Science and Technology of Materials, Interfaces, and Processing

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CLEAN ENERGY, SKIN CREAM, PLATINUM, POLLUTION, AND PLASMAS: Highlights of AVS 56th International Symposium & Exhibition, San Jose, CA, Nov. 8-13, 2009

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FOR IMMEDIATE RELEASE

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October 30, 2009 -- The AVS 56th International Symposium & Exhibition next month in San Jose, CA will showcase advances in alternative energy, materials research, nanotechnology, and medicine. Highlights of papers from among the 1,250 talks and posters at the meeting are described below.

The symposium takes place November 8-13, 2009 at the San Jose Convention Center. Reporters are invited to attend the conference free of charge. Registration information can be found at the end of this release.

HIGHLIGHTS COVERED BELOW:

1) Energy Frontiers Sessions
2) Cleaning Pollutants with Plasmas
3) ENERGY: Cleaner Coal
4) Semiconductor Transistors -- Moving Beyond Silicon
5) The Physics Of Skin Cream
6) ENERGY: Nano-Platinum for Micro fuel cells
7) Rectenna -- Converting Light into DC Power
8) MICROFLUIDICS: Drop on Demand
9) THE NANOWORLD: Movies Of A Nanotube Bending And Twisting

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1) ENERGY FRONTIERS SESSIONS

In April 2009 the U.S. Department of Energy created 46 Energy Frontiers Research Centers (EFRC's). The AVS meeting has scheduled several sessions to look at the work going on in these labs. Highlights include

- Gary Rubloff (University of Maryland) talking about work toward energy storage devices with 10 times higher power and energy density than with present systems. The talk "Science of Precision Multifunctional Nanostructures for Electrical Energy Storage" is at 10:40 a.m. on Wednesday, November 11, 2009. Abstract: http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=EN-WeM-9

- Victor Klimov (Los Alamos National Laboratory) will look at how objects at the nanoscopic level, such as quantum dots deployed in solar cells, might address energy problems at the macroscopic level, such as harvesting sunlight. The talk "'Nano' Solutions to 'Macro' Energy Problems" is at 2:00 p.m. on Wednesday, November 11, 2009. Abstract: http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=EN-WeA-1

Mark Baldo (MIT) and Xiaoyang Zhu (Univ Texas) will report on the latest research on excitonics, devices which exploit the movement through a semiconducting material of electrons paired up with vacancies in the crystal. The talk "Excitonics" is at 4:00 p.m. on Wednesday, November 11, 2009. Abstract: http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=EN-WeA-9

2) CLEANING POLLUTANTS WITH PLASMAS

The pollution of land with organic compounds like jet fuel and industrial solvents is a major problem in the United States and Europe because many petroleum-based pollutants are not soluble in water, and they will not wash away over time. In order to remove the chemicals, contaminated soil can be burned in a furnace, but this may produce dioxins -- which are also dangerously toxic.

A few years ago, François Reniers and his colleagues at Université Libre de Bruxelles, Beligium were approached by a chemical company to help find an alternative process for degrading these compounds, which they did by applying low-temperature plasmas to them.

The plasmas are created by igniting an electrical discharge in a container filled with atmospheric pressure helium or argon gas, oxygen and water vapor. The electrical discharge ionizes the gas, freeing electrons that then react with molecular oxygen and with the water vapor to create oxygen and hydroxyl radicals that then degrade the pollutants. Recently Reniers and his colleagues showed that they are able to degrade both solid and liquid organic pollutants with these plasmas. They followed the degradation of the compounds by monitoring the production of carbon dioxide, which is produced as the compounds break down. The advantage of this approach, says Reniers, is that it does not produce dioxins.

The talk "Atmospheric Plasma for the Degradation of Pollutants : The Promoting Effect of Water" is at 8:40 a.m. on Friday, November 13, 2009.
Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=PS-FrM-2

3) CLEANER COAL

About half of the electricity in the United States comes from burning coal. Even with the imposition of a carbon caps, coal will probably be important as a fuel for decades to come. A considerable effort is under way to mitigate the heavy burden of carbon dioxide released during coal combustion. In one approach, solid coal is turned into a synthetic gas, referred to

as syn gas, from which carbon dioxide can be removed (and either used industrially or stored) before the main power-generating combustion takes place.

Chintalapalle Ramana, an engineer at the University of Texas at El Paso, will report on monitoring the gasification process at grueling temperatures of 500 C. Specifically, the device built by Ramana and colleagues keeps track of the hydrogen-sulphur gas produced as a by-product of the syn-gas. Sulphur is a pollutant if released to the air, where it can lead to the formation of acid rain, and a corrosive substance inside the gasifier. The Texas sensors employ a tungsten-oxide film, whose nanocrystalline facets are able to thrive in the high heat and to carefully track the presence of sulphur.

The talk "Tungsten Oxide Thin Films for Application in Advanced Energy Systems" is at 2:40 p.m. on Wednesday, November 11, 2009. Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=TF-WeA-3

4) SEMICONDUCTOR TRANSISTORS -- MOVING BEYOND SILICON Since its invention 60 years ago at Bell Labs, the transistor has driven an exponential increase in computing power. Keeping up with Moore's law -- which says the number of transistors on integrated circuits should reliably double every two years -- has led to the development of progressively smaller and faster versions of these tiny electronic switches.

