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DEVELOPMENT OF DNA ELECTROCHEMICAL SENSOR BASED ON SILICON NANOWIRES/GOLD NANOPARTICLES-MODIFED ELECTRODE FOR EARLY DETECTION OF DENGUE VIRUS

JAHWARHAR IZUAN BIN ABDUL RASHID

ITMA 2016 7

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By

JAHWARHAR IZUAN BIN ABDUL RASHID

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

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy

DEVELOPMENT OF DNA ELECTROCHEMICAL SENSOR BASED ON SILICON NANOWIRES/GOLD NANOPARTICLES-MODIFED ELECTRODE FOR EARLY DETECTION OF DENGUE VIRUS

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JAHWARHAR IZUAN ABDUL RASHID

August 2016

Chairman : Professor Nor Azah Yusof, PhD
Faculty : Institute of Advance Technology

A new DNA electrochemical sensor based on silicon nanowires (SiNWs) and gold nanoparticles (AuNPs) modified electrode was developed for dengue virus detection. In this study, two different fabricated electrodes; SiNWs/AuNPs-modified Indium tin oxide (ITO) and SiNWs/AuNPs-modified screen printed gold electrode (SPGE) have been fabricated. Field Emission Scanning Electron Microscope (FE-SEM) and Energy Dispersive X-ray Spectroscopy (EDX) analysis confirmed that the SiNWs/AuNPs-nanocomposite was deposited and uniformly distribution on the surface of ITO and SPGE. Based on cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) characterization, the fabricated SiNWs/AuNPs-ITO and SiNWs/AuNPs-SPGE have shown a good electrical conductivity compared to unmodified electrode. SiNWs/AuNPs nanocomposite was further explored as DNA matrix for DNA probe immobilization where dengue virus oligonucleotide was used as bio-sensing model to evaluate the performances of DNA electrochemical sensor. Electrochemical detection of hybridization events between immobilized DNA probe and complementary sequences of dengue virus were monitored by Different pulse voltammetry (DPV) technique using methylene blue (MB) as a redox indicator. The decrease of MB peak current was obtained after hybridization detection by both fabricated electrodes. The optimal performance of SiNWs/AuNPs-ITO and SiNWs/AuNPs-SPGE for electrochemical detection of dengue virus were obtained using response surface methodology (RSM): SiNWs volume (10.8 µL and 6 µL), dithiopropionic acid (DTPA) (0.52 mM and 0.45 µL), AuNPs volume (83 µL and 29 µL), DNA probe concentration (5.8 µM and 5 µM), immobilization time (14 hours and 10 hours), pH buffer (7.5 and 7.8), NaCl concentration (1.45 M and 0.80 M), hybridization temperature (45 ℃ and 42 ℃) and incubation time (12 min and 10 min), respectively. Under optimized condition, developed DNA sensor showed a higher sensitivity of oligonucleotide detection as compared to the non-optimized condition. It was shown that the developed DNA sensors; SiNWs/AuNPs-ITO and SiNWs/AuNPs-SPGE were able to detect complementary oligonucleotide dengue virus as low as 0.0891 ng/µL (10 pM) and 0.0000891 ng/µL (10 fM), respectively. The stability studies also have shown that fabricated ssDNA/AuNPs/SiNWs-ITO and the

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ssDNA/AuNPs/SiNWs-SPGE could be stored at 4 ℃ for 10 weeks and 7 weeks, respectively. It was found that the MB current signal of both developed DNA sensors have increased after the hybridization of immobilized DNA probe with genomic dengue virus from cell culture samples. However, this finding was unclear to justify the ability of both developed DNA sensor for direct detection of genomic dengue virus because of MB binding interaction issue and high non-specific hybridization for long genomic sequences. Hence, the preparation of specific and amplified target genomic dengue virus using reverse-transcribe-polymerase chain reaction (RT-PCR) were investigated. The parameters of annealing temperature, sonication time and reverse-forward (R/F) primer ratio using RT-PCR methods have been studied. Both developed DNA sensors are capable to discriminate the MB signal of blank electrode, negative serum samples, dengue 1 and 2 –spiked serum, cell culture and negative control. The LOD obtained for RT-PCR products value were 5.6 ng/µL and 2.8 ng/µL for SiNWs/AuNPs-ITO and SiNWs/AuNPs-SPGE, respectively. Furthermore, the developed DNA sensors; SiNWs/AuNPs-ITO and SiNWs/AuNPs-SPGE showed good reproducibility for nine measurements where the RSD value of 9.34 % and 8.23 % were obtained, respectively.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBANGUNAN ELEKTROKIMIA SENSOR DNA BERDASARKAN ELEKTROD MODIFIKASI NANOWAYAR SILIKON/NANOPARTIKEL EMAS UNTUK PENGESANAN AWAL VIRUS DENGGI

Oleh

JAHWARHAR IZUAN ABDUL RASHID

Ogos 2016

Pengerusi : Professor Nor Azah Yusof, PhD
Fakulti : Insititut Teknologi Maju

Sensor elektrokimia DNA baru berdasarkan modifikasi elektrod nanowayar silikon (SiNWs) dan nanopartikel emas (AuNPs) telah dibangunkan untuk pengesanan virus denggi. Dalam kajian ini, dua fabrikasi electrod berbeza; ITO modifikasi SiNWs/AuNPs dan SPGE modifikasi SiNWs/AuNPs telah difabrikasikan. Analisis FE-SEM dan EDX mengesahkan nanokomposit SiNWs/AuNPs terenap dan disebarkan dengan sekata atas permukaan ITO dan SPGE. Berdasarkan pencirian CV dan EIS, fabrikasi ITO-SiNWs/AuNPs and SPGE-SiNWs/AuNPs mempamerkan konduktiviti elektrik yang baik berbanding dengan electrod yang tidak dimodifikasikan. Nanokomposit SiNWs/AuNPs kemudian diuji sebagai matrik DNA untuk imobilisasi prob DNA di mana oligonukleotida virus denggi digunakan sebagai model bio-pengesanan untuk menilai kemampuan sensor elektrokimia DNA. Pengesanan peristiwa penghibridan secara elektrokimia antara prob DNA dan pelengkap jujukan virus denggi dipantau oleh teknik DPV menggunakan metilena biru (MB) sebagai petunjuk redoks. Penurunan puncak arus MB diperoleh selepas pengesanan penghibridan oleh kedua-dua fabrikasi elektrod. Kemampuan optimum bagi SiNWs/AuNPs-ITO and SiNWs/AuNPs-SPGE untuk pengesanan virus denggi menggunakan kaedah gerak balas permukaan (RSM); isipadu SiNWs (10.8 µL dan 6 µL), dithiopropionic acid (DTPA) (0.52 mM dan 0.45 µL), isipadu AuNPs (83 µL dan 29 µL), kepekatan prob DNA (5.8 µM dan 5 µM), masa immobilisasi (14 hours dan 10 hours), pH penampan (7.5 dan 7.8), NaCl concentration (1.45 M dan 0.80 M), suhu penghibridan (45 ℃ dan 42 ℃) and masa eraman (12 min dan 10 min), masing-masing. Di bawah keadan optimum, sensor DNA yang dibangunkan menunjukkan sensitiviti tinggi dalam pengesanan oligonukleotida virus denggi berbanding keadaan tidak optimum. Ia telah ditunjukkan bahawa sensor DNA yang dibangunkan; ITO-SiNWs/AuNPs and SPGE-SiNWs/AuNPs mampu mengesan virus denggi pelengkap oligonukleotida pada serendah masing-masing 0.0891 ng/µL (10 pM) dan 0.0000891 ng/µL (10 fM). Kajian kestabilan menunjukkan fabrikasi ITO- SiNWs/AuNPs/ssDNA dan SPGE- SiNWs/AuNPs/ssDNA boleh masing-masing disimpan pada 4 ℃ selama 10 minggu dan 7 minggu. Ia telah didapati bahawa isyarat arus MB untuk kedua-dua sensor DNA yang dibangunkan meningkat selepas penghibridan antara prob DNA yang diimobilisasi dengan virus denggi genomik dari sampel kultur sel. Bagaimanapun,

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penemuan ini tidak jelas untuk mengesahkan keupayaan kedua-dua sensor DNA yang dibangunkan mampu mengesan virus denggi genomik secara langsung kerana isu hubungan pelekatan MB dan penghibridan tidak spesifik yang tinggi pada jujukan genomik panjang. Oleh itu, penyediaan pengandaan dan spesifik sasaran denggi virus menggunakan trancriptase berbalik-reaksi rantai polimerase (RT-PCR) dikaji. Parameter seperti suhu penyepulih-indapan, masa sonikasi dan nisbah primer depan-belakang (R/F) mengunakan kaedah RT-PCR telah dikaji. Kedua-dua sensor DNA yang dibangunkan mampu untuk membezakan isyarat MB antara electrode kosong, sampel serum negatif, serum yang disuntik denggi jenis 1 dan 2, kultur sel denggi virus dan kawalan negatif. LOD untuk nilai produk RT-PCR adalah masing masing 5.6 ng/µL and 2.8 ng/µL untuk ITO- SiNWs/AuNPs dan SPGE- SiNWs/AuNPs. Tambahan pula, DNA sensor yang dibangunkan menunjukkan kebolehulangan yang baik dengan sembilan pengiraan di mana nilai RSD yang diperoleh masing-masing adalah 9.34% dan 8.23%.

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I certify that a Thesis Examination Committee has met on 2 August 2016 to conduct the final examination of Jahwarhar Izuan Abdul Rashid on his thesis entitled "Development of DNA Electrochemical Sensor Based on Silicon Nanowires/Gold Nanoparticles-Modified Electrode for Early Detection of Dengue Virus" 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 Doctor of Philosophy.

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Shigeori Takenaka, PhD
Professor
Kyushu Institute of Technology
Japan
(External Examiner)

ZULKARNAIN ZAINAL, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 28 September 2016

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

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Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Jaafar Abdullah, PhD
Senior Lecturer
Faculty of Science
Universiti Putra Malaysia
(Member)

Uda Hashim, PhD
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Institute of Nanoelectronic Engineering,
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LIST OF ABBREVIATIONS

APTES	Aminopropyl-triethoxysilane
AuNPs	Gold nanoparticles
BLAST	Basic local alignment search tool
bp	Base pairs
CCD	Central composite design
CE	Counter electrode
CV	Cyclic voltammetry
DNA	Deoxyribonucleic acid
DPV	Different pulse voltammetry
DPTA	3,3 dithiopronionic acid
dsDNA	Double stranded DNA
EIS	Electrochemical impedance spectroscopy
FESEM	Field-emission Scanning electron microscopy
F/R ratio	Forward to reverse primer concentration ratio
FTIR	Fourier transform infrared spectroscopy
GPES	General purpose electrochemical system
ITO	Indium tin oxide
LOD	Limit of detection
MB	Methylene blue
NCBI	National center for biotechnology information
PCR	Polymerase chain reaction
RNA	Ribonucleic acid
RT-PCR	Reverse transcribe-polymerase chain reaction
SiNWs	Silicon nanowires
RSM	Response surface Methodology
RSD	Relative standard deviation
SAM	Self-assembly monolayer
SEM	Scanning electron microscopy
SPGE	Screen printed gold electrode
ssDNA	Single stranded DNA

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Tris	Tris(hydrometyhl) amino methane
UV-Vis	Ultraviolet-visible

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Malaysia is among the seriously affected countries with a rapid increase in the number of dengue fever cases from 7103 in 2000 to 108,698 including 215 deaths in 2014 (Lee et al., 2015a). As of 5 December 2015, the number of dengue cases which has been recorded were 111,285 including 301 deaths that is 16.3% higher than 95,693 cases obtained in 2014 for the same period (WHO, 2015). A few factors that contribute to the dengue incidence in Malaysia are due to the massive urbanization, climate changes, poor environmental cleanliness, and increase human travel (Haliza and Eva, 2015; Mudin, 2015). Dengue fever is caused by the dengue virus, the genus of Flaviviridae virus family, which is transmitted to the human through the bite of female mosquitoes, *Aedes aegypti* (Lo et al., 2007).

The dengue virus genome consists of a single-stranded RNA virus and grouped into four antigenically serotypes (type-1, type -2, type-3, type-4). Any of these serotypes can cause a mild febrile disease at first primary infection and have high potential to develop into a more severe dengue shock syndrome (DSS) hemorrhagic fever (DHF) that can lead to fatality (Rai et al., 2012b). Until now, there is no specific medication or antibiotic to kill the dengue virus and patients just solely depend on the treatment of the dengue infection symptoms (Wright and Pritt, 2012). To date, reducing and destroying the population of mosquito dengue vector is the effective way to control the dengue virus transmission (Lee et al., 2015a).

There are several diagnostic tool which have been established for dengue virus detection including virus isolation (Gurukumar et al., 2009; Jyothi and Metri, 2015), Serology test (Wu et al., 2001; Guey Chuen et al., 2011; Zhang et al., 2015), NS1-capture ELISA (Hang et al., 2009; Blacksell, 2012; Jyothi and Metri, 2015) and reverse transcriptase polymerase chain reaction (RT-PCR) assay combined agarose gel electrophoresis technique (Najioullah et al., 2014; Decker et al., 2015). However, these existing diagnostic assays possess certain drawbacks such as time-consuming, expensive, laborious, low selectivity and sensitivity and the results will usually obtained after 5 -7 days upon dengue infection (Souza et al., 2011). Due to virulence of dengue virus, the development of sensitive, high selectivity, rapid detection of dengue virus at early diagnosis has seemed to be highly desirable to prevent the spread of dengue infection. The use of nucleic acid (DNA/RNA) biosensor based on DNA hybridization events has become a promising diagnostic tool for nucleic acid detection due to its ability to shorten the assay time, high specificity and allowing detection almost in real time (Hejazi et al., 2008; Karamollaoğlu et al., 2009; Wipawakarn et al., 2012). DNA biosensors are sensing devices consist of single-stranded DNA probe as biological recognition elements incorporated with the sensor transducer for converting hybridization DNA events into a useful analytical signal (Taufik et al., 2011). Several transducers hybridization events detection have been reported such as the

electrochemical transducer (Mandong et al., 2007; Wu et al., 2013), optical transducer (Lai et al., 2011; Delport et al., 2012), piezoelectric transducer (Rodaree et al., 2011) and electrical transducer (Sorgenfrei et al., 2011).

For the past few years, the application of nucleic acid-based electrochemical sensor has tremendously increased in the microbial pathogen, which provides a rapid detection, high sensitivity, cost-effective portability and ease miniaturization (Lee et al., 2003; Feng et al., 2006; Yang et al., 2009; Girousi and Kinigopoulou, 2010; Wu et al., 2013; Cui et al., 2014). Generally, the electrochemical methods are based on the DNA hybridization events where a single-stranded DNA (ssDNA) known as DNA probe was immobilized on the electrode surface to capture specific DNA target (Li et al., 2008). This hybridization event was converted into a measurable signal based on the redox activities of either direct detection (guanine or adenine bases oxidation) or indirect detection (redox indicator, enzyme and nanoparticle label). Methylene blue (MB) is commonly employed as the redox indicator in DNA electrochemical detection (Bolat et al., 2013; Lin et al., 2014; Zhang et al., 2014). This is due the fact that MB shows a different affinities while binding to the surfaces of ssDNA and dsDNA, resulting in the variation of the electrochemical signal with or without the presence of DNA target (Sassolas et al., 2008; Bolat et al., 2013; Lin et al., 2014).

With the growing of nanotechnology fields, it has been proven that the utilization of nanomaterials in DNA biosensors can enhance the DNA immobilization on the transducer surface and can be acted as the signal amplifier for the hybridization events, thus increasing the electrochemical responses of DNA biosensor (Kerman et al., 2004; LaGier et al., 2005; Girousi and Kinigopoulou, 2010). Numerous kinds of nanomaterials have been explored in the construction of DNA sensors based nanomaterials including gold nanoparticles (AuNPs) (Zhang et al., 2010a; Thiruppathiraja et al., 2011; Li et al., 2012; Gao et al., 2013), nanowires (Wu et al., 2012; Ramulu et al., 2013), carbon nanotubes (Elahi et al., 2012), quantum dots (Qds) (Li et al., 2011a; Sharma et al., 2012) and nanoporous substrates (Li et al., 2011b; Ahangar and Mehrgardi, 2012).

In recent years, silicon nanowires (SiNWs), the one-dimensional nanostructures has been frequently utilized as the sensing materials for chemical and biological detections (Zhang et al., 2008; Singh et al., 2010; Zhang et al., 2011; Kulkarni et al., 2012; Oh et al., 2012; Yang et al., 2013). This is due to possessing some unique characteristics such as high surface area, excellent mechanical and electrical properties and good favorable biocompatibility characteristic (Zhang et al., 2009; He et al., 2010; Singh et al., 2010). However, most of the previous studies were based on SiNWs-Field-Effect Transistor (FET) sensor for ultrasensitive and selective DNA detection. Zhang et al. (2010b) had successfully employed a single SiNWs based on FET sensor to detect RT-PCR product of dengue virus below 10 fM within 30 minutes. Nevertheless, the high cost generated for the fabrication of SiNWs-FET sensor has become the main barrier to develop a low-cost sensor since it involved advanced lithography method such as E-beam, AFM or deep UV lithography (Wenga et al., 2013).
However, there are some reports on the utilization of SiNWs as sensing material for fabrication of electrochemical biosensors. For example Yan et al., (2012) reported the utilization of $Ni(OH)_2$-SiNWs as working electrode for the detection of hydrogen

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peroxide (H_2O_2). The sensitivity of an electrochemical sensor for the detection of acetylcholinesterase was greatly enhanced after the modification of working electrode with SiNWs coated with AuNPs (Su et al., 2008). Similar research have also found that the modified electrodes based on SiNWs could enhance electron transfer and conductivity of sensors for electrochemical detection of bovine serum albumin protein (Kwon et al., 2011), glucose (Chen et al., 2006), ascorbic acid (Su et al., 2013), pesticide (Su et al., 2008), ethanol (Tao et al., 2009) and glutamate (Yang et al., 2006).

1.2 Problem statements and research motivation

Current clinical diagnostic for early dengue virus detection relies on the application of molecular biology diagnostic based on nucleic acid amplification via reverse-transcriptase polymerase chain reaction (RT-PCR) combined with agarose electrophoresis (Poloni et al., 2010; Najioullah et al., 2014; Decker et al., 2015). Since the molecular size of amplified RT-PCR product becomes the main analytical for nucleic acid detection through agarose gel electrophoresis, there are a few limitations observed. Firstly, agarose gel electrophoresis does not provide quantitative results and has low specificity which cannot differentiate the size of amplified nucleic acid between non-complementary and DNA target that can lead to the false-positive results (Giakoumaki et al., 2003; Pedrero et al., 2011). Secondly, the analysis procedures of gel agarose electrophoresis are time-consuming, include tedious steps and require hazardous elements such as ethidium bromide for gel staining and ultraviolet for band visualization (Wang, 2002; Chua et al., 2011; Bora et al., 2013).

To overcome this issues, an ultrasensitive DNA electrochemical sensor is highly suggested as a promising way for a direct detection of nucleic acid dengue virus instead of using agarose gel electrophoresis. This is because DNA electrochemical sensor could display high specificity of amplified nucleic between nonspecific and specific DNA target and the level concentration of amplified nucleic acid can be quantified by monitoring the current response. However, electrochemical detection of nucleic acid dengue virus is challenging because of its low concentrations in the real samples. Chemically modified electrodes have been frequently used to overcome the problems of poor selectivity and sensitivity faced at bare electrodes.

In the present study, silicon nanowires decorated with gold nanoparticles (SiNWs/AuNPs)-modified electrode is employed as one of the strategies to improve the electrochemical detection of nucleic acid dengue virus. To date, the utilization of SiNWs in the electrochemical system for detection of DNA/RNA has not been explored. Thus, the suitability of SiNWs as DNA immobilization and hybridization layers in the electrochemical detection is still unknown. The suitability of the immobilization procedure and DNA layer on the electrochemical transducer (electrode) for DNA probe loading and hybridization are the main challenges in designing an ultrasensitive DNA sensor with a low detection limit. This is because an effective modifying layer on the electrode must be compatible with the DNA probe immobilization in terms of good orientation, reactivity and must be able to avoid nonspecific interaction as well as being sensitive enough to convert DNA hybridization events into a measurable signal. Hence, the performance of DNA electrochemical

sensor greatly depends on the optimum condition of DNA layer formation, DNA probe immobilization and hybridization. Without understanding the nature of DNA probe loading and hybridization process in the presence of SiNWs as sensing material, it is difficult to propose and develop high sensitive and selective of electrochemical DNA biosensor for rapid identification of dengue virus

1.3 Novelty of research

The utilization of silicon nanowires (SiNWs) decorated gold nanoparticles (AuNPs) nanocomposites is the first being employed in the DNA electrochemical biosensor construction as DNA probe immobilization and hybridization matrix. In addition, the role of SiNWs/AuNPs nanocomposites in the current response for DNA hybridization detection based on electrochemical methods was first explored. By monitoring the redox current changes with or without DNA sequences dengue detection by SiNWs/AuNPs-based electrochemical sensor can be an alternative technique to the gold standard nucleic acid detection, which relies on the agarose gel electrophoresis and southern/northern blotting.

1.4 Objectives of the study

The goal of this study is to develop novel, simple and cost-effective DNA electrochemical sensor based on SiNWs/AuNPs-modified electrodes using methylene blue as redox indicator for early detection of nucleic acid dengue virus. The following specific objectives were designed to achieve this goal;

I. To prepare and characterize the SiNWs/AuNPs-modified ITO and SiNWs/AuNPs-modified SPGE for electrochemical detection of dengue virus.

II. To enhance DNA probe loading on the surface of SiNWs/AuNPs-modified ITO and SiNWs/AuNPs-modified SPGE for electrochemical detection of dengue virus.

III. To optimize the electrochemical detection of dengue virus and its analytical performance using SiNWs/AuNPs-modified ITO and SiNWs/AuNPs-modified SPGE.

IV. To evaluate the analytical performance of optimized DNA electrochemical sensor for the detection of genomic dengue virus from real samples.

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1.5 Scope and limitation

In this study, the immobilized DNA probe on the modified electrode are specific for biorecogniton sensing for nucleic acid dengue virus serotype 1 and 2. Therefore, there is a limitation in this study when employing this DNA electrochemical sensor for the detection of different serotype of dengue virus such as serotype 3,4 and 5, Furthermore, this DNA electrochemical could play detect the samples dengue virus for the first 5 days. After 5 days, the nucleic acid dengue virus was degraded upon the formation of antibody igG and igM.

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REFERENCES

Abdul Rahman, S., Saadun, R., Azmi, N. E., Ariffin, N., Abdullah, J., Yusof, N. A. and Hajian, R. (2014). Label-Free Dengue Detection Utilizing PNA/DNA Hybridization Based on the Aggregation Process of Unmodified Gold Nanoparticles. *Journal of Nanomaterials*, vol. 2014, Article ID 839286, 5 pages, Doi:10.1155/2014/839286.

Afshari, K., Samavati, V., and Shahidi, S.A. (2015). Ultrasonic-assisted extraction and in-vitro antioxidant activity of polysaccharide from *Hibiscus* leaf. *International journal of biological macromolecules* 74: 558-567.

Agarry, S. (2012). Enhanced bioremediation of soil artificially contaminated with kerosene: optimization of biostimulation agents through statistical experimental design [Electronic version] *Journal of Petroleum & Environmental Biotechnology*, vol. 2015, Article ID 657349, 7 pages, Doi:10.1155/2015/657349.

Ahammad, A. J. S., Choi, Y. H., Koh, K., Kim, J. H., Lee, J. H. and Lee, M. (2011). Electrochemical Detection of Cardiac Biomarker Troponin I at Gold Nanoparticle-Modified ITO Electrode by Using Open Circuit Potential. *International Journal of Electrochemical Science* 6:1906-1916.

