ENERGY FOCUS

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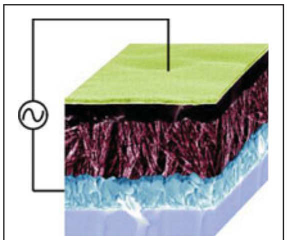
Porous TiO_2 electrodes speed up electrons in dye-sensitized solar cells

ACS Nano DOI: 10.1021/nn1024434

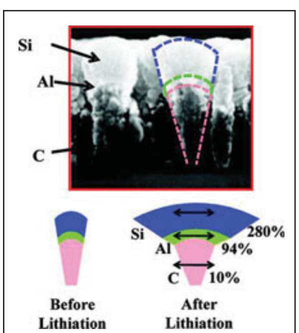
A new method of forming porous titanium dioxide electrodes for use in solid-state dye-sensitized solar cells for faster electron transport, as an alternative to nanoparticle-based electrodes, has been developed. The new process uses titanium dioxide nanorods, which self assemble and join together to form a 3D network of fused single-crystalline nanowires very quickly from aqueous solution. The main aim is to speed up electron transport through the electrode structure and avoid recombination with holes. The new structure showed several orders of magnitude faster electron transport compared to conventional electrodes, and yielded a conversion efficiency of 4.9%.



Strain-graded "nanoscoop" anodes allow faster Li-ion batteries

Nano Letters DOI: 10.1021/nl102981d

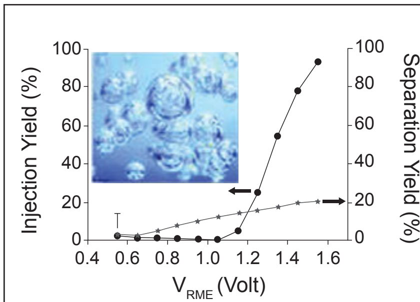
A new nanomaterial for use in Li-ion battery anodes has been developed. The shape of the nanomaterial resembles a cone with a scoop of ice cream on top, hence the moniker "nanoscoop" by the researchers. The structure incorporates a carbon (C) nanorod base topped with a thin layer of nanoscale aluminum (Al) and a "scoop" of nanoscale silicon (Si). An anode made of arrays of this material was shown to withstand extremely high rates of charge and discharge that would cause conventional electrodes used in current Li-ion batteries to rapidly deteriorate and fail. The electrode was demonstrated to charge/discharge at a rate 40 to 60 times faster than conventional battery anodes while maintaining a comparable energy density for more than 100 continuous charge/discharge cycles. The segmented structure of the nanoscoop allows strain, during the charging and discharging of Li ions, to be gradually transferred from the C base to the Al layer and finally to the Si scoop, thereby minimizing mismatch at the interfaces between the differentially strained materials.



Hematite photoanodes unravel bottleneck in water photo-oxidation

Energy & Environmental Science DOI: 10.1039/C0EE00570C

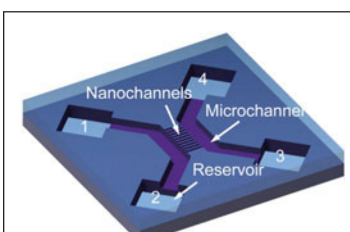
Hematite (α-Fe_2O_3) is a very promising photoanode material for hydrogen production using solar radiation by photoelectrochemically splitting water, due to its unique combination of properties. With an energy bandgap of 2.1 eV, hematite photoanodes can reach solar-to-hydrogen conversion efficiencies as high as 15.5%. However, in practice, only a quarter of this theoretical limit has been achieved thus far, attributed to surface and bulk recombination losses connected with a low rate of water oxidation and short diffusion lengths of the photogenerated minority carriers (holes). The question of the rate-limiting step in hematite photoanodes and whether carrier recombination occurs at the bulk or the surface has been under investigation. A report now presents a new approach to answering this fundamental question, using hydrogen peroxide as a hole scavenger that readily accepts holes arriving at the electrode/electrolyte interface, by deconvoluting bulk and surface recombination losses. This provides the ability to distinguish between, and quantify, bulk and surface recombination losses and predict the expected photocurrent with a perfect catalyst.



