Nanotechnology hold promise for new hydrogen fuel technologies

June 29 2005

Nanotechnology may hold the key to developing a viable hydrogen economy, according to Jin Zhang, professor of chemistry and biochemistry at the University of California, Santa Cruz. Zhang will receive $535,000 in grants from the U.S. Department of Energy (DOE) for his part in two research projects aimed at developing new technologies for the production and storage of hydrogen fuel using nanostructured materials.

Producing hydrogen from water using solar energy is the focus of one of the projects. Zhang is leading that effort and is also a coinvestigator on a second project to develop a method for highly efficient hydrogen storage. Both of the three-year projects rely on a novel approach to create nanostructured materials with special properties. Nanostructure refers to dimensions on the scale of billionths of a meter.

"The goal is to produce clean energy," Zhang said. "The idea of using solar energy and water as a source of hydrogen is very attractive, and we believe nanostructured materials can be used to do this efficiently."

The grants are among 70 hydrogen research projects funded through a $64 million DOE initiative aimed at making vehicles powered by hydrogen fuel cells available, practical, and affordable for American consumers by 2020. Zhang's collaborators on the hydrogen production project are Yiping Zhao of the University of Georgia at Athens and Wei Chen of Nomadics Inc. The hydrogen storage project is headed by Zhao and also involves Matthew McCluskey of Washington State University.

Hydrogen offers an attractive alternative to fossil fuels because it is highly efficient and clean. But major technological hurdles must be overcome to make the use of hydrogen fuel practical.

The first hurdle is how to produce the hydrogen. Water molecules can be split to form pure hydrogen and oxygen using electricity (a process called electrolysis). But the environmental advantages of hydrogen would be lost if the electricity used to generate it came from burning fossil fuels. Using solar energy to split water and generate hydrogen is not a new concept, but Zhang says his team's approach could lead to a device efficient enough for practical use.

"We want to build a device that you can put in the sun, fill it with water, and get hydrogen without using any outside source of energy," Zhang said.

The device will integrate two kinds of solar cells--a photovoltaic cell to produce electricity and a photoelectrochemical cell to produce hydrogen from the electrolysis of water. Both will use specially designed materials based on arrays of nanowires with uniform orientation. The main focus of the project will be on developing these nanostructured materials to optimize the efficiency of both the photovoltaic cell and the photoelectrochemical cell.

The researchers will use a technique called glancing angle deposition (GLAD) to fabricate the nanowire arrays. Zhao is an expert on the use of this technique for making nanowires and nanorods. Zhang's lab will focus on characterizing the structure and properties of the materials Zhao makes and evaluating their suitability for achieving the highest possible efficiencies for the photovoltaic cell and the photoelectrochemical cell.

The hydrogen storage project will also involve using the GLAD

technique to fabricate nanostructured materials. One of the problems with hydrogen as a fuel is that it is a bulky gas that is not easily transported and stored. A promising solution is to store it in a solid form as a metal hydride compound. Metal hydride nanostructures could greatly improve the efficiency of this type of storage, Zhang said.

"Nanostructures have a much larger surface area than bulk materials, so they could hold more hydrogen per unit weight," he said.

The researchers plan to find the optimum conditions for fabricating metal hydride nanostructures to achieve highly efficient hydrogen storage.

"The key to our success in each of these projects is the material. We need to understand the properties of these materials and then explore their applications in devices," Zhang said.

Source: UC Santa Cruz

Citation: Nanotechnology hold promise for new hydrogen fuel technologies (2005, June 29) retrieved 23 April 2024 from https://phys.org/news/2005-06-nanotechnology-hydrogen-fuel-technologies.html

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