Biohydrogen Production: Sustainability of Current Technology and Future Perspective

Microbial fuel cells (MFCs) are comparatively new technique of simultaneously generating electricity from bio-waste while degrading the organic waste. The use of microbes to generate electricity is an uninterrupted process in MFCs since the bacteria replicate and continue to produce power indefinitely as long as there is enough food source to nurture the bacteria. Besides, MFCs have the potential to produce hydrogen for fuel cells, desalinate sea water, and provide sustainable energy sources for remote areas. Factors like type of electrodes used in the cells, partitioning of cells, oxygen complement and configurations are important factors that affect the performance of MFCs. The fabrication of microbial fuel cells of different configurations and the relationship between the factors affecting the efficiency of single chambered (SC-MFCs) and double chambered (DC-MFCs) will be presented. The experimental data on observations made on the effects of these materials on the MFCs characteristics, electricity generation and wastewater treatment have also been included. The main aim of this study is to find out whether a nonconventional inexpensive clay could be used as an ion-exchange medium alternative to the conventional expensive PEM in the fabrication of MFCs. The results obtained on power generation, current density, open circuit voltage, etc., clearly show that PEM-less MFCs can be used as practical devices for sustainable energy generation.

Microbial Fuel Cell

Bioremediation, Nutrients, and Other Valuable Product Recovery

Progress and Recent Trends in Microbial Fuel Cells provides an in-depth analysis of the fundamentals, working principles, applications and advancements (including commercialization aspects) made in the field of Microbial Fuel Cells research, with critical analyses and opinions from experts around the world. Microbial Fuel cell,
Microbial Fuel Cells: Electricity Generation From Waste Water

Advanced Technology for the Conversion of Waste into Fuels and Chemicals: Volume 1: Biological Processes presents advanced and combined techniques that can be used to convert waste to energy, including combustion, gasification, paralysis, anaerobic digestion and fermentation. The book focuses on solid waste conversion to fuel and energy and presents the latest advances in the design, manufacture, and application of conversion technologies. Contributors from the fields of physics, chemistry, metallurgy, engineering and manufacturing present a truly trans-disciplinary picture of the field. Chapters cover important aspects surrounding the conversion of solid waste into fuel and chemicals, describing how valuable energy can be recouped from various waste materials. As huge volumes of solid waste are produced globally while huge amounts of energy are produced from fossil fuels, the technologies described in this comprehensive book provide the information necessary to pursue clean, sustainable power from waste material. Presents the latest advances in waste to energy techniques for converting solid waste to valuable fuel and energy Brings together contributors from physics, chemistry, metallurgy, engineering and the manufacturing industry Includes advanced techniques such as combustion, gasification, paralysis, anaerobic digestion and fermentation Goes far beyond municipal waste, including discussions on recouping valuable energy from a variety of industrial waste materials Describes how waste to energy technologies present an enormous opportunity for clean, sustainable energy

Microbial Fuel Cells for the Treatment of Waste Streams with Energy Recovery

This book encompasses the most updated and recent account of research and implementation of Microbial Electrochemical Technologies (METs) from pioneers and experienced researchers in the field who have been working on the interface between electrochemistry and microbiology/biotechnology for many years. It provides a holistic view of the METs, detailing the functional mechanisms, operational configurations, influencing factors governing the reaction process and integration strategies. The book not only provides historical perspectives of the technology and its evolution over the years but also the most recent examples of up-scaling and near future commercialization, making it a must-read for researchers, students, industry practitioners and science enthusiasts. Key Features: Introduces novel technologies that can impact the future infrastructure at the water-energy nexus. Outlines methodologies development and application of microbial electrochemical technologies and details out the illustrations of microbial and electrochemical concepts. Reviews applications across a wide variety of scales, from power generation in the laboratory to approaches. Discusses techniques such as molecular biology and mathematical modeling; the future development of this promising technology; and the role of the system components for the implementation of bioelectrochemical technologies for practical utility. Explores key challenges for implementing these systems and compares them to similar renewable energy technologies, including their efficiency, scalability, system lifetimes, and
Progress and Recent Trends in Microbial Fuel Cells

