



# MRS Meeting Scene...

Presented by the Materials Research Society

## 2011 MRS Fall Meeting

A Publication of the  
Materials Research Society  
*Advancing materials. Improving the quality of life.*

Boston, MA  
November 27 - December 2

 [Blog](#) |  [Facebook](#) |  [Twitter](#)

### Meeting Scene Days 1 and 2, Sunday and Monday

Look around you. If Thanksgiving is just past and you find yourself in Boston surrounded by more than 5,000 materials scientists, then you must be attending the 2011 MRS Fall Meeting & Exhibit! This version of our longstanding Fall Meeting kicked off on what we called "Super Sunday" with seven tutorials, the Acta Materialia Materials and Society Award Forum, four professional development workshops including one on Careers in Academia, and the Fred Kavli Distinguished Lectureship in Nanoscience by Mark E. Davis of Caltech.

The full technical program started on Monday, with accomplished invited speakers giving perspectives on their particular slice of the materials science field, while somewhere a graduate student was presenting a talk to her peers for the first time. Symposium X got off to a great start with a panel of government experts giving an overview of the Materials Genome Initiative, which will start funding projects in FY 2012. At the Plenary Session in the evening, MRS President Jim DeYoreo and Immediate Past President Dave Ginley introduced the Meeting Chairs, the Congressional Fellows, the MRS Bulletin Volume Organizers, and two new MRS University Chapters. Eric J. Amis of United Technologies Research Center followed with a Plenary Talk that took a detailed look at three materials and three challenges they present to the materials science community. The evening was topped off by the Student Mixer and a Poster Session. Not a bad way to spend a Monday!

#### Sponsors



SPI Supplies

Silicon Nitride Membrane Window  
Grids

Visit MRS Booth 1202



Harrick Plasma, Inc.

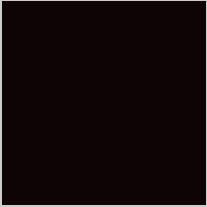
Surface Cleaning,  
Activation, Pre-bond Preparation



Welcome back to Boston!



National  
Electrostatics Corp.  
Ion Beams, RBS, PIXE,  
AMS, MeV implant  
Visit MRS Booth 311



MMR Technologies  
Microcryogenic and  
Thermal Stage Systems  
Visit MRS Booth 1003



Wiley  
New journal:  
Advanced Healthcare Materials  
Visit MRS Booth 114



Complete characterization  
tools in electron microscopy  
Gatan Inc.  
The Leader in  
EM Instrumentation  
Visit MRS Booth 600

## MEETING HIGHLIGHTS

- [Fred Kavli Distinguished Lectureship in Nanoscience: Mark E. Davis](#)
- [Careers in Academia Workshop](#)
- [Symposium X: The Materials Genome Initiative](#)
- [Plenary Session: Eric J. Amis](#)
- [Technical Program](#)

## Other Links of Interest

- [Itinerary Planner](#)
- [2011 MRS Fall Meeting Author Index](#)
- [Submission of Proceedings Papers](#)
- [Career Center](#)

## CONNECT WITH US AT THE MEETING

### Take our Meetings of the Future survey

This [online survey](#) will help us to learn what you are looking for in a scientific meeting, and get your ideas on what future meetings should look like. Please take a few minutes to let us know what you think.

### MRS Meetings Blog

#### *The MRS Meeting Experience*

View the MRS Fall Meeting through the eyes of our student bloggers and reporters. A glimpse of the Meeting as you have never seen it before!

### 2011 MRS Fall Meeting Facebook Group

Connect with your fellow 2011 MRS Fall Meeting attendees in the [Fall Meeting Facebook Group](#). Discuss talks and events, get the scoop on local dining and entertainment options, post pictures, and more.

### Twitter

Join in the conversation!



**GLOBALFOUNDRIES**  
The first truly  
global foundry



Alan Taub (center), Vice President of General Motors Global Research and Development, receiving the 2011 Acta Materialia Materials and Society Award on Sunday.



