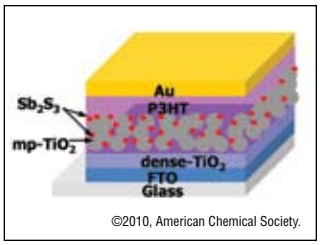
ENERGY FOCUS

Compiled by Gopal R. Rao

Hybrid solar cells show stability and efficiency

Nano Letters DOI: 10.1021/nl101322h



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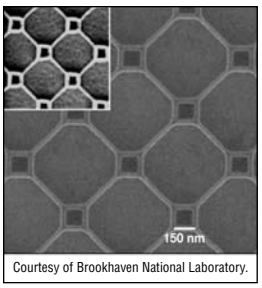
Each of the different types of solar cells currently under development, such as dye-sensitized, inorganic semiconductor, and organic solar cells, have various advantages but also specific disadvantages. One approach to a good balance for practical applications is to combine different solar cell types to form hybrid solar cells. Michael Grätzel of the Swiss Federal Institute of Technology and colleagues report high-efficiency solid-state inorganic–organic solar cells. These heterojunction cells use Sb_2S_3 as the absorbing semiconductor and poly(3-hexylthiophene) (P3HT) as the hole conducting dye and light absorber on a mesoporous TiO_2 layer. The cells exhibit over 5% conversion efficiency under full sun. The cells are extremely stable in air. The addition of an interface modifier between the Sb_2S_3 and P3HT was found to further improve the conversion efficiency, demonstrating that a better understanding of the junction structure and charge recombination will lead to further improvements in efficiency.

Superconducting thin films form nanopatterned loops

Nature Nanotechnology DOI: 10.1038/nnano.2010.111

Layered copper-oxide superconductors have been subjected to intense scrutiny because of the relatively high temperatures at which they become superconducting. Thin films of one such material ($La_{1.84}Sr_{0.16}Cu_{O4}$) have now been patterned using electron-beam lithography to form nanoscale loops, with the sides of the loops resembling nanowires. The arrays remained superconducting below ~30 K. Nanoscale superconducting wires will be very useful for future electronic devices, and these nanopatterned structures are a major step in that direction. The electrical resistance could be varied by placing the array in a magnetic field perpendicular to the loops. The loop resistance oscillated with a frequency corresponding to discrete units of the magnetic flux. The nanopatterned material shows a discrete, switchable form of magneto-resistance between a superconducting and a nonsuperconducting state.

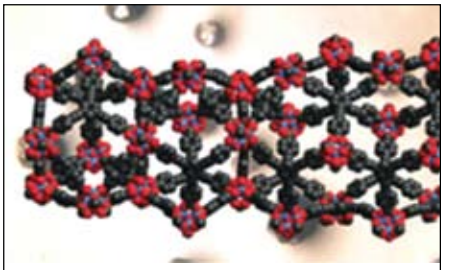


Courtesy of Brookhaven National Laboratory.

MOFs yield record uptake of CO_2 and N

Science DOI: 10.1126/science.1192160

Metal-organic framework (MOF) compounds contain large pores and high surface areas, allowing them to store large amounts of a gas or be used for purification applications. This is a consequence of their structure, which is composed of metal ions or clusters connected by organic linkers. Further increasing their porosity and gas uptake could boost their prospects for commercialization. Omar Yaghi of the University of California, Los Angeles, and colleagues revealed new MOFs that can be synthesized by lengthening the organic linkers in existing MOFs and by using various linker combinations. In two of the MOFs that they created, MOF-200 and MOF-210, the uptake of carbon dioxide and nitrogen was around 2,400 cm^3/g, which exceeds the previous record. The surface area of MOF-210 is 6240 m^2/g, another record. A single gram of MOF-210 has ~90% the surface area of a soccer field, according to a *Chemical & Engineering News* report (http://pubs.acs.org/cen/news/88/i27/8827notw1.html). The ultrahigh surface areas of MOF-200 and 210 are close to the ultimate limit for solid materials, according to the researchers.


Courtesy of Hiroyasu Furukawa, UCLA. ©2010, AAAS.