Increase in green, renewable and sustainable energy demand due to higher environmental impacts (e.g. Greenhouse gases emissions, climate change, etc.) on consumption of fossil fuel resource put down an extra pressure on government, researchers and industrialists. Among several available biofuel options, biohydrogen is considered as one of the best environmentally clean fuel and a strong candidate to fulfil the future demand of sustainable energy resource. Although, biohydrogen production technology and its use as a fuel is still in infancy stage. Selection of most sustainable production pathway, increase in production upto industrial scale and cost efficiency are some issue still persist with the biohydrogen research. “Biohydrogen Production: Sustainability of Current Technology and Future Perspective” is giving an insight for the sustainable production of biohydrogen at industrial scale. The process of biohydrogen production is complex and to opt the best suited production system for industrial scale is a frantic task. This book will provide an in depth information on all available technologies for biohydrogen production and feedstock options to choose upon. This book is also providing information on present status of the research in the field and possibility to change future fuel economy in to biohydrogen economy. Experts views provided in the chapters by renowned researchers from all over the globe in the field of biohydrogen research made this book a cornucopia of present research and future perspective of biohydrogen. This book is targeted at the researchers working on biohydrogen as well as the bioenergy scientist planning to move towards biohydrogen research. This book will provide a platform for motivation of researchers and industrialists for innovative ideas and thoughts to bring biohydrogen production at industrial scale.

Modelling Trends in Solid and Hazardous Waste Management

In view of the increased consumption of energy due to the proliferation of electronic devices, this book addresses the trends, similarities, differences and advances in fuel cells of both chemical and biological composition. Fundamentals of microbial fuel cells are described, accompanied by details surrounding their uses and limitations. Chapters on electricigens, microbial group investigations and performance, Rumen Fluid microbes and state-of-the-art advances in microbial fuel cell technology are discussed. The book elaborates upon analytical techniques used for biofilm characterization. It also includes chapters on MFC models that include plant-based MFCs, Algal/Fungi MFCs, MDCs and MFCs using animal waste. A critical review on the performance of MFC technology in field trials is offered in an exclusively dedicated section. By addressing one of the most promising sources for clean and renewable energy, this book fills a pressing need to understand a possible solution for meeting the energy demands in our highly advanced technical world.

Advanced Technology for the Conversion of Waste into Fuels and Chemicals

In the context of wastewater treatment, Bioelectrochemical Systems (BESs) have gained considerable interest in the past few years, and several BES processes are on the brink of application to this area. This book, written by a large number of world experts in the different sub-topics, describes the different aspects and processes relevant to their development. Bioelectrochemical Systems (BESs) use micro-organisms to catalyze an oxidation and/or reduction reaction at an anodic and cathodic electrode respectively. Briefly, at an anode oxidation of organic and inorganic electron donors can occur. Prime examples of such electron donors are waste organics and sulfides. At the cathode, an electron acceptor such as oxygen or nitrate can be reduced. The anode and the cathode are connected through an
electrical circuit. If electrical power is harvested from this circuit, the system is called a Microbial Fuel Cell; if electrical power is invested, the system is called a Microbial Electrolysis Cell. The overall framework of bio-energy and bio-fuels is discussed. A number of chapters discuss the basics - microbiology, microbial ecology, electrochemistry, technology and materials development. The book continues by highlighting the plurality of processes based on BES technology already in existence, going from wastewater based reactors to sediment based bio-batteries. The integration of BESs into existing water or process lines is discussed. Finally, an outlook is provided of how BES will fit within the emerging biorefinery area.

Microbial Fuel Cells 2018

Microbial Fuel Cells 2018

Sustainable Food Waste-to-Energy Systems assesses the utilization of food waste in sustainable energy conversion systems. It explores all sources of waste generated in the food supply chain (downstream from agriculture), with coverage of industrial, commercial, institutional and residential sources. It provides a detailed analysis of the conventional pathways for food waste disposal and utilization, including composting, incineration, landfilling and wastewater treatment. Next, users will find valuable sections on the chemical, biochemical and thermochemical waste-to-energy conversion processes applicable for food waste and an assessment of commercially available sustainable food waste-to-energy conversion technologies. Sustainability aspects, including consideration of environmental, economic and social impacts are also explored. The book concludes with an analysis of how deploying waste-to-energy systems is dependent on cross-cutting research methods, including geographical information systems and big data. It is a useful resource for professionals working in waste-to-energy technologies, as well as those in the food industry and food waste management sector planning and implementing these systems, but is also ideal for researchers, graduate students, energy policymakers and energy analysts interested in the most recent advances in the field. Provides guidance on how specific food waste characteristics drive possible waste-to-energy conversion processes Presents methodologies for selecting among different waste-to-energy options, based on waste volumes, distribution and properties, local energy demand (electrical/thermal/steam), opportunities for industrial symbiosis, regulations and incentives and social acceptance, etc. Contains tools to assess potential environmental and economic performance of deployed systems Links to publicly available resources on food waste data for energy conversion