**Neaspec GmbH**  
Infrared spectroscopy with 10nm  
spatial-resolution  
Visit MRS Booth 1102

**Fred Kavli Distinguished Lectureship in Nanoscience**

**Mark E. Davis, California Institute of Technology**  
**Fighting Cancer with Nanoparticle Medicines—The Nanoscale Matters!**

*The Kavli Foundation supports scientific research, honors scientific achievement, and promotes public understanding of scientists and their work. Its particular focuses are astrophysics, nanoscience, and neuroscience. For more information about the Foundation, visit their website at [www.kavlifoundation.org](http://www.kavlifoundation.org).*



**CRC Press/**  
**Taylor & Francis Group**  
New Books from  
CRC Press  
Visit MRS Booth 104



Mark E. Davis wants to improve the quality of cancer patients' lives while killing the tumors that are trying to kill them. While chemotherapy treatment has been around since 1955, its necessary introduction into the bloodstream allows it to systemically attack healthy as well as cancerous cells in the body, leading to the terrible side effects that decrease the quality of life: nausea, hair loss, and a compromised immune system, to name just a few. His alternative approach is to "move the therapy inside the cancer cell, and then release it."

Davis's weapon of choice is organic nanoparticles containing the cancer killing drug. To be sure, others have tried and are trying this approach, but Davis is perhaps unique in the attention to metrics he brings to the investigation. Not content with using any nanoparticles that fit the standard definition of 1-100 nm dimensions, Davis has tried to pinpoint precisely the size of the nanoparticle that will most effectively deliver the drug over an extended period and then leave the body. This has led to investigations of the holes in "leaky" blood vessels that grow to feed solid tumors, and the pore sizes of organs like the kidneys, through which therapeutic nanoparticles must ultimately fit if they are to leave the body, preventing undesirable build-up. As the title of his talk emphasized, "the nanoscale matters!"

In his Kavli Lecture, Davis explained the biology to the assembled materials scientists. Most molecular-based chemotherapy drugs, which are about 100 times smaller than nanoparticles, exit the body rapidly through the kidneys as urine, so a high dose has to be administered to ensure that enough actually reaches the tumor. Once a solid tumor reaches a size of about 1mm in diameter, the tumor needs new blood vessels to continue growing. These new blood vessels typically grow quickly but inefficiently, leaving them "leaky" with holes. These holes can provide a way to get



**Whitaker International**  
**Program**  
Biomedical Engineering Grants  
Visit MRS Booth 221



**CRAIC Technologies**  
Spectroscopy of  
microscopic sample areas  
Visit MRS Booth 1209

cancer-killing drugs inside the tumor. But if you are using nanoparticles as the delivery agent, they must be the right size.

From his decades of study, Davis has determined the 50 nm is the “right size to do the right thing, in the right place, at the right time.” That is, a 50-nm particle can get through the holes in the leaky blood vessels to deliver the drugs to the tumor without hurting healthy cells along the way. A 100-nm particle would be too big to pass through the holes and would get stuck in the blood vessel, while a 10-nm particle would pass through the pores of the kidneys and never get to the tumor. Through his careful investigation of particle sizes between 10 and 100 nm, Davis determined that 50 nm is the generally the correct size for the drug delivery stage. He emphasized that eventually you want to rid the body of excess nanoparticles that are no longer delivering drugs, so it is important to have a mechanism whereby the particles disassemble and pass through the kidneys.



**Attolight AG**  
Discover the new easy  
Cathodoluminescence  
Visit MRS Booth 821

Starting in 1996, he and his colleagues began working with PEGylated gold nanoparticles as drug delivery agents to solid tumors. Besides just size, they experimented with the zeta potential to determine the optimal charge of the particles. Eventually they settled on a cyclodextrin (a ring of sugar) along with gold nanoparticles as parts of a linear polymer backbone to deliver drugs to tumors. Ten years later, in 2006, he was first able to test this therapy on a human patient with advanced metastatic pancreatic cancer. The drug was able to circulate and release drugs in the patient for two days—a long time—without causing side effects. The original patient survived for another two years and maintained a high quality of life. Now this CRLX101 therapy is in randomized Phase II trials in patients.

More recently, Davis has been using RNA as a therapeutic agent to attack cancer. In the RNA interference (RNAi) technique, two pieces of RNA act together to cut messenger RNA in the cancer cell at a specific spot along its chain. This prevents the messenger RNA from creating a protein that would allow the cancer to grow. Davis uses a bathtub analogy to explain the difference between traditional chemotherapy and RNAi. In chemotherapy, the proteins keep being made until the tub fills up and they spill on to the floor; the chemotherapeutic drugs simply mop up these excess proteins. In contrast, RNAi turns off the faucet.