Carbon nanotube electrodes form high-power lithium-batteries

Nature Nanotechnology DOI: 10.1038/nnano.2010.116

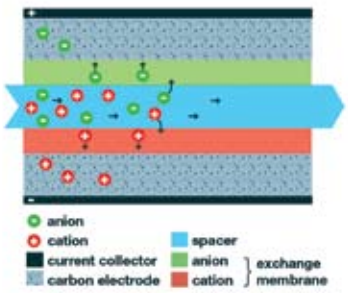
Energy storage devices need to have high-energy storage capacities as well as high-power delivery capability. Lithium-ion batteries are being increasingly used, but their power output levels remain low. Electrodes made from carbon nanotubes have now been demonstrated and tested for use in Li-ion batteries. A layer-by-layer assembly technique was used to pack functionalized multiwalled carbon nanotubes, forming an electrode with several micrometers thickness. Carbon nanotubes are excellent conductors and allow for fast transport of Li ions. The surface functionalization is critical since it allows for reactions to take place at the nanotube surface, yielding energy. The electrode was tested in a battery as the anode with a lithium titanium oxide as the cathode. The battery could store five times the power of a conventional electrochemical capacitor and deliver 10 times the power of a typical Li-ion battery.

https://doi.org/10.1557/mrs2010.676 Published online by Cambridge University Press

Mixing fresh and salt water generates electricity

Environmental Science & Technology DOI: 10.1021/es100852a

Mixing two solutions with different salinities, such as fresh water and salt water, increases entropy, as per thermodynamics. This increase in entropy can be used to generate energy. This is well-known and has been used in devices to harvest this energy. Such systems are typically complex, with low efficiencies. A research team from the Netherlands has unveiled a small-scale device that generates electricity by the sequential flow of fresh and salt water through a flow cell, without the need for additional processes or converters. The flow cells consist of porous activated carbon electrodes and ion-exchange membranes. Fresh and salt water are sequentially flowed through the cell, yielding movement of sodium and chloride ions in the ion exchange membrane and generating a current.



United States awards $2 billion for solar push

U.S. Department of Energy www.energy.gov

The U.S. Department of Energy has awarded ~$2 billion in economic stimulus funds to two solar companies. Abengoa Solar, Inc. will receive $1.45 billion for constructing the largest concentrating solar power plant in the world. The facility will add 250 MW of capacity to the electrical grid of its plant in Arizona using parabolic trough solar collectors and a thermal energy storage system. Abound Solar Manufacturing of Loveland, Colorado, will receive $400 million to develop cadmium telluride (CdTe) thin-film solar panels. Abound expects to produce millions of photovoltaic modules a year using a process in which thin films of CdTe are deposited onto glass panels using a proprietary technique developed jointly by Colorado State University, the National Renewable Energy Laboratory, and the National Science Foundation.

Solar-powered plane remains aloft for 26 hours

Solar Impulse www.solarimpulse.com

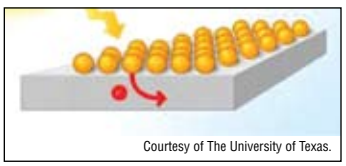
A solar-powered experimental airplane completed its first test flight in July 2010 of more than 24 hours powered solely by solar energy. The plane named Solar Impulse took off from Payerne near Bern, Switzerland, and landed after 26 hours and 9 minutes with 12,000 solar panels charging its batteries. Piloted by André Borschberg, a former Swiss Air Force fighter pilot, this was also the first night flight by a solar-powered airplane. The propeller-driven plane is made of a carbon fiber composite, is powered by four small electric motors, and weighs around 3,500 pounds. It achieved a maximum speed of 68 knots or 78 miles per hour. The plane is designed to stay aloft indefinitely, recharging batteries during the day and using the stored power overnight.

Courtesy of of Solar Impulse.

Solar cells capture "hot-electrons" energy

Science DOI: 10.1126/science.1185509

Higher energy sunlight is typically lost as heat through "hot electrons" in conventional semiconductor solar cells. Capturing these hot electrons and using them quickly before they cool and lose their energy will increase the solar-to-electric power conversion efficiency. Using nanocrystals of these semiconductors has been shown to slow cooling of hot electrons, but it is still crucial to extract the electrons. A study has now demonstrated the critical step of transfer of hot electrons from photoexcited lead selenide nanocrystals to an electron conductor made of titanium dioxide. Incorporating these in a solar cell and controlling the transfer to occur in a narrow energy window to further minimize losses is expected to yield high-efficiency solar cells. □



Courtesy of The University of Texas.

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