Ahangar, L. E., and Mehrgardi, M. A. (2012). Nanoporous gold electrode as a platform for the construction of an electrochemical DNA hybridization biosensor. *Biosensors and Bioelectronics 38*(1): 252-257.

Ahmad, A., Alkharfy, K. M., Wani, T. A. and Raish, M. (2015). Application of Box–Behnken design for ultrasonic-assisted extraction of polysaccharides from Paeonia emodi. *International journal of biological macromolecules* 72: 990-997.

Ahmad, M., Pan, C. and Zhu, J. (2010). Electrochemical determination of L-Cysteine by an elbow shaped, Sb-doped ZnO nanowire-modified electrode. *Journal of Materials Chemistry 20*(34):7169-7174.

Ahmed, M. U., Nahar, S., Safavieh, M. and Zourob, M. (2013). Real-time electrochemical detection of pathogen DNA using electrostatic interaction of a redox probe. *Analyst, 138*(3): 907-915.

Alegret, S., and Merkoçi, A. (2007). Electrochemical sensor analysis. Vol. 49: Elsevier.

Alizadeh, T. and Zare, M. (2009). Enhancement of sensitivity of molecularly imprinted polymer based parathion voltammetric sensor by using experimental design techniques. *Analytical and Bioanalytical Electrochemistry* 1:169-187.

© COPYRIGHT UPM

Alkilany, A. M., Bani Yaseen, A. I. and Kailani, M. H. (2015). Synthesis of Monodispersed Gold Nanoparticles with Exceptional Colloidal Stability with Grafted Polyethylene Glycol-g-polyvinyl Alcohol [Electronic version]. *Journal of Nanomaterials*, vol. 2015, Article ID 712359, 9 pages, 2015. Doi:10.1155/2015/712359

Alonso-Lomillo, M. A., Domínguez-Renedo, O., Ferreira-Gonçalves, L. and Arcos-Martínez, M. J. (2010). Sensitive enzyme-biosensor based on screen-printed electrodes for Ochratoxin A. *Biosensors and Bioelectronics 25*(6):1333-1337.

Altschul, S. F., Gish, W., Miller, W., Myers, E. W. and Lipman, D. J. (1990). Basic local alignment search tool. *Journal of molecular biology 215*(3):403-410.

An, R., Jia, Y., Wan, B., Zhang, Y., Dong, P., Li, J. and Liang, X. (2014). Non-Enzymatic Depurination of Nucleic Acids: Factors and Mechanisms. *PloS one 9*(12): e115950.

Ananthanawat, C., Vilaivan, T., and Hoven, V. P. (2009). Synthesis and immobilization of thiolated pyrrolidinyl peptide nucleic acids on gold-coated piezoelectric quartz crystals for the detection of DNA hybridization. *Sensors and Actuators B: Chemical* 137(1): 215-221.

Anders, K. L., Nguyet, N. M., Quyen, N. T. H., Van Ngoc, T., Van Tram, T., Gan, T. T. and Wills, B. (2012). An evaluation of dried blood spots and oral swabs as alternative specimens for the diagnosis of dengue and screening for past dengue virus exposure. *The American journal of tropical medicine and hygiene*, 87(1):165-170.

Anne, A., Bouchardon, A. and Moiroux, J. (2003). 3'-ferrocene-labeled oligonucleotide chains end-tethered to gold electrode surfaces: Novel model systems for exploring flexibility of short DNA using cyclic voltammetry. *Journal of the American Chemical Society* 125(5):1112-1113.

Apte, M., Girme, G., Bankar, A., RaviKumar, A., and Zinjarde, S. (2013). 3, 4-dihydroxy-L-phenylalanine-derived melanin from Yarrowia lipolytica mediates the synthesis of silver and gold nanostructures. *J Nanobiotechnol* 11(2): 1-9.

Arinaga, K., Rant, U., Knežević, J., Pringsheim, E., Tornow, M., Fujita, S. and Yokoyama, N. (2007). Controlling the surface density of DNA on gold by electrically induced desorption. *Biosensors and Bioelectronics* 23(3): 326-331.

Arora, K., Prabhakar, N., Chand, S., and Malhotra, B. (2008). Esherichia coli genosensor based on polyaniline. *Anal. Chem, 1*(80), 1833.

Atias, D., Liebes, Y., Chalifa-Caspi, V., Bremand, L., Lobel, L., Marks, R. S. and Dussart, P. (2009). Chemiluminescent optical fiber immunosensor for the detection of IgM antibody to dengue virus in humans. *Sensors and Actuators B: Chemical* 140(1): 206-215.

© COPYRIGHT UPM

Avci-Adali, M., Paul, A., Wilhelm, N., Ziemer, G. and Wendel, H. P. (2009). Upgrading SELEX technology by using lambda exonuclease digestion for single-stranded DNA generation. *Molecules 15*(1): 1-11.

Aydogdu, G., Zeybek, D. K., Pekyardimci, S. and Kiliç, E. (2013). A novel amperometric biosensor based on ZnO nanoparticles-modified carbon paste electrode for determination of glucose in human serum. *Artificial Cells, Nanomedicine, and Biotechnology* 41(5): 332-338.

Azhar, E., Kao, M., Niedrig, M., Masri, B., Godus, A., Badierah, R. and Jamjoom, G. (2010). Virological diagnosis of dengue fever in Jeddah, Saudi Arabia: Comparison between RT-PCR and virus isolation in cell culture. J*ournal of Infectious Disease and Immunity* 2(2):23-29.

Aziz, M. A., Kim, J.-P., Shaikh, M. N., Oyama, M., Bakare, F. O. and Yamani, Z. H. (2015). Size-controlled preparation of fluorescent gold nanoparticles using pamoic acid. *Gold Bulletin 48*(1-2):85-92.

Baeumner, A. J., Schlesinger, N. A., Slutzki, N. S., Romano, J., Lee, E. M. and Montagna, R. A. (2002). Biosensor for dengue virus detection: sensitive, rapid, and serotype specific. *Analytical chemistry* 74(6):1442-1448.

Bagni, G., Osella, D., Sturchio, E. and Mascini, M. (2006). Deoxyribonucleic acid (DNA) biosensors for environmental risk assessment and drug studies. *Analytica Chimica Acta 573*:81-89.

Bai, R. S. and Abraham, T. E. (2002). Studies on enhancement of Cr (VI) biosorption by chemically modified biomass of Rhizopus nigricans. *Water research 36*(5):1224-1236.

Bai, Y.H., Li, J.Y., Xu, J.J. and Chen, H.Y. (2010). Ultrasensitive electrochemical detection of DNA hybridization using Au/Fe_3O_4 magnetic composites combined with silver enhancement. *Analyst* 135(7):1672-1679.

Bakthavathsalam, P., Rajendran, V. K. and Mohammed, J. A. B. (2012). A direct detection of Escherichia coli genomic DNA using gold nanoprobes. *J. Nanobiotechnol.* 10(8): 1-10.

Bard, A. J. and Faulkner, L. R. (2001). *Electrochemical methods, 2nd ed*: Wiley, New York.

Benvidi, A., Firouzabadi, A. D., Tezerjani, M. D., Moshtaghiun, S., Mazloum-Ardakani, M. and Ansarin, A. (2015a). A highly sensitive and selective electrochemical DNA biosensor to diagnose breast cancer. *Journal of Electroanalytical Chemistry* 750: 57-64.

Benvidi, A., Rajabzadeh, N., Mazloum-Ardakani, M. and Heidari, M. M. (2015b). Comparison of impedimetric detection of DNA hybridization on chemically and electrochemically functionalized multi-wall carbon nanotubes modified electrode. *Sensors and Actuators B: Chemical* 207: 673-682.

© COPYRIGHT UPM

Benvidi, A., Rajabzadeh, N., Zahedi, H. M., Mazloum-Ardakani, M., Heidari, M. M., and Hosseinzadeh, L. (2015c). Simple and label-free detection of DNA hybridization on a modified graphene nanosheets electrode. *Talanta* 137:80-86.

Benyidi, A., Firouzabadi, A. D., Moshtaghiun, S. M., Mazloum-Ardakani, M. and Tezerjani, M. D. (2015). Ultrasensitive DNA sensor based on gold nanoparticles/reduced graphene oxide/glassy carbon electrode. *Analytical biochemistry* 484:24-30.

Bernalte, E., Marín-Sánchez, C., Pinilla-Gil, E. and Brett, C. M. (2013). Characterisation of screen-printed gold and gold nanoparticle-modified carbon sensors by electrochemical impedance spectroscopy. *Journal of Electroanalytical Chemistry* 709:70-76.

Bessoff, K., Delorey, M., Sun, W. and Hunsperger, E. (2008). Comparison of two commercially available dengue virus (DENV) NS1 capture enzyme-linked immunosorbent assays using a single clinical sample for diagnosis of acute DENV infection. *Clinical and Vaccine Immunology* 15(10):1513-1518.

Bettazzi, F., Lucarelli, F., Palchetti, I., Berti, F., Marrazza, G., and Mascini, M. (2008). Disposable electrochemical DNA-array for PCR amplified detection of hazelnut allergens in foodstuffs. *Analytica Chimica Acta* 614(1):93-102.

Bezerra, M. A., Santelli, R. E., Oliveira, E. P., Villar, L. S., and Escaleira, L. A. (2008). Response surface methodology (RSM) as a tool for optimization in analytical chemistry. *Talanta* 76(5), 965-977.

Bhat, V. G., Chavan, P., Ojha, S., and Nair, P. K. (2015). Challenges in the Laboratory Diagnosis and Management of Dengue Infections. *Open Microbiology Journal* 9:33-37.

Blacksell, S. D. (2012). Commercial dengue rapid diagnostic tests for point-of-care application: recent evaluations and future needs? [Electronic version] *BioMed Research International*, vol. 2012, Article ID 151967, 12 pages, 2012. Doi:10.1155/2012/151967.

Blacksell, S. D., Mammen, M. P., Thongpaseuth, S., Gibbons, R. V., Jarman, R. G., Jenjaroen, K. and Day, N. P. (2008). Evaluation of the Panbio dengue virus nonstructural 1 antigen detection and immunoglobulin M antibody enzyme-linked immunosorbent assays for the diagnosis of acute dengue infections in Laos. *Diagnostic microbiology and infectious disease* 60(1): 43-49.

Bo, Y., Yang, H., Hu, Y., Yao, T. and Huang, S. (2011). A novel electrochemical DNA biosensor based on graphene and polyaniline nanowires. *Electrochimica Acta* 56(6):2676-2681.

Bohunicky, B. and Mousa, S. A. (2011). *Nanotechnology, Science and Applications, 4*, 1-10.

© COPYRIGHT UPM

Bolat, G., Kuralay, F., Eroglu, G. and Abaci, S. (2013). Fabrication of a Polyaniline Ultramicroelectrode via a Self Assembled Monolayer Modified Gold Electrode. *Sensors* 13(7):8079-8094.

Bora, U., Sett, A., and Singh, D. (2013). Nucleic Acid Based Biosensors for Clinical Applications [Electronic version]. *Biosensor Journal* 1:104.

Brouard, D., Ratelle, O., Bracamonte, A. G., St-Louis, M. and Boudreau, D. (2013). Direct molecular detection of SRY gene from unamplified genomic DNA by metal-enhanced fluorescence and FRET. *Analytical Methods* 5(24):6896-6899.

Bruno, J. G. and Kiel, J. L. (1999). In vitro selection of DNA aptamers to anthrax spores with electrochemiluminescence detection. *Biosensors and Bioelectronics* 14(5):457-464.

Buchillet, D. (2012). Dengue and dengue-like outbreaks in the past: The case of the Macau epidemic fever of 1874. *Infection, Genetics and Evolution 12*(5):905-912.

Cagnin, S., Caraballo, M., Guiducci, C., Martini, P., Ross, M., SantaAna, M. and Lanfranchi, G. (2009). Overview of electrochemical DNA biosensors: new approaches to detect the expression of life. *Sensors* 9(4):3122-3148.

Cai, H., Wang, Y., He, P., and Fang, Y. (2002). Electrochemical detection of DNA hybridization based on silver-enhanced gold nanoparticle label. *Analytica Chimica Acta* 469(2):165-172.

Calisher, C. H., and Gould, E. A. (2003). Taxonomy of the virus family Flaviviridae. *Advances in virus research* 59:1-19.

Callahan, J. D., Wu, S.J. L., Dion-Schultz, A., Mangold, B. E., Peruski, L. F., Watts, D. M. and King, C.C. (2001). Development and evaluation of serotype-and group-specific fluorogenic reverse transcriptase PCR (TaqMan) assays for dengue virus. *Journal of clinical microbiology* 39(11):4119-4124.

Calvo-Munoz, M.-L., Bile, B. E.A., Billon, M. and Bidan, G. (2005). Electrochemical study by a redox probe of the chemical post-functionalization of N-substituted polypyrrole films: Application of a new approach to immobilization of biotinylated molecules. *Journal of Electroanalytical Chemistry* 578(2), 301-313.

Canete-Rosales, P., Álvarez-Lueje, A. and Bollo, S. (2014). Ethylendiamine-functionalized multi-walled carbon nanotubes prevent cationic dispersant use in the electrochemical detection of dsDNA. *Sensors and Actuators B: Chemical* 191: 688-694.

Castaneda, M. e. T., Alegret, S., and Merkoci, A. (2007). Electrochemical sensing of DNA using gold nanoparticles. *Electroanalysis* 19(7):743-753.

© COPYRIGHT UPM

Castro-Jorge, L. A., Machado, P. R., Favero, C. A., Borges, M. C., Passos, L. M., de Oliveira, R. M. and Fonseca, B. A. (2010). Clinical evaluation of the NS1 antigen-capture ELISA for early diagnosis of dengue virus infection in Brazil. *Journal of medical virology* 82(8):1400-1405.

Castro, A. C. H., França, E. G., de Paula, L. F., Soares, M. M., Goulart, L. R., Madurro, J. M. and Brito-Madurro, A. G. (2014). Preparation of genosensor for detection of specific DNA sequence of the hepatitis B virus. *Applied Surface Science* 314:273-279.

Cao, S., Mishra, R., Pilla, S., Tripathi, S., Pandey, M. K., Shah, G., Mishra, A. K., Prabaharan, M., Mishra, S. B. & Xin, J. 2010. Novel chitosan/gold-MPA nanocomposite for sequence-specific oligonucleotide detection. *Carbohydrate Polymers* 82**:**189-194.

Cavalcanti, I. T., Guedes, M. I., Sotomayor, M. D., Yamanaka, H. and Dutra, R. F. (2012). A label-free immunosensor based on recordable compact disk chip for early diagnostic of the dengue virus infection. *Biochemical Engineering Journal* 67:225-230.

Cavic, B. A. and Thompson, M. (2002). Interfacial nucleic acid chemistry studied by acoustic shear wave propagation. *Analytica Chimica Acta* 469(1): 101-113.

Chakravarti, A., Kumaria, R., Kar, P., Batra, V. and Verma, V. (2006). Improved detection of dengue virus serotypes from serum samples-Evaluation of single-tube multiplex RT-PCR with cell culture. *Dengue Bulletin* 30:133-140

Chattoraj, S., Mondal, N. K., Das, B., Roy, P. and Sadhukhan, B. (2014). Biosorption of carbaryl from aqueous solution onto Pistia stratiotes biomass. *Applied Water Science* 4(1):79-88.

Chaubey, A., and Malhotra, B. (2002). Mediated biosensors. *Biosensors and Bioelectronics* 17(6): 441-456.

Cheah, W., Ng, K., Marzilawati, A. and Lum, L. (2014). A review of dengue research in malaysia. *The Medical journal of Malaysia* 69:59-67.

Chen, J., Zhang, J., Wang, K., Lin, X., Huang, L. and Chen, G. (2008). Electrochemical biosensor for detection of BCR/ABL fusion gene using locked nucleic acids on 4-aminobenzenesulfonic acid-modified glassy carbon electrode. *Analytical chemistry* 80(21):8028-8034.

Chen, K.I., Li, B.R. and Chen, Y.T. (2011a). Silicon nanowire field-effect transistor-based biosensors for biomedical diagnosis and cellular recording investigation. *Nano Today 6*(2):131-154.

Chen, K., Zhang, Z.-L., Liang, Y.M. and Liu, W. (2013a). A graphene-based electrochemical sensor for rapid determination of phenols in water. *Sensors* 13(5): 6204-6216.

© COPYRIGHT UPM

Chen, L., Qiu, Y. and Wang, G. (2015). An amplified electrochemical aptasensor based on hybridization chain reactions and catalysis of silver nanoclusters. *Nanoscale* 7(7):3300-3308.

Chen, L., Zhang, L., Qiu, T. and Cao, W. (2011b). Chemiluminescent detection of DNA hybridization based on signal DNA probe modified with gold and cobalt nanoparticles. *Int. J. Electrochem. Sci.* 6:5325-5336.

Chen, L. H. and Wilson, M. (2005). Non-Vector Transmission of Dengue and Other Mosquito-Borne Flaviviruses. *Dengue Bulletin* 29:18-31.

Chen, S.H., Chuang, Y.C., Lu, Y.C., Lin, H.-C., Yang, Y.-L. and Lin, C.S. (2009). A method of layer-by-layer gold nanoparticle hybridization in a quartz crystal microbalance DNA sensing system used to detect dengue virus. *Nanotechnology 20*(21):215501.

Chen, W.Y., Chen, H.C., Yang, Y.S., Huang, C.J., Chan, H. W.H. and Hu, W.P. (2013b). Improved DNA detection by utilizing electrically neutral DNA probe in field-effect transistor measurements as evidenced by surface plasmon resonance imaging. *Biosensors and Bioelectronics* 41:795-801.

Chien, L.J., Liao, T.L., Shu, P.Y., Huang, J.-H., Gubler, D. J. and Chang, G.J. J. (2006). Development of real-time reverse transcriptase PCR assays to detect and serotype dengue viruses. *Journal of clinical microbiology 44*(4):1295-1304.

Chin, G., Pei, L., Rijiravanich, P. and Marimuthu, K. (2013). Talanta Gold-nanoparticle based electrochemical DNA sensor for the detection of fish pathogen Aphanomyces invadans. *Talanta* 117:312-317.

Choi, J.H., Kim, H., Kim, H.-S., Um, S. H., Choi, J.-W., and Oh, B.-K. (2013). MMP-2 detective silicon nanowire biosensor using enzymatic cleavage reaction. *Journal of biomedical nanotechnology* 9(4):732-735.

Chowdhury, A. D., Gangopadhyay, R. and De, A. (2014a). Highly sensitive electrochemical biosensor for glucose, DNA and protein using gold-polyaniline nanocomposites as a common matrix. *Sensors and Actuators B: Chemical* 190:348-356.

Chowdhury, A. D., Gangopadhyay, R. and De, A. (2014b). Highly sensitive electrochemical biosensor for glucose, DNA and protein using gold-polyaniline nanocomposites as a common matrix. *Sensors and Actuators B: Chemical 190*: 348-356.

Chua, A., Yean, C. Y., Ravichandran, M., Lim, B., and Lalitha, P. (2011). A rapid DNA biosensor for the molecular diagnosis of infectious disease. *Biosensors and Bioelectronics*, *26*(9), 3825-3831.

Chung, R.J. and Shih, H.T. (2014). Preparation of Multifunctional Fe@ Au Core-Shell Nanoparticles with Surface Grafting as a Potential Treatment for Magnetic Hyperthermia. *Materials*, 7(2), 653-661.

© COPYRIGHT UPM

Citartan1, M., Tang1, T.-H., Tan, S.-C., Hoe1, C.H., Saini, R., Tominaga, J. and Gopinath, S. C. (2012). Asymmetric PCR for good quality ssDNA generation towards DNA aptamer production. *Sonklanakarin Journal of Science and Technology* 34(2):125-131.

Clack, N. G., Salaita, K. and Groves, J. T. (2008). Electrostatic readout of DNA microarrays with charged microspheres. *Nature biotechnology* 26(7): 825-830.

Clark, L. C. and Lyons, C. (1962). Electrode systems for continuous monitoring in cardiovascular surgery. *Annals of the New York Academy of sciences 102*(1), 29-45.

Coffey, L. L., Mertens, E., Brehin, A.C., Fernandez-Garcia, M. D., Amara, A., Després, P. and Sakuntabhai, A. (2009). Human genetic determinants of dengue virus susceptibility. *Microbes and Infection* 11(2): 143-156.

Costa, M. P., Andrade, C. A., Montenegro, R. A., Melo, F. L. and Oliveira, M. D. (2014). Self-assembled monolayers of mercaptobenzoic acid and magnetite nanoparticles as an efficient support for development of tuberculosis genosensor. *Journal of colloid and interface science* 433:141-148.

D'Agata, R., Corradini, R., Ferretti, C., Zanoli, L., Gatti, M., Marchelli, R. and Spoto, G. (2010). Ultrasensitive detection of non-amplified genomic DNA by nanoparticle-enhanced surface plasmon resonance imaging. *Biosensors and Bioelectronics* 25(9):2095-2100.

Dai Tran, L., Nguyen, B. H., Van Hieu, N., Tran, H. V., Le Nguyen, H. and Nguyen, P. X. (2011). Electrochemical detection of short HIV sequences on chitosan/Fe 3 O 4 nanoparticle based screen printed electrodes. *Materials Science and Engineering: C, 31*(2):477-485.

Daniels, J. S. and Pourmand, N. (2007). Label-free impedance biosensors: Opportunities and challenges. *Electroanalysis 19*(12): 1239-1257.

Dash, S. K., Sharma, M., Khare, S. and Kumar, A. (2013). rmpM genosensor for detection of human brain bacterial meningitis in cerebrospinal fluid. *Applied biochemistry and biotechnology 171*(1): 198-208.

Dash, S. K., Sharma, M., Kumar, A., Khare, S. and Kumar, A. (2014). Carbon composite-based DNA sensor for detection of bacterial meningitis caused by N*eisseria meningitidis. Journal of Solid State Electrochemistry* 18(10):2467-2659.

Davis, F., Hughes, M. A., Cossins, A. R. and Higson, S. P. (2007). Single gene differentiation by DNA-modified carbon electrodes using an AC impedimetric approach. *Analytical chemistry* 79(3):1153-1157.

De Costa, N. T. S. and Heemstra, J. M. (2013). Evaluating the effect of ionic strength on duplex stability for PNA having negatively or positively charged side chains. *PloS one, 8*(3), e58670.

© COPYRIGHT UPM

De Pablo, F., Scanes, C. G. and Weintraub, B. D. (1993). *Handbook of endocrine research techniques*: Academic Press.

De Paula, S. O., and Fonseca, B. A. L. d. (2004). Dengue: a review of the laboratory tests a clinician must know to achieve a correct diagnosis. *Brazilian Journal of Infectious Diseases* 8(6):390-398.

Decker, D. S., Vray, M., Sistek, V., Labeau, B., Enfissi, A., Rousset, D. and Matheus, S. (2015). Evaluation of the diagnostic accuracy of a new dengue IgA capture assay (Platelia Dengue IgA Capture, Bio-Rad) for dengue Infection detection. *PLoS neglected tropical diseases, 9*(3):e0003596-e0003596.

Dell'Atti, D., Zavaglia, M., Tombelli, S., Bertacca, G., Cavazzana, A. O., Bevilacqua, G. and Mascini, M. (2007). Development of combined DNA-based piezoelectric biosensors for the simultaneous detection and genotyping of high risk Human Papilloma Virus strains. *Clinica Chimica Acta 383*(1): 140-146.

Delport, F., Pollet, J., Janssen, K., Verbruggen, B., Knez, K., Spasic, D. and Lammertyn, J. (2012). Real-time monitoring of DNA hybridization and melting processes using a fiber optic sensor. *Nanotechnology* 23(6):065503.

