ADVANCES IN FUEL CELLS pdf

1: An Inexpensive Fuel-Cell Generator - MIT Technology Review

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Received Aug 25; Accepted Oct 9. The use, distribution or reproduction in other forums is permitted, provided the original author s or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms. This article has been cited by other articles in PMC. Abstract This review summarizes recent trends in the field of enzymatic fuel cells. Thanks to the high specificity of enzymes, biofuel cells can generate electrical energy by oxidation of a targeted fuel sugars, alcohols, or hydrogen at the anode and reduction of oxidants O2, H2O2 at the cathode in complex media. The combination of carbon nanotubes CNT , enzymes and redox mediators was widely exploited to develop biofuel cells since the electrons involved in the bio-electrocatalytic processes can be efficiently transferred from or to an external circuit. Original approaches to construct electron transfer based CNT-bioelectrodes and impressive biofuel cell performances are reported as well as biomedical applications. Moreover, the ever-increasing depletion of fossil fuels and the need for clean methods of producing electricity have stimulated the emergence of new sources of sustainable and renewable energy without greenhouse gas emissions or environmental pollution. Among these clean alternative sources, the production of electrical energy thanks to biofuel cells, a subcategory of fuel cells, is a rapidly growing field. In particular, enzymatic fuel cells that convert chemical energy into electrical energy by catalytic reaction of the enzymes, is one of the most common and studied configuration Barton et al. These biofuel cells use redox enzymes for the specific oxidation of fuels alcohols, hydrogen, lactate, sugars such as glucose, fructose, lactose, or cellobiose at the anode and the reduction of oxidizers O2, H2O2 at the cathode in order to generate electric power Meredith and Minteer, A vast majority of these biofuel cells produce electric power from the electro-enzymatic degradation of glucose and oxygen. Compared to hydrogen or methanol fuel cells, sugars like glucose present the unique advantage of being a perfect energy storage compound in many living organisms and have absolutely no toxicological, explosive or flammable risks. Taking into account that catalysts, fuels, and products are biodegradable, the inherent ecological aspect of the biofuel cells compared to fuel cells should be noted. Fuel cells require catalysts based on precious metals or transition metals such as nickel, gold, silver, rhodium, ruthenium, palladium or chromium, or alloys such as Raney nickel Zhang, The main application of biofuel cells is to design devices whose power and size will be compatible with a use as portable source of energy miniature generators of low power for mobile phone or GPS. Combined with conventional batteries, these biosystems will also be able to ensure a recharging of the batteries and a standby mode for electronic equipment. Owing to the presence of some fuels such as glucose and lactate in physiological fluids, another major motivation for the development of biofuel cells concerns the production of electricity from human body. Two approaches are in constant development: The objectives are for the former to power implanted medical devices like cardiac pacemakers, muscle stimulators, neurological stimulators, cochlear implants, drug pumps, sensors, while those for the latter are to harvest energy from human for powering wearable electronics Jia et al. Although the first example of a biofuel cell has been reported in the 60s Yahiro et al. Since the early s, tremendous advances have been achieved in the field of biofuel cells as evidenced by the exponential increase of scientific publications devoted to this topic. This results from the removal of technological barriers directly related to profound progress made in the field of electrochemical biosensors like the design of new materials and procedures for immobilization and electrical connection of enzymes Polsky et al. In particular, the development of biointerfaces has triggered enormous attention in the field of energy conversion. Taking into account that the bioelectrode activity was related to the activity of the wired enzymes, three-dimensional structures were designed to enhance the specific surface of the conductive substrate and the immobilized amount of enzymes and redox mediators serving as electron shuttle between enzymes and the electrode surface. In this context, numerous efforts have been focused in the production of novel biomaterials based on aerogels Wen et al.