Compendium of Hydrogen Energy

The rapid growth of global energy consumption and simultaneous waste discharge requires more sustainable energy production and waste disposal/recovery technology. In this respect, microbial fuel cell and bioelectrochemical systems have been highlighted to provide a platform for waste-to-energy and cost-efficient treatment. Microbial fuel cell technology has also contributed to both academia and industry through the development of breakthrough sustainable technologies, enabling cross- and multi-disciplinary approaches in microbiology, biotechnology, electrochemistry, and bioprocess engineering. To further spread these technologies and to help the implementation of microbial fuel cells, this Special Issue, entitled “Microbial Fuel Cells 2018”, was proposed for the international journal Energies. This Special Issue mainly covers original research and studies related to the above-mentioned topic, including, but not limited to, bioelectricity generation, microbial electrochemistry, useful resource recovery, system and process design, and the implementation of microbial fuel cells.
**Microbial Fuel Cell (MFC) Technique for Electricity Production**

Yeast-based biotechnology traditionally regards the empirical production of fermented drinks and leavened bread, processes which surprisingly keep posing challenges and fuelling research. But yeasts nowadays also provide amenable cell factories, producing bulk and fine chemicals and molecules, and are increasingly used as tools in processes as diverse as food preservation or bioremediation. Importantly, yeasts are excellent models of cell and molecular biology for higher eukaryotes, including humans, contributing with key discoveries to understand processes and diseases. All taken, yeast-related business is worth billions, critically contributing to the economical welfare of many differently developed countries. This book provides some insights into aspects of yeast science and biotechnology less frequently addressed in the literature but nonetheless decisive to improve knowledge and, accordingly, boost up yeast-based innovation.

**PEM-Less Microbial Fuel Cells**

This book explores state-of-art techniques based on methodological and modeling aspects of solid and hazardous waste management, specifically focusing on the recent trends in data acquisition and robust modeling of the results obtained. In addition to an in-depth description of the recent regulatory paradigm for solid waste disposal and revealing insights into solid waste management models, the book also addresses significant case history and remediation methodologies for sustainable development in emerging economies like India, China and Brazil. The main emphasis is on a suitable regulatory framework with site-specific baseline calibration and aimed at the robust modeling of contaminant transport and its remediation. This is based on instructive case history in various locations/regions worldwide. The focus on recent modeling and quantification methods is the backbone of the book. One of the major aspects discussed is the application of non-invasive methods for studies related to the Earth's interior, which are increasingly preferred over invasive techniques thanks to their economic utility, as well as robust techniques for the interpretation of geophysical data. The increasing demand for groundwater and energy resources, especially for rapidly emerging countries with large populations like India and China, has made it vital to derive safe utilization approaches for our resources, including suitable waste disposal and remediation methodologies that can be adopted for 'contaminated sites.'

**Bioenergy for Sustainability and Security**

Biochemical Engineering and Biotechnology, 2nd Edition, outlines the principles of biochemical processes and explains their use in the manufacturing of everyday products. The author uses a direct approach that should be very useful for students in following the concepts and practical applications. This book is unique in having many solved problems, case studies, examples and demonstrations of detailed experiments, with simple design equations and required calculations. Covers major concepts of biochemical engineering and biotechnology, including applications in bioprocesses, fermentation technologies, enzymatic processes, and membrane separations, amongst others. Accessible to chemical engineering students who need to both learn, and apply, biological knowledge in engineering principals. Includes solved problems, examples, and demonstrations of detailed experiments with simple design equations and all required calculations. Offers many graphs that present actual experimental data, figures, and tables, along with explanations.

