Biomimetic Interfaces Based on Membrane Proteins for Bioelectronic Applications

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Engineering Interfaces For Bioelectronic Applications

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Engineering Interfaces For Bioelectronic Applications:

Tailoring Conducting Polymer Interface for Sensing and Biosensing Lingyin Meng,2020-09-17 The routine measurement of signi cant physiological and biochemical parameters has become increasingly important for health monitoring especially in the cases of elderly people infants patients with chronic diseases athletes and soldiers etc Monitoring is used to assess both physical fitness level and for disease diagnosis and treatment Considerable attention has been paid to electrochemical sensors and biosensors as point of care diagnostic devices for healthcare management because of their fast response low cost high specificity and ease of operation The analytical performance of such devices is significantly driven by the high quality sensing interface involving signal transduction at the transducer interface and efficient coupling of biomolecules at the transducer bio interface for specific analyte recognition The discovery of functional and structured materials such as metallic and carbon nanomaterials e g gold and graphene has facilitated the construction of high performance transducer interfaces which benefit from their unique physicochemical properties Further exploration of advanced materials remains highly attractive to achieve well designed and tailored interfaces for electrochemical sensing and biosensing driven by the emerging needs and demands of the Internet of Things and wearable sensors Conducting polymers CPs are emerging functional polymers with extraordinary redox reversibility electronic ionic conductivity and mechanical properties and show considerable potential as a transducer material in sensing and biosensing While the intrinsic electrocatalytic property of the CPs is limited especially for the bulk polymer tailoring of CPs with controlled structure and efficient dopants could improve the electrochemical performance of a transducer interface by delivering a larger surface area and enhanced electrocatalytic property In addition the rich synthetic chemistry of CPs endows them with versatile functional groups to modulate the interfacial properties of the polymer for effective biomolecule coupling thus bridging organic electronics and bioelectrochemistry Moreover the soft material characteristics of CPs enable their use for the development of flexible and wearable sensing platforms which are inexpensive and light weight compared to conventional rigid materials such as carbons metals and semiconductors This thesis focuses on the exploration of CPs for electrochemical sensing and biosensing with improved sensitivity selectivity and stability by tailoring CP interfaces at different levels including the CP based transduction interface CP based bio interface and CP based device interface First we demonstrate different strategies for tailoring the physicochemical properties of poly 3 4 ethylenedioxythiophene PEDOT beyond its intrinsic properties via charge effects structural effects and by the use of hybrid materials as a CP based transduction interface to improve sensing performance of various analytes 1 A positively charged PEDOT interface and a negatively charged carboxylic acid functionalised PEDOT PEDOT COOH interface were developed to modulate the electrode kinetics for oppositely charged analytes e g negatively charged nicotinamide adenine dinucleotide NADH and positively charged dopamine DA respectively These interfaces displayed high sensitivity and wide linear range towards the analytes due to the electrostatic attraction effect 2 Various

structured PEDOT including porous microspheres and nanofibres were synthesised via hard template and soft template methods respectively and were employed as building blocks for a hierarchical PEDOT and 3D nanofibrous PEDOT transduction interface that facilitated signal transduction for NADH 3 A PEDOT hybrid material interface was developed via using a novel bi functional graphene oxide derivative with high reduction degree and negatively charged sulphonate terminal functionality S RGO as dopant to create PEDOT S RGO which delivered an enhanced electrochemical performance for various analytes Based on the established CP based transduction interface biomolecules e g enzymes could be coupled to the CP surface to create CP based bio interfaces for biosensing The immobilisation of enzyme was realised via either covalent bonding to a PEDOT derivative bearing a COOH group PEDOT COOH through EDC NHS chemistry or by physical absorption into the 3D porous PEDOT structure The CP based bio interfaces were used to demonstrate the stable immobilisation of two different types of enzymes i e lactate dehydrogenase and lactate oxidase achieving the biosensing of analytes by relay bioelectrochemical signal transduction Together CP was employed as the CP based device interface for the fabrication of a flexible and wearable biosensing device A 3D honeycomb structured graphene network was generated in situ on a flexible polyimide surface by mask free patterning using laser irradiation The substrate was then reinforced with PEDOT as a polymeric binder to stabilise the 3D porous network by adhesion and binding thus minimising the delamination of the biosensing interface under deformation and enhancing the mechanical behaviours for use in flexible and wearable devices The subsequent nanoscale coating of Prussian blue and immobilisation of enzyme into the 3D porous network provided a flexible platform for wearable electrochemical biosensors to detect lactate in sweat Rutinm ssig vervakning av h lsorelaterade fysiologiska och biokemiska parametrar har blivit allt viktigare f r ett stort antal m nniskor bland annat seniorer sp dbarn patienter med kroniska sjukdomar idrottare soldater och med flera p b de en fysisk niv f r f rebyggande av sjukdomar samt p en medicinsk niv f r diagnos och behandling av sjukdomar Stor uppm rksamhet har lagts p utveckling av elektrokemiska sensorer och biosensorer som point of care PoC diagnostiska enheter for rutinm ssig sjukv rdsledning genom deras snabba svar l ga kostnad h ga specificitet och enkla drift Deras analytiska funktioner drivs av avk nningsgranssnittet vilket involverar signaltransduktion vid transducer gr nssnittet och effektiv koppling av biomolekyler till transducer biogr nssnittet f r specifik analytigenk nning Uppt ckten av konventionella funktionella och strukturerade material t ex metalliska nanopartiklar kolnanor r och grafen har underl ttat konstruktionen av transducergr nssnitt med h g prestanda p grund av deras unika fysiokemiska egenskaper Ytterligare forskning av avancerade material ar nskv rt for att uppn ett v ldesignat och skr ddarsytt gr nsnitt for elektrokemisk avk nning och biosensering for Internet of Things och kl dd sensorer Ledande polymerer LP ar en typ av nya funktionella polymerer med extraordin r redoxomv ndbarhet elektronisk jonisk ledningsf rm ga och mekaniska egenskaper som uppvisar betydande potential som ett givarmaterial vid avk nning och biosensering Medan de inneboende elektrokatalytiska egenskaperna i LP er r begr nsade speciellt for den skrymmande polymeren kan skr ddarsydda