Deng, J. and Toh, C.S. (2013). Impedimetric DNA biosensor based on a nanoporous alumina membrane for the detection of the specific oligonucleotide sequence of dengue virus. *Sensors* 13(6):7774-7785.

Deutscher, M. P. (2006). Degradation of RNA in bacteria: comparison of mRNA and stable RNA. *Nucleic acids research* 34(2):659-666.

Dias, A. C. M., Gomes-Filho, S. L., Silva, M. M. and Dutra, R. F. (2013). A sensor tip based on carbon nanotube-ink printed electrode for the dengue virus NS1 protein. *Biosensors and Bioelectronics* 44:216-221.

Dias, R., and Lindman, B. (2008). *DNA interactions with polymers and surfactants*. John Wiley & Sons.

Dias, S. l. L., Fujiwara, S. T., Gushikem, Y. and Bruns, R. E. (2002). Methylene blue immobilized on cellulose surfaces modified with titanium dioxide and titanium phosphate: factorial design optimization of redox properties. *Journal of Electroanalytical Chemistry* 531(2):141-146.

Díaz-Badillo, A., Muñoz, M. L., Ramirez, G. L., Altuzar, V., Burgueño, J., Alvarez, J. G. M. and Sinencio, F. S. (2014). A DNA Microarray-based assay to detect dual infection with two dengue virus serotypes. *Sensors* 14:7580-7601.

Ding, S.J., Chang, B.W., Wu, C.C., Lai, M.F. and Chang, H.C. (2005). Electrochemical evaluation of avidin–biotin interaction on self-assembled gold electrodes. *Electrochimica Acta* 50(18):3660-3666.

© COPYRIGHT UPM

Ding, Y., Liu, Y., Parisi, J., Zhang, L. and Lei, Y. (2011). A novel NiO–Au hybrid nanobelts based sensor for sensitive and selective glucose detection. *Biosensors and Bioelectronics* 28(1): 393-398.

Donmez, S., Arslan, F. and Arslan, H. (2015). A Nucleic Acid Biosensor for Detection of Hepatitis C Virus Genotype 1a Using Poly (l-Glutamic Acid)-Modified Electrode. *Applied biochemistry and biotechnology* 176(5):1431-1444.

Drosten, C., Göttig, S., Schilling, S., Asper, M., Panning, M., Schmitz, H. and Günther, S. (2002). Rapid detection and quantification of RNA of Ebola and Marburg viruses, Lassa virus, Crimean-Congo hemorrhagic fever virus, Rift Valley fever virus, dengue virus, and yellow fever virus by real-time reverse transcription-PCR. *Journal of clinical microbiology* 40(7):2323-2330.

Drummond, T. G., Hill, M. G. and Barton, J. K. (2003). Electrochemical DNA sensors. *Nature biotechnology* 21(10):1192-1199.

Du, M., Yang, T., Li, X. and Jiao, K. (2012). Fabrication of DNA/graphene/polyaniline nanocomplex for label-free voltammetric detection of DNA hybridization. *Talanta* 88:439-444.

Dubey, R. K., and Tripathi, D. (2005). A study of thermal denaturation/renaturation in dna using laser light scattering: a new approach. *Indian Journal Of Biochemistry And Biophysics* 42(5): 301-307.

Dupont-Filliard, A., Billon, M., Livache, T. and Guillerez, S. (2004). Biotin/avidin system for the generation of fully renewable DNA sensor based on biotinylated polypyrrole film. *Analytica Chimica Acta* 515(2):271-277.

Dupont-Filliard, A., Billon, M., Bidan, G. and Guillerez, S. (2004b). Investigation by QCM of the specific and nonspecific avidin interaction onto a biotinylated polypyrrole film. *Electroanalysis* 16(8), 667-673.

Dutse, S. W., Yusof, N. A., Ahmad, H., Hussein, M. Z. and Zainal, Z. (2012). An electrochemical DNA biosensor for ganoderma boninense pathogen of the Oil palm utilizing a New ruthenium complex,[Ru (dppz) $_2$ (qtpy)] Cl_2. *Int J Electrochem Sci. 7*:8105-8115.

Dutse, S. W., Yusof, N. A., Ahmad, H., Hussein, M. Z., Zainal, Z., Hushiarian, R. and Hajian, R. (2014). An Electrochemical Biosensor for the Determination of Ganoderma boninense Pathogen Based on a Novel Modified Gold Nanocomposite Film Electrode. *Analytical Letters 47*(5): 819-832.

Dzyadevych, S., Arkhypova, V., Soldatkin, A., El'skaya, A., Martelet, C. and Jaffrezic-Renault, N. (2008). Amperometric enzyme biosensors: past, present and future. *Irbm 29*(2):171-180.

© COPYRIGHT UPM

Eidelshtein, G., Halamish, S., Lubitz, I., Anzola, M., Giannini, C. and Kotlyar, A. (2013). Synthesis and Properties of Conjugates Between Silver Nanoparticles and DNA-PNA Hybrids. *Journal of Self-Assembly and Molecular Electronics (SAME),* 1(1): 69-84.

Elahi, M. Y., Bathaie, S., Mousavi, M., Hoshyar, R. and Ghasemi, S. (2012). A new DNA-nanobiosensor based on G-quadruplex immobilized on carbon nanotubes modified glassy carbon electrode. *Electrochimica Acta 82*:143-151.

Erdem, A., Ariksoysal, D. O., Karadeniz, H., Kara, P., Sengonul, A., Sayiner, A. A. and Ozsoz, M. (2005). Electrochemical genomagnetic assay for the detection of hepatitis B virus DNA in polymerase chain reaction amplicons by using disposable sensor technology. *Electrochemistry communications 7*(8):815-820.

Erdem, A., Eksin, E., and Congur, G. (2015). Indicator-free electrochemical biosensor for microRNA detection based on carbon nanofibers modified screen printed electrodes. *Journal of Electroanalytical Chemistry 755*:167-173.

Erdem, A., Kerman, K., Meric, B., Akarca, U. S. and Ozsoz, M. (2000). Novel hybridization indicator methylene blue for the electrochemical detection of short DNA sequences related to the hepatitis B virus. *Analytica Chimica Acta, 422*(2), 139-149.

Erdem, A., Meric, B., Kerman, K., Dalbasti, T. and Ozsoz, M. (1999). Detection of interaction between metal complex indicator and DNA by using electrochemical biosensor. *Electroanalysis* 11(18):1372-1376.

Erdem, A., Papakonstantinou, P., Murphy, H., McMullan, M., Karadeniz, H. and Sharma, S. (2010). Streptavidin Modified Carbon Nanotube Based Graphite Electrode for Label-Free Sequence Specific DNA Detection. *Electroanalysis 22*(6):611-617.

Ermini, M., Mariani, S., Scarano, S. and Minunni, M. (2013). Direct detection of genomic DNA by surface plasmon resonance imaging: an optimized approach. *Biosensors and Bioelectronics* 40(1):193-199.

Fanjul-Bolado, P., Hernández-Santos, D., González-García, M. B. and Costa-García, A. (2007). Alkaline phosphatase-catalyzed silver deposition for electrochemical detection. *Analytical chemistry* 79(14):5272-5277.

Farjami, E., Clima, L., Gothelf, K. V. and Ferapontova, E. E. (2010). DNA interactions with a methylene blue redox indicator depend on the DNA length and are sequence specific. *Analyst* 135(6):1443-1448.

Feng, K.J., Yang, Y.H., Wang, Z.-J., Jiang, J.H., Shen, G.L. and Yu, R.Q. (2006b). A nano-porous CeO_2/chitosan composite film as the immobilization matrix for colorectal cancer DNA sequence-selective electrochemical biosensor. *Talanta* 70(3): 561-565.

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Ferapontova, E. E. and Gothelf, K. V. (2009). Effect of serum on an RNA aptamer-based electrochemical sensor for theophylline. *Langmuir* 25(8): 4279-4283.

Figueiredo, A., Vieira, N. C., Dos Santos, J. F., Janegitz, B. C., Aoki, S. M., Junior, P. P. and Guimarães, F. E. (2015). Electrical Detection of Dengue Biomarker Using Egg Yolk Immunoglobulin as the Biological Recognition Element. *Scientific reports 5*, Article number:7865. Doi:10.1038/srep07865

Flechsig, G.U. and Reske, T. (2007). Electrochemical detection of DNA hybridization by means of osmium tetroxide complexes and protective oligonucleotides. *Analytical chemistry* 79(5): 2125-2130.

Fordyce, S. L., Kampmann, M.L., Van Doorn, N. L. and Gilbert, M. T. P. (2013). Long-term RNA persistence in post mortem contexts. *Investigative genetics 4*(1):7-16

Fox, H. S. and Parslow, T. G. (1988). Polymerase Chain Reaction—A Novel Method for Analyzing Specific DNA Sequences. *Western Journal of Medicine* 149(5):594-595

Fresco, J. R., Amosova, O., Wei, P., Alvarez-Dominguez, J. R., Glumcher, D. and Torres, R. (2011). Site-specific self-catalyzed dna depurination, the basis of a spontaneous mutagenic mechanism of wide evolutionary significance *Evolutionary Biology–Concepts, Biodiversity, Macroevolution and Genome Evolution* (pp. 3-19): Springer.

Fritz, J., Cooper, E. B., Gaudet, S., Sorger, P. K. and Manalis, S. R. (2002). Electronic detection of DNA by its intrinsic molecular charge. *Proceedings of the National Academy of Sciences 99*(22):14142-14146.

Fry, S. R., Meyer, M., Semple, M. G., Simmons, C. P., Sekaran, S. D., Huang, J. X. and Young, P. R. (2011). The diagnostic sensitivity of dengue rapid test assays is significantly enhanced by using a combined antigen and antibody testing approach. *PLoS Negl Trop Dis. 5*(6):e1199.

Fu, Y., Yuan, R., Xu, L., Chai, Y., Liu, Y., Tang, D. and Zhang, Y. (2005). Electrochemical impedance behavior of DNA biosensor based on colloidal Ag and bilayer two-dimensional sol–gel as matrices. *Journal of biochemical and biophysical methods* 62(2):163-174.

Fuchs, J., Fiche, J.B., Buhot, A., Calemczuk, R. and Livache, T. (2010). Salt concentration effects on equilibrium melting curves from DNA microarrays. *Biophysical journal* 99(6):1886-1895.

Gajovic-Eichelmann, N., Ehrentreich-Förster, E. and Bier, F. F. (2003). Directed immobilization of nucleic acids at ultramicroelectrodes using a novel electro-deposited polymer. *Biosensors and Bioelectronics* 19(5): 417-422.

© COPYRIGHT UPM

Gamero-Quijano, A., Huerta, F., Salinas-Torres, D., Morallón, E. and Montilla, F. (2013). Electrocatalytic Performance of SiO2-SWCNT Nanocomposites Prepared by Electroassisted Deposition. *Electrocatalysis* 4(4):259-266.

Gao, A., Lu, N., Dai, P., Li, T., Pei, H., Gao, X. and Fan, C. (2011). Silicon-nanowire-based CMOS-compatible field-effect transistor nanosensors for ultrasensitive electrical detection of nucleic acids. *Nano letters* 11(9):3974-3978.

Gao, F., Zhu, Z., Lei, J., Geng, Y. and Ju, H. (2013a). Sub-femtomolar electrochemical detection of DNA using surface circular strand-replacement polymerization and gold nanoparticle catalyzed silver deposition for signal amplification. *Biosens Bioelectron. 39*(1): 199-203.

Gao, H., Sun, M., Lin, C. and Wang, S. (2012). Electrochemical DNA Biosensor Based on Graphene and TiO2 Nanorods Composite Film for the Detection of Transgenic Soybean Gene Sequence of MON89788. *Electroanalysis* 24(12): 2283-2290.

Garibyan, L., and Avashia, N. (2013). Research Techniques Made Simple: Polymerase Chain Reaction (PCR). *The Journal of investigative dermatology*, *133*(3), e6.

Geddes, C. D., Cao, H., and Lakowicz, J. R. (2003). Enhanced photostability of ICG in close proximity to gold colloids. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, *59*(11), 2611-2617.

Ghanbari, K., Bathaie, S. and Mousavi, M. (2008). Electrochemically fabricated polypyrrole nanofiber-modified electrode as a new electrochemical DNA biosensor. *Biosensors and Bioelectronics* 23(12): 1825-1831.

Gharibzahedi, S. M. T., Razavi, S. H. and Mousavi, M. (2014). Enzymatically hydrolysed molasses and sodium citrate as new potentials for the improvement of canthaxanthin batch synthesis by Dietzia natronolimnaea HS-1: a statistical media optimisation. *Czech Journal of Food Sciences* 32(4): 326-336.

Ghasemlou, M., Khodaiyan, F. and Gharibzahedi, S. M. T. (2012). Enhanced production of Iranian kefir grain biomass by optimization and empirical modeling of fermentation conditions using response surface methodology. *Food and Bioprocess Technology* 5(8):3230-3235.

Giakoumaki, E., Minunni, M., Tombelli, S., Tothill, I. E., Mascini, M., Bogani, P. and Buiatti, M. (2003). Combination of amplification and post-amplification strategies to improve optical DNA sensing. *Biosensors and Bioelectronics* 19(4):337-344.

Gibbons, R. V. and Vaughn, D. W. (2002). Dengue: an escalating problem. *BMJ: British Medical Journal* 324(7353): 1563.

Gilmour, S. G. (2006). Response surface designs for experiments in bioprocessing. *Biometrics* 62(2): 323-331.

© COPYRIGHT UPM

Girousi, S. and Kinigopoulou, V. (2010). Detection of short oligonucleotide sequences using an electrochemical DNA hybridization biosensor. *Central European Journal of Chemistry* 8(4): 732-736.

Glazer, M., Fidanza, J., McGall, G. and Frank, C. (2001). Colloidal silica films for high-capacity DNA probe arrays. *Chemistry of materials* 13(12), 4773-4782.

Goda, T., Singi, A. B., Maeda, Y., Matsumoto, A., Torimura, M., Aoki, H. and Miyahara, Y. (2013). Label-free potentiometry for detecting DNA hybridization using peptide nucleic acid and DNA probes. *Sensors* 13(2), 2267-2278.

Gong, J., Zhou, T., Song, D. and Zhang, L. (2010). Monodispersed Au nanoparticles decorated graphene as an enhanced sensing platform for ultrasensitive stripping voltammetric detection of mercury (II). *Sensors and Actuators B: Chemical*, 150(2), 491-497.

Grabowska, I., Stachyra, A., Góra-Sochacka, A., Sirko, A., Olejniczak, A. B., Leśnikowski, Z. J. and Radecka, H. (2014). DNA probe modified with 3-iron bis (dicarbollide) for electrochemical determination of DNA sequence of Avian Influenza Virus H5N1. *Biosensors and Bioelectronics* 51:170-176.

Graham, D., Ferreira, H., Feliciano, N., Freitas, P., Clarke, L. and Amaral, M. (2005). Magnetic field-assisted DNA hybridisation and simultaneous detection using micron-sized spin-valve sensors and magnetic nanoparticles. *Sensors and Actuators B: Chemical* 107(2), 936-944.

Grobusch, M., Niedrig, M., Göbels, K., Klipstein-Grobusch, K. and Teichmann, D. (2006). Evaluation of the use of RT-PCR for the early diagnosis of dengue fever. *Clinical microbiology and infection* 12(4): 395-397.

Gubicza, J., Lábár, J. L., Quynh, L. M., Nam, N. H. and Luong, N. H. (2013). Evolution of size and shape of gold nanoparticles during long-time aging. *Materials Chemistry and Physics* 138(2):449-453.

Gubler, D., Kuno, G., Sather, G., Velez, M. and Oliver, A. (1984). Mosquito cell cultures and specific monoclonal antibodies in surveillance for dengue viruses. *The American journal of tropical medicine and hygiene* 33(1): 158-165.

Gubler, D. J. (1998). Dengue and dengue hemorrhagic fever. *Clinical microbiology reviews* 11(3): 480-496.

Gubler, D. J. (2002). Epidemic dengue/dengue hemorrhagic fever as a public health, social and economic problem in the 21st century. *Trends in microbiology* 10(2):100-103.

Gubler, D. J. *Dengue/dengue haemorrhagic fever: history and current status.* Paper presented at the Novartis foundation symposium. 2006.

Guey Chuen, P., Huan-Yao, L., Yee-Shin, L. and Kulkanya, C. (2011). Dengue vaccines: challenge and confrontation. *World Journal of Vaccines* 4:109-130.

© COPYRIGHT UPM

Gui, H., Wei, B. and Wang, J. (2015). The hybridization and optimization of complementary DNA molecules on organic field-effect transistors. *Materials Science in Semiconductor Processing* 30:250-254.

Guo, Y., Su, S., Wei, X., Zhong, Y., Su, Y., Huang, Q. and He, Y. (2013). A silicon-based electrochemical sensor for highly sensitive, specific, label-free and real-time DNA detection. *Nanotechnology* 24(44):444012.

Gurukumar, K., Priyadarshini, D., Patil, J., Bhagat, A., Singh, A., Shah, P. and Cecilia, D. (2009). Development of real time PCR for detection and quantitation of Dengue Viruses. *Virology journal 6*(1):10-18

Guzmán, M. a. G. and Kouŕi, G. (2004). Dengue diagnosis, advances and challenges. *International journal of infectious diseases 8*(2): 69-80.

Guzman, M. G., Halstead, S. B., Artsob, H., Buchy, P., Farrar, J., Gubler, D. J. and Martínez, E. (2010). Dengue: a continuing global threat. *Nature Reviews Microbiology* 8:7-16.

Guzman, M. G. and Kouri, G. (2002). Dengue: an update. *Lancet Infect Dis.* 2(1):33-42.

Guzman, M. G. and Kouri, G. (2004). Dengue diagnosis, advances and challenges. *Int J Infect Dis. 8*(2):69-80.

Guzmán, M. G. and Kouri, G. (1996). Advances in dengue diagnosis. *Clinical and diagnostic laboratory immunology 3*(6):621-627

Haliza, A. and Eva, N. (2015). Knowledge, Attitude and Practice (KAP) of Dengue Fever Prevention among Community in Kampung Bayam, Kubang Kerian, Kelantan, Malaysia. *Advances in Environmental Biology* 9(9):10-16.

Hamdan, N. A., Issa, R., Noli, M. F. M. and Zin, N. M. (2012). Electrochemical Technique using Methylene Blue with Pencil Graphite Electrode for Optimum Detection of Mycobacterium tuberculosis DNA. *Current Research in Tuberculosis* 4(1):1-12.

Hammon, W. (1973). Dengue hemorrhagic fever--do we know its cause? *The American journal of tropical medicine and hygiene* 22(1):82-91.

Han, K., Liang, Z., and Zhou, N. (2010). Design strategies for aptamer-based biosensors. *Sensors* 10(5):4541-4557.

Hang, V. T., Nguyet, N. M., Trung, D. T., Tricou, V., Yoksan, S., Dung, N. M. and Wills, B. (2009). Diagnostic accuracy of NS1 ELISA and lateral flow rapid tests for dengue sensitivity, specificity and relationship to viraemia and antibody responses. *PLoS neglected tropical diseases* 3(1):e360.

Hanley, K. A., and Weaver, S. C. (2010). *Frontiers in Dengue Virus Research*: Horizon Scientific Press.

© COPYRIGHT UPM

Hároníková, L., Špaček, J., Plucnara, M., Horáková, P., Pivoňková, H., Havran, L. and Fojta, M. (2015). Enzyme-linked electrochemical detection of DNA fragments amplified by PCR in the presence of a biotinylated deoxynucleoside triphosphate using disposable pencil graphite electrodes. *Monatshefte für Chemie-Chemical Monthly* 146(5):849-855.

Hartati, Y. W., Topkaya, S. N., Maksum, I. P. and Ozsoz, M. (2013). Sensitive detection of mitochondrial DNA A3243G tRNALeu mutation via an electrochemical biosensor using meldola's blue as a hybridization indicator. *Advances in Analytical Chemistry* 3: 20-27.

Hayat, A., and Marty, J. L. (2014). Aptamer based electrochemical sensors for emerging environmental pollutants. *Frontiers in chemistry*, 2:41

He, C.Z., Zhang, K.H., Wang, T., Wan, Q.S., Hu, P.P., Hu, M.D. and Lv, N.H. (2013). Single-primer-limited amplification: A method to generate random single-stranded DNA sub-library for aptamer selection. *Analytical biochemistry 440*(1): 63-70.

He, Y., Fan, C., and Lee, S.-T. (2010). Silicon nanostructures for bioapplications. *Nano Today 5*(4):282-295.

He, Y., Su, S., Xu, T., Zhong, Y., Zapien, J. A., Li, J. and Lee, S.T. (2011). Silicon nanowires-based highly-efficient SERS-active platform for ultrasensitive DNA detection. *Nano Today 6*(2):122-130.

He, Y. Q., Liu, S. P., Kong, L. and Liu, Z. F. (2005). A study on the sizes and concentrations of gold nanoparticles by spectra of absorption, resonance Rayleigh scattering and resonance non-linear scattering. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy* 61(13): 2861-2866.

Hejazi, M., Pournaghi-Azar, M. and Ahour, F. (2010). Electrochemical detection of short sequences of hepatitis C 3a virus using a peptide nucleic acid-assembled gold electrode. *Analytical biochemistry* 399(1): 118-124.

Hejazi, M. S., Pournaghi-Azar, M. H., Alipour, E. and Karimi, F. (2008). Construction, electrochemically biosensing and discrimination of recombinant plasmid (pEThIL-2) on the basis of interleukine-2 DNA insert. *Biosensors and Bioelectronics* 23(11):1588-1594.

Henchal, E., Gentry, M., McCown, J. and Brandt, W. (1982). Dengue virus-specific and flavivirus group determinants identified with monoclonal antibodies by indirect immunofluorescence. *Am J Trop Med Hyg.* 31(4): 830-836.

Hernández, S. I., Mateos, S. G., Aguilar, H. F., Martinez, I. L., Aranda, C. A., Ludert, J. E. and del Angel, R. M. (2012). Evaluation of a novel commercial rapid test for dengue diagnosis based on specific IgA detection. *Diagnostic microbiology and infectious disease* 72(2):150-155.

© COPYRIGHT UPM

Herne, T. M. and Tarlov, M. J. (1997). Characterization of DNA probes immobilized on gold surfaces. *Journal of the American Chemical Society* 119(38):8916-8920.

Hezard, T., Fajerwerg, K., Evrard, D., Collière, V., Behra, P. and Gros, P. (2012). Gold nanoparticles electrodeposited on glassy carbon using cyclic voltammetry: Application to Hg (II) trace analysis. *Journal of Electroanalytical Chemistry* 664:46-52.

Hianik, T., Ostatná, V., Zajacová, Z., Stoikova, E. and Evtugyn, G. (2005). Detection of aptamer–protein interactions using QCM and electrochemical indicator methods. *Bioorganic & medicinal chemistry letters* 15(2):291-295.

Hinkelmann, K. (2011). *Design and Analysis of Experiments, Special Designs and Applications* (Vol. 3): John Wiley and Sons.

Howe, G. M. (1977). *A world geography of human diseases*: Academic Press Inc.(London) Ltd., 24-28 Oval Road, London NW1 7DX.

Hu, W., Hu, Q., Li, L., Kong, J. and Zhang, X. (2015). Detection of sequence-specific DNA with a morpholino-functionalized silicon chip. *Analytical Methods* 7(6): 2406-2412.

Hu, Y. W., Yang, T., Wang, X. X. and Jiao, K. (2010). Highly Sensitive Indicator-Free Impedance Sensing of DNA Hybridization Based on Poly (m-aminobenzenesulfonic acid)/TiO2 Nanosheet Membranes with Pulse Potentiostatic Method Preparation. *Chemistry-A European Journal* 16(6):1992-1999.