But modern computers, which cram nearly a billion silicon dioxide transistors onto their chips, will soon need a new kind of transistor to keep the trend going. "Silicon has reached a fundamental limit," says Christopher Hinkle, a material scientist at the University of Texas, Dallas. "To increase the transistor performance, we have to move to higher-mobility materials."

Hinkle is building transistors out of a material that engineers have been testing for thirty years: gallium arsenide. He and his colleagues believe that semiconductors containing gallium arsenide may offer the next step in computing speed. At the AVS meeting, they will present data showing how to overcome one of the limitations of the material to take a step towards fast semiconductor transistors that function reliably.

"The transistors that we've produced are faster than silicon transistors right now," says Hinkle. Transistors made of an indium, gallium, and arsenic semiconductor offer a potential ten-fold boost in switching speed. But these transistors are not reliable right now because transistors fabricated out of semiconductors have tricky surface chemistry -- dangling chemical bonds at the surface create traps that affect how charge moves.

Hinkle's group thinks they have solved the problem --- a layer of gallium oxide (Ga2O3) that forms at the surface when gallium reacts with oxygen and creates lots of these traps. They will discuss the improvements that they have achieved by coating semiconductors either with silicon or with another gallium compound that has better electrical properties.

The talk "III-V MOS Device Performance Enhancement by Detection and Control of Individual Surface Oxidation States" is at 4:00 p.m. on Wednesday, November 11, 2009. Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=SS1+EM-MoA-1

5) THE PHYSICS OF SKIN CREAM
The smoothness of a skin cream is a hard property to quantify. Unlike a lotion's scent, which is strictly defined by adding tiny amounts of perfumes and essential oils, the feel of a skin cream depends both on the cream itself and how it is rubbed.

Skin creams are basically oil and water emulsions, and as they are applied, they partially absorb and dissolve. As they do, their viscosity changes, and this affects the feel of the cream. But these subtleties are difficult to measure, says Bharat Bhushan of The Ohio State University. Typically, cosmetic companies will convene focus groups to try out different products and rely on surveys to get data on the feel of a skin cream.

Seeking a more quantitative measure, Bhushan has been developing a way to characterize the frictional properties of various skin creams and beauty products using atomic force microscopy to measure the friction a cream exerts at a microscopic point. Friction is the key to the feel of a skin cream, he says, because it is an indirect measure of how the brain perceives the smoothness. The more the friction, the more the rubbing tingles tiny sensory receptors in the skin, which then send messages along nerve fibers to the brain -- as if to say, not so smooth.

The talk "Nanotribological Characterization of Various Skin Cream Ingredients using Atomic Force Microscopy" is at 5:20 p.m. on Tuesday, November 10, 2009. Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=TR+SS-TuA-11

6) NANO-PLATINUM FOR MICRO FUEL CELLS
When people dream of a “hydrogen economy,” they dream of a state that relies heavily on hydrogen fuel -- which, in simple terms, burns hydrogen and oxygen and produces electricity and water. Such an economy is still a long way from being realized, but the use of hydrogen in fuel cells for a variety of purposes in industry is considerable today.
Better designs and reduced fabrication costs are crucial here, as they are for any other high-tech product.

A hydrogen-based fuel cell, basically an engine for mixing hydrogen with oxygen in the presence of a catalyst, usually employs two electrodes separated by a membrane. At one electrode (the anode), hydrogen molecules are split into positively charged protons and negatively charged electrons. The electrons proceed out into an external circuit as electricity while the protons migrate into one-way membranes that only allow protons through. At the other electrode (the cathode) oxygen is mixed with the returning electrons and the protons to form water.

One of the major expenses in making fuel cells is the platinum catalyst. Antonella Milella and her colleagues at the University of Bari in Italy have been working to reduce the amount of platinum needed by resorting to ever-smaller platinum particles, ensconced in a polymer matrix. Presently their platinum nanoparticles are as small as 3 nanometers in size and reside in a catalytic electrode only 500 nanometers wide. This reduction in the size of the components, Milella says, allows for decreasing the overall amount of platinum used while keeping output power high enough, and helps to promote the further miniaturization of fuel cells. This might lead to micro-fuel-cells powering microelectronic components.

The talk "Plasma Deposition of Platinum-Based Nanocomposite Films as Fuel Cell Electrocatalysts" is at 9:40 a.m. on Wednesday, November 11, 2009. Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=PS2+TF-WeM-6

7) RECTENNA: CONVERTING LIGHT INTO DC POWER A rectenna is a prospective device that converts visible light directly into direct-current (DC) electricity, in analogy to an antenna, which, on the rooftop, converts radio waves into an electrical signal. But rooftop antennas are meant to receive and amplify weak signals for the purpose of getting information. A rectenna, by contrast, is meant to harvest waves in order to capture energy from visible sunlight.