These conducting polymer hydrogels were thus applied to the entrapment of enzymes glucose oxidase, glucose dehydrogenase, bilirubin oxidase, laccase onto platinum microelectrodes and nanostructured scaffolds of carbon fibers grown by chemical vapor deposition Soukharev et al. In addition, the modulation of the tethering of redox centers to the polymer backbone was investigated for optimizing the enzyme wiring Forster et al. Moreover, the stabilization of the bioarchitectures was envisioned by photoinitiated polymerization of poly ethylene-glycol diacrylate as outer layer Suraniti et al. Owing to the intense research activity in this field, we aim not to give a complete coverage of biofuel cells literature involving 3D constructs, but rather to review briefly the recent strategies employed with carbon nanotubes CNT for enzyme immobilization and their wiring. Enzymatic Fuel Cells Based on Carbon Nanotube Deposits Within the vast number of available nanostructured materials and nano-objects, CNTs exhibit, between others, nanowire morphology, biocompatibility, and excellent conductivity Dai, ; Smart et al. These particularities confer to nanotubes a pivotal role for designing electrochemical biosensors and biofuel cells. Furthermore, the possibility to add appropriate functionalities via organic functionalization enabled optimal tuning of such nanostructured electrodes by attaching specific redox sites for fixing proteins or catalyzing electrochemical reactions with enzymes or coenzymes. In this context, CNTs have played an important role for interfacing enzymes with electronic circuitry. In particular, these CNT can establish an electrical communication with enzymes via their intrinsic conductivity or via an electron transport to enzymes ensured by electron hopping between immobilized redox centers. As a consequence, electrodes modified by CNTs have aroused widespread attention in the design of biofuel cells Holzinger et al.

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2: Recent Advances in Carbon Nanotube-Based Enzymatic Fuel Cells

Fuel cells have been recognized to be destined to form the cornerstone of energy technologies in the twenty-first century. The rapid advances in fuel cell system development have left current information available only in scattered journals and Internet sites. Advances in Fuel Cells fills the.

Posted in Fuel Cells Future Technology Hydrogen Fuel Hydrogen has great potential as a fuel of future because it is an environmentally clean energy fuel and save us from the undesirable side effects of greenhouse gases. Before becoming it a fuel of the masses we need necessary infrastructure to store it and move it. We will also need fuel cells on economical scale. To make hydrogen as a popular alternative fuel some engineers are working on storage factor of hydrogen fuel. They want to store hydrogen fuel into a large molecule. When we want hydrogen out of the molecule we will need a catalyst. Now, researchers have new details about one such catalyst. They are finding out the characteristics of the catalyst which are a cluster of rhodium, boron and other atoms. The catalyst chemically reacts with ammonia borane to release the hydrogen as a gas. Ammonia borane is a molecule that stores hydrogen densely. If we can find a way to change the hard part, that is, make it easier to release the hydrogen, then we can improve this catalyst. Ammonia borane contains hydrogen atoms and serves as structural hold-on. The scientists are working on various structural combinations that can give maximum output. Right now they are trying various shapes such as tetrahedron, or a triangular pyramid with four rhodium atoms at the core. To arrive at the ideal combination they are trying both theory and experimental work. They employed several methods for ammonia borane reaction. They used one unusual technique operando XAFS. They X-rayed the catalysts in action instead of the usual standstill X-ray. They collected important data but they require exhaustive analysis before they can make any sense. The research team used computer models to solve this data puzzle so that they can construct a theoretical molecular configuration that accounted for all the data. The computer model created a structure that best integrated the experimental data. They tested the authenticity of the data too with computer simulation with the help of an operando XAFS analysis of the catalytic structure reacting with ammonia borane. The next logical step was to compare the simulated data with real data of the catalyst. The chemical character of the structure and supplementary experimental data helped the team to chart the chemical reaction occurring between the catalyst and the ammonia borane. The catalyst is always in the state of a motion so it is difficult to spot but nonetheless it is a good catalyst. How this catalyst actually works? First it marks out hydrogen from the ammonia borane molecule. This ammonia borane consists of a nitrogen atom in the molecule holding onto two hydrogen atoms. First, the catalyst picks out one hydrogen atom. This is the hardest part of the reaction. This first step makes the bond between the remaining hydrogen and boron unstable. Now plucking off second hydrogen atom becomes easier. Same holds true for the last two hydrogen atoms. These hydrogen atoms can be utilized in engines or fuel cells. The team has yet to figure out the additional details but this study makes a big dent in what they need to know to design a good, inexpensive catalyst. We get a lot more information this way than doing either one alone. Well intentioned testimonies, of hydrogen users, that say they can run their vehicles on hydrogen, produced on their vehicles, are mistaken. Hydrogen can be relatively safely stored in metal hydride for possible mobility. Engines need to have their timing advanced to run on hydrogen. There is evidence that burning hydrogen, in engines, will cause premature engine failure, because hydrogen burns hotter than gasoline.

