 μL PSA (6.25, 50, 200 and 400 ng/mL) was subsequently pipetted onto the PSA-IMS. After waiting for 180 seconds, the PSA was then removed and the PSA-IMS was immersed and softly washed with PBS (25 mM, pH 7.0). Then, a fresh PBS (10 μL, 25 mM, pH 7.0) was consequently pipetted onto the PSA-IMS. After waiting for 60 seconds, impedance spectrum was recorded again and this recorded impedance spectrum is called impedance spectrum of the PSA (Z_{PSA}). The PSA-IMS impedance response to PSA is calculated by subtracting Z_{PSA} from Z_{PBS} (i.e. $Z_{PSA} - Z_{PBS}$) of PSA at various concentrations.

Three discrete measurements were conducted consecutively with the intention of testing the reliability of the impedance spectrum measurements.

III. Results and Discussion

Fig. 2 showed the subtracted impedance spectrum (i.e. $Z_{PSA} - Z_{PBS}$) of PSA at various concentrations within the frequency range of 20 Hz – 10MHz. A specific frequency range (22.80 Hz – 2.57 kHz) was found, in which an excellent linear response range (6.25 – 400 ng/mL) could be obtained, with r^2>0.9. This excellent linear response range covers the normal physiological and pathological ranges of blood PSA levels. Fig. 3 showed the calibration curve of the PSA-IMS on measuring PSA at 26 Hz. It was found that the PSA-IMS has excellent linear (r^2=0.95) response with the sensitivity of -72.53 Ω/Log(ng/mL).

In order to evaluate the ability of the PSA-IMS on PSA determination, evaluation study had been conducted at the frequency of 26 Hz (Table 1). It was found that the PSA-IMS was able to precisely determine the concentrations of PSA (6.25 – 400 ng/mL) with the maximum percentage error of 3.00%.

Reproducibility of a variable can be evaluated by intraclass correlation coefficient (ICC). ICC>0.75 is generally suggested for good reliability [7]. In medical measurements, ICC>0.90 is definitely required so as to guarantee reasonable validity [8]. In this study, the ICC(3,1) value was 0.95 (Table 1) and this suggests that they have excellent reliability and validity.

Research is ongoing to study the interference study, the long-term stability of the PSA-IMS and real sample (i.e. PSA in blood) study. This result will be reported in due course.

Table 1. Evaluation of the PSA-IMS on the determination of the concentrations of PSA solutions at the frequency of 3.5 MHz.

Standard PSA Solutions (ng/mL)	Measured PSA Concentration (ng/mL)			Mean (ng/mL)	SD (ng/mL)	% Error	Intrarater Reliability (ICC 3,1)
	Trial 1	*Trial 2*	*Trial 3*				
6.25	5.98	6.41	6.12	6.17	0.22	3.00	0.95
25	25.32	25.39	25.23	25.31	0.08	1.26	
100	101.89	96.42	98.90	99.07	2.73	2.19	
400	399.85	394.05	393.03	395.65	3.67	1.09	

IV. Conclusion

A simple and reliable impedimetric PSA immumosensor was successfully designed and developed. A specific frequency range (22.80 Hz – 2.57 kHz) was found, in which an excellent linear response range could be obtained, with r^2>0.9. The PSA immumosensor has a linear working range, 6.25 – 400 ng/mL. It is capable of precisely determining blood PSA levels in the range of pathological and normal physiological regions. Therefore, a screening method was proposed in this study with the advantages of rapidity and inexpensiveness.

Acknowledgment

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