2-nm nanochannels fabricated for higher ion mobility

Nature Nanotechnology DOI: 10.1038/nnano.2010.233

Channels in biological transmembrane proteins are sufficiently small to allow ions or molecules of a certain size to pass through, while keeping out larger objects. However, it has been difficult to form individual artificial nanochannels of this size. Now, researchers have fabricated nanochannels that are only 2 nm in size, using standard semiconductor manufacturing processes. High-precision

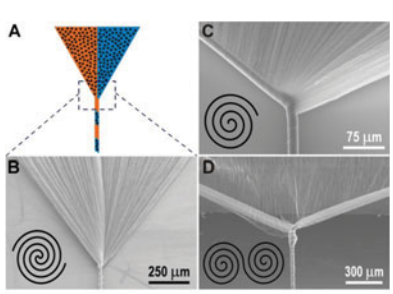


Credit: Chuanhua Duan, Lawrence Berkeley Lab ion etching was combined with anodic bonding to fabricate channels of a specific size and geometry on a silicon-on-glass die. A much higher rate of proton and ionic mobility in these confined hydrated nanochannels, up to a fourfold increase over that in larger nanochannels (10–100 nm), was obtained. Fluidic nanochannels could play critical roles in future fuel cells and batteries by improving the power density and practical energy density. Enhanced ion transport could reduce internal resistance in fuel cells and batteries, which would reduce the internal energy loss and increase practical energy densities.

Carbon nanotube sheets spun into yarns

Science DOI: 10.1126/science.1195912

Electrically conducting yarns have been spun from webs of carbon nanotubes (CNTs), incorporating various "guest" powders and nanofibers, using a technique called biscrolling. The technique involves overlaying "host" CNT sheets with "guest" powders using an electrostatic powder-coating gun and then twist-spinning the guest-host stack to form a biscrolled yarn. The carbon nanotubes are drawn from a forest of similar length tubes deposited on a substrate while applying a twist at the same time. The twisting can be adjusted to produce different-shaped structures such as Archimedean, dual-Archimedean, or Fermat scrolls. The yarns are very strong and can be woven, sewn, knitted, and braided into a variety of structures. In one example, as reported in Physicsworld.com, superconducting yarn was made by biscrolling a mixture of magnesium and boron powders (up to 99 wt%) as the guest on CNT sheets, and then thermally annealing the biscrolled yarn. In another example, biscrolled yarns containing up to 98 wt% graphene oxide nanoribbons were converted to graphene nanoribbon yarn by reducing the graphene oxide. These yarns could be used to make weavable anodes for flexible lithium-ion batteries.



Endotaxial SrTe nanocrystals in PbTe yield high thermolectric efficiency

Nature Chemistry DOI: 10.1038/nchem.955

Lead telluride (PbTe) is a well known thermoelectric material. Researchers have now endotaxially incorporated SrTe nanocrystals in a PbTe matrix doped with Na_2Te and achieved a high thermoelectric figure of merit. Past attempts at nanoscale inclusion in bulk material improved the energy conversion efficiency of lead telluride but also increased the scattering of electrons, which reduced overall conductivity. The new study offers the first example of using crystallographically aligned nanostructures in PbTe to reduce electron scattering and increase the energy conversion efficiency of the material by inhibiting the heat flow in the system without affecting hole mobility. The system achieved a thermoelectric figure of merit of 1.7 at ~800 K, and is expected to enable 14% of heat waste conversion to electricity.

U.S. Department of Energy releases report on critical materials for energy

http://www.energy.gov/news/documents/criticalmaterialsstrategy.pdf

A report from the U.S. Department of Energy (DOE) examines the role of critical materials for energy-related uses, including rare-earth metals. According to the report, several clean energy technologies use materials that are at risk of supply disruptions in the short term, even as the share of the global consumption of critical materials grows over the longer term. Five rare-earth metals, dysprosium, neodymium, terbium, europium, and yttrium, as well as indium, were determined to be the most critical in the short term. The report suggests that sound policies and strategic investments are needed to reduce the risk of supply disruptions. It describes DOE plans to develop an integrated research agenda addressing critical materials, strengthen its capacity for information gathering, and work closely with international partners to reduce vulnerability to supply disruptions and address critical material needs.

CSTEP releases report on techno-economics of solar energy in India

http://www.cstep.in/node/217

In December 2009, the Indian Government announced the Jawaharlal Nehru National Solar Mission (JNNSM) to establish India as a global leader in solar energy by creating favorable policy conditions. It envisages the installation of more than 20,000 MW of grid-connected solar power and another 2,000 MW of off-grid solar power by 2022. The Center for Study of Science, Technology and Policy (CSTEP) in Bangalore, India, has now released a report analyzing the techno-economics of several decentralized solar applications. The report discusses policy implications and makes the case for decentralized options getting more impetus to help meet the urgent need for clean energy options. The report focuses on solar photovoltaic technologies that convert solar energy directly into electrical energy and solar thermal technologies that convert solar energy into heat energy for non-electrical use. □