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3: New Advances in Hydrogen Fuel Catalysts

Fuel cells have been recognized to be destined to form the cornerstone of energy technologies in the twenty-first century. The rapid advances in fuel cell system development have left current information available only in scattered journals and Internet sites.

It not a great surprise to close Apple watchers, Apple has filed other patent applications for light weight hydrogen fuel cells. Those patents, which were brought to light this past October, described a building process where multiple fuel cells are connected by a power bus in a parallel pattern, and a voltage-multiplying circuit is added for additional voltage from the stack. Apple hopes to utilize these lighter, more efficient fuel cells in its mobile products in an effort to promote renewable energy sources and offer devices with the ability to run for days or even weeks without refuelling, according to the patent applications. The devices will also be lighter and less bulky due to the lack of traditional batteries. The interesting thing and idea to watch is Apple wants to integrate fuel cells right into their electronics. No fuel cartridge needed. But Apple allows creating a hydrogen fuel cell system that is cost-effective is a challenge. The puzzle remains how hydrogen gas storage costs are going to make fuel cells economically viable, hydrogen is very difficult to store. The smallest atom making the smallest molecule in H2 form needs compressed or exotic materials to keep it in one place. The more interesting fuel cells rely on low cost stores of hydrogen in methanol or ethanol, liquids that have very high hydrogen density and only need plastic tanks at atmospheric pressure. Click image for the largest view. Army is especially interested in hydrogen based fuel cell technology, says Maj. Mark Owens, which drastically reduces the amount of batteries that soldiers carry on dismounted missions. The test was the 1st Battalion of the 1st Infantry Division deployed to Afghanistan in with their rucksacks full of experimental renewable energy equipment. Also under evaluation is a 4. The problem is the money â€” all the fuel cells from simple hydrogen to those reacting heavy petrochemicals like kerosene all rely in expensive and rare elements like platinum, palladium and even rhodium. And they run hot, s of degrees centigrade. While the Finns have come up with a much less costly way to use the metals platinum and palladium , the investment will still be very substantial and the growth of the industry will simply push the metal prices higher. Still, there are glimmers of research looking for ways to build fuel cells without the precious metal component. One small break, in an industry building and selling fuel cells in specialized uses with great regularity, offers hope that mass markets can be addressed. Bloom Energy can build fuel cells reacting with natural gas, or methane fuel for sensible prices. Bloom and many others can be expected to be looking for ways to downsize and use liquid fuels. There is intense interest and cash on the line for the market right now. So far details are rare, but you can be sure there will news coming soon.

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4: Catalyst advance could lead to economical fuel cells

recent advances in fuel cells In considering - the areas where improvement in fuel cells is needed, the three most prominent are: a) Electrocatalysts, primarily as they affect cost and perfor-.

May 4, - Nan Cooper, School of Engineering Baikun Li, assistant professor of civil and environmental engineering, tests the voltage of a microbial fuel cell. Photo by Jessica Tommaselli Professor Baikun Li and her industrial partners are seeking to harness the energy-production capabilities of microscopic bacteria to produce power and clean wastewater on a large commercial scale. They have recently received funding for the project from the U. The grant garnered matching funds from the Water Environment Research Foundation, an international water pollution research and outreach group. Although they have been studied since the early s, microbial fuel cells are still in their infancy, says Li, noting that most research to date has focused on very small-scale lab units. In a microbial fuel cell, a feedstock â€" in this case, carbohydrate-laden wastewater â€" is fed into a vacuum-sealed cell, where anaerobic bacteria embedded in a carbon tube dine on the fatty acids, glucose, and other organic carbons prevalent in wastewater. The bacteria degrade these organic compounds and generate protons and electrons. The electrons are transported to an electrode â€" the anode â€" and conducted through a copper wire circuit to a second electrode, called a cathode. At the cathode, electrons and protons react with oxygen, generating electricity. A microbial fuel cell operates at room temperature and requires only wastewater as its influent, in contrast with solid oxide fuel cells and most polymer electrolyte membrane fuel cells, which require higher temperatures and pressures, a costly catalyst often platinum in the case of polymer electrolyte membrane fuel cells, and additional hydrogen or nitrogen to operate. But while solid oxide fuel cells and most polymer electrolyte membrane fuel cells are costly to operate in comparison with microbial fuel cells, they are considerably more efficient sources of energy, producing about 3, watts per cubic meter of energy, in contrast with the approximately 3 watts per cubic meter a microbial fuel cell may produce. Conventional sewage treatment plants rely on a mixture of processes, including microbes, to produce clean water. In the process, they use huge amounts of power and release tens of millions of tons of carbon dioxide into the atmosphere every year. Curtis says microbial fuel cell technology takes a high-energy resource, such as the carbohydrates in sanitary sewage, and exploits it in energy production. The carbon supplying the fuel cell has effectively been sequestered from the atmosphere, making this a green, carbon-neutral process. At a small scale, microbial fuel cells can produce a relatively large amount of energy. Their energy conversion capacity declines, however, as the scale is increased, rendering them inefficient power sources currently for most commercial applications. Li and her colleagues seek to develop high-energy output microbial fuel cells and units suitable for various commercial applications. In her UConn laboratory, Li has developed ml and 1 liter microbial fuel cell units. If we could harness this untapped resource to produce high quality energy and clean water, we could reverse the current energy balance of sewage treatment facilities.