**Microbial Fuel Cell Technology for Bioelectricity**

This book compiles research findings directly related to sustainable and economic waste management and resource recovery. Mining wastes and municipal, urban, domestic, industrial and agricultural wastes and effluents—which contain persistent organic pollutants, nanoparticle organic chemicals, nutrients, energy, organic
materials, heavy metal, rare earth elements, iron, steel, bauxite, coal and other valuable materials—are significantly responsible for environmental contamination. These low-tenor raw materials, if recycled, can significantly address the demand-supply chain mismatch and process sustainability as a whole while simultaneously decreasing their impacts on human life and biodiversity. This book summarises the large volume of current research in the realm of waste management and resource recovery, which has led to innovation and commercialisation of sustainable and economic waste management for improved environmental safety and improved economics. Key Features: Reviews the key research findings related to sustainable and economic resource recovery and waste management techniques Discusses minimizing waste materials and environmental contaminants with a focus on recovering valuable resources from wastes Examines the potential uses of mining waste in the re-extraction of metals, provision of fuel for power plants, and as a supply of other valuable materials for utilisation/processing Presents research on recycling of municipal, urban, domestic, industrial and agricultural wastes and wastewater in the production and recovery of energy, biogas, fertilizers, organic materials and nutrients Outlines topical research interests resulting in patents and inventions for sustainable and economic waste management techniques and environmental safety

Biochemical Engineering and Biotechnology

An introduction to the fundamental concepts and rules in bioelectrochemistry and explores latest advancements in the field Bioelectrochemical Interface Engineering offers a guide to this burgeoning interdisciplinary field. The authors—noted experts on the topic—present a detailed explanation of the field's basic concepts, provide a fundamental understanding of the principle of electrocatalysis, electrochemical activity of the electroactive microorganisms, and mechanisms of electron transfer at electrode-electrolyte interfaces. They also explore the design and development of bioelectrochemical systems. The authors review recent advances in the field including: the development of new bioelectrochemical configurations, new electrode materials, electrode functionalization strategies, and extremophilic electroactive microorganisms. These current developments hold the promise of powering the systems in remote locations such as deep sea and extra-terrestrial space as well as powering implantable energy devices and controlled drug delivery. This important book: • Explores the fundamental concepts and rules in bioelectrochemistry and details the latest advancements • Presents principles of electrocatalysis, electroactive microorganisms, types and mechanisms of electron transfer at electrode-electrolyte interfaces, electron transfer kinetics in bioelectrocatalysis, and more • Covers microbial electrochemical systems and discusses bioelectrosynthesis and biosensors, and bioelectrochemical wastewater treatment • Reviews microbial biosensor, microfluidic and lab-on-chip devices, flexible electronics, and paper and stretchable electrodes Written for researchers, technicians, and students in chemistry, biology, energy and environmental science, Bioelectrochemical Interface Engineering provides a strong foundation to this advanced field by presenting the core concepts, basic principles, and newest advances.

Scale-up Microbial Fuel Cell as Waste-to-energy System for the Colorado Convention Center

This book represents a novel attempt to describe microbial fuel cells (MFCs) as a renewable energy source derived from organic wastes. Bioelectricity is usually produced through MFCs in oxygen-deficient environments, where a series of microorganisms convert the complex wastes into electrons via liquefaction through a cascade of enzymes in a bioelectrochemical process. The book provides a detailed description of MFC technologies and their applications, along with the theories underlying the electron transfer mechanisms, the biochemistry and the microbiology involved, and the material characteristics of the anode, cathode and separator.
is intended for a broad audience, mainly undergraduates, postgraduates, energy researchers, scientists working in industry and at research organizations, energy specialists, policymakers, and anyone else interested in the latest developments concerning MFCs.

**Microbial Energy Conversion**

This book represents a novel attempt to describe microbial fuel cells (MFCs) as a renewable energy source derived from organic wastes. Bioelectricity is usually produced through MFCs in oxygen-deficient environments, where a series of microorganisms convert the complex wastes into electrons via liquefaction through a cascade of enzymes in a bioelectrochemical process. The book provides a detailed description of MFC technologies and their applications, along with the theories underlying the electron transfer mechanisms, the biochemistry and the microbiology involved, and the material characteristics of the anode, cathode and separator. It is intended for a broad audience, mainly undergraduates, postgraduates, energy researchers, scientists working in industry and at research organizations, energy specialists, policymakers, and anyone else interested in the latest developments concerning MFCs.

**Bioelectrochemical Interface Engineering**

Microbial fuel cells (MFCs) are electrochemical devices that use metabolic activities of microorganisms to oxidize organic and inorganic matter and generate electricity. MFC technology is a multidisciplinary approach to the quest for alternate sources of energy. In recent years, MFC technology expressed itself as potential technology for simultaneous electricity generation and waste treatment. It is the purpose of this book to outline, in a concise but comprehensible manner, the fundamentals and development of MFCs and their application as wastewater treatment device. This Book comprises six parts: Chapter 1 contains Introduction and aim of present work. Chapter 2 deals with the critical analysis of MFC research in past and future possibilities. Chapter 3 discloses major methodology used, while Chapter 4 shows the detailed results. Chapter 5 contains conclusion and Chapter 6 is conclusion of present research. As this book is based on results of MFC research, in writing it, the author has drawn about all aspects of MFCs to understand MFCs from every point of view. This book will be beneficial for students, researchers and teachers working on wastewater treatment and bioelectricity.

