



June 2011  
Volume 11 • Issue 11



## In this Issue!

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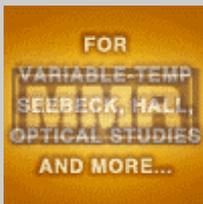
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## IN FOCUS



### [2011 MRS Fall Meeting & Exhibit](#)

November 28 - December 2, 2011  
Hynes Convention Center, Boston, MA

The 2011 MRS Fall Meeting will host 46 technical symposia, an international exhibit and more. The [Calls for Papers](#) are now available, and the abstract submission site is Open, with abstracts being accepted until **June 21, 2011**.



### [MRS Communications](#)

#### [Call for Papers](#)

[MRS Communications](#), a new journal focused on rapid communications and high-quality, high-impact review articles across the broad materials spectrum, is published by MRS in partnership with Cambridge University Press. MRS Communications is a full-color, online-only publication with accepted papers appearing immediately on Cambridge Journals Online (CJO).

## NEWS FROM THE WORLD OF MATERIALS

Keep up with materials research news through MRS!

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### [Materials in Focus](#)

#### [Ductile or brittle at the flip of a switch](#)

(Technical University of Hamburg and Shenyang National Laboratory for Materials Science, China)  
Photo credit: Technical University of Hamburg. Click image to enlarge.



Hamburg and Hai-Jun Jin at the Shenyang National Laboratory for Materials Science in China have

Generally, a material's basic properties are determined by its composition and microstructure during the manufacturing process. Changes in these properties may occur during extended use, but this is generally a slow process governed by creep, fatigue, or some other factor. Now, however, researchers Jörg Weissmüller at the Technical University of

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developed a hybrid nanostructure material that can change properties at the flip of a switch. As reported recently in *Science*, they have developed a material consisting of a nanoporous gold backbone filled with a liquid electrolyte that is capable of fast, reversible tuning of its yield strength, flow stress, and ductility through the application of an electric field. “The concept allows the user to select, for instance,” the authors wrote, “a soft and ductile state for processing and a high-strength state for service as a structural material.”

Starting with a gold/silver alloy, they removed the silver by corrosion, leaving a monolithic skeleton characterized by contiguous gold ligaments and an equally contiguous pore structure. The pores were then filled with a 1M HClO<sub>4</sub> electrolyte. Compression of this hybrid nanostructure material under different electric potential conditions revealed the change in properties. Using a sample with gold ligaments having a diameter of 20 nm, compression under a constant applied voltage of 1.03 V showed ductility up to high strain conditions. The same process performed with an applied voltage of 1.48 V showed a 36% increase in yield strength and a loss of ductility. Also, the flow stress doubled when switching from 1.03 V to 1.48 V. These changes were completely reversible when the applied voltages were reversed.

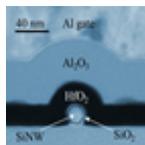
The researchers noted that at 1.48 V the gold ligaments are covered with adsorbed oxygen, while at 1.03 V they are “clean.” This led them to investigate the role of surface stress and surface tension on these property variations; they concluded that neither surface stress nor surface tension was responsible. The most likely explanation according to the researchers is that the adsorbed oxygen exerts a drag on dislocations that intersect the surface, resulting in “adsorption locking,” which increases the yield strength and the flow stress at the higher voltage. “For the first time we have succeeded in producing a material which, while in service, can switch back and forth between a state of strong and brittle behavior and one of soft and malleable,” Weismuller said in a press release issued by the Technical University of Hamburg. “We are still at the fundamental research stage but our discovery may bring significant progress in the development of so-called smart materials.” [[Science](#)]

### Nano Focus

#### [Si nanowire-based non-volatile memory devices reduce power consumption](#)

(NIST and George Mason University)

Photo credit: Bonevich/NIST. Click image to enlarge.



Using small, 20-nm diameter Si nanowires wrapped in HfO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub>, researchers Curt Richter at NIST and Qiliang Li at George Mason University may have found a path to creating low-power, fast-writing, non-volatile memories that could eventually replace DRAM and SRAM. The DRAM devices require frequent refreshing to retain stored data, which consumes a large part of the power. The SRAM devices used for cache memory in computers’ central processing units (CPUs) are volatile and need to be powered to retain data. The standby power for data remanence is a significant part of the total power dissipation. The lower power consumption of non-volatile memory could mean longer intervals between recharging batteries in computers and other electronic devices. This is very attractive for portable and stand-alone electronics.