“I really feel strongly that we are learning the design rules” for creating therapies to kill cancer, Davis said. “They are going to be complex, but they are going to be worth it.”

**HAMAMATSU**

**Hamamatsu Corporation**  
Absolute Quantum Yield  
Measurement System  
Visit Booth 524

### Careers in Academia Workshop

On Sunday afternoon Cammy Abernathy, Peter Green, Debra Rolison, Paul Braun, Masashi Kawasaki, and Kathy Wahl gave a tutorial to help Ph.D. students decide on a career path. The tutorial was designed to help them make informed career decisions; allow them to successfully compete for academic positions; and enable them to succeed in academic life. Abernathy led most of the tutorial, focusing extensively on what an academic career is really like, and comparing it to careers in industry, government labs, start-ups, etc. The other panelists frequently added to the discussion and answered students’ questions.

Abernathy first asked the students to consider the following questions: (1) How much risk can I tolerate? (2) How much intellectual freedom do I need? (3) Do I want to be a manager? (4) How entrepreneurial am I? (5) Do I like teaching? (6) Do I value financial rewards over job security? The answers to these and other questions could lead the students to choose from a job in industry, a government lab, a 4 or 5 year college, or a research university. A Ph.D. in science could also lead to a career in law, medicine, policy, or science journalism, she added.



**KP Technology**  
Scanning Kelvin  
Probe Photovoltage Spectroscopy  
Visit MRS Booth 829

With the help of Rolison, a Section Head at the Naval Research Laboratory, who talked about life in a government lab, Abernathy explored the ins and outs of each potential path. In industry (the management side) you probably won’t get to publish, but you’ll be well paid. On the other hand, you may have to relocate frequently. In industrial R&D you’ll probably write a lot of internal technical memos, but not publish in journals; patents may be more important. In a start-up, you have to be highly risk tolerant and a jack of all trades. This can produce high stress but also high satisfaction. Life at a teaching college will require you to teach 3 to 4 courses a semester, so you had better like student interaction. At a research university you can expect a lighter teaching load, but you will need to find the funding to support 5 or 6 graduate students if you want to get tenure.

**Thermo**  
SCIENTIFIC

Visit MRS Booth 416

Still, “a full professor is the most autonomous creature on the face of the earth,” Abernathy observed.



### Symposium X: The Materials Genome Initiative

(View the complete set of presentation slides [here](#))



A four-person panel of high ranking officials from the White House, national laboratories, and funding agencies convened to give an overview of the Materials Genome Initiative (MGI) announced by President Obama in a June 2011 speech. The speakers were Cyrus Wadia, Assistant Director, Clean Energy and Materials R&D, White House Office of Science and Technology Policy; Harriet Kung, Director, Basic Energy Sciences, Department of Energy (DOE); Ian Robertson, Director, Division of Materials Research, National Science Foundation (NSF); and Linda Horton, Director of Materials Science and Engineering, Basic Energy Sciences, DOE.

Wadia started the conversation by saying that the initiative’s motto is “two times faster and two times cheaper.” That is, the government wants to enable researchers to develop and bring new materials to market in half the time and at half the cost compared to past efforts, which typically took 20 to 30 years from lab bench to market. To do this, they are establishing a “Materials Innovation Infrastructure” that includes the areas of computational tools, experimental tools, and digital data. Wadia emphasized that the government is specifically interested in the center of balance at the intersection of these three segments. The plan is to bring in the software community to create open platforms and universal access to computational tools to enable materials researchers to replace some experiments with simulations. Also, experimentalists need to develop new techniques and new figures of merit to bridge the experimental/computational divide. Regarding digital data Wadia said, “We believe that data transparency encourages innovation.” There is currently no repository for large amounts of materials data, so a new

“ecosystem” will be built to encourage data sharing. Extending that theme, Wadia encouraged researchers to think of themselves as an “ecosystem of collaborators” rather than as individual principal investigators.