Huan, J., Liu, Q., Fei, A., Qian, J., Dong, X., Qiu, B. and Wang, K. (2015). Amplified solid-state electrochemiluminescence detection of cholesterol in near-infrared range based on CdTe quantum dots decorated multiwalled carbon nanotubes@ reduced graphene oxide nanoribbons. *Biosensors and Bioelectronics* 73:221-227.

Huang, H., Bai, W., Dong, C., Guo, R. and Liu, Z. (2015). An ultrasensitive electrochemical DNA biosensor based on graphene/Au nanorod/polythionine for human papillomavirus DNA detection. *Biosensors and Bioelectronics* 68:442-446.

Huang, K.J., Liu, Y.J., Wang, H.B., Gan, T., Liu, Y.M. and Wang, L.L. (2014a). Signal amplification for electrochemical DNA biosensor based on two-dimensional graphene analogue tungsten sulfide–graphene composites and gold nanoparticles. *Sensors and Actuators B: Chemical* 191:828-836.

K.-J., Liu, Y.J., Wang, H.B., Wang, Y.Y. and Liu, Y.M. (2014b). Sub-femtomolar DNA detection based on layered molybdenum disulfide/multi-walled carbon nanotube composites, Au nanoparticle and enzyme multiple signal amplification. *Biosensors and Bioelectronics* 55:195-202.

© COPYRIGHT UPM

Huang, K.J., Liu, Y.J., Zhang, J.Z., Cao, J.T. and Liu, Y.M. (2015c). Aptamer/Au nanoparticles/cobalt sulfide nanosheets biosensor for 17β-estradiol detection using a guanine-rich complementary DNA sequence for signal amplification. *Biosensors and Bioelectronics* 67:184-191.

Huang, L., Guo, Z. R., Wang, M. and Gu, N. (2006). Facile synthesis of gold nanoplates by citrate reduction of $AuCl_4$ at room temperature. *Chinese Chemical Letters* 17(10):1405-1408.

Huang, S., Li, C., Lin, B. and Qin, J. (2010). Microvalve and micropump controlled shuttle flow microfluidic device for rapid DNA hybridization. *Lab on a Chip* 10:2925-2931.

Huhtamo, E., Hasu, E., Uzcátegui, N. Y., Erra, E., Nikkari, S., Kantele, A. and Piiparinen, H. (2010). Early diagnosis of dengue in travelers: comparison of a novel real-time RT-PCR, NS1 antigen detection and serology. *Journal of Clinical Virology 47*(1): 49-53.

Hunsperger, E. A., Yoksan, S., Buchy, P., Nguyen, V. C., Sekaran, S. D., Enria, D. A. and Drebot, M. (2009). Evaluation of commercially available anti–dengue virus immunoglobulin M tests. *Emerging infectious diseases* 15(3):436-440.

Husin, F., Chan, Y. Y., Gan, S. H., Sulaiman, S. A. and Shueb, R. H. (2015). The Effect of *Hydrocotyle sibthorpioides* Lam. Extracts on In Vitro Dengue Replication. *Evidence-Based Complementary and Alternative Medicine*, Article ID 596109, 9 pages. DOI: 10.1155/2015/596109.

Hwang, I.T., Kim, Y.J., Kim, S.H., Kwak, C.I., Gu, Y.Y. and Chun, J.Y. (2003). Annealing control primer system for improving specificity of PCR amplification. *BioTechniques* 35(6):1180-1191.

Hynek, D., Krejčová, L., Zítka, O., Adam, V., Trnková, L., Sochor, J. and Kizek, R. (2012). Electrochemical study of doxorubicin interaction with different sequences of single stranded oligonucleotides, Part II. *International Journal of Electrochemical Science* 7:34-49.

Ilkhani, H., Arvand, M., Ganjali, M. R., Marrazza, G. and Mascini, M. (2013). Nanostructured screen printed graphite electrode for the development of a novel electrochemical genosensor. *Electroanalysis* 25(2):507-514.

Issa, R., Hamdan, N. and Noh, M. (2010). Differential pulse voltammetric determination of DNA hybridization using methylene blue on screen printed carbon electrode for the detection of Mycobacterium tuberculosis. *Biotechnology* 9(3):304-311.

Iyer, M. A., Oza, G., Velumani, S., Maldonado, A., Romero, J., Muñoz, M. d. L. and Yi, J. (2014). Scanning fluorescence-based ultrasensitive detection of dengue viral DNA on ZnO thin films. *Sensors and Actuators B: Chemical* 202;1338-1348.

© COPYRIGHT UPM

Jacobsen, M. and Flechsig, G.U. (2011). Temperature Control in Electrochemical DNA Sensing. *Current Physical Chemistry* 1(4):292-298.

Jain, R. and Sharma, S. (2012). Glassy carbon electrode modified with multi-walled carbon nanotubes sensor for the quantification of antihistamine drug pheniramine in solubilized systems. *Journal of Pharmaceutical Analysis* 2(1):56-61.

Jalit, Y., Moreno, M., Gutierrez, F. A., Sanchez Arribas, A., Chicharro, M., Bermejo, E. and Rodríguez, M. C. (2013). Adsorption and Electrooxidation of Nucleic Acids at Glassy Carbon Electrodes Modified with Multiwalled Carbon Nanotubes Dispersed In Polylysine. *Electroanalysis* 25(5):1116-1121.

Jampasa, S., Wonsawat, W., Rodthongkum, N., Siangproh, W., Yanatatsaneejit, P., Vilaivan, T. and Chailapakul, O. (2014). Electrochemical detection of human papillomavirus DNA type 16 using a pyrrolidinyl peptide nucleic acid probe immobilized on screen-printed carbon electrodes. *Biosensors and Bioelectronics* 54:428-434.

Jayakumar, K., Rajesh, R., Dharuman, V. and Venkatesan, R. (2013). Graphene–PAMAM dendrimer–gold nanoparticle composite for electrochemical DNA hybridization detection *Methods Molecular Biology* 1039:201-219.

Jelen, F., Fojta, M. and Paleček, E. (1997). Voltammetry of native double-stranded, denatured and degraded DNAs. *Journal of Electroanalytical Chemistry* 427(1):49-56.

Jiang, Z., Jiang, X., Su, S., Wei, X., Lee, S. and He, Y. (2012). Silicon-based reproducible and active surface-enhanced Raman scattering substrates for sensitive, specific, and multiplex DNA detection. *Applied physics letters* 100(20):203104. Doi:10.1063/1.3701731.

Jiao, Z., Li, J.p., Nie, Y.h., Li, J.s. and Yang, J.f. (2013). Affinity and fluorescent detection of surfactants/ssDNA and single-walled carbon nanotube. *Transactions of Nonferrous Metals Society of China* 23(2):456-461.

Jin, H., Wei, M. and Wang, J. 2013. Electrochemical DNA biosensor based on the BDD nanograss array electrode. *Chemistry Central Journal* 7**:**1-6.

Jittmittraphap, A., Thammapalo, S., Ratanasetyuth, N., Wongba, N., Mammen, M. P. and Jampangern, W. (2006). Rapid detection of dengue viral RNA in mosquitoes by nucleic acid-sequence based amplification (NASBA). *Southest Asian J. Trop. Med. Public Health* 37(6):1117-1124.

Johnson, B. W., Russell, B. J. and Lanciotti, R. S. (2005). Serotype-specific detection of dengue viruses in a fourplex real-time reverse transcriptase PCR assay. *Journal of clinical microbiology* 43(10):4977-4983.

© COPYRIGHT UPM

Jyothi, P., and Metri, B. C. (2015). Correlation of serological markers and platelet count in the diagnosis of Dengue virus infection. *Advanced biomedical research 4*:26-36

Kainz, P., Schmiedlechner, A. and Strack, H. B. (2000). Specificity-enhanced hot-start PCR: addition of double-stranded DNA fragments adapted to the annealing temperature. *BioTechniques* 28(2):278-282.

Kamaldeep, D. K. and Dubey, K. K. (2012). Optimization of Zinc Oxide nanoparticles synthesis to fabricate glucose oxidase sensor. *Advances in Applied Science Research* 3(5): 3081-3088.

Kan, Y., Tan, Q., Wu, G., Si, W. and Chen, Y. (2015). Study of DNA adsorption on mica surfaces using a surface force apparatus. *Scientific reports* 5:8442. Doi:10.1038/srep08442

Kang, D., Zuo, X., Yang, R., Xia, F., Plaxco, K. W. and White, R. J. (2009). Comparing the properties of electrochemical-based DNA sensors employing different redox tags. *Analytical chemistry* 81(21):9109-9113.

Kao, C.L., King, C.C., Chao, D.Y., Wu, H.L. and Chang, G. (2005). Laboratory diagnosis of dengue virus infection: current and future perspectives in clinical diagnosis and public health. *J Microbiol Immunol Infect.* 38(1), 5-16.

Karamollaoğlu, İ., Öktem, H. A. and Mutlu, M. (2009). QCM-based DNA biosensor for detection of genetically modified organisms (GMOs). *Biochemical Engineering Journal* 44(2):142-150.

Karlin, K. D. and Tyeklár, Z. (2012). *Bioinorganic chemistry of copper*: Springer Science & Business Media.

Ke, Y., Nangreave, J., Yan, H., Lindsay, S. and Liu, Y. (2008). Developing DNA tiles for oligonucleotide hybridization assay with higher accuracy and efficiency. *Chem. Commun.*(43):5622-5624.

Keighley, S. D., Li, P., Estrela, P. and Migliorato, P. (2008). Optimization of DNA immobilization on gold electrodes for label-free detection by electrochemical impedance spectroscopy. *Biosensors and Bioelectronics* 23(8):1291-1297.

Kerman, K., Kobayashi, M. and Tamiya, E. (2004a). Recent trends in electrochemical DNA biosensor technology. *Measurement Science and Technology 15*(2). Doi:10.1088/0957-0233/15/2.

Kerman, K., Morita, Y., Takamura, Y. and Tamiya, E. (2005). *Escherichia coli* single-strand binding protein–DNA interactions on carbon nanotube-modified electrodes from a label-free electrochemical hybridization sensor. *Analytical and bioanalytical chemistry* 381(6):1114-1121.

© COPYRIGHT UPM

Kerman, K., Ozkan, D., Kara, P., Karadeniz, H., Ozkan, Z., Erdem, A. and Ozsoz, M. (2004b). Electrochemical detection of specific DNA sequences from PCR amplicons on carbon and mercury electrodes using Meldola's Blue as an intercalator. *Turkish Journal of Chemistry* 28:523-534.

Kerman, K., Ozkan, D., Kara, P., Meric, B., Gooding, J. J. and Ozsoz, M. (2002). Voltammetric determination of DNA hybridization using methylene blue and self-assembled alkanethiol monolayer on gold electrodes. *Analytica Chimica Acta* 462(1):39-47.

Khan, H. U., Roberts, M. E., Johnson, O., Knoll, W. and Bao, Z. (2012). The effect of ph and DNA concentration on organic thin-film transistor biosensors. *Organic Electronics* 13(3):519-524.

Khan, M. J. H., Hussain, M. A. and Mujtaba, I. M. (2014). Polypropylene Production Optimization in Fluidized Bed Catalytic Reactor (FBCR): Statistical Modeling and Pilot Scale Experimental Validation. *Materials* 7(4):2440-2458.

Kim, P. K., Cho, S. J., Sung, J., Oh, H. S. and Lim, G. *Bio-molecules detection sensor using silicon nanowire.* Paper presented at the Second International Conference on Smart Materials and Nanotechnology in Engineering. 2009.

Kim, Y.S., Cho, J.H., Ansari, S., Kim, H.I., Dar, M., Seo, H.K. and Shin, H.S. (2006). Immobilization of avidin on the functionalized carbon nanotubes. *Synthetic metals* 156(14):938-943.

Kim, Y. S., Jung, H. S., Matsuura, T., Lee, H. Y., Kawai, T. and Gu, M. B. (2007). Electrochemical detection of 17β-estradiol using DNA aptamer immobilized gold electrode chip. *Biosensors and Bioelectronics* 22(11), 2525-2531.

Knierim, E., Lucke, B., Schwarz, J. M., Schuelke, M. and Seelow, D. (2011). Systematic comparison of three methods for fragmentation of long-range PCR products for next generation sequencing. *PloS one* 6(11):e28240.

Koehne, J. E., Chen, H., Cassell, A. M., Ye, Q., Han, J., Meyyappan, M. and Li, J. (2004). Miniaturized multiplex label-free electronic chip for rapid nucleic acid analysis based on carbon nanotube nanoelectrode arrays. *Clinical chemistry* 50(10):1886-1893.

Koraka, P., Burghoorn-Maas, C. P., Falconar, A., Setiati, T. E., Djamiatun, K., Groen, J. and Osterhaus, A. D. (2003). Detection of immune-complex-dissociated nonstructural-1 antigen in patients with acute dengue virus infections. *Journal of clinical microbiology* 41(9):4154-4159.

Körbahti, B. K. and Rauf, M. (2008). Response surface methodology (RSM) analysis of photoinduced decoloration of toludine blue. *Chemical Engineering Journal* 136(1):25-30.

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Kuan, G. C., Sheng, L. P., Rijiravanich, P., Marimuthu, K., Ravichandran, M., Yin, L. S., and Surareungchai, W. (2013). Gold-nanoparticle based electrochemical DNA sensor for the detection of fish pathogen Aphanomyces invadans. *Talanta* 117:312-317.

Kulkarni, A., Xu, Y., Ahn, C., Amin, R., Park, S. H., Kim, T. and Lee, M. (2012). The label free DNA sensor using a silicon nanowire array. *Journal of biotechnology* 160(3):91-96.

Kumar, A., Madaria, A. R. and Zhou, C. (2010). Growth of aligned single-crystalline rutile TiO2 nanowires on arbitrary substrates and their application in dye-sensitized solar cells. *The Journal of Physical Chemistry C* 114(17):7787-7792.

Kumar, S., Aaron, J. and Sokolov, K. (2008). Directional conjugation of antibodies to nanoparticles for synthesis of multiplexed optical contrast agents with both delivery and targeting moieties. *Nature protocols* 3(2):314-320.

Kumarasamy, V., Wahab, A. A., Chua, S., Hassan, Z., Mohamad, M. and Chua, K. (2007). Evaluation of a commercial dengue NS1 antigen-capture ELISA for laboratory diagnosis of acute dengue virus infection. *Journal of virological methods* 140(1): 75-79.

Kwakye, S., Goral, V. N. and Baeumner, A. J. (2006). Electrochemical microfluidic biosensor for nucleic acid detection with integrated minipotentiostat. *Biosensors and Bioelectronics* 21(12):2217-2223.

Kwon, D., Kim, K. and Kwak, J. (2008). Electrochemical DNA hybridization detection using DNA cleavage. *Electroanalysis* 20(11):1204-1208.

Kwon, D. H., An, H. H., Kim, H.S., Lee, J. H., Suh, S. H., Kim, Y. H. and Yoon, C. S. (2011). Electrochemical albumin sensing based on silicon nanowires modified by gold nanoparticles. *Applied Surface Science* 257(10), 4650-4654.

Kwon, S. J. and Bard, A. J. (2012). DNA analysis by application of Pt nanoparticle electrochemical amplification with single label response. *Journal of the American Chemical Society* 134(26): 10777-10779.

Labuda, J., K Bubnicova, K., Kovalova, L., Vanickova, M., Mattusch, J. and Wennrich, R. (2005). Voltammetric detection of damage to DNA by arsenic compounds at a DNA biosensor. *Sensors* 5(6) 411-423.

LaGier, M. J., Scholin, C. A., Fell, J. W., Wang, J. and Goodwin, K. D. (2005). An electrochemical RNA hybridization assay for detection of the fecal indicator bacterium *Escherichia coli*. *Marine pollution bulletin* 50(11):1251-1261.

Lai, R. Y., Lagally, E. T., Lee, S.-H., Soh, H., Plaxco, K. W. and Heeger, A. J. (2006). Rapid, sequence-specific detection of unpurified PCR amplicons via a reusable, electrochemical sensor. *Proceedings of the National Academy of Sciences of the United States of America* 103(11):4017-4021.

© COPYRIGHT UPM

dleLai, S. L., Tan, W. L. and Yang, K.L. (2011). Detection of DNA targets hybridized to solid surfaces using optical images of liquid crystals. *ACS applied materials & interfaces* 3(9):3389-3395.

Lakard, S., Herlem, G., Lakard, B. and Fahys, B. (2004). Theoretical study of the vibrational spectra of polyethylenimine and polypropylenimine. *Journal of Molecular Structure: THEOCHEM* 685(1): 83-87.

Lan, M., Chen, C., Zhou, Q., Teng, Y., Zhao, H. and Niu, X. (2010). Voltammetric detection of microcystis genus specific-sequence with disposable screen-printed electrode modified with gold nanoparticles. *Adv Mater Lett.* 1(3):217-224.

Lanciotti, R. S., Calisher, C. H., Gubler, D. J., Chang, G.J. and Vorndam, A. V. (1992). Rapid detection and typing of dengue viruses from clinical samples by using reverse transcriptase-polymerase chain reaction. *Journal of clinical microbiology* 30(3):545-551.

Lau, Y.L., Lai, M.Y., Teoh, B.T., Abd-Jamil, J., Johari, J., Sam, S.S. and AbuBakar, S. (2015). Colorimetric Detection of Dengue by Single Tube Reverse-Transcription-Loop-Mediated Isothermal Amplification. *PloS one* 10(9): e0138694.

Lavorgna, M., Romeo, V., Martone, A., Zarrelli, M., Giordano, M., Buonocore, G. and Xia, H. (2013). Silanization and silica enrichment of multiwalled carbon nanotubes: Synergistic effects on the thermal-mechanical properties of epoxy nanocomposites. *European Polymer Journal* 49(2):428-438.

Le, M. H., Jimenez, C., Chainet, E. and Stambouli, V. (2015). A Label-Free Impedimetric DNA Sensor Based on a Nanoporous SnO_2 Film: Fabrication and Detection Performance. *Sensors* 15(5):10686-10704.

Lee, A.C., Du, D., Chen, B., Heng, C.-K., Lim, T.M. and Lin, Y. (2014a). Electrochemical detection of leukemia oncogenes using enzyme-loaded carbon nanotube labels. *Analyst,* 139(17): 4223-4230.

Lee, H.E., Kang, Y. O., and Choi, S.H. (2014b). Electrochemical-DNA Biosensor Development Based on a Modified Carbon Electrode with Gold Nanoparticles for Influenza A (H1N1) Detection: Effect of Spacer. *Int. J. Electrochem. Sci.* 9:6793-6808.

Lee, H., Hong, J., Lee, S., Kim, S.D., Kim, Y.W. and Lee, T. (2013). Selectively grown vertical silicon nanowire pn^+ photodiodes via aqueous electroless etching. *Applied Surface Science* 274:79-84.

Lee, H., Rohani, A., Khadri, M., Nazni, W., Rozilawati, H., Nurulhusna, A. and Teh, C. (2015a). Dengue Vector Control in Malaysia-Challenges and Recent Advances. *International Medical Journal Malaysia, 14*(1):1-6.

© COPYRIGHT UPM

Lee, S.H., Ahn, J.Y., Lee, K.A., Um, H.J., Sekhon, S. S., Park, T. S. and Kim, Y.H. (2015b). Analytical bioconjugates, aptamers, enable specific quantitative detection of *Listeria monocytogenes. Biosensors and Bioelectronics* 68:272-280.

Lee Yu, H. L., Montesa, C. M., Rojas, N. S. L. and Enriquez, E. P. (2012). Nucleic-acid based lateral flow strip biosensor via competitive binding for possible dengue detection. *Journal of Biosensor and Biolectronics* 3(5):128. Doi: 10.4172/2155-6210.1000128.

Lei, Y., Chen, W. and Mulchandani, A. (2006). Microbial biosensors. *Analytica Chimica Acta* 568(1):200-210.

Lemmer, K., Mantke, O. D., Bae, H.G., Groen, J., Drosten, C. and Niedrig, M. (2004). External quality control assessment in PCR diagnostics of dengue virus infections. *Journal of Clinical Virology* 30(4):291-296.

Lerner, M. B., Dailey, J., Goldsmith, B. R., Brisson, D. and Johnson, A. C. (2013). Detecting Lyme disease using antibody-functionalized single-walled carbon nanotube transistors. *Biosensors and Bioelectronics* 45:163-167.

Li, C., Karadeniz, H., Canavar, E. and Erdem, A. (2012a). Electrochemical sensing of label free DNA hybridization related to breast cancer 1 gene at disposable sensor platforms modified with single walled carbon nanotubes. *Electrochimica Acta* 82: 137-142.

Li, C., Liu, S., Guo, L.H. and Chen, D. (2005). A new chemically amplified electrochemical system for DNA detection in solution. *Electrochemistry communications* 7(1):23-28.

Li, F., Chen, W. and Zhang, S. (2008a). Development of DNA electrochemical biosensor based on covalent immobilization of probe DNA by direct coupling of sol–gel and self-assembly technologies. *Biosensors and Bioelectronics* 24(4):781-786.

Li, F., Feng, Y., Dong, P., Yang, L. and Tang, B. (2011a). Gold nanoparticles modified electrode via simple electrografting of in situ generated mercaptophenyl diazonium cations for development of DNA electrochemical biosensor. *Biosensors and Bioelectronics* 26(5):1947-1952.

Li, F., Han, X. and Liu, S. (2011b). Development of an electrochemical DNA biosensor with a high sensitivity of fM by dendritic gold nanostructure modified electrode. *Biosensors and Bioelectronics* 26(5):2619-2625.

Li, G.j., Liu, L.h., Qi, X.w., Guo, Y.-q., Sun, W. and Li, X.l. (2012b). Development of a sensitive electrochemical DNA sensor by 4-aminothiophenol self-assembled on electrodeposited nanogold electrode coupled with Au nanoparticles labeled reporter ssDNA. *Electrochimica Acta* 63:312-317.

© COPYRIGHT UPM

Li, G., Li, X., Wan, J. and Zhang, S. (2009a). Dendrimers-based DNA biosensors for highly sensitive electrochemical detection of DNA hybridization using reporter probe DNA modified with Au nanoparticles. *Biosensors and Bioelectronics* 24(11), 3281-3287.

Li, H., Sun, Z., Zhong, W., Hao, N., Xu, D., and Chen, H.-Y. (2010). Ultrasensitive electrochemical detection for DNA arrays based on silver nanoparticle aggregates. *Analytical chemistry, 82*(13), 5477-5483.

Li, J., Xu, M., Huang, H., Zhou, J., Abdel-Halimb, E., Zhang, J.R. and Zhu, J.J. (2011c). Aptamer-quantum dots conjugates-based ultrasensitive competitive electrochemical cytosensor for the detection of tumor cell. *Talanta* 85(4):2113-2120.

Li, K., Huang, J., Shi, G., Zhang, W. and Jin, L. (2011d). A Sensitive Nanoporous Gold-Based Electrochemical DNA Biosensor for Escherichia coli Detection. *Analytical Letters* 44(16):2559-2570.

Li, L. L., Cai, H., Lee, T. M. H., Barford, J. and Hsing, I. (2004). Electrochemical detection of PCR amplicons using electroconductive polymer modified electrode and multiple nanoparticle labels. *Electroanalysis* 16(1-2), 81-87.

Li, M., Li, Y.T., Li, D.W. and Long, Y.-T. (2012c). Recent developments and applications of screen-printed electrodes in environmental assays A review. *Analytica Chimica Acta* 734:31-44.

Li, S.J., Xia, N., Yuan, B.-Q., Du, W.-M., Sun, Z.F. and Zhou, B.B. (2015). A novel DNA sensor using a sandwich format by electrochemical measurement of marker ion fluxes across nanoporous alumina membrane. *Electrochimica Acta* 159:234-241.

