Energy

FONDAZIONE SILVIO TRONCHETTI PROVERA

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Electricity from Sugar Water

Researchers announce a faster way to make hydrogen from cheap biomass.

Researchers at the University of Minnesota have developed a catalytic method for producing hydrogen from fuels such soy oil and even a mixture of glucose and water. The hydrogen could be used in solid-oxide fuel cells, which now run on hydrogen obtained from fossil-fuel sources such as natural gas, to generate electricity. Further, by adjusting the amount of oxygen injected along with the soy oil or sugar water, the method can be adapted to make synthesis gas, a combination of carbon monoxide and hydrogen that can be burned as fuel or converted into synthetic gasoline. The method can also produce chemical feedstocks, such as olefins, which can be made into plastics.

Although the results are preliminary, the new catalysis process represents a fundamentally new way to directly use soy oil and other cheap biomass as fuels; such biomass now needs to be converted into biodiesel or ethanol in order to be used as fuels. Generally, people have steered clear of nonvolatile liquids--materials that you cannot vaporize, since these typically produce a carbon residue that stops the process of producing hydrogen. By eliminating the need to process soy oil and sugar water to make volatile fuels such as ethanol, the new method opens up the number of available biomaterial feedstocks.

The process begins when the researchers spray fine droplets of soy oil or sugar water onto a super-hot catalyst made of small amounts of cerium and rhodium. The rapid heating combined with catalyst-assisted reactions prevents the formation of carbon sludge that would otherwise deactivate the catalyst. And the reactions produce heat, keeping the catalyst hot enough to continue the reaction. As a result, although fossil fuels are used initially to bring the catalysts up to the 800 °C working temperature, no fossil fuels are needed to continue the process. "One of the virtues of our process is it requires no external process heat--it drives itself," says lead author Lanny Schmidt.

The key to the speed of the reactions is the small droplets. Existing processes for converting volatile fuels, such as ethanol or biodiesel, into hydrogen are slower because the fuels are inside pipes, and it takes up to a second for heat to transfer to them. In Schmidt's process, the droplets heat up instantaneously--in just a few milliseconds--and the system can be faster, cheaper, and smaller, he says. The speed makes it possible to produce more fuel from a smaller reactor, reducing capital costs and potentially making it practical for a farmer to use a small system on the farm.

Schmidt says the process could probably be adapted to work with other biomass, such as slurries or powders made from grass or wood, which are now difficult to convert into practical fuels for electricity generation or transportation because of their high cellulose content. The ability to create hydrogen and syngas directly from cellulosic sources would dramatically increase the amount of fuel that could be made from waste biomass because it would be possible, for example, to use the whole cornstalk, rather than just glucose derived from corn kernels, for fuel.

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Life Sciences

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Antiprotons Four Times More Effective than Protons for Cell Irradiation

A pioneering experiment at CERN with potential future application in cancer therapy has produced its first results. Started in 2003, ACE (Antiproton Cell Experiment) is the first investigation of the biological effects of antiprotons. “We have taken the first step towards a novel treatment for cancer. The results show that antiprotons are four times more effective than protons at terminating live cells. Although it still has to be compared with other existing methods, it is a breakthrough in this area of investigation.” says Michael Doser at CERN, one of the scientists collaborating on the experiment.

Current particle beam therapy commonly uses protons to destroy tumour cells inside a patient. The ACE experiment directly compared the effectiveness of cell irradiation using protons and antiprotons. To simulate a cross-section of tissue inside a body, tubes were filled with hamster cells suspended in gelatine. Researchers sent a beam of protons or antiprotons with a range of 2 cm depth into one end of the tube, and evaluated the fraction of surviving cells after irradiation along the path of the beam.

The results showed that antiprotons were four times more effective than protons. When comparing a beam of antiprotons with a beam of protons that cause identical damage at the entrance to the target, the experiment found the damage to cells inflicted at the end of the beam path to be four times higher for antiprotons than for protons. Michael Holzscheiter, spokesperson of the ACE experiment, summarises: “To achieve the same level of damage to cells at the target area one needs four times fewer antiprotons than protons. This significantly reduces the damage to the cells along the entrance channel of the beam for antiprotons compared to protons. Due to the antiproton's unsurpassed ability to preserve healthy tissue while causing damage to a specific area, this type of beam could be highly valuable in treating cases of recurring cancer, where this property is vital.”

Antiprotons are antimatter; they have to be produced in small amounts in a laboratory with the help of a particle accelerator. When matter and antimatter particles meet, they annihilate, or destroy each other, transforming their mass into energy. The experiment makes use of this property as the antiproton would annihilate with a part of the nucleus of an atom in a tumour cell. The fragments produced from the energy released by the annihilation would be projected into adjacent tumour cells, which are in turn destroyed.