LP er med kontrollerad struktur och effektiva dopmedel f rb ttra den elektrokemiska prestandan hos ett givargr nssnitt med st rre ytarea och f rb ttrade elektrokatalytiska egenskaper Dessutom ger den syntetiska kemin LP er m ngsidiga funktionella grupper f r att modulera gr nssnittsegenskaperna f r LP er f r att f rb ttra selektivitet for analytdetektering s v l som f r effektiv biomolekylkoppling som ett biogr nssnitt som verbryggar den organiska elektroniken och det biologiska system som st ds av de LP s organkemiska natur Dessutom m jligg r de mjuka materialegenskaperna f r LP er f r anv ndning i utveckling av en flexibla och b rbara avk nningsplattformar med l g kostnad och l tt vikt j mf rt med konventionella styva material s som metaller och halvledare Denna avhandling fokuserar p utforskning av LP er f r elektrokemisk avk nning och biosensering med f rb ttrad k nslighet selektivitet och stabilitet genom att skr ddarsy LP s gr nssnitt i olika niv er inklusive LP baserat transduktionsgr nssnitt LP baserat bio gr nssnitt och LP baserat enhetsgr nssnitt F rst demonstrerar vi olika strategier for att skr ddarsy fysikalisk kemiska egenskaper hos poly 3 4 etylendioxytiofen PEDOT som ett LP baserat transduktionsgr nssnitt f r avk nning via laddningseffekter struktureffekter och hybridmaterialeffekter f r f rb ttrad prestanda f r olika analyser ut ver dess inre egenskaper 1 Ett positivt laddat hierarkiskt PEDOT gr nssnitt och ett negativt laddat karboxylsyra funktionaliserad PEDOT PEDOT COOH gr nssnitt utvecklades for att modulera gr nssnittets kinetik for de motsatt laddade analyterna t ex negativt laddad s Nicotinamidadeninudukleotid NADH respektive positivt laddat dopamin DA Den elektrokemiska avk nningsprestandan hos dessa analyser f rb ttrades baserat p laddningseffekten med h gre k nslighet och ett bredare linj rt intervall 2 Med tanke p den v l skrymmande filmbildande egenskapen och den resulterande l ga tillg ngliga aktiva ytan f r PEDOT syntetiserades olika strukturerade PEDOT inklusive por sa mikrosf rer och nanofibrer via en h rd mall respektive en mjuk mall och anv ndes sedan som byggstenar f r hierarkiska PEDOT och 3D nanofibrosa PEDOT transduktionsgr nssnitt vilket underl ttar signaltransduktion for NADH 3 Ett LP hybridmaterialgr nssnitt utvecklades med anv ndning av ett nytt bi funktionellt grafenoxidderivat med h g reduktionsgrad och negativt laddad sulfonatterminal funktionalitet S RGO med f rb ttrad elektrokemisk prestanda f r olika analyser Baserat p det etablerade LP baserade transduktionsgr nssnittet utvecklades sedan de LP baserade bio gr nssnitten med immobilisering av biomolekyler t ex enzym f r biosensering Immobiliseringen av enzym p LP gr nssnittet realiserades via antingen kovalent bindning till PEDOT derivatb rande COOH grupper PEDOT COOH genom EDC NHS kemi eller fysisk absorption i por sa 3D PEDOT strukturer De LP biobaserade gr nssnitten visar stabil immobilisering av tv olika typer av enzymer d v s laktatdehydrogenas och laktatoxidas vilket uppn r biosensering av analyter genom en successiv bioelektrokemisk signaltransduktion Tillsammans anv ndes LP er som det LP baserade enhetsgr nssnittet f r tillverkning av en flexibel och b rbar biosenseringsanordning Ett tredimensionellt bikakestrukturerat grafennatverk genererades in situ p den flexibla polyimidytan genom maskfri m nstring med laserbestr lningsteknik Substratet f rst rktes sedan med nanodeponerat PEDOT som ett polymert bindemedel for att stabilisera det por sa 3D n tverket genom vidh ftning och bindning vilket s lunda f rb ttrade det mekaniska beteendet f r flexibla och b rbara anordningar Den sekventiella bel