**Microbial Electrochemical and Fuel Cells**

The theory, design, construction, and operation of microbial fuel cells Microbial fuel cells (MFCs), devices in which bacteria create electrical power by oxidizing simple compounds such as glucose or complex organic matter in wastewater, represent a new and promising approach for generating power. Not only do MFCs clean wastewater, but they also convert organics in these wastewaters into usable energy. Given the world's limited supply of fossil fuels and fossil fuels' impact on climate change, MFC technology's ability to create renewable, carbon-neutral energy has generated tremendous interest around the world. This timely book is the first dedicated to MFCs. It not only serves as an introduction to the theory underlying the development and functioning of MFCs, it also serves as a manual for ongoing research. In addition, author Bruce Logan, a leading pioneer in MFC research and development, provides practical guidance for the effective design and operation of MFCs based on his own firsthand experience. This reference covers everything you need to fully understand MFCs, including: * Key topics such as voltage and power generation, MFC materials and architecture, mass transfer to bacteria and biofilms, bioreactor design, and fundamentals of electron transfer * Applications across a wide variety of scales, from power generation in the laboratory to approaches for using MFCs for wastewater treatment * The role of MFCs in the climate change debate
Waste Water

As global populations continue to increase, the application of biotechnological processes for disposal and control of waste has gained importance in recent years. Advances in Waste-to-Energy Technologies presents the latest developments in the areas of solid waste management, Waste-to-Energy (WTE) technologies, biotechnological approaches, and their global challenges. It combines biotechnological procedures, sophisticated modeling, and techno-economic analysis of waste, and examines the current need for the maximum recovery of energy from wastes as well as the associated biotechnological and environmental impacts.

Features: Presents numerous waste management practices and methods to recover resources from waste using the best biotechnological approaches available. Addresses the challenges, management, and policy issues of waste management and WTE initiatives. Includes practical case studies from around the world. Serves as a useful resource for professionals and students involved in cross-disciplinary and trans-disciplinary research programs and related courses. Discusses the economic and regulatory contexts for managing waste. This book will serve as a valuable reference for researchers, academicians, municipal authorities, government bodies, waste managers, building engineers, and environmental consultants requiring an understanding of waste management and the latest WTE technologies.

Microbial Fuel Cell

Microbial Electrochemical and Fuel Cells: Fundamentals and Applications contains the most updated information on bio-electrical systems and their ability to drive an electrical current by mimicking bacterial interactions found in nature to produce a small amount of power. One of the most promising features of the microbial fuel cell is its application to generate power from wastewater, and its use in the treatment of water to remove contaminants, making it a very sustainable source of power generation that can feasibly find application in rural areas where providing more conventional sources of power is often difficult. The book explores, in detail, both the technical aspects and applications of this technology, and was written by an international team of experts in the field who provide an introduction to microbial fuel cells that looks at their electrochemical principles and mechanisms, explains the materials that can be used for the various sections of the fuel cells, including cathode and anode materials, and provides key analysis of microbial fuel cell performance looking at their usage in hydrogen production, waste treatment, and sensors, amongst other applications. Includes coverage of the types and principles of electrochemical cells Provides information on the construction of fuel cells and appropriate materials Presents the latest on this renewable source of energy and the process for the treatment of waste water

Strategies of Sustainable Solid Waste Management

electricity can be produce by degradation of organic matter in a microbial fuel cell.mfc s have a number of potential uses.the must readily apparent is harvesting electricity produced for uses as a power source. the use of mfc is attractive for application that required only low power.Virtually any organic matter could be used to feed mfc, including coupling cells to waste water treatment plants.Bacteria would consume waste material from water and produce supplementary power for the plant.the gains to be made for doing this are the MFCs are very clean and efficient method for energy production. chemical processing waste water and
designed synthetic waste water have been used to produce bio electricity in dual and single chamber mediator-less m f cs(non coated graphite electrodes)apart from waste water treatment.m f c can be used as use the measure to measure the solute concentration of waste water (i.e.as a bio sensor system). A number of companies have emerged to commercialize m f cs.these companies has attempted to tap into both the remediation and electricity generating aspects of the technologies