Li, S., Ma, W., Zhou, Y., Chen, X., Ma, M., Xu, Y. and Wu, X. (2013a). 3-aminopropyltriethoxysilanes modified porous silicon as a voltammetric sensor for determination of silver Ion. *Int. J. Electrochem. Sci.* 8:1802-1812.

Li, S., Wang, L., Li, Y., Zhu, X., Zhong, L., Lu, L. and Feng, W. (2013b). Electrochemical determination of BCR/ABL fusion gene based on in situ synthesized gold nanoparticles and cerium dioxide nanoparticles. *Colloids and Surfaces B: Biointerfaces* 112:344-349.

Li, S. Y., Ma, W., Zhou, Y., Chen, X., Ma, M., Xu, Y. and Wu, X. (2013c). 3-aminopropyltriethoxysilanes modified porous silicon as a voltammetric sensor for determination of Silver ion. *Int. J. Electrochem. Sci.* 8 1802-1812.

Li, W., Cui, S. W. and Kakuda, Y. (2006). Extraction, fractionation, structural and physical characterization of wheat β-D-glucans. *Carbohydrate polymers* 63(3):408-416.

© COPYRIGHT UPM

Li, Y., Qi, H., Yang, J., and Zhang, C. (2009b). Detection of DNA immobilized on bare gold electrodes and gold nanoparticle-modified electrodes via electrogenerated chemiluminescence using a ruthenium complex as a tag. *Microchimica Acta, 164*(1-2), 69-76.

Li, Z., Niu, T., Zhang, Z., Feng, G. and Bi, S. (2012d). Effect of monovalent cations (Li^+, Na^+, K^+, Cs^+) on self-assembly of thiol-modified double-stranded and single-stranded DNA on gold electrode. *Analyst* 137(7):1680-1691.

Li, Z., Zeng, G., Tang, L., Zhang, Y., Li, Y., Pang, Y. and Liu, Y. (2011e). Electrochemical DNA sensor for simultaneous detection of genes encoding two functional enzymes involved in lignin degradation. *Biochemical Engineering Journal* 55(3):185-192.

Liang, Z., Lao, R., Wang, J., Liu, Y., Wang, L., Huang, Q. and Fan, C. (2007). Solubilization of single-walled carbon nanotubes with single-stranded DNA generated from asymmetric PCR. *International Journal of Molecular Sciences* 8(7):705-713.

Libraty, D. H., Young, P. R., Pickering, D., Endy, T. P., Kalayanarooj, S., Green, S. and Rothman, A. L. (2002). High circulating levels of the dengue virus nonstructural protein NS1 early in dengue illness correlate with the development of dengue hemorrhagic fever. *Journal of Infectious Diseases* 186(8):1165-1168.

Liew, P. S., Lertanantawong, B., Lee, S. Y., Manickam, R., Lee, Y. H. and Surareungchai, W. (2015). Electrochemical genosensor assay using lyophilized gold nanoparticles/latex microsphere label for detection of *Vibrio cholerae*. *Talanta* 139:167-173.

Lima, C. (2013). *Application of response surface methodology (RSM) to optimize the hybridization efficiency of a PNA probe targeting Saccharomyces cerevisiae. (unpublished master dissertation).* University of Porto, Portugal.

Lin, C., Wu, Y., Luo, F., Chen, D. and Chen, X. (2014). A label-free electrochemical DNA sensor using methylene blue as redox indicator based on an exonuclease III-aided target recycling strategy. *Biosensors and Bioelectronics* 59:365-369.

Lin, Y., Peng, Y. and Di, J. (2015). Electrochemical detection of Hg (II) ions based on nanoporous gold nanoparticles modified indium tin oxide electrode. *Sensors and Actuators B: Chemical* 220:1086-1090.

Lindahl, T. (1993). Instability and decay of the primary structure of DNA. *Nature* 362:709-715.

Lindenbach, D, B. and Rice, C. M. (2001). Flaviviridae: the viruses and their replication. *Fields virology* 1:991-1041.

© COPYRIGHT UPM

Liu, C., Zeng, G.M., Tang, L., Zhang, Y., Li, Y.P., Liu, Y.Y. and Luo, J. (2011a). Electrochemical detection of Pseudomonas aeruginosa 16S rRNA using a biosensor based on immobilized stem–loop structured probe. *Enzyme and microbial technology* 49(3):266-271.

Liu, G., Wan, Y., Gau, V., Zhang, J., Wang, L., Song, S. and Fan, C. (2008). An enzyme-based E-DNA sensor for sequence-specific detection of femtomolar DNA targets. *Journal of the American Chemical Society* 130(21):6820-6825.

Liu, L., Xiang, G., Jiang, D., Du, C., Liu, C., Huang, W. and Pu, X. (2015). Electrochemical gene sensor for *Mycoplasma pneumoniae* DNA using dual signal amplification via a Pt@ Pd nanowire and horse radish peroxidase. *Microchimica Acta* 1-9. Doi:10.1007/s00604-015-1656-8.

Liu, X., Zhang, R., Yuan, X., Liu, L., Zhou, Y. and Gao, Q. 2013. Highly sensitive voltammetric detection of DNA hybridization in sandwich format using thionine-capped gold nanoparticle/reporter DNA conjugates as signal tags. *Gold Bulletin*:1-7.

Liu, M., Wang, L., Deng, J., Chen, Q., Li, Y., Zhang, Y. and Yao, S. (2012). Highly sensitive and selective dopamine biosensor based on a phenylethynyl ferrocene/graphene nanocomposite modified electrode. *Analyst* 137(19):4577-4583.

Liu, S.F., Li, Y.F., Li, J.R. and Jiang, L. (2005). Enhancement of DNA immobilization and hybridization on gold electrode modified by nanogold aggregates. *Biosensors and Bioelectronics* 21(5):789-795.

Liu, S., Liu, J., Han, X., Cui, Y. and Wang, W. (2010a). Electrochemical DNA biosensor fabrication with hollow gold nanospheres modified electrode and its enhancement in DNA immobilization and hybridization. *Biosensors and Bioelectronics* 25(7): 1640-1645.

Liu, S., Liu, J., Wang, L. and Zhao, F. (2010b). Development of electrochemical DNA biosensor based on gold nanoparticle modified electrode by electroless deposition. *Bioelectrochemistry* 79(1): 37-42.

Liu, X., Atwater, M., Wang, J. and Huo, Q. (2007). Extinction coefficient of gold nanoparticles with different sizes and different capping ligands. *Colloids and Surfaces B: Biointerfaces* 58(1):3-7.

Liu, X., Cheng, Z., Fan, H., Ai, S. and Han, R. (2011b). Electrochemical detection of avian influenza virus H5N1 gene sequence using a DNA aptamer immobilized onto a hybrid nanomaterial-modified electrode. *Electrochimica Acta* 56(18):6266-6270.

© COPYRIGHT UPM

Liu, X. and Tan, W. (1999). A fiber-optic evanescent wave DNA biosensor based on novel molecular beacons. *Analytical chemistry* 71(22):5054-5059.

Liu, Y. (2008). Electric DNA chips for determination of pathogenic microorganisms. (unpublished doctoral dissertation). Royal Institute of Technology, Sweeden.

Lo, C. L., Yip, S. P., Cheng, P. K., To, T. S., Lim, W. W. and Leung, P. H. (2007). One-Step Rapid Reverse Transcription–PCR Assay for Detecting and Typing Dengue Viruses with GC Tail and Induced Fluorescence Resonance Energy Transfer Techniques for Melting Temperature and Color Multiplexing. *Clinical chemistry* 53(4):594-599.

Loaiza, Ó. A., Campuzano, S., López-Berlanga, M., Pedrero, M. and Pingarrón, J. M. (2005). Development of a DNA sensor based on alkanethiol self-assembled monolayer-modified electrodes. *Sensors* 5(6):344-363.

Loaiza, Ó. A., Campuzano, S., Pedrero, M., García, P. and Pingarrón, J. M. (2009). Ultrasensitive detection of coliforms by means of direct asymmetric PCR combined with disposable magnetic amperometric genosensors. *Analyst* 134(1):34-37.

Lodish, H. F., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. and Darnell, J. (2000). *Molecular cell biology* (Vol. 4): Citeseer.

López, M. S.-P., Cabanillas, G. F., Castañón, M. J. L. and López-Ruiz, B. (2014). Development of a genosensor for peanut allergen ARA h 2 detection and its optimization by surface response methodology. *Biosensors and Bioelectronics* 62: 350-356.

Low, K.F., Karimah, A. and Yean, C. Y. (2013). A thermostabilized magnetogenosensing assay for DNA sequence-specific detection and quantification of *Vibrio cholerae*. *Biosensors and Bioelectronics* 47:38-44.

Lü, X., Cui, W., Huang, Y., Zhao, Y., and Wang, Z. (2009). Surface modification on silicon with chitosan and biological research. *Biomedical Materials* 4(4):044103. Doi:10.10888/1748-6041/4/4/044103.

Lu, Z., Li, C. M., Zhou, Q., Bao, Q.-L. and Cui, X. (2007). Covalently linked DNA/protein multilayered film for controlled DNA release. *Journal of colloid and interface science* 314(1):80-88.

Lucarelli, F., Marrazza, G., Turner, A. P. and Mascini, M. (2004). Carbon and gold electrodes as electrochemical transducers for DNA hybridisation sensors. *Biosensors and Bioelectronics* 19(6):515-530.

Lucarelli, F., Tombelli, S., Minunni, M., Marrazza, G. and Mascini, M. (2008). Electrochemical and piezoelectric DNA biosensors for hybridisation detection. *Analytica Chimica Acta* 609(2):139-159.

© COPYRIGHT UPM

Łuczak, T. (2011). Gold Electrodes modified with self-assembled layers made of sulphur compounds and gold nanoparticles used for selective electrocatalytic oxidation of catecholamine in the presence of interfering ascorbic and uric acids. *International Journal of Electrochemistry 2011*, Article ID 179474, 10 pages. Doi:10.4061/2011/179474

Łuczak, T. and Bełtowska-Brzezinska, M. (2011). Gold electrodes modified with gold nanoparticles and thio compounds for electrochemical sensing of dopamine alone and in presence of potential interferents. A comparative study. *Microchimica Acta* 174(1-2):19-30.

Lugo, J., Ocampo, M., Kirk, A., Plant, D. and Fauchet, P. (2007). Electrochemical sensing of DNA with porous silicon layers. *Journal of new materials for Electrochemical Systems* 10(2):113.

Lundstedt, T., Seifert, E., Abramo, L., Thelin, B., Nyström, Å., Pettersen, J. and Bergman, R. (1998). Experimental design and optimization. *Chemometrics and intelligent laboratory systems* 42(1):33-40.

Luo, C., Tang, H., Cheng, W., Yan, L., Zhang, D., Ju, H. and Ding, S. (2013). A sensitive electrochemical DNA biosensor for specific detection of Enterobacteriaceae bacteria by Exonuclease III-assisted signal amplification. *Biosens Bioelectron.* 48:132-137.

Luo, X., Morrin, A., Killard, A. J. and Smyth, M. R. (2006). Application of nanoparticles in electrochemical sensors and biosensors. *Electroanalysis* 18(4):319-326.

Lyons, M. E. G. and Keeley, G. P. (2006). The Redox Behaviour of Randomly Dispersed Single Walled Carbon Nanotubes both in the Absence and in the Presence of Adsorbed Glucose Oxidase. *Sensors* 6:1791-1826.

Macanovic, A., Marquette, C., Polychronakos, C. and Lawrence, M. (2004). Impedance-based detection of DNA sequences using a silicon transducer with PNA as the probe layer. *Nucleic acids research* 32(2):e20.

Madigan, M., Martinko, J., Dunlap, P. and Clark, D. (2009). Brock biology of microorganisms, Pearson Benjamin-Cummings. *San Francisco, CA*.

Maglia, G., Henricus, M., Wyss, R., Li, Q., Cheley, S. and Bayley, H. (2009). DNA strands from denatured duplexes are translocated through engineered protein nanopores at alkaline pH. *Nano letters* 9(11), 3831-3836.

Mahmoudi, B., Gabouze, N., Guerbous, L., Haddadi, M. and Beldjilali, K. (2007). Long-time stabilization of porous silicon photoluminescence by surface modification. *Journal of Luminescence* 127(2):534-540.

Malecka, K., Michalczuk, L., Radecka, H. and Radecki, J. (2014). Ion-Channel Genosensor for the Detection of Specific DNA Sequences Derived from Plum Pox Virus in Plant Extracts. *Sensors* 14(10):18611-18624.

© COPYRIGHT UPM

Malhotra, K., Foltz, L., Mahoney, W. C. and Schueler, P. A. (1998). Interaction and effect of annealing temperature on primers used in differential display RT-PCR. *Nucleic acids research* 26(3):854-856.

Mandong, G., Yanqing, L., Hongxia, G., Xiaoqin, W. and Lifang, F. (2007). Electrochemical detection of short sequences related to the hepatitis B virus using MB on chitosan-modified CPE. *Bioelectrochemistry* 70(2), 245-249.

Mansor, N. A., Zain, Z. M., Hamzah, H. H., Noorden, M. S. A., Jaapar, S. S., Beni, V. and Ibupoto, Z. H. (2014). Detection of breast cancer 1 (BRCA1) gene using an electrochemical dna biosensor based on immobilized Zn nanowires. *Open Journal of Applied Biosensor* 3:9-17. Doi: 10.4236/ojab.2014.32002.

Manzanares-Palenzuela, C. L., Martín-Fernández, B., López, M. S.-P. and López-Ruiz, B. (2015). Electrochemical genosensors as innovative tools for detection of genetically modified organisms. *TrAC Trends in Analytical Chemistry* 66, 19-31.

Manzanares, C. L., de-los-Santos-Álvarez, N., Lobo-Castañón, M. J. and López-Ruiz, B. (2015). Multiplex electrochemical DNA platform for Femtomolar-level quantification of genetically modified soybean. *Biosensors and Bioelectronics* 15(68):259-265.

Mao, X., Jiang, J., Xu, X., Chu, X., Luo, Y., Shen, G. and Yu, R. (2008). Enzymatic amplification detection of DNA based on "molecular beacon" biosensors. *Biosensors and Bioelectronics* 23(10):1555-1561.

Mao, X., Yang, L., Su, X.-L. and Li, Y. (2006). A nanoparticle amplification based quartz crystal microbalance DNA sensor for detection of Escherichia coli O157: H7. *Biosensors and Bioelectronics* 21(7):1178-1185.

Maran, J. P. and Manikandan, S. (2012). Response surface modeling and optimization of process parameters for aqueous extraction of pigments from prickly pear (Opuntia ficus-indica) fruit. *Dyes and Pigments* 95(3):465-472.

Maran, J. P., Manikandan, S., Thirugnanasambandham, K., Nivetha, C. V. and Dinesh, R. (2013a). Box–Behnken design based statistical modeling for ultrasound-assisted extraction of corn silk polysaccharide. *Carbohydrate polymers 92*(1):604-611.

Maran, J. P., Mekala, V. and Manikandan, S. (2013b). Modeling and optimization of ultrasound-assisted extraction of polysaccharide from Cucurbita moschata. *Carbohydrate polymers* 92(2):2018-2026.

Mardekian, S. K. and Roberts, A. L. (2015). Diagnostic options and challenges for dengue and chikungunya viruses. *BioMed Research International* Volume 2015, Article ID 834371, 8 pages Doi:10.1155/2015/834371.

© COPYRIGHT UPM

Marimuthu, C., Tang, T.-H., Tominaga, J., Tan, S.-C. and Gopinath, S. C. (2012). Single-stranded DNA (ssDNA) production in DNA aptamer generation. *Analyst* 137(6):1307-1315.

Marrazza, G., Chianella, I. and Mascini, M. (1999). Disposable DNA electrochemical biosensors for environmental monitoring. *Analytica Chimica Acta* 387(3):297-307.

Marrazza, G., Chiti, G., Mascini, M. and Anichini, M. (2000). Detection of human apolipoprotein E genotypes by DNA electrochemical biosensor coupled with PCR. *Clinical chemistry* 46(1):31-37.

Marshall, M. M., Ruzicka, J. A., Taylor, E. W. and Hall, A. R. (2014). Detecting DNA depurination with solid-state nanopores. *PloS one* 9(7):e101632. Doi:10.1371/journal.pone.0101632.

Martínez-Paredes, G., González-García, M. B. and Costa-García, A. (2010). Genosensor for detection of four pneumoniae bacteria using gold nanostructured screen-printed carbon electrodes as transducers. *Sensors and Actuators B: Chemical* 149(2):329-335.

Martins, S., Prazeres, D., Fonseca, L. and Monteiro, G. (2010). Quantitation of non-amplified genomic DNA by bead-based hybridization and template mediated extension coupled to alkaline phosphatase signal amplification. *Biotechnology letters* 32(2):229-234.

Martins, V., Alencar, C. H., Kamimura, M. T., de Carvalho Araujo, F. M., De Simone, S. G., Dutra, R. F. and Guedes, M. (2012). Occurrence of natural vertical transmission of dengue-2 and dengue-3 viruses in *Aedes aegypti* and *Aedes albopictus* in Fortaleza, Ceará, Brazil. *PloS one* 7(7):e41386. Doi: 10.1371/journal.pone.0041386.

Mazloum-Ardakani, M., Rajabzadeh, N., Benvidi, A. and Heidari, M. M. (2013). Sex determination based on amelogenin DNA by modified electrode with gold nanoparticle. *Analytical biochemistry* 443(2):132-138.

Mazzochette, Z. and Mugweru, A. (2014). Electrochemical DNA Hybridization Sensor Using Poly [vinylpyridine Os (bipyridine) 2Cl]-co-Ethylamine Redox Polymer. *Chemistry and Materials Research* 6(5):55-64.

Mehrgardi, M. A. and Ahangar, L. E. (2011). Silver nanoparticles as redox reporters for the amplified electrochemical detection of the single base mismatches. *Biosensors and Bioelectronics* 26(11):4308-4313.

Meric, B., Kerman, K., Marrazza, G., Palchetti, I., Mascini, M. and Ozsoz, M. (2004). Disposable genosensor, a new tool for the detection of NOS-terminator, a genetic element present in GMOs. *Food Control* 15(8): 621-626.

© COPYRIGHT UPM

Meric, B., Kerman, K., Ozkan, D., Kara, P., Erensoy, S., Akarca, U. S. and Ozsoz, M. (2002). Electrochemical DNA biosensor for the detection of TT and Hepatitis B virus from PCR amplified real samples by using methylene blue. *Talanta* 56(5): 837-846.

Metzenberg, S. (2007). Working with DNA: The Basics: Taylor and Francis Group: Florence, KY, USA.

Mikkelsen, S. R. (1996). Electrochecmical biosensors for DNA sequence detection. *Electroanalysis* 8(1):15-19.

Millan, K. M. and Mikkelsen, S. R. (1993). Sequence-selective biosensor for DNA based on electroactive hybridization indicators. *Analytical chemistry* 65(17):2317-2323.

Millan, K. M., Saraullo, A. and Mikkelsen, S. R. (1994). Voltammetric DNA biosensor for cystic fibrosis based on a modified carbon paste electrode. *Analytical chemistry* 66(18):2943-2948.

Minunni, M., Tombelli, S., Fonti, J., Spiriti, M. M., Mascini, M., Bogani, P. and Buiatti, M. (2005). Detection of fragmented genomic DNA by PCR-free piezoelectric sensing using a denaturation approach. *Journal of the American Chemical Society*, 127(22):7966-7967.

Miodek, A., Mejri, N., Gomgnimbou, M., Sola, C. and Korri-Youssoufi, H. (2015). E-DNA Sensor of *Mycobacterium tuberculosis* Based on Electrochemical Assembly of Nanomaterials (MWCNTs/PPy/PAMAM). *Analytical chemistry* 87(18): 9257-9264.

Mir, M., Katakis, I. and Vreeke, M. (2007). Aptamer biosensors: an alternative to immunosensors. *IVD Technol. 13*(4).

Mirmoghtadaie, L., Ensafi, A. A., Kadivar, M. and Norouzi, P. (2013). Highly selective electrochemical biosensor for the determination of folic acid based on DNA modified-pencil graphite electrode using response surface methodology. *Materials Science and Engineering: C*, 33(3):1753-1758.

Mix, M., Reske, T., Duwensee, H. and Flechsig, G. U. (2009). Electrochemical detection of asymmetric PCR products by labeling with osmium tetroxide. *Electroanalysis* 21(7):826-830.

Montgomery, D. C. (2008). *Design and analysis of experiments*: John Wiley and Sons.

Moorthy, M., Chandy, S., Selvaraj, K. and Abraham, A. (2009). Evaluation of a rapid immunochromatographic device for the detection of IgM and IgG antibodies to Dengue viruses (DENV) in a tertiary care hospital in South India. *Indian journal of medical microbiology* 27(3):254-256.

Morita, K., Maemoto, T., Honda, S., Onishi, K., Murata, M., Tanaka, M. and Igarashi, A. (1994). Rapid detection of virus genome from imported dengue fever and

© COPYRIGHT UPM

dengue hemorrhagie fever patients by direct polymerase chain reaction. *Journal of medical virology* 44(1):54-58.

Mudin, R. N. (2015). Dengue Incidence and the Prevention and Control Program in Malaysia. *The International Medical Journal of Malaysia* 14(1):05-10.

N. E. A., Quam, M. B. and Wilder-Smith, A. (2013). Epidemiology of dengue: past, present and future prospects. *Clinical epidemiology* 5:299-309.

Murugesan, K., Dhamija, A., Nam, I.H., Kim, Y.M. and Chang, Y.S. (2007). Decolourization of reactive black 5 by laccase: optimization by response surface methodology. *Dyes and Pigment*s 75(1):176-184.

Mustafa, M., Rasotgi, V., Jain, S. and Gupta, V. (2015). Discovery of fifth serotype of dengue virus (DENV-5): A new public health dilemma in dengue control. *Medical Journal Armed Forces India* 71(1):67-70.

Myers, R. H. and Anderson-Cook, C. M. (2009). *Response surface methodology: process and product optimization using designed experiments* (Vol. 705): John Wiley and Sons.

Myers, R. H., Montgomery, D. C. and Anderson-Cook, C. M. (2009). *Response surface methodology: process and product optimization using designed experiments* (Vol. 705): John Wiley and Sons.

Najioullah, F., Viron, F. and Césaire, R. (2014). Evaluation of four commercial real-time RT-PCR kits for the detection of dengue viruses in clinical samples. *Virology journal* 11(1):1-5.

Nalongsack, S., Yoshida, Y., Morita, S., Sosouphanh, K. and Sakamoto, J. (2009). Knowledge, attitude and practice regarding dengue among people in Pakse, Laos. *Nagoya journal of medical science* 71(1-2):29-37.

Napier, M., Mikulecky, J., Scaboo, K., Eckhardt, A., Baron, J., Popovich, N. and Gelardi, M. *Direct electrochemical detection of nucleic acids.* Paper presented at the Clinical chemistry. 2000.

Nascimento, G. A., Souza, E. V., Campos-Ferreira, D. S., Arruda, M. S., Castelletti, C. H., Wanderley, M. S. and Lima-Filho, J. L. (2012a). Electrochemical DNA biosensor for bovine papillomavirus detection using polymeric film on screen-printed electrode. *Biosensors and Bioelectronics* 38(1):61-66.

Nascimento, H. P., Oliveira, M. D., de Melo, C. P., Silva, G. J., Cordeiro, M. T. and Andrade, C. A. (2011b). An impedimetric biosensor for detection of dengue serotype at picomolar concentration based on gold nanoparticles-polyaniline hybrid composites. *Colloids and Surfaces B: Biointerfaces* 86(2):414-419.