As reported recently in *Nanotechnology*, Richter, Li, and their colleagues took advantage of electrical properties of the materials and the geometry of a small diameter nanowire to improve the electrostatics of gate control. The dielectric properties of HfO<sub>2</sub> make it a good charge-trapping layer, and an Al<sub>2</sub>O<sub>3</sub> layer acts as a blocking oxide. Richter says they can tune the stack through band engineering to produce the best possible charge trapping dielectric stacks. Then they take advantage of the small diameter of the Si nanowire to achieve 3D electrostatics, which Richter says, gives them better control than traditional 2D planar devices. “Better electrostatic control means faster, more effective turning on and off,” Richter says. “And we’ve also tuned the gate stack so that most of the electric field is dropped just over the tunnel barrier so we have better control. That means we can hopefully operate at lower voltages and reduce power compared to more traditional dielectric stacks in planar structures.”

Their goal is to achieve faster write/erase speeds for non-volatile memory with reduced power consumption. “Our plan is two-fold,” Li says. “One is to reduce the channel length so we can



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achieve higher memory density. The second is to do more engineering on the dielectric stack so that we can get the non-volatile memory programming speed to below 1 ns, similar to SRAMs." [[Nanotechnology](#)]

### Bio Focus

#### [Attaching proteins to electrodes in ambient conditions](#)

(University of Pennsylvania)

Image credit: Bonnell/University of Pennsylvania. Click image to enlarge.



Most research involving the attachment of proteins to electrodes to measure their electrical properties has been done in liquid solutions to understand the biological principles of the operation of proteins inside cells. But for other potential applications, such as energy harvesting or toxic chemical sensing, the protein/electrode device must function in ambient, open air conditions. Now researchers at the University of Pennsylvania led by Dawn A. Bonnell have demonstrated successful operation of a single molecular layer of artificial proteins attached to electrodes as optoelectronic devices in an ambient environment. What's more, they've developed a new AFM-based technique to quantitatively measure the resistance, capacitance, and dielectric constant of such devices, as reported in *ACS Nano*.

Researcher Bodhana Discher fabricated the artificial proteins used in these experiments. Device manufacture involved the self-assembly of amphiphilic protein helices in groups of four on a highly oriented pyrolytic graphite surface using microcontact printing. A single molecular layer of these helices measured  $6.6 \pm 0.5$  nm—the height of a protein helix standing vertically on the graphite surface. The optically active molecule zinc (II) protoporphyrin (ZnPP) was inserted into the interior of the scaffold formed by these four helices; later measurements showed that approximately five ZnPP molecules occupied a single scaffold.

Using their new AFM-based technique called torsional resonance nanoimpedance microscopy, the researchers oscillated a metal AFM tip sideways rather than up and down, so as not to damage the delicate protein structures. A blue LED with a wavelength of 425 nm emitted light near the sample-tip junction to excite the ZnPP molecules. "We use a technique we call 'force stabilization' to get very near the surface," Bonnell says, "without disrupting or damaging it. We call it 'soft contact.'" When combined with special circuitry that maximized the signal-to-noise ratio at a higher frequency, they were able to measure the dielectric constant quantitatively by "measuring the polarization volume change between the ground state when there is no light on the ZnPP and the excited state when the light is on it and it is absorbing photons," Bonnell says.

"You'll see lots of characterization papers on lots of different properties in these systems," Bonnell concludes, "but what was different here and I think is going to be generalized in a broader context is that we developed a technique that can measure the dielectric constant of a single-molecule-thick layer." [[ACS Nano](#)]

To hear Dawn Bonnell explain her views of the possible applications of this research (mp3, 59 sec.), click the soundwave icon:



Materials Research Society's  
"Sounds of Science"

### Energy Focus

#### [Dark plasmons trap more light](#)

(Northwestern University)

Photo credit: Northwestern University. Click image to enlarge.