Kung gave a historical overview of the time from discovery to application in the twentieth century, using Teflon (20 to 30 years) and Li-ion batteries (approximately 20 years) as examples. All renewable energy sectors in the United States supply less than 8% of our total energy needs, she said. How can we expedite development of the new materials needed to increase this percentage rapidly? “By turning to the scientific community to help formulate this [MGI] plan,” Kung said. She recounted the conclusions of the Multi-agency Workshop in 2009 and the Department of Energy’s Computational Materials Science and Chemistry 2010 Workshop: Creating an Innovative Ecosystem, as the outcomes of this collaboration with the community. These workshops noted that the federal government needs to maintain a long-term stewardship of integrated, sustainable software as an investment in the materials science community. This will enable “broad access to and adoption of simulation-based engineering and science,” Kung said.

Ian Robertson said that the idea behind the MGI was to apply the three elements of the Materials Innovation Infrastructure (computational tools, experimental tools, and digital data) simultaneously to all seven steps of the lab-to-market continuum: (1) discovery, (2) development, (3) property optimization, (4) systems design and integration, (5) certification, (6) manufacturing, and (7) deployment. Commenting on the digital data element, Robertson said that this was not something that the materials science community has done well in the past. “How can we create a data repository that we can actually interrogate?” he asked. He suggested that the materials community might learn from their colleagues in physics and astronomy about how to handle large data sets. Robertson closed by mentioning the multi-agency partnerships that are being established to support the MGI: DOE and NSF for development of the next generation of characterization tools; NIST, DOE, and NSF for development of standards; and the Department of Defense and NSF for recruitment of the next generation of scientists and engineers.

Finally, Linda Horton answered the overarching question of what is different about the MGI compared to the current research and development paradigm. MGI will (1) develop tools that will become a materials community resource and then an industry resource; (2) ensure that theorists and experimentalists will work together to guarantee scientific robustness; (3) provide a U.S. computational software suite for materials discovery; and (4) restore the U.S. to leadership in the materials research field. She noted that DOE’s Basic Energy Sciences has a budget request for \$40 million for FY 2012, which of course requires congressional approval. Other MGI funds will be available through other agencies.

---

## Plenary Session

Eric J. Amis

Director of Physical Sciences, United Technologies Research Center

### Three Materials, Three Challenges



“Materials scientists are not the center of the universe—we’re enablers,” Eric Amis said at the start of his Plenary Lecture. Amis, the Director of Physical Sciences at United Technologies Research Center, took the opportunity to speak about three materials and three related challenges of some importance to his company and to the audience members.

The first material he discussed was the flexible polymer belt, which the Otis Elevator Company, owned by United Technologies, used to replace steel cables in elevators about ten years ago. The 30 mm wide by 3 mm thick polyurethane-coated steel belt is more flexible, more durable, and quieter than stainless steel cables. This innovation made it possible to do away with whole floors at the tops of buildings being devoted to elevator machinery. The challenge in this case was performance: the flexible polymer belt could be made thinner and lighter than the cable used previously. “For

some of the tallest buildings in the world, the weight of the rope is the limiting factor,” Amis said. He went on to discuss a more fanciful idea of a space elevator with a cable 5,000 km long.

Material number two in his talk was polymeric membranes. Amis reported that the global market for membrane separation technologies is projected to reach \$16 billion by 2017. He cited examples of membranes being used for aircraft fuel tank inerting to reduce the amount of oxygen above the fuel in a tank. By forcing compressed air into a separation device and allowing the oxygen to permeate out through a membrane, a nitrogen rich blanket is produced to cover the fuel in the tank. A membrane is also used to remove dissolved oxygen from jet fuel to improve the fuel’s heat sinking capability. Amis noted that hollow fiber membranes are used as exchangers for heat and moisture (dehumidification). He was particularly excited to talk about flow batteries, which use ion exchange membranes that allow water and protons through but hold vanadium—an element in the redox reaction—back. The challenge with membranes is cost, Amis said.