Nasir, S. H. and Hadi, N. (2008). Gold Nanoparticles Embedded on the Surface of Polyvinyl Alcohol Layer. *Journal of Fundamental Science* 4:245-252.

© COPYRIGHT UPM

Ndlovu, T., Arotiba, O., Sampath, S., Krause, R. and Mamba, B. (2012). Reactivities of modified and unmodified exfoliated graphite electrodes in selected redox systems. *International Journal of Electrochemical Science* 7(10):9441-9453.

Nga, T. T. T., Thai, K. T., Phuong, H. L., Giao, P. T., Hung, L. Q., Binh, T. Q. and de Vries, P. J. (2007). Evaluation of two rapid immunochromatographic assays for diagnosis of dengue among Vietnamese febrile patients. *Clinical and Vaccine Immunology* 14(6):799-801.

Ngo, H. T., Wang, H. S., Fales, A., Nicholson, B., Woods, C. W. and Vo-Dinh, T. (2014). DNA bioassay-on-chip using SERS detection for dengue diagnosis. *Analyst* 139: 5655-5659.

Nimse, S. B., Song, K., Sonawane, M. D., Sayyed, D. R. and Kim, T. (2014). Immobilization Techniques for Microarray: Challenges and Applications. *Sensors* 14(12):22208-22229.

Nisalak, A. (2015). Laboratory diagnosis of dengue virus infections. *Southest Asian J Trop Med Public Health* 46(1):55-76.

Nobuchi, H. (1979). The symptoms of a dengue-like illness recorded in a Chinese medical encyclopedia. *Kanpo Rinsho* 26:422-425.

Normile, D. (2013). Surprising new dengue virus throws a spanner in disease control efforts. *Science* 342(6157):415-415.

Oh, J. Y., Jang, H.J., Cho, W.J. and Islam, M. S. (2012). Highly sensitive electrolyte-insulator-semiconductor pH sensors enabled by silicon nanowires with Al 2 O 3/SiO 2 sensing membrane. *Sensors and Actuators B: Chemical* 171:238-243.

Oliveira, N., Souza, E., Ferreira, D., Zanforlin, D., Bezerra, W., Borba, M. A. and Martins, D. (2015). A Sensitive and Selective Label-Free Electrochemical DNA Biosensor for the Detection of Specific Dengue Virus Serotype 3 Sequences. *Sensors* 15(7): 15562-15577.

Om, P., Muhammad Amiruddin, A., Fitrien, H. and Rafidah Hanim, S. (2015). An Early Evaluation on the Usefulness of NS1 Antigen-Capture ELISA versus IGM ELISA Tests for the Diagnosis of Acute Dengue Infection. *Health and the Environment Journal* 6(45-54).

Osorio, L., Ramirez, M., Bonelo, A., Villar, L. A. and Parra, B. (2010). Comparison of the diagnostic accuracy of commercial NS1-based diagnostic tests for early dengue infection. *Virol J 7*(361):7-361.

Owczarzy, R., Moreira, B. G., You, Y., Behlke, M. A. and Walder, J. A. (2008). Predicting stability of DNA duplexes in solutions containing magnesium and monovalent cations. *Biochemistry* 47(19): 5336-5353.

© COPYRIGHT UPM

Owczarzy, R., You, Y., Moreira, B. G., Manthey, J. A., Huang, L., Behlke, M. A. and Walder, J. A. (2004). Effects of sodium ions on DNA duplex oligomers: improved predictions of melting temperatures. *Biochemistry* 43(12):3537-3554.

Ozkan, D., Kara, P., Kerman, K., Meric, B., Erdem, A., Jelen, F. and Ozsoz, M. (2002). DNA and PNA sensing on mercury and carbon electrodes by using methylene blue as an electrochemical label. *Bioelectrochemistry* 58(1): 119-126.

Ozsoz, M., Erdem, A., Kerman, K., Ozkan, D., Tugrul, B., Topcuoglu, N. and Taylan, M. (2003). Electrochemical genosensor based on colloidal gold nanoparticles for the detection of Factor V Leiden mutation using disposable pencil graphite electrodes. *Analytical chemistry* 75(9):2181-2187.

Pal, S. and Alocilja, E. C. (2010). Electrically active magnetic nanoparticles as novel concentrator and electrochemical redox transducer in Bacillus anthracis DNA detection. *Biosensors and Bioelectronics* 26(4):1624-1630.

Pal, S., Dauner, A. L., Mitra, I., Forshey, B. M., Garcia, P., Morrison, A. C. and Wu, S.J. L. (2014). Evaluation of dengue NS1 antigen rapid tests and ELISA kits using clinical samples. Doi: 10.1371/journal.pone.0113411.

Pal, S., Dauner, A. L., Valks, A., Forshey, B. M., Long, K. C., Thaisomboonsuk, B. and Morrison, A. C. (2015). Multicountry Prospective Clinical Evaluation of Two Enzyme-Linked Immunosorbent Assays and Two Rapid Diagnostic Tests for Diagnosing Dengue Fever. *Journal of clinical microbiology* 53(4): 1092-1102.

Palecek, E. (1960). Oscillographic polarography of highly polymerized deoxyribonucleic acid. *Nature* 188:656-657.

Paleček, E. (1958). Oszillographische polarographie der nucleinsäuren und ihrer bestandteile. *Naturwissenschaften* 45(8): 186-187.

Paleček, E. (1996). From polarography of DNA to microanalysis with nucleic acid-modified electrodes. *Electroanalysis* 8(1):7-14.

Paleček, E., Fojta, M., Tomschik, M. and Wang, J. (1998). Electrochemical biosensors for DNA hybridization and DNA damage. *Biosensors and Bioelectronics* 13(6):621-628.

Palecek, E., Scheller, F., and Wang, J. (2005). *Electrochemistry of nucleic acids and proteins: towards electrochemical sensors for genomics and proteomics* (Vol. 1): Elsevier.

Pan-ngum, W., Blacksell, S. D., Lubell, Y., Pukrittayakamee, S., Bailey, M. S., de Silva, H. J. and Limmathurotsakul, D. (2013). Estimating the true accuracy of diagnostic tests for dengue infection using bayesian latent class models. *PloS one* 8(1): e50765. Doi: 10.1371/journal.pone.0050765

© COPYRIGHT UPM

Pan, D., Zuo, X., Wan, Y., Wang, L., Zhang, J., Song, S. and Fan, C. (2007). Electrochemical interrogation of interactions between surface-confined DNA and methylene blue. *Sensors* 7(11):2671-2680.

Pan, H.Z., Yu, H.W., Wang, N., Zhang, Z., Wan, G.C., Liu, H. and Chang, D. (2015). Electrochemical DNA biosensor based on a glassy carbon electrode modified with gold nanoparticles and graphene for sensitive determination of Klebsiella pneumoniae carbapenemase. *Journal of biotechnology* 214:133-138.

Pan, S. and Rothberg, L. (2005). Chemical control of electrode functionalization for detection of DNA hybridization by electrochemical impedance spectroscopy. *Langmuir* 21(3):1022-1027.

Pandey, C. M., Singh, R., Sumana, G., Pandey, M. K. and Malhotra, B. D. (2011). Electrochemical genosensor based on modified octadecanethiol self-assembled monolayer for *Escherichia coli* detection. *Sensors and Actuators: B. Chemical* 151(2):333-340.

Pang, J., Salim, A., Lee, V. J., Hibberd, M. L., Chia, K. S., Leo, Y. S. and Lye, D. C. (2012). Diabetes with hypertension as risk factors for adult dengue hemorrhagic fever in a predominantly dengue serotype 2 epidemic: a case control study. *PLoS Negl Trop Dis.* 6(5):e1641. Doi: 10.1371/journal.pntd.0001641.

Paniel, N., Baudart, J., Hayat, A. and Barthelmebs, L. (2013). Aptasensor and genosensor methods for detection of microbes in real world samples. *Methods* 64(3):229-240.

Parida, M., Horioke, K., Ishida, H., Dash, P. K., Saxena, P., Jana, A. M. and Morita, K. (2005). Rapid detection and differentiation of dengue virus serotypes by a real-time reverse transcription-loop-mediated isothermal amplification assay. *Journal of clinical microbiology* 43(6):2895-2903.

Park, H., Germini, A., Sforza, S., Corradini, R., Marchelli, R. and Knoll, W. (2007). Effect of ionic strength on PNA-DNA hybridization on surfaces and in solution. *Biointerphases* 2(2):80-88.

Pasternack, R. M., Rivillon Amy, S. and Chabal, Y. J. (2008). Attachment of 3-(aminopropyl) triethoxysilane on silicon oxide surfaces: dependence on solution temperature. *Langmuir 24*(22):12963-12971.

Patel, M. K., Solanki, P. R., Khandelwal, S., Agrawal, V. V., Ansari, S. and Malhotra, B. *Self-assembled monolayer based electrochemical nucleic acid sensor for Vibrio cholerae detection.* Paper presented at the Journal of Physics: Conference Series. 2012.

Patel, M. K., Solanki, P. R., Kumar, A., Khare, S., Gupta, S. and Malhotra, B. D. (2010). Electrochemical DNA sensor for Neisseria meningitidis detection. *Biosens Bioelectron.* 25:2586-2591.

© COPYRIGHT UPM

Pedrero, M., Campuzano, S. and Pingarrón, J. M. (2011). Electrochemical genosensors based on PCR strategies for microorganisms detection and quantification. *Analytical Methods* 3(4):780-789.

Peeling, R. W., Artsob, H., Pelegrino, J. L., Buchy, P., Cardosa, M. J., Devi, S. and Guzman, M. G. (2010). Evaluation of diagnostic tests: dengue. *Nature Reviews Microbiology* 8:30-37.

Peik-See, T., Pandikumar, A., Nay-Ming, H., Hong-Ngee, L. and Sulaiman, Y. (2014). Simultaneous Electrochemical Detection of Dopamine and Ascorbic Acid Using an Iron Oxide/Reduced Graphene Oxide Modified Glassy Carbon Electrode. *Sensors* 14(8):15227-15243.

Pena-Pereira, F., Duarte, R. M. and Duarte, A. C. (2012). Immobilization strategies and analytical applications for metallic and metal-oxide nanomaterials on surfaces. *TrAC Trends in Analytical Chemistry* 40:90-105.

Perumal, V., Hashim, U., Gopinath, S. C., Haarindraprasad, R., Foo, K., Balakrishnan, S. and Poopalan, P. (2015). 'Spotted Nanoflowers': Gold-seeded Zinc Oxide Nanohybrid for Selective Bio-capture. *Scientific report 5*, article number 12231(2015). Doi:10.1038/srep12231.

Pervin, M., Tabassum, S., Sil, B. K. and Islam, M. N. (2003). Isolation and serotyping of dengue viruses by mosquito inoculation and cell culture technique: An experience in Bangladesh. *Dengue Bulletin 27:81-90.*

Peytavi, R., Tang, L.-y., Raymond, F. R., Boissinot, K., Bissonnette, L., Boissinot, M. and Bergeron, M. G. (2005). Correlation between microarray DNA hybridization efficiency and the position of short capture probe on the target nucleic acid. *BioTechniques* 39(1):89-96.

Phuong, H. L., Thai, K. T., Nga, T. T., Giao, P. T., Hung, L. Q., Binh, T. Q. and de Vries, P. J. (2009). Detection of dengue nonstructural 1 (NS1) protein in Vietnamese patients with fever. *Diagnostic microbiology and infectious disease 63*(4): 372-378.

Pividori, M., Merkoci, A. and Alegret, S. (2000). Electrochemical genosensor design: immobilisation of oligonucleotides onto transducer surfaces and detection methods. *Biosensors and Bioelectronics* 15(5): 291-303.

Poddar, S. (2000). Symmetric vs asymmetric PCR and molecular beacon probe in the detection of a target gene of adenovirus. *Molecular and Cellular probes* 14(1):25-32.

Poloni, T. R., Oliveira, A. S., Alfonso, H. L., Galvão, L. R., Amarilla, A. A., Poloni, D. F. and Aquino, V. H. (2010). Detection of dengue virus in saliva and urine by real time RT-PCR. *Virol J. 7*(1):22. Doi.10.1186/1743-422x-7-22.

© COPYRIGHT UPM

Popovich, N., Eckhardt, A., Mikulecky, J., Napier, M. and Thomas, R. (2002). Electrochemical sensor for detection of unmodified nucleic acids. *Talanta* 56(5): 821-828.

Pournaghi-Azar, M., Hejazi, M. and Alipour, E. (2006). Developing an electrochemical deoxyribonucleic acid (DNA) biosensor on the basis of human interleukine-2 gene using an electroactive label. *Analytica Chimica Acta* 570(2):144-150.

Prabhakar, N., Arora, K., Arya, S. K., Solanki, P. R., Iwamoto, M., Singh, H. and Malhotra, B. (2008a). Nucleic acid sensor for M. tuberculosis detection based on surface plasmon resonance. *Analyst* 133(11): 1587-1592.

Prabhakar, N., Arora, K., Singh, H. and Malhotra, B. (2008b). Polyaniline based nucleic acid sensor. *Journal of Physical Chemistry* 17(112): 4808-4816.

Pray, L. (2008). Discovery of DNA structure and function: Watson and Crick. *Nature Education, 1*(1), 100.

Psomas, S., Liakopoulou-Kyriakides, M. and Kyriakidis, D. (2007). Optimization study of xanthan gum production using response surface methodology. *Biochemical Engineering Journal* 35(3):273-280.

Pyke, A. T., Moore, P. R., Taylor, C. T., Hall-Mendelin, S., Cameron, J. N., Hewitson, G. R., Pukallus, D. S., Huang, B., Warrilow, D., and van den Hurk, A. F. (2016). Highly divergent dengue virus type 1 genotype sets a new distance record. Scientific Reports *6*, 22356.

Qi, X., Gao, H., Zhang, Y., Wang, X., Chen, Y. and Sun, W. (2012). Electrochemical DNA biosensor with chitosan-Co 3 O 4 nanorod-graphene composite for the sensitive detection of staphylococcus aureus nuc gene sequence. *Bioelectrochemistry* 88:42-47.

Qian, L., Mao, J., Tian, X., Yuan, H. and Xiao, D. (2013). In situ synthesis of CuS nanotubes on Cu electrode for sensitive nonenzymatic glucose sensor. *Sensors and Actuators B: Chemical* 176:952-959.

Qicai, L., Qiang, Y., Wennan, W., Yu, W., Liqing, L., Chengfei, Z. and Xinhua, L. (2015). DNA Electrochemical Sensor for Detection of PRSS1 Point Mutation Based on Restriction Endonuclease Technique. *Preparative Biochemistry and Biotechnology* 45(5):430-437.

Qiu, L., Qiu, L., Wu, Z.-S., Shen, G. and Yu, R.-Q. (2013). Cooperative Amplification-Based Electrochemical Sensor for the Zeptomole Detection of Nucleic Acids. *Analytical chemistry* 85(17): 8225-8231.

Radhi, M. M., Jaffar Al-Mulla, A., E and Tan, W. T. (2012). Electrochemical characterization of the redox couple of Fe(III)/Fe(II) mediated by grafted polymer electrode. *Research on Chemical Intermediates 40*(1): 179-192.

© COPYRIGHT UPM

Rahman, M. M., Li, X.-B., Lopa, N. S., Ahn, S. J. and Lee, J.-J. (2015). Electrochemical DNA hybridization sensors based on conducting polymers. *Sensors* 15(2):3801-3829.

Rai, V., Deng, J. and Toh, C.S. (2012a). Electrochemical nanoporous alumina membrane-based label-free DNA biosensor for the detection of *Legionella sp*. *Talanta* 98:112-117.

Rai, V., Hapuarachchi, H. C., Ng, L. C., Soh, S. H., Leo, Y. S. and Toh, C.S. (2012b). Ultrasensitive cDNA detection of dengue virus RNA using electrochemical nanoporous membrane-based biosensor. *PloS one 7*(8): e42346. Doi:10.1371/journal.pone.0042346.

Ramulu, T., Venu, R., Sinha, B., Lim, B., Jeon, S., Yoon, S. and Kim, C. (2013). Nanowires array modified electrode for enhanced electrochemical detection of nucleic acid. *Biosensors and Bioelectronics* 40(1):258-264.

Ranjit, S. and Kissoon, N. (2011). Dengue hemorrhagic fever and shock syndromes*. *Pediatric Critical Care Medicine* 12(1):90-100.

Rashid, A., Izuan, J., Samat, N. and Wan Yusoff, W. M. (2011). Optimization of temperature, moisture content and inoculum size in solid state fermentation to enhance mannanase production by *Aspergillus terreus* SUK-1 using RSM. *Pakistan Journal of Biological Sciences 14*(9):533-539

Rashid, J. I. A., Samat, N. and Yusoff, W. M. W. (2012). Screening and optimization of medium composition for mannanase production by *Aspergillus terrus* SUK-1 in solid state fermentation using statistical experimental methods. *Research journal of microbiology* 7(5): 242-255.

Reiter, P. (2010). Yellow fever and dengue: a threat to Europe. *Euro Surveill, 15*(10), 19509.

Renedo, O. D., Alonso-Lomillo, M. and Martínez, M. A. (2007). Recent developments in the field of screen-printed electrodes and their related applications. *Talanta* 73(2): 202-219.

Retama, J. R., López, M. S.-P., Pérez, J. H., Cabanillas, G. F., López-Cabarcos, E. and López-Ruiz, B. (2005). Biosensors based on acrylic microgels: a comparative study of immobilized glucose oxidase and tyrosinase. *Biosensors and Bioelectronics 20*(11):2268-2275.

Ribeiro Teles, F. R., França dos Prazeres, D. M. and de Lima-Filho, J. L. (2007). Electrochemical detection of a dengue-related oligonucleotide sequence using ferrocenium as a hybridization indicator. *Sensors* 7(11):2510-2518.

© COPYRIGHT UPM

Rizzi, G., Østerberg, F. W., Henriksen, A. D., Dufva, M. and Hansen, M. F. (2014). On-chip magnetic bead-based DNA melting curve analysis using a magnetoresistive sensor. *Journal of Magnetism and Magnetic Materials*. Paper presented at 10th International conference on the Scientific and Clinical application of Magentic Carriers,June 2014,

Rodaree, K., Maturos, T., Chaotheing, S., Pogfay, T., Suwanakitti, N., Wongsombat, C. and Lomas, T. (2011). DNA hybridization enhancement using piezoelectric microagitation through a liquid coupling medium. *Lab on a Chip* 11(6): 1059-1064.

Rodenhuis-Zybert, I. A., Wilschut, J. and Smit, J. M. (2010). Dengue virus life cycle: viral and host factors modulating infectivity. *Cellular and molecular life sciences* 67(16):2773-2786.

Rodriguez-Mozaz, S., Marco, M.P., de Alda, M. and Barceló, D. (2004). Biosensors for environmental applications: Future development trends. *Pure and applied chemistry* 76(4):723-752.

Rodríguez, F., Cai, D., Teng, Y. and Spooner, D. (2011). Asymmetric single-strand conformation polymorphism: an accurate and cost-effective method to amplify and sequence allelic variants. *American Journal of Botany* 98(7):1061-1067.

Rowe, A. A., White, R. J., Bonham, A. J. and Plaxco, K. W. (2011). Fabrication of electrochemical-DNA biosensors for the reagentless detection of nucleic acids, proteins and small molecules. *Journal of visualized experiments 52(2922).* Doi: 10.3791/2922.

Rush, B. (1951). An account of the bilious remitting fever: As it appeared in philadelphia, in the summer and autumn of the year 1780. *The American Journal of Medicine* 11(5):546-550.

Rychlik, W., Spencer, W. and Rhoads, R. (1990). Optimization of the annealing temperature for DNA amplification in vitro. *Nucleic acids research* 18(21):6409-6412.

Sa-ngasang, A., Wibulwattanakij, S., Chanama, S., O-rapinpatipat, A., A-nuegoonpipat, A., Anantapreecha, S. and Kurane, I. (2003). Evaluation of RT-PCR as a tool for diagnosis of secondary dengue virus infection. *Japanese journal of infectious diseases* 56(5/6): 205-209.

Saberi, R. S., Shahrokhian, S. and Marrazza, G. (2013). Amplified Electrochemical DNA Sensor Based on Polyaniline Film and Gold Nanoparticles. *Electroanalysis* 25(6): 1373-1380.

Sadik, O. A., Mwilu, S. K. and Aluoch, A. (2010). Smart electrochemical biosensors: From advanced materials to ultrasensitive devices. *Electrochimica Acta* 55(14):4287-4295.

© COPYRIGHT UPM

Salinas-Torres, D., Huerta, F., Montilla, F. and Morallón, E. (2011). Study on electroactive and electrocatalytic surfaces of single walled carbon nanotube-modified electrodes. *Electrochimica Acta 56*(5):2464-2470.

Sambrook, J. and Russell, D. W. (2006). Fragmentation of DNA by sonication. *Cold Spring Harbor Protocols 2006*(4), pdb. prot4538.

Samei Pour, S. (2012). Direct Electron Transfer of Cytochrome c on ZnO Nanoparticles Modified Carbon Paste Electrode. *ISRN Biophysics, 2012*, Article ID937265, 6 pages. Doi: 10.5402/2012/937265.

Samuel, P. P. and Tyagi, B. (2006). Diagnostic methods for detection and isolation of dengue viruses from vector mosquitoes. *Indian journal of medical research* 123(5): 615-628.

Sánchez-Vargas, L. A., Sánchez-Marce, E. E. and Vivanco-Cid, H. (2014). Evaluation of the SD BIOLINE dengue duo rapid test in the course of acute and convalescent dengue infections in a Mexican endemic region. *Diagnostic microbiology and infectious disease* 78(4): 368-372.

Saoudi, B., Despas, C., Chehimi, M. M., Jammul, N., Delamar, M., Bessière, J. and Walcarius, A. (2000). Study of DNA adsorption on polypyrrole: interest of dielectric monitoring. *Sensors and Actuators B: Chemical* 62(1): 35-42.

Sassolas, A., Leca-Bouvier, B. D. and Blum, L. J. (2008). DNA biosensors and microarrays. *Chemical reviews* 108(1):109-139.

Schwartz, E., Mileguir, F., Grossman, Z. and Mendelson, E. (2000). Evaluation of ELISA-based sero-diagnosis of dengue fever in travelers. *Journal of Clinical Virology* 19(3):169-173.

Senapati, S., Slouka, Z., Shah, S. S., Behura, S. K., Shi, Z., Stack, M. S. and Chang, H.C. (2014). An ion-exchange nanomembrane sensor for detection of nucleic acids using a surface charge inversion phenomenon. *Biosensors and Bioelectronics* 60:92-100.

Setterington, E. B. and Alocilja, E. C. (2012). Electrochemical biosensor for rapid and sensitive detection of magnetically extracted bacterial pathogens. *Biosensors* 2(1): 15-31.

Shahrokhian, S., Kamalzadeh, Z. and Hamzehloei, A. (2013). Electrochemical determination of Clozapine on MWCNTs/New Coccine doped PPY modified GCE: An experimental design approach. *Bioelectrochemistry* 90:36-43.

Shamansky, L. M., Davis, C. B., Stuart, J. K. and Kuhr, W. G. (2001). Immobilization and detection of DNA on microfluidic chips. *Talanta* 55(5): 909-918. \

© COPYRIGHT UPM

Shao, M.W., Yao, H., Zhang, M.L., Wong, N.-B., Shan, Y.-Y., and Lee, S.-T. (2005). Fabrication and application of long strands of silicon nanowires as sensors for bovine serum albumin detection. *Applied physics letters* 87(18):3106. Doi:10.1063/1.2123393.