Researchers Teri Odom and Wei Zhou of Northwestern University recently reported



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in *Nature Nanotechnology* a new type of subradiant (dark) plasmon that is easily tunable by modification of the height of gold nanoparticles arranged in a large-scale, two-dimensional array. Previous attempts to make dark plasmons have involved structuring single nanoparticles or nanoparticle arrays in complex ways, in an attempt to take advantage of broken symmetries in the structure. “In our case we just change the height of the nanoparticles,” Odom says. “That’s easier than trying to manipulate sub-wavelength features in individual particles.”

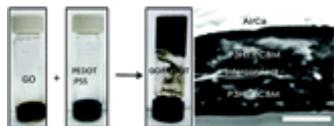
Abandoning the traditional electron beam lithographic methods, which limit the height of nanoparticles that can be made, the researchers used a template-stripping nanofabrication technique to obtain two-dimensional arrays of gold particles with heights ranging from 65 to 175 nm on transparent substrates. Experimenting with an array of 100-nm high, 160-nm diameter gold particles spaced at 400-nm intervals and covering a total area greater than 18 cm<sup>2</sup>, Odom and Zhou found an out-of-plane (EOz) electric component of transverse-magnetic polarized light that excited out-of-plane plasmon modes. These plasmon modes are narrow (FWHM~5 nm) at resonance, and strong coupling between their dipolar moments suppresses the radiative decay of the radiant (bright) plasmons, trapping light in the x-y plane of the nanoparticle array. “We’re finally accessing the third dimension,” Odom says. “Because we could make the gold nanoparticles so tall, we were able to discover this out-of-plane lattice mode which happens to have this dark plasmon character. We’re uncovering some of the unique outcomes of being able to manipulate structure in the z-dimension.”

Odom thinks these arrays, with their concentrated, in-plane local energy fields, might be valuable platforms on which to study the mechanisms of chemical reactions. Also, the scalability of the fabrication technique could lead to a coupling of plasmonic and photovoltaic applications. “Because these arrays can trap the light in a much more efficient way and because we can scale them,” Odom says, speculating about the distant future, “they could provide a practical first step for plasmonics-based photovoltaics.” [[Nature Nanotechnology](#)]

### [Graphene oxide "glue" makes stacking tandem solar cells easier](#)

(Northwestern University)

Photo credit: Huang/Northwestern University. Click image to enlarge.



Mixing graphene oxide (GO) and the common polymer PEDOT:PSS in water produces a sticky thin film upon casting that may make it simpler to fabricate tandem solar cells, according to research published recently in the *Journal of the American Chemical Society*. Jiaying Huang and his colleagues at Northwestern University describe a proof-of-concept using direct adhesive lamination of the layers of tandem devices with GO/PEDOT gel as

the glue, a process which they say is much easier than creating tandem architectures via solution processes, as is now commonly done.

Tandem solar cells are multijunction devices in which two sub-cells are stacked for increased solar energy absorption. This stacking requires that the “glue” interlayers be orthogonally processable, which is not easy to achieve in solution with organic solar cells. Also, careful choice of solvents is needed at each step to avoid damaging components in other layers. No such problems arise when aqueous solutions of GO (0.1 -2 wt%) and PEDOT:PSS (1.3-1.7wt.%) are mixed to form a viscous gel that can be easily applied to many substrates. Heat treatment at 60°C turns the gel into a sticky adhesive to bond stacks together. Furthermore, despite the electrically insulating nature of GO, the conductivity of PEDOT:PSS films increases by an order of magnitude when GO is added. The authors suggest that this may be due to a conformational change in PEDOT upon contact with GO. More generally, the GO:PEDOT gel could serve as a non-metallic solder for electrical and mechanical connections in any organic electronic device. [[Journal of the American Chemical Society](#)]

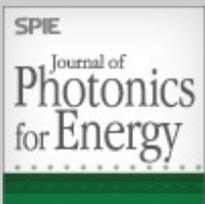
### [MATERIALS FOR ENERGY BLOG](#)

#### *Recent Posts*

Join the conversation! Read the latest blog entries on nuclear energy based on the Energy Quarterly section of the June issue of *MRS Bulletin*, and let us know what you think by adding a comment.