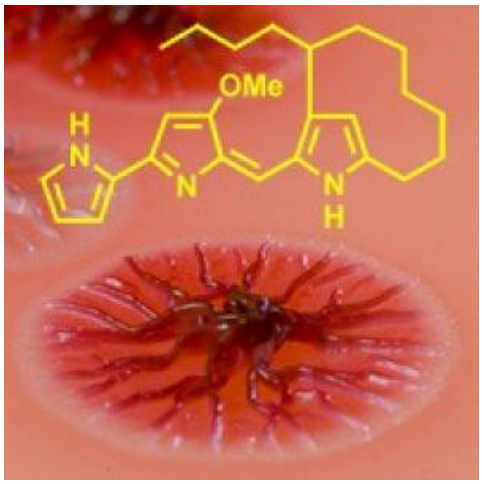
“CERN is a unique facility for this work. It is the only place in the world where an antiproton beam of sufficiently low energy and high quality is available. This is crucial for our research. Without access to the antiproton decelerator facility, these experiments would simply not have been possible.” says Niels Bassler, co-spokesperson of ACE. “This experiment is a fantastic example of how research in particle physics can generate innovative solutions with potential medical benefits.”

Researchers are currently conducting more tests to irradiate cells at a greater depth (about 15cm below the surface). Experiments to compare the effectiveness of antiprotons with another form of treatment using carbon ions will begin next month at GSI (Gesellschaft für Schwerionenforschung) in Germany. Further tests are planned to fully assess the effectiveness and suitability of antiprotons for cancer therapy, and to assure that less damage is caused to healthy tissues compared to other methods.

If all goes well, the first clinical application would still be a decade or more into the future.

Bacteria Could Make New Library Of Cancer Drugs That Are Too Complex To Create Artificially

Researchers at the University of Warwick are examining a way of using bacteria to manufacture a new suite of potential anti-cancer drugs that are difficult to create synthetically on a lab bench.



A colony of S. coelicolor bacteria that could be used to make a prodiginine such as streptorubin (shown in yellow)

The bacterium Streptomyces coelicolor naturally produce antibiotics called prodiginines.
This group of antibiotics has stimulated much recent interest as they can be used to target and kill cancer cells. A synthetic prodiginine analogue called GX15-070 is currently in phase 1 and 2 cancer treatment trials. However, analogues of other prodiginines, such as streptorubin B, could be even more powerful anti cancer tools, but they cannot currently be easily synthetically produced on a lab bench.

Professor Greg Challis and colleagues have looked at the enzymes controlling the process that allows the bacterium Streptomyces coelicolor to create streptorubin B and have gained a clear understanding of which are the key enzymes that act at particular steps of that process. By manipulation of the enzyme content of the bacteria, they aim to produce a range of different compounds based closely on the form of streptorubin B normally formed by the bacteria. Some of these analogues of streptorubin B could provide the basis for developing useful new anti cancer drugs.

Professor Challis said: "This approach combines the strengths of conventional organic synthesis, with the synthetic power of biology, to assemble complex and synthetically difficult structures. It could be particularly valuable for generating analogues of streptorubin B with all the promise that holds for the development of new anti cancer drugs"

Plaster cure for cancer

Researchers at the University of St Andrews and Ninewells Hospital, Dundee have developed a new light-emitting “sticking plaster” for use in the treatment of skin cancer. The new device, which builds on photodynamic therapy, reduces pain. Its developers claim it also has potential to be used by patients in their own home.
The breakthrough, a portable lightweight light source powered by a pocket-sized battery, is the idea of Ifor Samuel and James Ferguson.The pair teamed up four years ago to combine their expertise in photo-physics and photodynamic therapy to create a new way of treating skin cancer. The result is a “light bandage” that contains its own light source and is so portable that patients can go about their daily business while under treatment.As Samuel said: ‘By adapting the latest technology to an existing treatment method, we have developed a compact light source for treating common skin cancers. It can be worn by the patient in a similar way to a sticking plaster, while the battery is carried like an iPod.’The light is generated by an organic light-emitting diode, (OLED) and is a spin-off of Professor Samuel’s work on advanced displays. ‘It’s very exciting to be have developed a new technology that helps treat skin cancer patients,’ he said.”This new device will have a major impact on the treatment of skin cancers. The light-emitting patch is a low- cost, portable and convenient method of treatment. Our initial pilot trials have already shown its effectiveness and we find patients requesting this treatment over conventional methods.’

The new approach is said to be much more convenient and comfortable than conventional methods as lower light levels are used (reducing pain), and the patient can move around during treatment. The introduction of this product will mean that more patients can be treated, and opens up the possibility of treatment at GPs surgeries or at home.In addition to the treatment of skin cancers, the researchers believe that the technology could also be used in the cosmetic industry, for anti-aging treatments or for conditions such as acne.
The patented technology has been licensed to Lumicure, which is currently in discussions with venture capitalists to raise equity funds to commercialise the product.

Nanotech Triple Threat to Cancer

New technology finds, flags, and kills tumor cells.