Sharma, A., Pandey, C. M., Sumana, G., Soni, U., Sapra, S., Srivastava, A. and Malhotra, B. D. (2012). Chitosan encapsulated quantum dots platform for leukemia detection. *Biosensors and Bioelectronics 38*(1): 107-113.

Shen, L., Guo, Y., Chen, X., Ahmed, S. and Issa, J. (2007). Optimizing annealing temperature overcomes bias in bisulfite PCR methylation analysis. *BioTechniques* 42(1):48-52.

Sheng, Q., Wang, J., Zheng, J., Xu, Z. and Zhang, H. (2010). Ultrasensitive electrical biosensing of syphilis DNA using target-guided formation of polyaniline based on enzyme-catalyzed polymerization. *Biosensors and Bioelectronics* 25(9):2071-2077.

Shenoy, B., Menon, A. and Biradar, S. (2014). Diagnostic utility of dengue NS1 antigen. *Pediatric Infectious Disease* 6(3):110-113.

Shi, A., Wang, J., Han, X., Fang, X. and Zhang, Y. (2014). A sensitive electrochemical DNA biosensor based on gold nanomaterial and graphene amplified signal. *Sensors and Actuators B: Chemical* 200:206-212.

Shih, S.M., Su, W.F., Lin, Y.J., Wu, C.S. and Chen, C.D. (2002). Two-dimensional arrays of self-assembled gold and sulfur-containing fullerene nanoparticles. *Langmuir* 18(8):3332-3335.

Shu, P.Y., Chang, S.F., Kuo, Y.C., Yueh, Y.Y., Chien, L.J., Sue, C.L. and Huang, J.H. (2003). Development of group-and serotype-specific one-step SYBR green I-based real-time reverse transcription-PCR assay for dengue virus. *Journal of clinical microbiology* 41(6):2408-2416.

Shui, L., Bomer, J. G., Jin, M., Carlen, E. T. and Van den Berg, A. (2011). Microfluidic DNA fragmentation for on-chip genomic analysis. *Nanotechnology 22*(49):494013-494019.

Siddiquee, S., Yusof, N. A., Salleh, A. B., Bakar, F. A. and Heng, L. Y. (2010a). Electrochemical DNA biosensor for the detection of specific gene related to Trichoderma harzianum species. *Bioelectrochemistry* 79(1): 31-36.

Siddiquee, S., Yusof, N. A., Salleh, A. B., Tan, S. G., Bakar, F. A. and Heng, L. Y. (2010b). DNA hybridization based on Trichoderma harzianum gene probe immobilization on self-assembled monolayers on a modified gold electrode. *Sensors and Actuators B: Chemical* 147(1):198-205.

Silva, M. M., Cavalcanti, I. T., Barroso, M. F., Sales, M. G. F. and Dutra, R. F. (2010). Gold electrode modified by self-assembled monolayers of thiols to determine DNA sequences hybridization. *Journal of chemical sciences* 122(6):911-917.

© COPYRIGHT UPM

Silvestrini, M., Fruk, L., Moretto, L. M. and Ugo, P. (2015). Detection of DNA Hybridization by Methylene Blue Electrochemistry at Activated Nanoelectrode Ensembles. *Journal of Nanoscience and Nanotechnology* 15(5):3437-3442.

Sin, M. L., Mach, K. E., Wong, P. K. and Liao, J. C. (2014). Advances and challenges in biosensor-based diagnosis of infectious diseases. *Expert review of molecular diagnostics* 14(2) 225-244.

Singh, A., Choudhary, M., Singh, M. and Verma, H. (2015). DNA functionalized direct electro-deposited gold nanoaggregates for efficient detection of Salmonella typhi. *Bioelectrochemistry* 105: 7-15.

Singh, R., Prasad, R., Sumana, G., Arora, K., Sood, S., Gupta, R. and Malhotra, B. (2009). STD sensor based on nucleic acid functionalized nanostructured polyaniline. *Biosens Bioelectron.* 24(7):2232-2238.

Singh, R., Sumana, G., Verma, R., Sood, S., Pandey, M., Gupta, R. K. and Malhotra, B. (2010a). DNA biosensor for detection of Neisseria gonorrhoeae causing sexually transmitted disease. *Journal of biotechnology* 150(3):357-365.

Singh, R., Sumana, G., Verma, R., Sood, S., Pandey, M. K., Gupta, R. K. and Malhotra, B. D. (2010b). DNA biosensor for detection of Neisseria gonorrhoeae causing sexually transmitted disease. *Journal of biotechnology* 150(3):357-365.

Singh, R., Verma, R., Kaushik, A., Sumana, G., Sood, S., Gupta, R. K. and Malhotra, B. (2011). Chitosan–iron oxide nano-composite platform for mismatch-discriminating DNA hybridization for *Neisseria gonorrhoeae* detection causing sexually transmitted disease. *Biosensors and Bioelectronics* 26(6):2967-2974.

Singh, R., Verma, R., Sumana, G., Srivastava, A. K., Sood, S., Gupta, R. K. and Malhotra, B. (2012). Nanobiocomposite platform based on polyaniline-iron oxide-carbon nanotubes for bacterial detection. *Bioelectrochemistry* 86:30-37.

Singh, S., Kaushal, A., Khare, S., Kumar, P and Kumar, A. (2014a). Gold–mercaptopropionic acid–polyethylenimine composite based DNA sensor for early detection of rheumatic heart disease. *Analyst* 139(14):3600-3506

Singh, S., Zack, J., Kumar, D., Srivastava, S., Saluja, D., Khan, M. and Singh, P. (2010c). DNA hybridization on silicon nanowires. *Thin Solid Films* 519(3):1151-1155.

Singhi, S., Kissoon, N., and Bansal, A. (2007). Dengue and dengue hemorrhagic fever: management issues in an intensive care unit. *Jornal de Pediatria* 83(2):22-35.

Solanki, P. R., Kaushik, A., Chavhan, P. M., Maheswari, S. N. and Malhotra, B. D. (2009). Nanostructure zirconium oxide based genosensor for *Escherichia coli* detection. *Electrochemistry communications* 11(12): 2272-2277.

© COPYRIGHT UPM

Soler, M. (1997). Laboratory diagnosis to dengue virus infections. *Acta científica venezolana 49*:25-32.

Solomonides, T., Blanquer, I., Breton, V., Glatard, T. and Legre, Y. (2010). *Healthgrid Applications and Core Technologies: Proceedings of HealthGrid 2010* (Vol. 159): IOS Press.

Sorgenfrei, S., Chiu, C.-y., Gonzalez Jr, R. L., Yu, Y.-J., Kim, P., Nuckolls, C. and Shepard, K. L. (2011). Label-free single-molecule detection of DNA-hybridization kinetics with a carbon nanotube field-effect transistor. *Nature nanotechnology* 6(2): 126-132.

Sotillo, A., Pedrero, M., de Pablos, M., García, J. L., García, E., García, P. and Campuzano, S. (2014). Clinical evaluation of a disposable amperometric magneto-genosensor for the detection and identification of Streptococcus pneumoniae. *Journal of microbiological methods* 103:25-28.

Souza, E., Nascimento, G., Santana, N., Danielly, F., Lima, M., Natividade, E. and Lima-Filho, J. (2011). Label-Free Electrochemical Detection of the Specific Oligonucleotide Sequence of Dengue Virus Type 1 on Pencil Graphite Electrodes. *Sensors* 11:5616-5629.

Spain, E., Kojima, R., Kaner, R. B., Wallace, G. G., O'Grady, J., Lacey, K. and Forster, R. J. (2011). High sensitivity DNA detection using gold nanoparticle functionalised polyaniline nanofibres. *Biosensors and Bioelectronics* 26(5): 2613-2618.

Špringer, T., Šípová, H., Vaisocherová, H., Štěpánek, J. and Homola, J. (2010). Shielding effect of monovalent and divalent cations on solid-phase DNA hybridization: surface plasmon resonance biosensor study. *Nucleic acids research*, 38(20):7343-7351.

Steel, A. B., Herne, T. M. and Tarlov, M. J. (1998). Electrochemical quantitation of DNA immobilized on gold. *Analytical chemistry* 70(22):4670-4677.

Su, L., Sankar, C. G., Sen, D. and Yu, H.Z. (2004). Kinetics of ion-exchange binding of redox metal cations to thiolate-DNA monolayers on gold. *Analytical chemistry* 76(19):5953-5959.

Su, L., Zou, L., Fong, C.C., Wong, W.L., Wei, F., Wong, K.Y. and Yang, M. (2013a). Detection of cancer biomarkers by piezoelectric biosensor using PZT ceramic resonator as the transducer. *Biosensors and Bioelectronics* 46:155-161.

Su, S., He, Y., Song, S., Li, D., Wang, L., Fan, C. and Lee, S.-T. (2010). A silicon nanowire-based electrochemical glucose biosensor with high electrocatalytic activity and sensitivity. *Nanoscale* 2(9):1704-1707.

© COPYRIGHT UPM

Su, S., Wei, X., Guo, Y., Zhong, Y., Su, Y., Huang, Q. and He, Y. (2013b). A Silicon Nanowire-Based Electrochemical Sensor with High Sensitivity and Electrocatalytic Activity. *Particle and Particle Systems Characterization*, 30(4): 326-331.

Su, S., Wei, X., Zhong, Y., Guo, Y., Su, Y., Huang, Q. and He, Y. (2012). Silicon nanowire-based molecular beacons for high-sensitivity and sequence-specific DNA multiplexed analysis. *ACS nano* 6(3):2582-2590.

Suaya, J. A., Shepard, D. S., Siqueira, J. B., Martelli, C. T., Lum, L. C., Tan, L. H. and Montoya, R. (2009). Cost of dengue cases in eight countries in the Americas and Asia: a prospective study. *The American journal of tropical medicine and hygiene* 80(5):846-855.

Sufen, W., Tuzhi, P. and Yang, C. F. (2002). Electrochemical studies for the interaction of DNA with an irreversible redox compound–Hoechst 33258. *Electroanalysis* 14(23):1648-1653.

Sun, W., Qi, X., Zhang, Y., Yang, H., Gao, H., Chen, Y. and Sun, Z. (2012). Electrochemical DNA biosensor for the detection of *Listeria monocytogenes* with dendritic nanogold and electrochemical reduced graphene modified carbon ionic liquid electrode. *Electrochimica Acta* 85:145-151.

Sun, W., Qin, P., Gao, H., Li, G. and Jiao, K. (2010). Electrochemical DNA biosensor based on chitosan/nano-V 2 O 5/MWCNTs composite film modified carbon ionic liquid electrode and its application to the LAMP product of *Yersinia enterocolitica* gene sequence. *Biosensors and Bioelectronics* 25(6):1264-1270.

Sun, Y., Yang, S.B., LV, L.P., Lieberwirth, I., Zhang, L.C., Ding, C.X. and Chen, C.H. (2013). A composite film of reduced graphene oxide modified vanadium oxide nanoribbons as a free standing cathode material for rechargeable lithium batteries. *Journal of Power Sources* 241:168-172.

Tabarzad, M., Kazemi, B., Vahidi, H., Aboofazeli, R., Shahhosseini, S. and Nafissi-Varcheh, N. (2014). Challenges to design and develop of dna aptamers for protein targets. i. Optimization of asymmetric PCR for generation of a single stranded DNA library. *Iranian journal of pharmaceutical research* 13:133-141.

Tabrizi, M. A. and Shamsipur, M. (2015). A label-free electrochemical DNA biosensor based on covalent immobilization of salmonella DNA sequences on the nanoporous glassy carbon electrode. *Biosensors and Bioelectronics* 69:100-105.

Takahashi, S., Watahiki, R., Tomida, K., Wang, B. and Anzai, J. (2013). Voltammetric Studies on Gold Electrodes Coated with Chitosan-Containing Layer-by-Layer Films. *Materials* 6(11):5427-5439.

© COPYRIGHT UPM

Talin, A. A., Hunter, L. L., Léonard, F. and Rokad, B. (2006). Large area, dense silicon nanowire array chemical sensors. *Applied physics letters* 89(15):153102.

Tam, P. D., Tuan, M. A., Aarnink, T. and Chien, N. (2008). *Directly immobilized DNA sensor for label-free detection of herpes virus.* Paper presented at the Information Technology and Applications in Biomedicine, 2008.

Tam, P. D., Tuan, M. A., Van Hieu, N. and Chien, N. D. (2009a). Impact parameters on hybridization process in detecting influenza virus (type A) using conductimetric-based DNA sensor. *Physica E: Low-dimensional Systems and Nanostructures* 41(8):1567-1571.

Tam, P. D., Van Hieu, N., Chien, N. D., Le, A.T. and Anh Tuan, M. (2009b). DNA sensor development based on multi-wall carbon nanotubes for label-free influenza virus (type A) detection. *Journal of immunological methods* 350(1): 118-124.

Tan, S., Wang, L., Yu, J., Hou, C., Jiang, R., Li, Y. and Liu, Q. (2015). DNA-functionalized silicon nitride nanopores for sequence-specific recognition of DNA biosensor. *Nanoscale research letters* 10(1):1-10.

Tan, Z.J. and Chen, S.J. (2006). Nucleic acid helix stability: effects of salt concentration, cation valence and size, and chain length. *Biophysical journal* 90(4):1175-1190.

Tang, L., Zeng, G., Shen, G., Li, Y., Liu, C., Li, Z. and Yang, C. (2009). Sensitive detection of lip genes by electrochemical DNA sensor and its application in polymerase chain reaction amplicons from *Phanerochaete chrysosporium*. *Biosensors and Bioelectronics* 24(5):1474-1479.

Taufik, S., Yusof, N. A., Tee, T. W. and Ramli, I. (2011). Bismuth oxide nanoparticles/chitosan/modified electrode as biosensor for DNA hybridization. *Int. J. Electrochem. Sci*. 61:880-1891.

Tavallaie, R., Darwish, N., Hibbert, D. B. and Gooding, J. J. (2015). Nucleic-acid recognition interfaces: how the greater ability of RNA duplexes to bend towards the surface influences electrochemical sensor performance. *Chemical Communications* 51:16526-16529.

Tedjo, A., Ibrahim, A. S. and Kusmardi. (2010). Photoelectrochemical detection of dengue-related oligonucleotide sequence using anthocyanin as a intercalating agent and electrochromic material. *Makara Seri Kesehatan* 14(2):70-74.

Teh, H. F., Gong, H., Dong, X.D., Zeng, X., Lai Kuan Tan, A., Yang, X. and Tan, S. N. (2005a). Electrochemical biosensing of DNA with capture probe covalently immobilized onto glassy carbon surface. *Analytica Chimica Acta* 551(1):23-29.

Teh, H. F., Gong, H., Dong, X.-D., Zeng, X., Tan, A. L. K., Yang, X. and Tan, S. N. (2005b). Electrochemical biosensing of DNA with capture probe covalently immobilized onto glassy carbon surface. *Analytica Chimica Acta* 551(1): 23-29.

© COPYRIGHT UPM

Teles, F., and Fonseca, L. (2008). Trends in DNA biosensors. *Talanta* 77(2):606-623.

Teles, F., Prazeres, D. and Lima-Filho, J. (2005). Trends in dengue diagnosis. *Reviews in medical virology* 15(5):287-302.

Teoh, B.T., Sam, S.-S., Tan, K.K., Johari, J., Danlami, M. B., Hooi, P.S. and AbuBakar, S. (2013). Detection of dengue viruses using reverse transcription-loop-mediated isothermal amplification. *BMC infectious diseases* 13(1): 387. Doi:10.1186/1471-2334-13-387.

Thiruppathiraja, C., Kamatchiammal, S., Adaikkappan, P., Santhosh, D. J. and Alagar, M. (2011). Specific detection of *Mycobacterium* sp. genomic DNA using dual labeled gold nanoparticle based electrochemical biosensor. *Analytical biochemistry* 417(1):73-79.

Thomas, F., and Henze, G. (2001). *Introduction to voltammetric analysis: theory and practice*: Csiro Publishing.

Thorp, H. H. (1998). Cutting out the middleman: DNA biosensors based on electrochemical oxidation. *Trends in Biotechnology* 16(3):117-121.

Thorp, H. H. (2003). Reagentless detection of DNA sequences on chemically modified electrodes. *Trends in Biotechnology* 21(12):522-524.

Tichoniuk, M., Gwiazdowska, D., Ligaj, M. and Filipiak, M. (2010). Electrochemical detection of foodborne pathogen Aeromonas hydrophila by DNA hybridization biosensor. *Biosensors and Bioelectronics* 26(4):1618-1623.

Tichoniuk, M., Ligaj, M. and Filipiak, M. (2008). Application of DNA hybridization biosensor as a screening method for the detection of genetically modified food components. *Sensors* 8(4): 2118-2135.

Titball, R., and Squirrell, D. (1997). Probes for nucleic acids and biosensors. *Handbook of Biosensors and Electronic Noses: Medicine, Food, and the Environment, CRC Press, Boca Raton, FL*, 91-109.

Tiwari, I., Singh, M., Pandey, C. M. and Sumana, G. (2015). Electrochemical genosensor based on graphene oxide modified iron oxide–chitosan hybrid nanocomposite for pathogen detection. *Sensors and Actuators B: Chemical* 206:276-283.

Tlili, A., Abdelghani, A., Hleli, S. and Maaref, M. A. (2004). Electrical characterization of a thiol sam on gold as a first step for the fabrication of immunosensors based on a quartz crystal microbalance. *Sensors* 4(6):105-114.

Todorov, T. I. and Morris, M. D. (2002). Comparison of RNA, single-stranded DNA and double-stranded DNA behavior during capillary electrophoresis in semidilute polymer solutions. *Electrophoresis* 23(7-8):1033-1044.

© COPYRIGHT UPM

Tong, H. D., Chen, S., van der Wiel, W. G., Carlen, E. T. and van den Berg, A. (2009). Novel top-down wafer-scale fabrication of single crystal silicon nanowires. *Nano letters* 9(3):1015-1022.

Tong, P., Shao, Y., Chen, J., He, Y. and Zhang, L. (2015). A sensitive electrochemical DNA biosensor for Microcystis spp. sequence detection based on an Ag@ Au NP composite film. *Analytical Methods* 7(7):2993-2999.

Topkaya, S. N. (2015). Gelatin methacrylate (GelMA) mediated electrochemical DNA biosensor for DNA hybridization. *Biosensors and Bioelectronics* 64:456-461.

Torati, S. R., Reddy, V., Yoon, S. S. and Kim, C. (2015). Protein immobilization onto electrochemically synthesized CoFe nanowires. *International journal of nanomedicine* 10:645-651.

Torrey, J. D., Kirschling, T. L. and Greenlee, L. F. (2015). Processing and Characterization of Nanoparticle Coatings for Quartz Crystal Microbalance Measurements. *Journal of Research of the National Institute of Standards and Technology* 120:1. Doi:10.6028/jres.120.001.

Tosar, J., Branas, G. and Laiz, J. (2010). Electrochemical DNA hybridization sensors applied to real and complex biological samples. *Biosens Bioelectron. 26*:1205-1217.

Tran, L. D., Nguyen, B. H., Van Hieu, N., Tran, H. V., Nguyen, H. L. and Nguyen, P. X. (2011). Electrochemical detection of short HIV sequences on chitosan/Fe3O4 nanoparticle based screen printed electrodes. *Materials Science and Engineering: C*, 31(2):477-485.

Tsien, R. Y. and Zlokarnik, G. (1998). Measuring gene expression: Google Patents.

Tuan, M. A. and Hai, N. *DNA enrichment by functionalied magnetic nanoparticles for on-site and fast detection of virus in biomedical application* Paper presented at the Journal of Physics: Conference Series, APCTP–ASEAN Workshop on Advanced Materials Science and Nanotechnology (AMSN08). 2009.

Turkevich, J., Stevenson, P. C. and Hillier, J. (1951). A study of the nucleation and growth processes in the synthesis of colloidal gold. *Discussions of the Faraday Society* 11:55-75.

Uliana, C. V., Riccardi, C. S., Tognolli, J. O. and Yamanaka, H. (2008). Optimization of an amperometric biosensor for the detection of hepatitis C virus using fractional factorial designs. *Journal of the Brazilian Chemical Society* 19(4):782-787.

Uliana, C. V., Tognolli, J. O. and Yamanaka, H. (2011). Application of factorial design experiments to the development of a disposable amperometric DNA biosensor. *Electroanalysis* 23(11):2607-2615.

© COPYRIGHT UPM

Ulianas, A., Heng, L. Y., Ahmad, M., Lau, H.-Y., Ishak, Z. and Ling, T. L. (2014a). A regenerable screen-printed DNA biosensor based on acrylic microsphere–gold nanoparticle composite for genetically modified soybean determination. *Sensors and Actuators B: Chemical* 190:694-701.

Ulianas, A., Heng, L. Y., Hanifah, S. A. and Ling, T. L. (2012a). An electrochemical DNA microbiosensor based on succinimide-modified acrylic microspheres. *Sensors* 12(5):5445-5460.

Ulianas, A., Heng, L. Y., Lau, H.Y., Ishak, Z. and Ling, T. L. (2014b). Single-step and reagentless analysis of genetically modified soybean DNA with an electrochemical DNA biosensor. *Analytical Methods* 6(16):6369-6374.

Urkut, Z., Kara, P., Goksungur, Y. and Ozsoz, M. (2011). Response surface methodology for optimization of food borne pathogen detection in real samples based on label free electrochemical nucleic acid biosensors. *Electroanalysis* 23(11):2668-2676.

Usawattanaku, W., Jittmittraphap, A., Tapchaisri, P., Siripanichgon, K., Buchachart, K., Hong-ngarm, A. and Endy, T. (2002). Detection of dengue viral RNA in patients' sera by nucleic acid sequence-based amplification (NASBA) and polymerase chain reaction (PCR). *Dengue Bulletin* 26:131-139.

Valdés, K., Alvarez, M., Pupo, M., Vázquez, S., Rodríguez, R. and Guzmán, M. G. (2000). Human dengue antibodies against structural and nonstructural proteins. *Clinical and diagnostic laboratory immunology* 7(5):856-857.

Vaughn, D. W., Green, S., Kalayanarooj, S., Innis, B. L., Nimmannitya, S., Suntayakorn, S. and Ennis, F. A. (2000). Dengue viremia titer, antibody response pattern, and virus serotype correlate with disease severity. *Journal of Infectious Diseases* 181(1):2-9.

Velásquez, P., Leinen, D., Pascual, J., Ramos-Barrado, J., Cordova, R., Gómez, H., and Schrebler, R. (2001). XPS, SEM, EDX and EIS study of an electrochemically modified electrode surface of natural chalcocite (Cu 2 S). *Journal of Electroanalytical Chemistry* 510(1):20-28.

Velusamy, V., Arshak, K., Yang, C. F., Yu, L., Korostynska, O. and Adley, C. (2011). Comparison between DNA immobilization techniques on a redox polymer matrix. *American Journal of Analytical Chemistry* (2):392-400.

Venkatesan, V., Hoti, S. L., Kamaraj, N., Ghosh, S. and Rajaram, K. (2013). Optimisation of an asymmetric polymerase chain reaction assay for the amplification of single-stranded DNA from Wuchereria bancrofti for electrochemical detection. *Memórias do Instituto Oswaldo Cruz* 108(6):804-807.

© COPYRIGHT UPM

Verma, R., Sood, S., Singh, R., Sumana, G., Bala, M., Sharma, V. K. and Malhotra, B. D. (2014). Coupling electrochemical response of a DNA biosensor with PCR for *Neisseria gonorrhoeae* detection. *Diagnostic microbiology and infectious disease 78*(1):16-23.

Vrabel, M., Horakova, P., Pivoňková, H., Kalachova, L., Černocká, H., Cahova, H. and Hocek, M. (2009). Base-Modified DNA Labeled by $[Ru(bpy)_3]^{2+}$ and $[Os(bpy)_3]^{2+}$ Complexes: Construction by Polymerase Incorporation of Modified Nucleoside Triphosphates, Electrochemical and Luminescent Properties, and Applications. *Chemistry-A European Journal* 15(5):1144-1154.