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5: Advances In Fuel Cell Technology Target Drones - AVweb flash Article

Currently, there is a good deal of interest in the possibility that fuel cells will make an important contribution to world energy supplies for both mobile and stationary applications.

August 22, Storms and other issues are making backup power increasingly important, but diesel generators are loud and dirty. People could soon get cleaner energy from a compact fuel-cell generator in their backyards, at costs cheaper than power from the grid. A complete generator from Redox would feature several stacks of these ceramic plates. Redox is developing fuel cells that feed on natural gas, propane, or diesel. The cells, which generate electricity through electrochemical reactions rather than combustion, could allow businesses to continue operating through power outages like those caused by massive storms such as Hurricane Sandy, but they promise to be far cleaner and quieter than diesel generators. They can also provide continuous power, not just emergency backup power, so utilities could use them as distributed power sources that ease congestion on the grid, preventing blackouts and lowering the overall cost of electricity. Redox claims to have developed fuel cells based on novel materials that could cut costs by nearly 90 percent. The first product will be a kilowatt generator that Redox says produces enough electricity for a grocery store. The company eventually plans to sell smaller versions for homes. The company says its fuel cells will pay for themselves with electricity-bill savings in two years. Redox, a self-funded company founded just two years ago, is basing its cost estimates on data derived from manufacturing key components of the fuel-cell systems. The type of fuel cell Redox makes is called a solid-oxide fuel cell. Like all fuel cells, it produces power through electrochemical reactions. Unlike those being developed for use in cars, it can run on a variety of fuels, not just hydrogen. Department of Energy, who is not connected to Redox. Citrin says the company has made the individual ceramic plates that fit inside the fuel-cell system. Citrin says the company plans to finish a kilowatt prototype by the end of the year, in time to start selling complete systems by the end of Eric Wachsman , director of the University of Maryland Energy Research Center, who developed the original technology, believes the system will perform well over time because it operates at lower temperatures than other versions, reducing damage to the fuel cells. He says data from individual cells suggest that the systems could last for 10 yearsâ€”still far short of the lifetime of a power plant, but within the payback period. Want to go ad free? No ad blockers needed.

6: Catalyst advance could lead to economical fuel cells | WSU Insider | Washington State University

Fuel cell advances: Last year, the U.S. Department of Energy cut substantially into federal funding of hydrogen fuel-cell research. Congress put some of this back, but generally the sentiments.

7: Team advances fuel cell car technology

You will gain insight into the current status of solid oxide fuel cells technology and the latest developments in the areas of fabrication, characterization, testing, performance, electrodes, electrolytes, seals, cell and stack development, proton conductors, fuel reforming, mechanical behavior, powder synthesis, etc.

8: Ceres Power unveils latest steelcell advances at fuel cell expo - Ceres Power plc

A look at the development of Fuel Cells in , the different types and their advantages and disadvantages. Could become the year that cheap fuel cells replace traditional.

9: Collaboration Advances Microbial Fuel Cell Commercialization - UConn Today

demonstrated that fuel cells using gaseous fuels were possible, a Symposium on Fuel Cells was organized and held by

the Gas and Fuel Chemistry Division of the American Chemical Society at the th National Meeting in September,

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