ENERGY FOCUS

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Correction of cyanobacteria misinformation could improve biofuels production

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The discovery of two enzymes in cyanobacteria that do the work of one missing enzyme has opened new possibilities for genetically engineering bacteria to produce biofuels more efficiently than currently available methods. As reported by Donald Bryant and Shuyi Zhang of The Pennsylvania State University in a recent issue of *Science*, research done in 1966 concluded that a missing enzyme in cyanobacteria prevented the completion of the tricarboxylic acid (TCA, or Krebs) cycle, which helps to break down biomass through oxidation. This ostensibly rendered the organisms incapable of oxidizing metabolites for energy production. By taking a look 44 years later using modern instrumentation and enhanced biochemical and genetics tools, Bryant and his team discovered two enzymes that perform the same task of the missing enzyme, completing the TCA cycle by a slightly different path. Equipped with this new understanding of how cyanobacteria make energy, the next step for the researchers is to determine how to genetically engineer a cyanobacterial strain to synthesize 1,3-butanediol—an organic precursor for making biofuels.

Quantum dot paint acts as a solar cell

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Researchers at the University of Notre Dame in Indiana, led by Prashant V. Kamat, have developed what they call "Sun-Believable" solar paint, using TiO_2 nanoparticles coated with CdS and CdSe quantum dots as the solar energy absorbing constituents. Using a pseudo-SILAR (sequential ionic layer absorption and reaction) approach, they deposited Cd_2+ along with S_2– or Se_2– onto suspended TiO_2 nanoparticles. Mixing these particles with a tert-butyl alcohol/water solution produced a yellow paint that could be applied in a one-step, brush-on process to conducting glass electrodes to form photoanodes. Subsequent photoelectrochemical characterization revealed a rapid photoresponse in each paint type, with photocurrent generation efficiencies of 30–40%. A paint mixture containing both CdS/TiO_2 and CdSe/TiO_2 yielded the best power conversion efficiency of 1%. Although admitting this figure is very low, Kamat said the low cost and the ease of making the solar paint in large quantities could make it a viable solar energy technology if the efficiency can be increased by a moderate amount in the future.

This paste of cadmium sulfide-coated titanium dioxide nanoparticles could turn large surfaces into solar cells. *Credit: ACS Nano.*

Alane stores hydrogen at high capacity

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A system incorporating a fuel cell and light-weight hydrogen storage material. *Credit:* Savannah River National Laboratory.

With the goal of producing a portable power system small and lightweight enough for soldiers to carry in their backpacks or to power a lightweight drone aircraft, scientists Ted Motyka, Ragaiy Zidan, and Kit Heung at the U.S. Department of Energy's Savannah River National Laboratory are studying alane (aluminum hydride, AlH_3) as a hydrogen storage material for portable fuel cells. Alane can store twice as much hydrogen, in the same volume, as liquid hydrogen, with a high gravimetric capacity of 10 wt%, making it a great candidate for portable systems. To date, researchers have developed a method of producing alane that minimizes the use of solvents and yields pure, halide-free alane at a lower cost than traditional synthesis methods. They also have invented a two-step process that releases twice as much hydrogen from alane as the previous one-step process. In a promising demonstration, a system containing 240 grams of alane was able to operate a 150-watt commercial fuel cell at near full power for over three hours.

Methane eliminates CO_2 in coal gasification

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Using methane as a component of a coal-to-liquids process could lead to lower energy consumption and eliminate the need to add water, since methane can replace water as the source of hydrogen necessary to produce syngas (H_2 plus CO), a precursor to liquid fuels. As reported by Ripudaman Malhotra, associate director of the Chemical Science and Technology Laboratory at SRI International in Menlo Park, Calif., at the 28th annual International Pittsburgh Coal Conference, the process is environmentally friendly because it does not produce the greenhouse gas CO_2 as in other syngas-based processes, such as Fischer–Tropsch synthesis. The process, called "coal gasification with methane reforming," eliminates the need to combust a portion of the coal feed to produce energy to power the conversion. Instead, electricity from renewable sources could be supplied to gasify the coal, thus eliminating the combustion step that forms CO_2. Though these results are based on bench-scale experiments and are therefore preliminary, the researchers calculate that the capital cost of a full-scale plant based on this technology could be about half that of a Fischer–Tropsch plant.

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