The final materials class was composites, specifically polymer matrix composites. In bridges, glass fiber reinforced polymer rebar is being used to replace steel rebar, reducing corrosion and weight while adding strength. Engineers have begun wrapping Kevlar mats around this rebar for seismic strengthening in earthquake prone areas. Transport vehicles such as automobiles, boats, and airplanes are using an increasing amount of composites. Much of the new Boeing 787 is built of carbon reinforced plastic using thermoset materials, Amis said. Wind turbine blades which had diameters of 15 meters in 1985 now span 126 meters in diameter, with 160 meters coming soon. Composites are used in this application for their light weight, strength, and stiffness. The challenge in composites is speed, according to Amis.

United Technologies is working on all three materials and challenges and many more across the wide range of companies under their corporate umbrella.



2011 MRS Fall Meeting chairs recognized for their hard work before the Plenary Session. (L-R) Paul Braun, Masashi Kawasaki, Kathryn Wahl, and Cammy Abernathy.

---

## TECHNICAL PROGRAM

### **Symposium A: Material challenges in current and future nuclear technologies**

#### **A1.4 Effect of Cr segregation to UO<sub>2</sub> grain boundaries**

**Minki Hong, University of Florida**

Large grain size decreases the internal pressure of UO<sub>2</sub> in nuclear reactors, so bigger grains are

desirable.  $\text{Cr}_2\text{O}_3$  is known to be a grain growth promoter in this system. Minki Hong reported on work that he and his colleagues at the Computational Materials Science Focus Group at the University of Florida have done using atomistic simulations to determine the effects of Cr on grain growth. Their simulations showed that Cr substitutes for U and tends to segregate at the core of the grain boundary. Simultaneously, Cr bonds covalently with O in  $\text{UO}_2$ , reducing the ionic bonding nature of the oxide and enhancing cation diffusivity. This effect is particularly noticeable at grain boundaries. The researchers found that as the number of Cr atoms at the grain boundary increased, the grain boundary energy decreased. This led to the conclusion that while Cr promotes grain growth in  $\text{UO}_2$ , too much Cr could limit grain growth. The optimal amount of Cr for maximum grain growth is still to be determined.



### Symposium B: Advanced Materials for Fuel Cells

Invited speaker: James E. McGrath, Virginia Tech

#### B1.1 Disulfonated poly(arylene ether) copolymers as proton exchange membranes for $\text{H}_2$ /Air and DMFC fuel cells

In an invited talk, James McGrath said that a practical proton exchange membrane (PEM) should have high proton conductivity at ambient humidity, good mechanical properties in wet and dry conditions, low fuel and oxidant permeability, and oxidative and hydrolytic stability. The major technological challenge is to increase the operating temperature from the current value of  $80^\circ\text{C}$  to the  $100\text{-}120^\circ\text{C}$  range, while decreasing the relative humidity (RH) operating range from the current value of  $80\text{-}100\%$ . Toward this end, he and his colleagues at Virginia Tech are investigating sulfonated dichloro diphenylsulfone monomers (SDCDPS) as elements in block copolymers for use as PEMs.

By carefully creating a nanophase-separated morphology with a sharp interface between the hydrophilic and hydrophobic blocks of the copolymer, they were able to increase the water self-diffusion coefficient and obtain better performance of the PEM at lower relative humidity. In one experiment, the block copolymer performed comparably to the standard Nafion PEM at  $100^\circ\text{C}$  and  $40\%$  RH; it far exceeded the performance of a random polymer PEM. Interestingly, the researchers found three types of water in these systems, depending on the morphology of the copolymer: (1) non-freezable, tightly bound water; (2) freezable, loosely bound water, with a broad melting behavior; and (3) free water, with the normal sharp freezing point at  $0^\circ\text{C}$ . By annealing the material above the  $T_g$  of the hydrophobic phase, the copolymer morphology self-assembled more quickly, and the material showed more ductility as RH increased.