**Food Industry Wastes**

Microbial Energy Conversion documents the proceedings of a seminar in Gottingen in October 1976. This book discusses the potential of microorganisms to use solar energy or convert biomass produced by solar energy in such a way that new microbial energy sources can supplement or partially replace conventional sources. This compilation reviews biomass production and elaborates on in detail the microbial processes that are involved in the conversion of the primary biomass–either freshly harvested or disposed of as waste–into energy sources that are similar to hydrogen, methane, propane, gasoline, Diesel oil, methanol, ethanol, or electricity. The microbial processes that contribute to the development of known energy resources, such as mining of low grade ores of copper, zinc, and uranium; reclamation of oil from oil shale; and recovery of conventional and heavy oil and gas, are also deliberated. This text likewise elaborates on the study of photosynthetic enzyme systems, hydrogenase, immobilization of enzymes and pigments on membranes, and construction of artificial photosynthetic units. This book is beneficial to students and researchers conducting work on microbial energy conversion.

**Harvesting Electricity from the Organic Fraction of Municipal Solid Waste Using Microbial Fuel Cells**

Bioremediation and Nutrients and Other Valuable Products Recovery: Using Bioelectrochemical Systems reviews key applications in transforming fuel waste substrates into simple low impact and easily assimilative compounds that are environmentally non-labile and tolerant. The book emphasizes waste treatment and nutrient removal and recovery from a diverse array of waste substrates, utilizing Bioelectrochemical Systems (BES) approaches. Throughout, the work emphasizes the utilization of electrode and/or electrolyte components in building self-sustaining fuel cell systems that target the removal of both conventional and emerging pollutants, along with the production of energy. Bioremediation strategies with potential scale-up options for wastewater treatment, metal removal and soil remediation drug derivates and emerging contaminants are discussed with particular emphasis. Chapters explore applications for these varied pollutants, together with prospects in waste minimization, nutrient recycling, water purification and bioremediation of natural resources. Explores a detailed panorama of potential known pollutants with detailed reviews on their removal and recovery Discusses bioproduct recovery application frontiers across wastewater treatment and bioremediation, metal removal and soil remediation, extraction of drug derivates and emerging contaminants Emphasizes pilot scale-up and commercialization potential for each recovery application discussed

**Sustainable Food Waste-to-Energy Systems**

There is an increasing interest in alternative energy sources as the fossil fuel reserves like petroleum, charcoal and natural gas are limited and utilization of these fuels creates environmental pollution. The microbial fuel cell (MFC) is a new form of renewable energy technology that can generate electricity from what would otherwise be considered waste. In an MFC, bacteria are separated from a terminal electron acceptor at the cathode so that the only means for respiration is to transfer electrons to the anode thus converting chemical energy to electrical energy by the catalytic reaction of microorganisms. There has been a growing interest worldwide on MFC as it utilizes biowaste for power generation and reduces
environmental pollution. In the present investigation, an attempt was made to generate electricity from MFC by utilizing different biowastes such as fresh cow dung, kitchen drain water and wastewater. A mathematical model based on the data collected has been developed to express voltage generated with respect to time. It has been found that for any biowaste whatsoever, voltage generated in an MFC is a linear function of time with a negative slope.

Microbial Fuels

Microbial fuel cells are very promising as renewable energy sources. They are based on the direct conversion of organic or inorganic materials to electricity by utilizing microorganisms as catalysts. These cells are well suited for applications that require only low power, e.g. ultracapacitors, toys, electronic gadgets, meteorological buoys, remote sensors, digital wristwatches, smartphones and hardware in space and robots. In addition to electricity generation, microbial fuel cells can be used for wastewater treatment, desalination and biofuel production.

The book addresses characterization techniques and operating conditions of microbial fuel cells, as well as the usefulness of various types of anode and cathode materials.

Microbial Fuel Cells

Summarizes research encompassing all of the aspects required to understand, fabricate and integrate enzymatic fuel cells. Contributions span the fields of bioelectrochemistry and biological fuel cell research. Teaches the reader to optimize fuel cell performance to achieve long-term operation and realize commercial applicability. Introduces the reader to the scientific aspects of bioelectrochemistry including electrical wiring of enzymes and charge transfer in enzyme fuel cell electrodes. Covers unique engineering problems of enzyme fuel cells such as design and optimization.