ggningen p nanoskala av Preussiskt bl tt PB och immobiliseringen av enzym i det por sa 3Dnatverket minimerade delaminering av biosenseringsgr nssnittet vid deformation vilket f rsedde en flexibel plattform f r en b rbar elektrokemisk biosensor f r detektering av laktat i svett med det monterade treelektrodsystemet **Engineering Interfaces for Bioelectronic Applications** Brian Lloyd Hassler,2009 Bioelectronics and Medical Devices Kunal Pal,Heinz-Bernhard Kraatz,Anwesha Khasnobish,Sandip Bag,Indranil Banerjee,Usha Kuruganti,2019-06-15 Bioelectronics and Medical Devices From Materials to Devices Fabrication Applications and Reliability reviews the latest research on electronic devices used in the healthcare sector from materials to applications including biosensors rehabilitation devices drug delivery devices and devices based on wireless technology This information is presented from the unique interdisciplinary perspective of the editors and contributors all with materials science biomedical engineering physics and chemistry backgrounds Each applicable chapter includes a discussion of these devices from materials and fabrication to reliability and technology applications Case studies future research directions and recommendations for additional readings are also included The book addresses hot topics such as the latest state of the art biosensing devices that have the ability for early detection of life threatening diseases such as tuberculosis HIV and cancer It covers rehabilitation devices and advancements such as the devices that could be utilized by advanced stage ALS patients to improve their interactions with the environment In addition electronic controlled delivery systems are reviewed including those that are based on artificial intelligences Presents the latest topics including MEMS based fabrication of biomedical sensors Internet of Things certification of medical and drug delivery devices and electrical safety considerations Presents the interdisciplinary perspective of materials scientists biomedical engineers physicists and chemists on biomedical electronic devices Features systematic coverage in each chapter including recent advancements in the field case studies future research directions and recommendations for additional readings **Insights In Biomaterials 2022 / 2023 - Novel Developments, Current Challenges, and Future Perspectives** Hasan Uludag,Yunbing Wang,Nihal Engin Vrana,Candan Tamerler,Chandra Kothapalli,Milana C. Vasudev,2024-03-04 Switchable Bioelectronics Onur Parlak,2020-04-21 This book reviews the rapidly emerging field of switchable interfaces and its implications for bioelectronics The authors piece together early breakthroughs and key developments and highlight the future of switchable bioelectronics by focusing on bioelectrochemical processes based on mimicking and controlling biological environments with external stimuli as well as responsive systems for drug delivery All chapters in the book strive to answer the fundamental question How do living systems probe and respond to their surroundings Following on from that how can one transform these concepts to serve the practical world of bioelectronics The central obstacle to this vision is the absence of versatile interfaces that are able to control and regulate the means of communication between biological and electronic systems This book summarizes the overall progress made to date in building such interfaces at the level of individual biomolecules and focuses on the latest efforts to generate device platforms