Hands-on science demonstration

### Symposium F: Mobile Energy

Invited Speaker: Rodrigo F. Martins, FCTUNL, Caparica, Portugal

#### F1.1: Solid state paper battery

Cellulose, a major biopolymer available on our planet, is cheap, flexible, lightweight, recyclable, and has good dielectric properties. In both its natural and artificial states, cellulose clearly has properties that make it attractive for use in self-sustained paper-based disposable electronics. This group has already demonstrated a host of applications like paper-based transistors, memory, and electrochromic devices. Developing a paper-based battery to power these devices was clearly a natural extension to their work. The solid state paper battery comprises a paper electrolyte sandwiched between thin film electrodes. Parameters like ion content, porosity, fiber size, hydrophobicity, and hydrophilicity of the paper can be controlled to attain the desired electrochemical behavior. In addition to the ions implanted during paper making, the adsorbed water and hydroxyl ions also help battery operation. The initial paper battery prototypes using an Al anode and Cu cathode produced 3.4 V and could survive up to 150°C without degradation in performance. It was also seen that humidity levels play a key role: short circuit currents scale directly with increase in humidity. Electrochemical tests reveal that these paper batteries discharge abruptly, but can be recharged to recover up to 80% of their initial voltage on exposure to 70% humidity. In the future, these paper batteries could be used in the cosmetics industry and in medical drug delivery to inject drugs directly into the skin. A plethora of applications is envisaged in other areas like RF tags, intelligent packaging, disposable toys, and origami electronics.



Tim Miller of Spoken Science gives tips on Mastering Science Presentations with a little help from Al Gore (background)

Pritesh Hiralal, University of Cambridge, United Kingdom

#### F1.5: Stretchable electrochemical capacitors: Power for stretchable electronics

Pritesh Hiralal started his presentation by stating the meaning of stretchable electronics from an application viewpoint: As electronic materials and/or components form across a substrate in a way that allows the overall substrate to repeatedly deform  $\gg 5\%$  without electrical failure, the materials should not exceed their elastic limit (for repeated stretchability). The main target of this

research is the creation of stretchable devices which embed actively in electronics, especially in elastic structures (e.g., sensors, actuators, etc.). The researchers are also looking at ordered nanoscale internal structures for controlling the elasticity. Hiralal discussed an architecture that starts with an elastomeric substrate, followed by a rigid island platform which has DLC, polyimide, and active devices such as thin film transistors. These components are formed by low temperature processes. Finally, stretchable interconnects made of Au thin films that can be stretched in one or two dimensions are added.



Jan Yager leads Effective Time Management Workshop on Sunday

#### Invited Speaker: Manish Chhowalla, Rutgers University

##### F1.6: Low voltage and flexible electronics based on graphene

The mantra for this invited talk was that “reduced Graphene Oxide (rGO) is a flexible material for flexible electronics.” This group has already demonstrated their ability to tune graphene oxide chemistry by chemical synthesis routes. In this regard, removing oxygen groups is critical, particularly to improve electrical conductivity. By pioneering new routes for O<sub>2</sub> removal, a variety of applications was made possible. Among them were Light Emitting Electrochemical cells (LEC) which use GO as solution processed electrodes on flexible substrates. These GO layers were also demonstrated as Hole Transport Layers (HTL) to replace the corrosive PEDOT:PSS-based HTL. Another use was to replace the platinum-based counter electrode used in Dye Sensitized Solar Cells (DSSC) by an electrode comprised of rGO-metal hybrid nanoparticles. Finally, solution processed GO was used to demonstrate CO<sub>2</sub> reduction and low voltage Thin Film Transistors (TFT) using Self Assembled Monolayers (SAMs).



Monday night's Student Mixer

#### Symposium J: Photonic and plasmonic materials for enhanced photovoltaic performance

##### Invited Speaker: Harry Atwater, Caltech

##### J1.1: A thermodynamic approach to artificial photonic materials for solar energy conversion

Dr. Atwater's talk on a topic at the forefront of current solar energy research surprisingly began with the thermodynamics of photonics. What he called this “rather old work” laid the foundation of limiting theories (like the 1961 Shockley-Queisser efficiency limit), which to this day haunt those working on increasing the power conversion efficiency of solar cells. These efficiency limits can be

traced to a variety of sources of entropy gain that occur during the light absorption and energy conversion process. The main takeaway from this talk was ways to design an optimum solar cell that minimizes these losses. Three factors are of importance, namely high internal quantum efficiency, control of radiative emission angles, and density of states. Novel light collimation techniques like close-packed arrays of microphotonic collimators can significantly reduce emission angles, thereby reducing phonon entropy. The traditional  $4n^2$  light trapping limit will no longer suffice as solar cells get thinner and efficiency values need to climb higher. Here the Atwater group showed that by generating structures that manipulate the density of states in photonic materials, they could achieve light trapping levels that exceed traditional ray-optics-based approaches. The whispering gallery dielectric nanospheres for light trapping are an example that showed significant absorption enhancements in thin solar cells. Recent demonstration of a record 28% efficient single junction GaAs solar cell by Alta Devices generated this concluding remark from Atwater: "I see no reason why working together we cannot attain 50-70% efficiencies in the next 10 years or so."