Waste to Watts and Water: Enabling Self-Contained Facilities Using Microbial Fuel Cells

The steady increase in industrialization, urbanization and enormous population growth are leading to production of huge quantities of wastewaters that may frequently cause environmental hazards. This makes waste water treatment and waste water reduction very important issues. The book offers a collection of studies and findings concerning waste water treatment, minimization and reuse.

Old Yeasts

The book will highlight major trends and developments in the field of microbial fuels, with contributions from a number of highly experienced researchers. It will serve as a comprehensive reference for industrial stakeholders, scientists, researchers and graduate students interested in microbial fuels. The aims of this work are to present the technologies and perspectives taking into account different socio-economic contexts. A specific chapter will focus on the general perspectives of microbial fuels for low-income and emerging countries.

Waste Bioremediation

Global trends linking population and economic growth to ecological security highlight the urgency of developing renewable, carbon-neutral energy technologies. A microbial fuel cell (MFC) is such an environmental biotechnology that exploits microorganisms (pure or mixed inocula) in the catalytic conversion of organic matter (simple or complex substrate) to electrical energy. In developing countries, where solid waste management is a major challenge, the organic fraction of municipal solid waste (OFMSW) is an abundant, potentially attractive source of
biomass energy. The objective of this thesis was to test the potential of direct power generation from OFMSW-fed MFCs by exploring a variety of seeds; wastewater sludge, cattle manure and rumen microorganisms. To achieve this objective, nine cube-shaped, single-chambered, air-cathode MFCs were constructed using carbon cloth electrodes. The OFMSW (domestic food waste) was collected and processed to obtain a feed with particles of size 0.3-0.85 mm. The MFCs were initially fed glucose and inoculated with wastewater sludge (10% v/v), operating in fed-batch mode until a stable voltage was reached. Then, the glucose solution was replaced with a diluted solution of OFMSW (soluble COD ~1000 mg/L) and six of the MFCs were inoculated with either cattle manure or rumen microorganisms (10% v/v). The performance of the nine MFCs (triplicate MFCs for each type of seed) was evaluated at different SCOD concentrations (1178, 3555 and 6605 mg/L), in terms of power density, Coulombic efficiency (CE) and organic removal. At low SCOD, the wastewater and manure-seeded MFCs performed better than the rumen-seeded MFCs. Power density reached 122 mW/m2 and CE reached 24%, values comparable to other MFC studies utilizing complex substrates. COD removal reached 88%, higher than what has been reported with complex substrates. Upon increasing the organic loading, the performance of all the MFCs declined, possibly due to catalyst exhaustion, biofilm growth and/or drop in pH. This thesis corroborates the potential of power generation from OFMSW-fed MFCs, but extensive research is needed relating to the long-term stability of such systems as well as technological optimization for upscaling.

**Waste to Sustainable Energy**

The book provides an overview on various microorganisms and their industrialization in energy conversion, such as ethanol fermentation, butanol fermentation, biogas fermentation and fossil energy conversion. It also covers microbial oil production, hydrogen production and electricity generation. The content is up to date and suits well for both researchers and industrial audiences.

**Sustainable and Economic Waste Management**

This book discusses the generation of green energy, providing fundamental scientific information on the availability of sustainable biological resources. It addresses inter- and multidisciplinary topics, including policies and strategies for sustainable energy; the environment and advanced renewable energy technology; electricity generation through solid waste management; and direct electricity generation using microbial fuel cells. It examines the application of the principles and quantitative relationships that define the process – as an effective technique to teach applied aspects of biomass energy technology conversion. In addition, it describes the latest commercialisation of microbial fuel cell technologies, bio-diesel production from microalgae, fermentation technology based on biobutanol from bacteria, and direct ethanol production from microalgae with attractive illustrations and models developed by corporate sectors.

**Advances in Waste-to-Energy Technologies**

**Microbial Electrochemical Technologies**

With no emissions and water as a byproduct, the globe could imagine a sustainable and resilient human kind that obliterates any possible chances of future climate change. With increased globalization, there has been an unprecedented escalation in production processes thus generating valued products and byproducts. A significant quantum of the waste materials generated can be transformed into fuels with the help of MFCs. MFC’s utilities would bring about a paradigm shift built on the principles of sustainability, encompassing closed loop biorefinery approach. A MFC’s bio-refinery ensures complete allocation of products and byproducts in various processes yielding zero waste. Such efforts would not only help in managing
waste but also contribute to generation of renewable fuel and valued products that fosters sustainable development. To cater to the needs of the present challenges in waste management, bioenergy and bio product recovery and commercial sustainability, this book on MFCs will emphasize and throw light on various mechanisms, routes and reaction engineering approaches for complete transformation of waste to wealth.