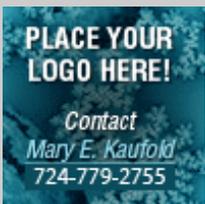


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- [Regional Initiative: France's nuclear power program continues in force](#)

Also, be sure to check out the ongoing discussion on the hydraulic fracking process:

### [Shale rock fracking keeps U.S. economy from cracking](#)

By Russell R. Chianelli, The University of Texas at El Paso, MRTI

In a recent article in The Wall Street Journal titled “Stepping on the Gas,” Daniel Yergin, noted for his book *The Prize*, which covers the rise of the major oil companies, describes how gas from shale rock can lead the United States out of dependence on foreign oil imports.<sup>1</sup> In this article, he discusses how independent energy producers in the Houston, Texas, area have tapped a resource called the Barnett Shale reserve located around Dallas/Forth Worth, Texas. This is now producing massive amounts of natural gas using techniques developed over the past 30 years to open reservoir rocks. Specifically, a technique called fracking expands rock fractures, releasing gas. Fracking has changed the U.S. energy equation. As part of the so-called Unconventional Natural-Gas Revolution, the technique has turned a natural gas shortage into a surplus, resulting in lowering of the price of natural gas. It is now estimated that the United States has a resource base of natural gas across the country of 2,500 trillion cubic feet (see Reference 2 for worldwide production). This makes it probable that the United States will become a net exporter of natural gas. Fracking has critics who speak about threats to groundwater and the handling of water recovered from the operation. However, the industry states that they have a long, untarnished safety record. In an accompanying article titled “The Road to Clean Energy?” environmentalist Mark Brownstein discusses the risks and appeals to the industry to allay such fears.<sup>2</sup> Besides the obvious direct uses of natural gas for energy applications, the abundance of natural gas also offers opportunities to the catalytic materials community to convert it to useful transportation liquids. Future blog entries will discuss this in more detail.

1. D. Yergin, “Stepping on the Gas,” *The Wall Street Journal*, Saturday/Sunday, April 2-3, 2011
2. M. Brownstein, “The Road to Clean Energy?,” *The Wall Street Journal*, Saturday/Sunday, April 2-3, 2011

Add your comments, or e-mail [materialsforenergy@mrs.org](mailto:materialsforenergy@mrs.org) to suggest future topics and contributors.

### [Image in Focus](#)



#### Nano-garden

Field emission scanning electron microscope image. This was supposed to be a hydrothermally grown ZnO nanowire on sintered Ag, but excessive temperature caused a bubble, which produced a garden-like scene by chance.

*Credit: Sukjoon Hong, School of Mechanical Engineering and Aerospace Systems, KAIST*  
(One of three Science as Art competition second place winners at the 2011 MRS Spring Meeting)

[We invite you to [submit your images](#) to the Editor for possible inclusion in this feature]

## HAPPENINGS AT MRS

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### MRS News

#### Aldrich Materials Science Endows a Mid-Career Researcher Award through the Materials Research Society



The Materials Research Society announces a new addition to its Awards Portfolio—the **Mid-Career Researcher Award**. Established through a permanent endowment by [Aldrich® Materials Science](#), a strategic growth initiative of [Sigma-Aldrich](#) (NASDAQ:SIAL), this award will honor individuals that have made outstanding mid-career advances in the scientific materials industry.

Nominations for the inaugural award are open through October 1, 2011, with the inaugural presentation to take place at the 2012 MRS Spring Meeting and Exhibit in San Francisco, April 9-13. Open to researchers, scientists and engineers in all areas of materials research between the ages of 40 and 52 at the time of nomination, the award is fully funded by Aldrich® Materials Science and managed by the Materials Research Society. In addition to the prestige of being recognized by their peers within the materials research community, the winner will receive a \$5,000 cash award.

More information on the award, eligibility and the nomination process will be available soon. Look for details in future issues of *MRS Bulletin* and *Materials 360*, or on the MRS Web site at [www.mrs.org/awards](http://www.mrs.org/awards).

### [The MRS Apprentice Science Reporter Program](#)

Are you a student or post-doc interested in exploring science writing as a possible career? What better place to give it a try than in Cancun, Mexico, this summer, as an MRS Apprentice Science Reporter!