Wang, C., Zhou, H., Zhu, W., Li, H., Jiang, J., Shen, G. and Yu, R. (2013a). Ultrasensitive electrochemical DNA detection based on dual amplification of circular strand-displacement polymerase reaction and hybridization chain reaction. *Biosensors and Bioelectronics* 47:324-328.

Wang, H.B., Zhang, H.D., Xu, S.P., Gan, T., Huang, K.J. and Liu, Y.M. (2014a). A sensitive and label-free electrochemical impedance biosensor for protein detection based on terminal protection of small molecule-linked DNA. *Sensors and Actuators B: Chemical* 194:478-483.

Wang, J. (2002). Electrochemical nucleic acid biosensors. *Analytica Chimica Acta* 469(1): 63-71.

Wang, J. (2005). Electrochemical nucleic acid biosensors. *Perspectives in Bioanalysis*, 1: 175-194.

Wang, J., Rivas, G., Cai, X., Palecek, E., Nielsen, P., Shiraishi, H. and Chicharro, M. (1997). DNA electrochemical biosensors for environmental monitoring. A review. *Analytica Chimica Acta* 347(1):1-8.

Wang, J., Rivas, G., Fernandes, J. R., Paz, J. L. L., Jiang, M. and Waymire, R. (1998). Indicator-free electrochemical DNA hybridization biosensor. *Analytica Chimica Acta* 375(3):197-203.

Wang, J., Shi, A., Fang, X., Han, X. and Zhang, Y. (2014b). Ultrasensitive electrochemical supersandwich DNA biosensor using a glassy carbon electrode modified with gold particle-decorated sheets of graphene oxide. *Microchimica Acta* 181(9-10):935-940.

Wang, K., Lei, Y., Zhong, G.X., Zheng, Y.J., Sun, Z.L., Peng, H.P. and Lin, X.H. (2015a). Dual-probe electrochemical DNA biosensor based on the "Y" junction structure and restriction endonuclease assisted cyclic enzymatic amplification for detection of double-strand DNA of PML/RARα related fusion gene. *Biosensors and Bioelectronics* 71:463-469.

Wang, L., Chen, X., Wang, X., Han, X., Liu, S. and Zhao, C. (2011a). Electrochemical synthesis of gold nanostructure modified electrode and its development in electrochemical DNA biosensor. *Biosensors and Bioelectronics* 30(1):151-157.

© COPYRIGHT UPM

Wang, L., Hua, E., Liang, M., Ma, C., Liu, Z., Sheng, S. and Feng, W. (2014c). Graphene sheets, polyaniline and AuNPs based DNA sensor for electrochemical determination of BCR/ABL fusion gene with functional hairpin probe. *Biosensors and Bioelectronics* 51:201-207.

Wang, L., Liao, X., Ding, Y., Gao, F. and Wang, Q. (2014d). DNA biosensor based on a glassy carbon electrode modified with electropolymerized Eriochrome Black T. *Microchimica Acta* 181(1-2):155-162.

Wang, L., Liu, S., Liang, W., Li, D., Yang, J. and He, Y. (2015b). Detection of DNA utilizing a fluorescent reversible change of a biosensor based on the electron transfer from quantum dots to polymyxin B sulfate. *Journal of colloid and interface science* 15:257-264.

Wang, M., Tian, Y., Cui, S. and Qian, L. (2013b). Effect of salt concentration on the conformation and friction behaviour of DNA. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 436:775-781.

Wang, Q., Ding, Y., Gao, F., Jiang, S., Zhang, B., Ni, J. and Gao, F. (2013c). A sensitive DNA biosensor based on a facile sulfamide coupling reaction for capture probe immobilization. *Analytica Chimica Acta* 788:158-164.

Wang, Q., Xu, N., Lei, J. and Ju, H. (2014e). Regulative peroxidase activity of DNA-linked hemin by graphene oxide for fluorescence DNA sensing. *Chemical Communications* 50(51):6714-6717.

Wang, Q., Zhang, B., Lin, X. and Weng, W. (2011b). Hybridization biosensor based on the covalent immobilization of probe DNA on chitosan–mutiwalled carbon nanotubes nanocomposite by using glutaraldehyde as an arm linker. *Sensors and Actuators B: Chemical* 156(2):599-605.

Wang, S., Li, L., Jin, H., Yang, T., Bao, W., Huang, S. and Wang, J. (2013d). Electrochemical detection of hepatitis B and papilloma virus DNAs using SWCNT array coated with gold nanoparticles. *Biosensors and Bioelectronics* 41:205-210.

Wang, S. M. and Sekaran, S. D. (2010). Early diagnosis of Dengue infection using a commercial Dengue Duo rapid test kit for the detection of NS1, IGM, and IGG. *The American journal of tropical medicine and hygiene* 83(3):690-695.

Wang, W., Song, L., Gao, Q., Qi, H. and Zhang, C. (2013e). Highly sensitive detection of DNA using an electrochemical DNA sensor with thionine-capped DNA/gold nanoparticle conjugates as signal tags. *Electrochemistry communications* 34:18-21.

Wang, X., Lim, H. J. and Son, A. (2014f). Characterization of denaturation and renaturation of DNA for DNA hybridization. *Environmental health and toxicology, 29*:e2014007. Doi: 10.5620/eht.2014.29.e2014007.

© COPYRIGHT UPM

Wang, X. and Son, A. (2013). Effects of pretreatment on the denaturation and fragmentation of genomic DNA for DNA hybridization. *Environmental Science: Processes and Impacts* 15(12):2204-2212.

Watson, J. D. and Crick, F. H. (1953). Molecular structure of nucleic acids. *Nature, 171*:737-738.

Weber, J., Jeedigunta, S. and Kumar, A. (2008). Fabrication and characterization of ZnO nanowire arrays with an investigation into electrochemical sensing capabilities. *Journal of Nanomaterials, 2008*, article ID 638523, 5 pages. Doi: 10.1155/2008/638523.

Wenga, G., Jacques, E., Salaün, A.-C., Rogel, R., Pichon, L. and Geneste, F. (2013). Step-gate polysilicon nanowires field effect transistor compatible with CMOS technology for label-free DNA biosensor. *Biosensors and Bioelectronics* 40(1): 141-146.

WHO. (2015). *Dengue Situation Update 480, 15 December 2015*. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/dengue_biweekly_20151215.pdf

Wilder-Smith, A., Chen, L. H., Massad, E., and Wilson, M. E. (2009). Threat of dengue to blood safety in dengue-endemic countries. *Emerging infectious diseases 15*(1): 8. Doi:10.3201/eid1501.071097.

Williams, E. H., Davydov, A. V., Oleshko, V. P., Steffens, K. L., Levin, I., Lin, N. J. and Rao, M. V. (2014). Solution-based functionalization of gallium nitride nanowires for protein sensor development. *Surface Science* 627:23-28.

Wipawakarn, P., Ju, H. and Wong, D. K. (2012). A label-free electrochemical DNA biosensor based on a Zr (IV)-coordinated DNA duplex immobilised on a carbon nanofibre| chitosan layer. *Analytical and bioanalytical chemistry:* 402(9), 2817-2826.

Won, B. Y., Yoon, H. C. and Park, H. G. (2008). Enzyme-catalyzed signal amplification for electrochemical DNA detection with a PNA-modified electrode. *Analyst* 133(1):100-104.

Wong, I. Y. and Melosh, N. A. (2010). An electrostatic model for DNA surface hybridization. *Biophysical journal* 98(12):2954-2963.

Wright, W. F. and Pritt, B. S. (2012). Update: The diagnosis and management of dengue virus infection in North America. *Diagnostic microbiology and infectious disease* 73(3):215-220.

Wu, C.Y., Hsu, P.Y., Wang, C. L., Liao, T.C., Cheng, H.C. and Wu, Y.L. (2012). Polysilicon nanowire sensor devices based on high-k dielectric membrane for pH sensing and DNA detection. *ECS Transactions* 45(3):537-542.

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Wu, G., Wang, Z., Zhang, H., Yang, N., Du, J. and Lu, X. (2010a). Electrochemical detection of B-1,3-glucanase gene from transgenic capsicums using asymmetric PCR generated by a detecting probe and an anchoring probe. *Journal of biotechnology*, 145:1-8.

Wu, N.Y., Gao, W., He, X.l., Chang, Z. and Xu, M.T. (2013). Direct electrochemical sensor for label-free DNA detection based on zero current potentiometry. *Biosensors and Bioelectronics* 39(1):210-214.

Wu, S.J. L., Lee, E. M., Putvatana, R., Shurtliff, R. N., Porter, K. R., Suharyono, W. and Hayes, C. G. (2001). Detection of dengue viral RNA using a nucleic acid sequence-based amplification assay. *Journal of clinical microbiology* 39(8):2794-2798.

Xiao, Y., Lai, R. Y. and Plaxco, K. W. (2007). Preparation of electrode-immobilized, redox-modified oligonucleotides for electrochemical DNA and aptamer-based sensing. *Nature protocols* 2(11):2875-2880.

Xiao, Y., Lubin, A. A., Baker, B. R., Plaxco, K. W. and Heeger, A. J. (2006). Single-step electronic detection of femtomolar DNA by target-induced strand displacement in an electrode-bound duplex. *Proceedings of the National Academy of Sciences* 103(45):16677-16680.

Xiao, Z., Guo, X. and Ling, L. (2013). Sequence-specific recognition of double-stranded DNA with molecular beacon with the aid of Ag^{+} under neutral pH environment. *Chemical Communications* 49(34):3573-3575.

Xie, H., Zhang, C. and Gao, Z. (2004). Amperometric detection of nucleic acid at femtomolar levels with a nucleic acid/electrochemical activator bilayer on gold electrode. *Analytical chemistry* 76(6):1611-1617.

Xu, B., Zheng, D., Qiu, W., Gao, F., Jiang, S. and Wang, Q. (2015). An ultrasensitive DNA biosensor based on covalent immobilization of probe DNA on fern leaf-like α-Fe 2 O 3 and chitosan Hybrid film using terephthalaldehyde as arm-linker. *Biosensors and Bioelectronics 72*:175-181.

Xu, C., Cai, H., He, P. and Fang, Y. (2001a). Electrochemical detection of sequence-specific DNA using a DNA probe labeled with aminoferrocene and chitosan modified electrode immobilized with ssDNA. *Analyst* 126(1), 62-65.

Xu, G., Jiao, K., Fan, J. and Sun, W. (2006a). Electrochemical detection of specific gene related to CaMV35S using methylene blue and ethylenediamine-modified glassy carbon electrode. *Acta chimica slovenica* 53(4):486-491.

© COPYRIGHT UPM

Xu, H., Di, B., Pan, Y.X., Qiu, L.W., Hao, W., He, L.J. and Che, X.Y. (2006b). Serotype 1-specific monoclonal antibody-based antigen capture immunoassay for detection of circulating nonstructural protein NS1: Implications for early diagnosis and serotyping of dengue virus infections. *Journal of clinical microbiology* 44(8), 2872-2878.

Xu, J., Zhu, J.-J., Huang, Q. and Chen, H.Y. (2001b). A novel DNA-modified indium tin oxide electrode. *Electrochemistry communications* 3(11):665-669.

Xu, M., Zhuang, J., Chen, X., Chen, G. and Tang, D. (2013a). A difunctional DNA–AuNP dendrimer coupling DNAzyme with intercalators for femtomolar detection of nucleic acids. *Chemical Communications* 49(66):7304-7306.

Xu, S., Tu, G., Peng, B. and Han, X. (2006c). Self-assembling gold nanoparticles on thiol-functionalized poly (styrene-co-acrylic acid) nanospheres for fabrication of a mediatorless biosensor. *Analytica Chimica Acta* 570(2):151-157.

Xu, X., Liu, X., Li, Y. and Ying, Y. (2013b). A simple and rapid optical biosensor for detection of aflatoxin B1 based on competitive dispersion of gold nanorods. *Biosensors and Bioelectronics* 47:361-367.

Yan, F., Erdem, A., Meric, B., Kerman, K., Ozsoz, M. and Sadik, O. A. (2001). Electrochemical DNA biosensor for the detection of specific gene related to Microcystis species. *Electrochemistry communications* 3(5), 224-228.

Yan, Q., Wang, Z., Zhang, J., Peng, H., Chen, X., Hou, H. and Liu, C. (2012). Nickel hydroxide modified silicon nanowires electrode for hydrogen peroxide sensor applications. *Electrochimica Acta* 61:148-153.

Yang, I. V. and Thorp, H. H. (2001). Modification of indium tin oxide electrodes with repeat polynucleotides: electrochemical detection of trinucleotide repeat expansion. *Analytical chemistry* 73(21):5316-5322.

Yang, K., Wang, H., Zou, K. and Zhang, X. (2006). Gold nanoparticle modified silicon nanowires as biosensors. *Nanotechnology* 17(11):276-279.

Yang, L., Li, X., Yan, S., Wang, M., Liu, P., Dong, Y. and Zhang, C. C. (2015). Single-walled carbon nanotubes-carboxyl functionalized graphene oxide based electrochemical DNA biosensor for thermolabilehemolysin gene detection. *Analytical Methods* 7:5303-5310.

Yang, L., Lin, H., Zhang, Z., Cheng, L., Ye, S. and Shao, M. (2013a). Gas sensing of tellurium-modified silicon nanowires to ammonia and propylamine. *Sensors and Actuators B: Chemical* 177, 260-264.

Yang, T., Meng, L., Wang, X., Wang, L. and Jiao, K. (2013b). Direct electrochemical DNA detection originated from the self-redox signal of sulfonated polyaniline enhanced by graphene oxide in neutral solution. *ACS applied materials and interfaces* 5(21):10889-10894.

© COPYRIGHT UPM

Yang, Y., Wang, Z., Yang, M., Li, J., Zheng, F., Shen, G. and Yu, R. (2007). Electrical detection of deoxyribonucleic acid hybridization based on carbon-nanotubes/nano zirconium dioxide/chitosan-modified electrodes. *Analytica Chimica Acta* 584(2): 268-274.

Yao, D., Kim, J., Yu, F., Nielsen, P. E., Sinner, E.K. and Knoll, W. (2005). Surface density dependence of PCR amplicon hybridization on PNA/DNA probe layers. *Biophysical journal* 88(4):2745-2751.

Yardım, Y., Keskin, E., Levent, A., Özsöz, M. and Şentürk, Z. (2010). Voltammetric studies on the potent carcinogen, 7, 12-dimethylbenz [a] anthracene: Adsorptive stripping voltammetric determination in bulk aqueous forms and human urine samples and detection of DNA interaction on pencil graphite electrode. *Talanta* 80(3):1347-1355.

Ye, J. and Baldwin, R. P. (1988). Catalytic reduction of myoglobin and hemoglobin at chemically modified electrodes containing methylene blue. *Analytical chemistry* 60(20):2263-2268.

Yguerabide, J. and Yguerabide, E. E. (1998). Light-scattering submicroscopic particles as highly fluorescent analogs and their use as tracer labels in clinical and biological applications: I. Theory. *Analytical biochemistry* 262(2):137-156.

Yogeswaran, U. and Chen, S.M. (2008). A review on the electrochemical sensors and biosensors composed of nanowires as sensing material. *Sensors* 8(1):290-313.

Young, P. R., Hilditch, P. A., Bletchly, C. and Halloran, W. (2000). An antigen capture enzyme-linked immunosorbent assay reveals high levels of the dengue virus protein NS1 in the sera of infected patients. *Journal of clinical microbiology* 38(3):1053-1057.

Yu, C., Ji, W., Wang, Y., Bao, N. and Gu, H. (2013). Graphene oxide-modified electrodes for sensitive determination of diethylstilbestrol. *Nanotechnology* 24(11):115502. Doi:10.1088/0957-4484/24/11/115502

Zainah, S., Wahab, A. A., Mariam, M., Fauziah, M., Khairul, A., Roslina, I. and Chua, K. (2009). Performance of a commercial rapid dengue NS1 antigen immunochromatography test with reference to dengue NS1 antigen-capture ELISA. *Journal of virological methods* 155(2): 157-160.

Zaytseva, N. V., Montagna, R. A. and Baeumner, A. J. (2005). Microfluidic biosensor for the serotype-specific detection of dengue virus RNA. *Analytical chemistry* 77(23): 7520-7527.

Zhai, J., Cui, H. and Yang, R. (1997). DNA based biosensors. *Biotechnology advances* 15(1):43-58.

Zhan, Z., Ma, X., Cao, C. and Sim, S. J. (2012). Gold-based optical biosensor for single-mismatched DNA detection using salt-induced hybridization. *Biosensors and Bioelectronics* 32(1):127-132.

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Zhang, B., Salieb-Beugelaar, G. B., Nigo, M. M., Weidmann, M. and Hunziker, P. (2015a). Diagnosing dengue virus infection—rapid tests and the role of micro/nanotechnologies. *Nanomedicine: Nanotechnology, Biology and Medicine*, 11(7):1745-1761.

Zhang, C., Xu, S., Zhang, X., Huang, D., Li, R., Zhao, S. and Wang, B. (2014). Electrochemical detection of specific DNA sequences related to bladder cancer on CdTe quantum dots modified glassy carbon electrode. *Journal of Electroanalytical Chemistry* 735:115-122.

Zhang, D., Huarng, M. C. and Alocilja, E. C. (2010a). A multiplex nanoparticle-based bio-barcoded DNA sensor for the simultaneous detection of multiple pathogens. *Biosensors and Bioelectronics* 26(4):1736-1742.

Zhang, G.J., Chua, J. H., Chee, R.E., Agarwal, A. and Wong, S. M. (2009a). Label-free direct detection of MiRNAs with silicon nanowire biosensors. *Biosensors and Bioelectronics* 24(8):2504-2508.

Zhang, G.-J., Huang, M. J., Ang, J. A. J., Liu, E. T. and Desai, K. V. (2011). Self-assembled monolayer-assisted silicon nanowire biosensor for detection of protein–DNA interactions in nuclear extracts from breast cancer cell. *Biosensors and Bioelectronics* 26(7):3233-3239.

Zhang, G.-J., Zhang, L., Huang, M. J., Luo, Z. H. H., Tay, G. K. I., Lim, E.-J. A. and Chen, Y. (2010b). Silicon nanowire biosensor for highly sensitive and rapid detection of Dengue virus. *Sensors and Actuators B: Chemical* 146(1):138-144.

Zhang, J., Lang, H. P., Yoshikawa, G. and Gerber, C. (2012). Optimization of DNA hybridization efficiency by pH-driven nanomechanical bending. *Langmuir, 28*(15): 6494-6501.

Zde, J., Lao, R., Song, S., Yan, Z., and Fan, C. (2008a). Design of an oligonucleotide-incorporated nonfouling surface and its application in electrochemical DNA sensors for highly sensitive and sequence-specific detection of target DNA. *Analytical chemistry* 80(23):9029-9033.

Zhang, L., Li, Z., Zhou, X., Yang, G., Yang, J., Wang, H. and Lu, Y. (2015b). Hybridization performance of DNA/mercaptohexanol mixed monolayers on electrodeposited nanoAu and rough Au surfaces. *Journal of Electroanalytical Chemistry* 757:203-209.

Zhang, L., Wan, Y., Zhang, J., Li, D., Wang, L., Song, S. and Fan, C. (2009b). The enzyme-amplified amperometric DNA sensor using an electrodeposited polymer redox mediator. *Science in China Series B: Chemistry* 52(6):746-750.

Zhang, W. (2015). Poly (indole-5-carboxylic acid)-functionalized ZnO nanocomposite for electrochemical DNA hybridization detection. *Journal of Solid State Electrochemistry*, 1-8. Doi:10.1007/s10008-015-3071-9.

© COPYRIGHT UPM

Zhang, X., Gao, F., Cai, X., Zheng, M., Gao, F., Jiang, S. and Wang, Q. (2013). Application of graphene–pyrenebutyric acid nanocomposite as probe oligonucleotide immobilization platform in a DNA biosensor. *Materials Science and Engineering: C* 33(7):3851-3857.

Zhang, X., Guo, Q., and Cui, D. (2009c). Recent advances in nanotechnology applied to biosensors. *Sensors*, *9*(2), 1033-1053.

Zhang, Y., Zhang, K. and Ma, H. (2009d). Electrochemical DNA biosensors based on gold nanoparticles/cysteamine/poly (glutamic acid) modified electrode. *Am. J. Biomed. Sci.1*(2):115-125.

Zheng, D., Vashist, S. K., Al-Rubeaan, K., Luong, J. H. and Sheu, F.-S. (2012). Mediatorless amperometric glucose biosensing using 3-aminopropyltriethoxysilane-functionalized graphene. *Talanta* 99:22-28.

Zheng, D., Vashist, S. K., Dykas, M. M., Saha, S., Al-Rubeaan, K., Lam, E. and Sheu, F.S. (2013). Graphene versus multi-walled carbon nanotubes for electrochemical glucose biosensing. *Materials*, 6(3):1011-1027.

Zheng, J., Chen, C., Wang, X., Zhang, F. and He, P. (2014). A sequence-specific DNA sensor for Hepatitis B virus diagnostics based on the host–guest recognition. *Sensors and Actuators B: Chemical* 199:168-174.

Zheng, Q., Wu, H., Shen, Z., Gao, W., Yu, Y., Ma, Y. and Wang, J. (2015). An electrochemical DNA sensor based on polyaniline/graphene: high sensitivity to DNA sequences in a wide range. *Analyst* 140(19):6660-6670.

Zhenqing, D., Changxin, C., Yaozhong, Z., Liangming, W., Jing, Z., Dong, X. and Yafei, Z. (2012). ZnO nanowire network transistors based on a self-assembly method. *Journal of Semiconductors 33*(8):084003. Doi:10.1088/1674-4926/33/8/084003.

Zhou, L., Gan, T., Zheng, D., Yan, J., Hu, C. and Hu, S. (2012). High-density gold nanoparticles on multi-walled carbon nanotube films: a sensitive electrochemical nonenzymatic platform of glucose. *Journal of Experimental Nanoscience* 7(3):263-273.

Zhou, X., Xing, D., Tang, Y. and Chen, W. R. (2009). PCR-free detection of genetically modified organisms using magnetic capture technology and fluorescence cross-correlation spectroscopy. *PloS one*, *26*(4), 11. Doi:10.1371/jpurnal.pone.0008074.

Zhou, X. C., Huang, L. Q. and Li, S. F. Y. (2001). Microgravimetric DNA sensor based on quartz crystal microbalance: comparison of oligonucleotide immobilization methods and the application in genetic diagnosis. *Biosensors and Bioelectronics* 16(1):85-95.

© COPYRIGHT UPM

Zhu, C. and Liu, X. (2013). Optimization of extraction process of crude polysaccharides from Pomegranate peel by response surface methodology. *Carbohydrate polymers* 92(2):1197-1202.

Zhu, L., Zhao, R., Wang, K., Xiang, H., Shang, Z. and Sun, W. (2008). Electrochemical behaviors of methylene blue on DNA modified electrode and its application to the detection of pcr product from NOS sequence. *Sensors* 8(9):5649-5660.

Zhu, N., Cai, H., He, P. and Fang, Y. (2003). Tris (2, 2′-bipyridyl) cobalt (III)-doped silica nanoparticle DNA probe for the electrochemical detection of DNA hybridization. *Analytica Chimica Acta* 481(2):181-189.

Zuo, S.H., Zhang, L.F., Yuan, H.H., Lan, M.B., Lawrance, G. A. and Wei, G. (2009a). Electrochemical detection of DNA hybridization by using a zirconia modified renewable carbon paste electrode. *Bioelectrochemistry 74*(2):223-226.

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