**Bioelectrochemical Systems**

Compendium of Hydrogen Energy, Volume 2: Hydrogen Storage, Distribution and Infrastructure focuses on the storage and transmission of hydrogen. As many experts believe the hydrogen economy will, at some point, replace the fossil fuel economy as the primary source of the world's energy, this book details hydrogen storage in pure form, including chapters on hydrogen liquefaction, slush production, as well as underground and pipeline storage. Other sections in the book explore physical and chemical storage, including environmentally sustainable methods of hydrogen production from water, with final chapters dedicated to hydrogen distribution and infrastructure. Covers a wide array of methods for storing hydrogen, detailing hydrogen transport and the infrastructure required for transition to the hydrogen economy. Written by leading academics in the fields of sustainable energy and experts from the world of industry Part of a very comprehensive compendium which looks at the entirety of the hydrogen energy economy.

**Microbial Energy Conversion**

The world is currently experiencing increased environmental contamination with solid waste, which is one of the greatest environmental threats today. Although solid waste is harmful, proper management and profitable recycling can make it beneficial to the environment. In this regard, estimation of the true quantities of solid wastes generated annually in developed and developing countries is important for evaluating suitable strategies for economic and sustainable procedures of waste management. This book presents an interesting review of the economics of solid waste management in various developing and developed countries. It examines several economic applications of solid waste, such as innovative methods to generate bioelectricity from organic waste using microbial fuel cells and using solid waste as an alternative fuel in cement kilns.

**Generation of Electricity from Microbial Fuel Cells Using Biowastes**

Lack of investment in future agile combat-support technologies could lead to a strategic surprise that diverts military attention and resources from critical air, space, and cyber operations. Looking to the national security environment in 2030, this research explores one technology—the microbial fuel cell (MFC)—that gives life to self-contained facilities decoupled from vulnerable supply lines and infrastructure networks. MFCs can dispose of waste (sewage, food scraps, gray water, etc.) while producing clean water (up to 70 percent of required volumes) and power (up to 600 watts per person). Using relevance tree methodology, the research concludes that USAF research and development investment alone will not bring MFCs to fruition. A successful strategy for MFCs will be collaborative, addressing not only the technological barriers but also the key social, industrial, and political hurdles to enabling this capability. Fully developed, this technology could save up to $50 million a day for a 150,000-person deployment. Beyond cost and mobility advantages, MFCs could enable homeland security against the terrorist threat and provide power, water, and sanitary waste disposal after wars or natural disasters. They could also bolster the legitimacy of stressed governments, offer security against chronic water and energy shortages, and function in isolated areas as well as urban centers. In addition to military uses, MFCs could become a diplomatic and economic tool to pursue a better state of peace by building a foundation for democratic and economic development.
Microbial Fuel Cells

This book discusses the bioremediation of both solid and liquid waste, including regional solutions for India as well as globally relevant applications. The topics covered include pollutant reduction through composting, solutions for petroleum refinery waste, use of microorganisms in the bioremediation of industrial waste and toxicity reduction, microbial fuel cells, and microbial depolymerisation. The book also explores the biosorption of metals and the bioremediation of leachates, especially with regard to soil and groundwater remediation. It is a valuable resource for researchers, professionals, and policy makers alike.

Enzymatic Fuel Cells

The rapid growth of global energy consumption and simultaneous waste discharge requires more sustainable energy production and waste disposal/recovery technology. In this respect, microbial fuel cell and bioelectrochemical systems have been highlighted to provide a platform for waste-to-energy and cost-efficient treatment. Microbial fuel cell technology has also contributed to both academia and industry through the development of breakthrough sustainable technologies, enabling cross- and multi-disciplinary approaches in microbiology, biotechnology, electrochemistry, and bioprocess engineering. To further spread these technologies and to help the implementation of microbial fuel cells, this Special Issue, entitled "Microbial Fuel Cells 2018", was proposed for the international journal Energies. This Special Issue mainly covers original research and studies related to the above-mentioned topic, including, but not limited to, bioelectricity generation, microbial electrochemistry, useful resource recovery, system and process design, and the implementation of microbial fuel cells.

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