that integrate biointerfaces with electronics Chapter 1 introduces the general concept of dynamic interfaces for bioelectronics and gives an overview of the importance of materials and systems for switchable bioelectronics introducing the reader to different biointerfaces Chapter 2 pieces together different types of stimuli responsive polymers and applications Chapter 3 lays special emphasis on stimuli responsive polymers with tunable release kinetics and describes the importance of polymer design for delivery applications Chapter 4 reviews the field of conformational switching in nanofibers for gas sensing applications Finally Chapter 5 focuses on molecular imprinting polymers as recognition elements for sensing applications As informative as it is lucid this handbook makes an essential resource for advanced undergraduate and graduate level students in chemistry as well as researchers in polymer science and electrochemistry especially those with an interest in responsive polymers and biosensors *Nanoionics* Inamuddin,Tariq Altalhi,Mohammad Luqman,Jorddy Neves Cruz,2025-08-22 This book offers a comprehensive and cutting edge overview of nanoionics covering fundamental principles experimental techniques emerging trends and advanced topics making it a one stop resource for both beginners and professionals in the field Nanoionics Fundamentals and Applications provides a comprehensive and cutting edge overview of the field of nanoionics focusing on recent advancements and their practical applications Nanoionics is an interdisciplinary field that explores the behavior and manipulation of ions at the nanoscale with applications spanning various domains including energy storage electronics sensors and biomedical devices This book delves into the fundamental principles experimental techniques and emerging trends in nanoionics highlighting the latest breakthroughs in the field Beginning with a solid foundation in the principles of nanoionics including ion transport electrochemical processes and nanomaterials the book details advanced topics such as nanoscale characterization techniques interface engineering and ion based devices Throughout the book emphasis is placed on the integration of theory simulations and experimental findings to provide a comprehensive understanding of nanoionics phenomena The book will also explore the interface between nanoionics and related fields such as nanoelectronics nanophotonics and nanomaterials showcasing the potential for cross disciplinary collaborations and technological advancements Readers will find this volume Provides comprehensive coverage of the field of nanoionics encompassing fundamental principles experimental techniques advanced topics and cross disciplinary applications Highlights the latest advancements in nanoionics incorporating recent research findings and breakthroughs by featuring discussions on emerging trends novel materials and innovative device designs Emphasizes the practicality of nanoionics showcasing real world applications in areas such as energy storage electronics sensors and biomedical devices Offers in depth analyses of key concepts and phenomena in nanoionics supported by theoretical models experimental data and simulation results providing readers with a deeper understanding of the underlying principles governing ion transport electrochemical processes and material properties at the nanoscale Audience Researchers graduate students and professionals in the fields of materials science and engineering nanotechnology chemistry electrical engineering and physics

Functionalized Nanomaterials for Biosensing and Bioelectronics Applications Sudheesh K. Shukla,Chaudhery Mustansar Hussain,Jagriti Narang,Roberto Pilloton,2024-06-04 Functionalized Nanomaterials for Biosensing and Bioelectronics Applications Trends and Challenges describes current and future opportunities for integrating the unique properties of two dimensional nanomaterials with bioelectronic interfaces Sections focus on background information and fundamental concepts review the available functionalized nanomaterials and their properties explore the integration of functionalized nanomaterials with bioelectronics including available fabrication and characterization methods electrical behavior at the interface and design and synthesis guidelines and review examples of microsystems where functionalized nanomaterials are being integrated with bioelectronics This book is suitable for researchers and practitioners in academia and R D working in materials science and engineering analytical chemistry and related fields Introduces the most common functionalized nanomaterials and their morphologies properties and mechanisms for sensing applications Reviews functionalization and fabrication methods and techniques for the integration of one and two dimensional materials for sensing applications Addresses the most relevant applications of functionalized nanomaterials for biosensing and bioelectronics applications **Chemical Engineering Progress** ,2005 Engineering the Bioelectronic Interface Jason J. Davis,2009 The interfacing of man made electronics with redox proteins and enzymes not only tells us a great deal about the levels of sophistication active in biology but also paves the way to using it in derived sensory devices Some of these have already had a profound impact on both clinical diagnostics and the quality of life enjoyed by those unfortunate enough to live with disease Though much remains to be learnt about controlling and optimising these interfacial interactions their potential uses are if anything growing Written by leaders in the field this is the only book to focus on the generation of biosensing interfaces with analyses and control at the molecular level Some of these are enzyme based others associated with the generation of surfaces for protein protein recognition Summaries of state of the art investigations into the interfacing of structurally complex molecular species with electrode surfaces are included along with their design analysis and potential application Studies into the wiring of biomolecules to man made surfaces through the use of delocalised molecular wires or carbon nanotubes are detailed as are the application of surface chemical and genetic engineering methods to the construction of robust orientated biomolecular monolayers Polyelectrolytes Based Biomimetic Interfaces for Bioelectronic Applications Neeraj Kohli,2007 Undergraduate Catalog Issue University of New Hampshire,1975 College of Engineering (University of Michigan) Publications University of Michigan. College of Engineering,2002 Also contains brochures directories manuals and programs from various College of Engineering student organizations such as the Society of Women Engineers and Tau Beta Pi **Sensors, Update 5** Henry Baltes,W. Göpel,J. Hesse,1999 Sensors Update ensures that you stay at the cutting edge of the field Built upon the series Sensors it presents an overview of highlights in the field Coverage includes current developments in materials design production and applications of sensors signal detection and

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In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is really astonishing. Within the pages of "**Engineering Interfaces For Bioelectronic Applications**," an enthralling opus penned by a very acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve in to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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