### Symposium AA: Carbon Nanotubes, Graphene, and Related Nanostructures

Invited Speaker: Motoo Yumura, AIST-Nanotube Research Center, Japan

AA1.1: Putting single-walled carbon nanotubes to use as industrial materials- Recent progress in development of single-walled carbon nanotube mass production and their development into applications in Japan

Motoo Yumura spoke straight to the point on recent mass production of single-walled carbon nanotubes (SWCNTs) and expectations in the near future both in research and industry. The AIST Nanotube Research Center concentrates on three major areas:

- (1) Development of techniques for controlling, separation, and characterization of SWCNTs. The idea is to use metal semiconductors to separate SWCNTs. Also, new techniques like gel-column have the potential for high throughput.
- (2) Technology development for dispersion of SWCNTs. This involves the thermal-conductive super-growth of SWCNT rubber. These composite resin/rubbers have high thermal conductivity and are good dispersants.
- (3) Safety management of nano-materials. The goal is to develop a quick and simple method for toxicity assessment, like onsite measurement.

The current mass production technique for producing SWCNTs is by direct injection pyrolytic synthesis (DIPS). Though quite simple, it does not produce high quality industrial materials, and thus requires post-treatment such as purification or modification on the part of the users. But by precisely controlling the reaction conditions in the DIPS method a synthesis has been successfully developed by Yumura and colleagues. The result is high strength fiber SWCNTs with a diameter control of 0.1 nm precision. Kenji Hata at AIST discovered the super-growth (SG) technology based on a novel growth technique whose basic elements are ethylene and water. It allows ultra high efficiency synthesis at a rate 1000 times faster than current technologies, and ultra-high purity of 99.88% .



## Symposium JJ: Nanofunctional materials, nanostructures and nanodevices for cancer applications

Invited Speaker: Michael J. Cima, MIT  
 JJ 2.6: Implanted diagnostic devices

A biopsy is a classical technique used to obtain a tissue sample, which can then be analyzed to diagnose the presence of cancer and how far it has progressed. As surgical procedures done in operating rooms, biopsies can be pretty invasive, especially if they need to be done multiple times during a patient's illness. The Cima Lab proposes to implant a tiny device inside the tissue using the same needle used for the biopsy. The device can then do further analysis as and when needed by the physician, thereby eliminating the need for more biopsies. In a typical process, a biomarker is transported into the device, which interacts with the sensing media to change the MR contrast. The result can finally be read out on an MRI scan. This idea was initially tested out using cardiac markers on mice, which can be used to detect the possibility for heart attacks. The MRI signal from the implanted device was found to correlate with the magnitude of the heart attack, a result not observed previously. The devices have also recently been used to measure the degree of hypoxia (oxygen deficiency) in tumor cells. Hypoxic tumors need higher doses of radiation to completely damage the DNA of the tumor cells, and this necessitates higher doses of radiation therapy to get the same result as non-hypoxic tumors. It has therefore become important for physicians to measure the degree of hypoxia during the treatment phase. The Cima lab implanted PDMS/siloxane-based sensors into mice and successfully used them to measure their oxygen response inside a MRI scanner, thereby demonstrating the viability of their implantable diagnostic devices.

---



---

### ABOUT THE MEETING SCENE

- This Meeting Scene e-mail was compiled and edited by [Tim Palucka](#), with writing help from Apprentice Science Reporters B. Reeya Jayan and Rahul Reddy. Photographs are by Kasia Bruniany of MRS.
- You have received this as a subscriber to the Meeting Scene.
- To **Unsubscribe**, please e-mail [info@mrs.org](mailto:info@mrs.org).
- [Archived Meeting Scene Issues](#) are available online.
- View all free [MRS e-newsletters and alerts](#) and subscribe.

© [Materials Research Society](#), 2011