Solar cells do this too. The difference between the two is related to the two manifestations of light -- as waves and particles. Solar cells interact with light in the form of particles, photons. An incoming photon creates electron-hole pairs in a semiconducting material, where the electron and hole are separately collected to generate electricity.
By contrast, a rectenna interacts with light in its wave form: the light wave influences the electrons in the antenna where the light wave's electric field drives electrons back and forth. If this back-and-forth driving could be converted, with diodes, into a one-way electric current, then sunlight could be directly converted into electricity. The trouble here is that diodes, simple components that allow current to flow in one direction only (that is, they rectify the current), don't operate at the high frequencies of visible light, around 10^15 hertz.

Rectennas operate in the microwave part of the electromagnetic spectrum, says Philip Parilla of the National Renewable Energy Lab in Colorado, but not yet at visible-light frequencies. His lab is currently investigating how this can be done. His colleague Prakash Periasamy of Colorado School of Mines will report on a broad study of materials that can serve as fast rectifiers, a necessary step for future high-frequency rectennas.

The talk "Fabrication and Characterization of Point Contact Metal-Insulator-Metal Diodes for Potential Applications in Energy Harvesting" is at 2:20 p.m. on Wednesday, November 11, 2009. Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=TF-WeA-2

8) DROP ON DEMAND
Inkjet printers are a big part of modern business life. These devices are best known for serving up masses of printed documents by hurling blobs of ink at a page with great accuracy and great speed. They do this either in a continuous train of drops (deflected electrostatically) or on a one-by-one basis as needed. This same technology can also be used to perform scientific experiments in which tiny volumes of reagents can be brought quickly into chemical or biological interaction. Thomas Tisone (BioDot, Inc.) will report on an integrated system that can maneuver a substrate and deliver a drop-on-demand in a variety of formats, with volumes over the range 10-5,000 nanoliters, with impact spot sizes of 300-5,000 microns, and with rates from one up to 300 per second. The drop is ejected quickly by a hydraulic pressure wave applied by a syringe.

The talk "Drop on Demand Ink Jet Methods for Development and Manufacturing of Array Based Sensors and Diagnostics" is at 9:20 a.m. on Wednesday, November 11, 2009.
Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=BI+AS+BM+MS-WeM-5

9) MOVIES OF A NANOTUBE BENDING AND TWISTING Nanotubes are tiny molecular cylinders with a variety of properties and potential applications in future medical, electronic, and other devices.
As with any material, engineers would like to be able to characterize the strength and physical properties of these materials by stretching them, twisting them, heating them, or loading weight on top of them until they crumble or bend.

These measurements are easy to make on new composite materials that contain nanotubes, but scientists have found it difficult to characteristics the strength and physical properties of a single nanotube.

Ifat Kaplan-Ashiri and her colleagues at Weizmann Institute of Science in Israel have now made the first such measurements on nanotubes made of tungsten disulfide. By attaching two ends of a nanotube on opposite tips of a device called an atomic force microscope, they can tease the ends in one or more directions and measure the force needed to push, pull, or twist the tubes. They have movies showing the bending and stretching of nanotubes under an applied force, and they can correlate these measurements with the number of defects in the nanotube (atoms that are not tungsten or sulfur).

One thing that this direct testing has revealed is that a tungsten disulfide nanotube can be stretched to a unexpected degree. Their measurements show that pulling both ends of a tungsten disulfide nanotube will stretch it out to a length about 14 percent longer than its original before it breaks -- surprising for a material that is considered completely brittle, says Kaplan-Ashiri. In addition, the results of the experiments agree very well with theoretical calculations, which demonstrates the crystalline perfection of the nanotubes.

The talk "Excitonics" is at 5:00 p.m. on Tuesday, November 10, 2009.
Abstract:
http://www.avssymposium.org/Open/SearchPapers.aspx?PaperNumber=TR+SS-TuA-10

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INFORMATION FOR JOURNALISTS
The AVS 56th International Symposium & Exhibition lasts from November 8-13, 2009 in San Jose, CA. All meeting information, including directions to the San Jose Convention Center is at: http://www2.avs.org/symposium/

Staff reporters and freelance journalists working on assignment for major media outlets are invited to attend the conference free of charge.

Journalist registration instructions can be found at: http://www.avs.org/pdf/pressinvite.pdf

USEFUL LINKS
Online press room: http://www.avs.org/inside.press.aspx
Searchable abstracts:
http://www.avssymposium.org/Open/SearchPapers.aspx
Full meeting program: http://www.avssymposium.org/Overview.aspx
Main meeting page: http://www2.avs.org/symposium/AVS56/pages/info.html

ONSITE MEETING PRESS ROOM
The AVS press room will be located in Concourse 1 of the San Jose Convention Center. Press room hours are Monday-Thursday, 8:00-5:00 pm.
The phone number there is 408-271-6100. Press Kits containing company product announcements and other news will be available on CD-ROM in the press room.

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As a professional membership organization, AVS fosters networking within the materials, processing, and interfaces community at various local, national or international meetings and exhibits throughout the year. AVS publishes four journals, honors and recognizes members through its prestigious awards program, offers training and other technical resources, as well as career services.