A new nanotechnology-based treatment developed by researchers at the University of Texas's Southwestern could double the effectiveness of cancer drugs without increasing side effects, while allowing doctors to see immediately whether the treatment is working.
Nanotechnology-based drug treatments are already starting to be approved for use, but so far they are neither very precise nor very potent. Current cancer-fighting nanotechnologies, which involve little more than nanoscopic containers packed with chemotherapy drugs, reach tumors by leaking through holes in tumor blood vessels and gradually releasing a drug. To kill appreciable amounts of the tumor this way, doctors must flood the body with these drug-bearing nanocarriers, says Jinming Gaolead author. These can get soaked up by the body's natural filters, such as the liver and spleen, in which they can cause side effects, he says.What's more, doctors can't get a good view of what's happening once nanocarriers are administered. They don't know whether the nanocarriers are reaching targets or delivering drugs until they remove tissue from the patient, the tumor starts to shrink, or the first side effects appear. It's like fighting cancer in a "black box," Gao says.

Now a growing cadre of researchers are developing next-generation nanotechnology that can both deliver drugs only to cancer cells and allow doctors to monitor the progress of the treatment. The University of Texas system delivers both an anti-cancer drug and a highly effective magnetic resonance imaging (MRI) contrast agent to allow doctors to see that the drug is being delivered to a tumor. The nanocarriers are made of polymers with an inner core that traps doxorubicin, a common chemotherapy drug, and iron-oxide particles that show up clearly with MRI. Polymer strands on the outside of the nanocarrier bear targeting molecules that are recognized only by tumor blood-vessel cells. The nanocarriers latch on to the vessel cells, and the cells engulf the carriers. The polymer releases the drug once inside the cell, where it is most effective.
Tests on cells grown in the lab showed promising results, says Gao. Nanocarriers equipped with the targeting molecule delivered twice the amount of drug and killed twice the number of cells (94%) as those without it, he reported online in the journal Nano Letters. Because of the nanoparticles, the tumor blood-vessel cells were visible at a resolution unattainable with current MRI contrasts. "We could detect as few as 50,000 cells," Gao says. Studies in mice are now in progress.

At this point, the nanocarriers only target tumors' blood vessels, so they can't image or attack tumors without vasculature. This includes most tumors smaller than about two mm^3. But Gao says tumors in the dangerous process of spreading, or metastasizing, are large, have well-established vessels, and can be directly attacked. And unlike other targeted cancer therapies, he adds, the nanocarriers are easy to modify. As researchers discover more targets unique to cancer cells, the nanocarriers can be equipped to find, image, and destroy other types of cells within tumors and also different types of cancer, he says. He is now working on a system that directly targets lung-cancer cells.

But toxicity remains a risk, even with the targeted nanocarriers. Gao's team should run tests to ensure that none of the drug leaks out as the nanocarriers travel through the bloodstream. Although the nanocarriers deliver drugs and imaging particles directly to tumors, when tumor cells die, they'll likely release free drug and imaging particles into the bloodstream, adds "These particles naturally accumulate in clearance organs like the liver and spleen" and "could lead to severe side effects,"

Comprehensive model is first to map protein folding at atomic level

Unlike previous methods, new technique can trace full folding of small proteins to native state
Scientists at Harvard University have developed a computer model that, for the first time, can fully map and predict how small proteins fold into three-dimensional, biologically active shapes. The work could help researchers better understand the abnormal protein aggregation underlying some devastating diseases, as well as how natural proteins evolved and how proteins recognize correct biochemical partners within living cells.

The technique, which can track protein folding for some 10 μs -- about as long as some proteins take to assume their biologically stable configuration, and at least a thousand times longer than previous methods -- is described in the Proceedings of the National Academy of Sciences.
"For years, a sizable army of scientists has been working toward better understanding how proteins fold," says co-author Eugene I. Shakhnovich "One of the great problems in science has been deciphering how amino acid sequence -- a protein's primary structure -- also determines its three-dimensional structure, and through that its biological function. Our paper provides a first solution to the folding problem, for small proteins, at an atomic level of detail."

Fiendishly intricate, protein folding is crucial to the chemistry of life. Each of the body's 20 amino acids, the building blocks of proteins, is attracted or repulsed by water; it's largely these affinities that drive the contorting of proteins into distinctive three-dimensional shapes within the watery confines of a cell. The split-second folding of gangly protein chains into tight three-dimensional shapes has broad implications for the growing number of disorders believed to result from misfolded proteins or parts of proteins, most notably neurodegenerative disorders such as Alzheimer's and Parkinson's diseases.

The model developed by Shakhnovich and colleagues faithfully describes and catalogs countless interactions between the individual atoms that comprise proteins. In so doing, it essentially predicts, given a string of amino acids, how the resulting protein will fold -- the first computer model to fully replicate folding of a protein as happens in nature. In more than 4,000 simulations conducted by the researchers, the computer model consistently predicted folded structures nearly identical to those that have been observed experimentally.

"This work should open new vistas in protein engineering, allowing rational control of not only protein folding, but also the design of pathways that lead to these folds," says Shakhnovich, who has studied protein folding for nearly two decades. "We are also using these techniques to better understand two fundamental biological questions: How have natural proteins evolved, and how do proteins interact in living cells to recognize correct partners versus promiscuous ones?"