This joint program between the Materials Research Society (MRS) and the NSF International Center for Materials Research (ICMR) at the University of California, Santa Barbara funds graduate students/post-docs in materials-related areas at US universities to accompany MRS staff to conferences outside the US and compile daily technical reports for inclusion in the MRS Meeting Scene e-newsletter. For 2011, we are looking for two graduate students or post-docs for covering the XX International Materials Research Congress 2011 in Cancun, Mexico, from August 14-18. The candidates will need to have an interest in science writing, be able to attend talks in materials research areas outside their specific areas of expertise and be able to write up short summaries quickly. They will need to be a graduate student or post-doctoral researcher at a US-based university at the time of the conference. The application by e-mail should include a Resume, writing samples related to materials science/engineering, and a brief letter of intent sent to Tim Palucka ([palucka@mrs.org](mailto:palucka@mrs.org)).

## MEETINGS UPDATE

### Critical Meeting Deadlines

<a href="#">Organic Microelectronics &amp; Optoelectronics Workshop VII</a> July 18-20, 2011, San Francisco, California	Early Registration Deadline— July 1, 2011
<a href="#">International Materials Research Congress XX</a> August 14-19, 2011, Cancun, Mexico	Preregistration Deadline— July 15, 2011
<a href="#">MRS WORKSHOP SERIES—Directed Self-Assembly of Materials</a> September 28 - October 1, 2011 Nashville, Tennessee	CALL FOR PAPERS Abstract Deadline— July 8, 2011
<a href="#">MRS WORKSHOP SERIES—Photovoltaic Materials and Manufacturing Issues II</a> October 4-7, 2011, Denver, Colorado	CALL FOR PAPERS Abstract Deadline— July 8, 2011
<a href="#">2011 MRS FALL MEETING &amp; EXHIBIT</a> November 28 - December 2, 2011, Boston, MA	CALL FOR PAPERS Abstract deadline-- June 21, 2011
<a href="#">6th International Conference of the African Materials Research Society</a> December 11-16, 2011, Victoria Falls, Zimbabwe	Abstract Deadline— June 30, 2011

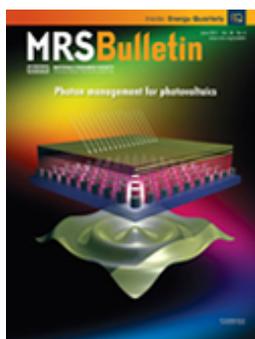
## JUST PUBLISHED

### MRS Bulletin

#### Photon management for photovoltaics

June 2011 Issue

Guest Editors: E.T. Yu and J. van de Lagemaat

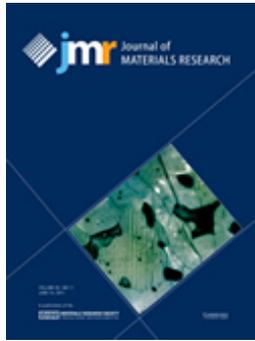


Photovoltaics are expected to play an important role in the future energy infrastructure. However, achieving simultaneously high efficiency in both light absorption and carrier collection remains a challenging tradeoff. Photon management, which refers to the engineering of materials and device structures to control the spatial distribution of optical energy, offers a number of promising routes to optimizing this tradeoff. Progress in fabrication of nanostructured materials combined with advances in the understanding of nanophotonic devices has enabled new strategies for photon management in a range of photovoltaic devices. Prominent among these are structures with pronounced surface topography or graded refractive-index profiles that reduce surface reflectivity; materials processing that increases optical absorption in materials such as silicon; incorporation of semiconductor nanostructures that enables

simultaneous improvements in optical absorption and photogenerated carrier collection; and coherent light trapping in optical waveguide modes via plasmonic or optical scattering effects. The articles in this issue review some of these emerging directions.

### Journal of Materials Research

[June 2011, Volume 26, Issue 11 - A selection of papers](#)



[Towards an integrated materials characterization toolbox](#)

Ian M. Robertson, Christopher A. Schuh, John S. Vetrano, Nigel D. Browning, David P. Field, Dorte Juul Jensen, Michael K. Miller, Ian Baker, David C. Dunand, Rafal Dunin-Borkowski, Bernd Kabius, Tom Kelly, Sergio Lozano-Perez, Amit Misra, Gregory S. Rohrer, Anthony D. Rollett, Mitra L. Taheri, Greg B. Thompson, Michael Uchic, Xun-Li Wang and Gary Was, DOI:10.1557/jmr.2011.41

[Modeling of exact viscoelastic stresses in bilayer systems due to thermal and/or lattice mismatch: Maxwell model](#)

Hsiang-Chun Hsueh, Donyau Chiang and Sanboh Lee, DOI:10.1557/jmr.2011.100

[Nanoindentation strain-rate jump tests for determining the local strain-rate sensitivity in nanocrystalline Ni and ultrafine-grained Al](#)

Verena Maier, Karsten Durst, Johannes Mueller, Björn Backes, Heinz Werner Höppel and Mathias Göken, DOI:10.1557/jmr.2011.156

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**Upcoming JMR Focus Issues - Calls for Papers**

[February 2012 – One-Dimensional Micro/Nano Materials](#)

Manuscript Submission Deadline: June 28, 2011

[March 2012 – Plasma and Ion-Beam Assisted Materials Processing](#)

Manuscript Submission Deadline: July 15, 2011

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**DIVERSIONS**

**Did You Know?**

The [2011 World Materials Summit](#) will be held in Washington, D.C., from October 8-12. This invitation-only event is the third in a series of international summits sponsored jointly by the Materials Research Society (MRS), the European Materials Research Society (E-MRS) and the Chinese Materials Research Society (C-MRS).

**Quiz**

How many elements are considered to be "energy critical elements" according to [the joint report](#) issued by MRS and the APS Panel on Public Affairs?  
(Answer will be published in the next Materials360®)

***Answer to the Quiz in the previous Materials360®:***

The Mid-Career Researcher Award, sponsored jointly by MRS and Aldrich® Materials Science, is the latest award added to the already impressive line-up of honors that MRS bestows upon deserving researchers.

## NEW PRODUCTS FOCUS

### [New Software Package for Nanoindentation and Tensile Testing](#)

Agilent Technologies Inc. recently announced the availability of Agilent NanoSuite 6.0, an enhanced-performance software package designed specifically for use with popular Agilent Nano Indenter G200, G300 and T150 UTM systems. NanoSuite 6.0 gives researchers in scientific and industrial settings an unprecedented combination of speed, flexibility, ease of use and exclusive new application methods for nanoindentation. The new software package is ideal for nanomechanical properties measurements involving polymers, composites, thin film materials, MEMS, surface topology, stiffness mapping, and scratch testing.

[Contact: [joan\\_horwitz@agilent.com](mailto:joan_horwitz@agilent.com) or 480-756-5905]

### [New Compression Fixture for Composite Testing](#)



Zwick Roell, a supplier of test equipment to the fibre composite industry, has introduced the hydraulic composites compression fixture (HCCF), which improves specimen handling, enables different specimen geometries to be tested and guarantees reproducible results due to exact alignment. Found to deliver good results following tests carried out by a major European aircraft manufacturer in 2010, the HCCF was developed and patented by IMA Materialforschung und Anwendungstechnik GmbH in Dresden, Germany. It is produced and marketed by Zwick.

[Contact: [info@zwickroell.eu](mailto:info@zwickroell.eu) or 49-7305-10-0]

### [New Specimen Cleaning Chamber](#)



XEI Scientific Inc, maker of the EVACTRON® De-Contaminator Plasma Cleaning System for electron microscopes and other vacuum chambers, announces their new SoftClean™ specimen cleaning chamber to be used with the Evactron De-Contaminator for electron microscopy. The SoftClean, when used with an Evactron® De-Contaminator and a vacuum pump, can pre-clean samples with high hydrocarbon contamination levels from the sample surface by a downstream ashing process before introduction into the microscope chamber. The

SoftClean chamber can be also used as a stand-alone storage system, preserving clean specimens.  
[Contact: [levesque@evactron.com](mailto:levesque@evactron.com) or 972-318-0196]

*[To suggest items for inclusion in Industry News and New Products Focus, please contact [Mary Kaufold](#) at 724-779-2755]*

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