Commercialization of NanoMaterials 2007

November 11-13, 2007
Sheraton Station Square Hotel
Pittsburgh, Pennsylvania, USA

FINAL PROGRAM

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Welcome to Commercialization of NanoMaterials 2007!

We have assembled a program to invite dialogue among industry, small business, academia, and government to understand each others' needs and discuss opportunities for nanomaterials solutions. This conference presents advances that will pave the way for the evolution of materials and materials industries through nanotechnology.

Invited Keynotes

Andy Hannah, President and CEO, Plextronics Inc.
Presenting "Printing Nanomaterials will Revolutionize the Electronics Industry"

Scott Livingston, Managing Director, Axiom Capital Management Inc.
Presenting "Investing for Commercialization: Wall Street, Venture Capital and Nanomaterials"

E. Clayton Teague, Director, Federal National Nanotechnology Coordination Office
Presenting "National Nanotechnology Initiative"

Invited Plenary Speakers

Jong-Goo Park, Director General, Nano Korea – *Nano Technology Research Association, South Korea*

Peter Hauptmann, Director, *Saarland Economic Promotion Corp., Germany*

Tatsuro Ichihara, Chief Executive Officer, *ASTEM, Japan*

Mehdi Moussavi, Chief, *Department of Nanomaterials Technologies, France*

Nils Petersen, Director General, *National Institute for Nanotechnology, Alberta, Canada*

Special Features

- Intellectual Property Workshop
- Environmental, Health and Safety Panel Discussion
- Venture Capitalist and Investor Panel Discussion
- Exhibition
- Networking and Social Events
- Student Poster Competition

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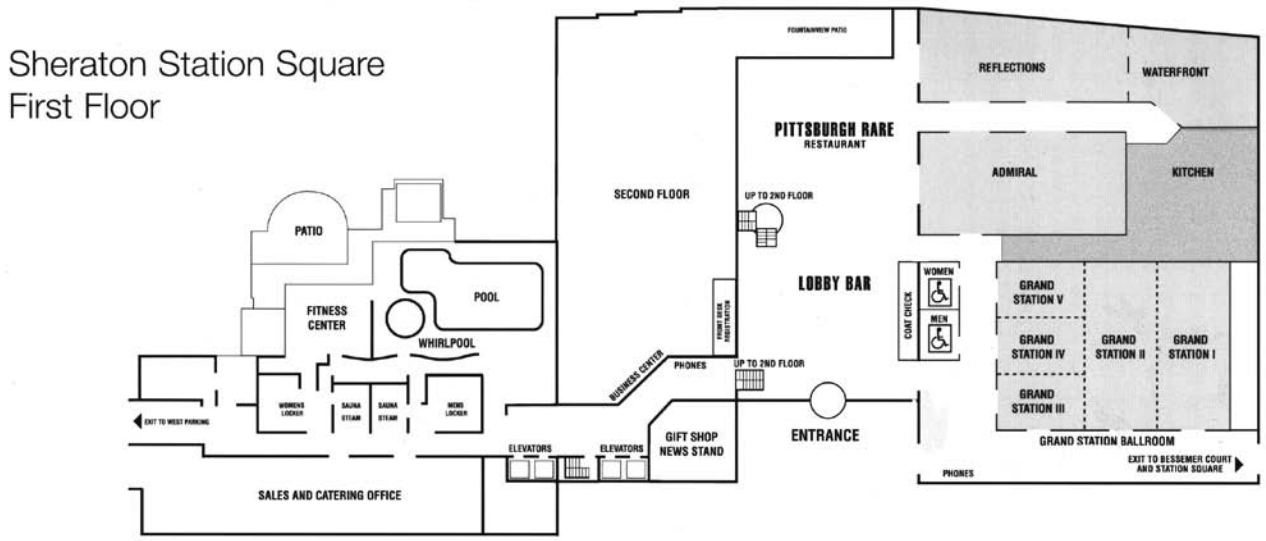

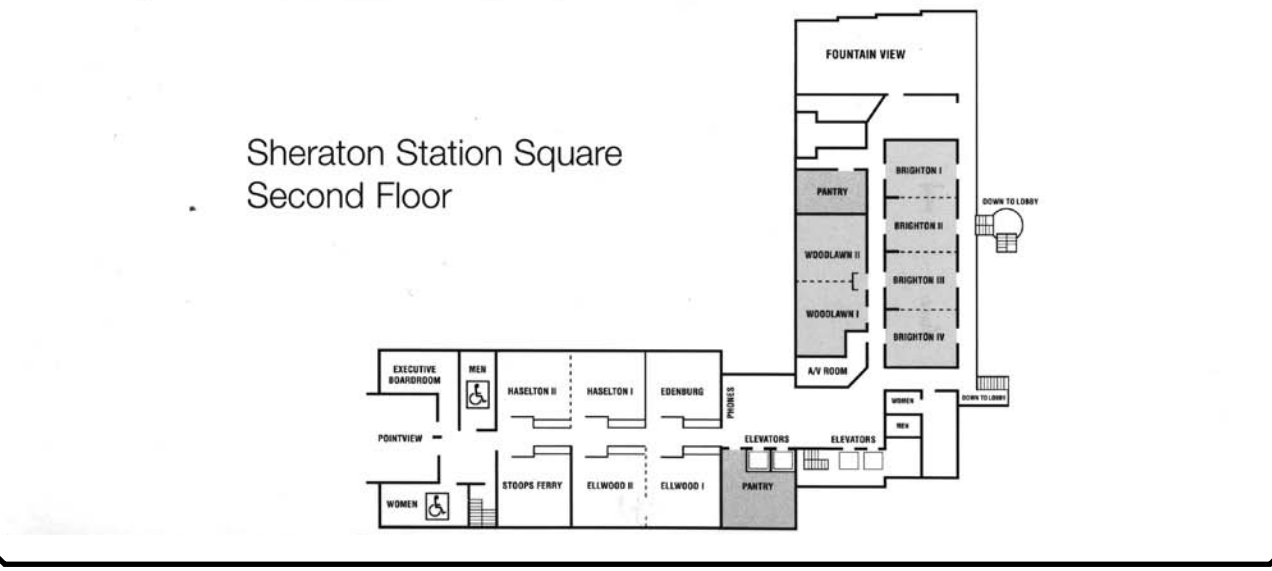

Internet Access

Complimentary wireless Internet service is available in the hotel lobby, business center and sleeping rooms.

Policies

Badge Policy
Badges must be worn to gain access to technical sessions, exhibition and social functions.

Refund Policy
The deadline for refunds was October 29, 2007. No refunds are issued after the deadline.

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TMS strongly supports the federal Americans with Disabilities Act (ADA) which prohibits discrimination against, and promotes public accessibility for, those with disabilities. In support of, and in compliance with, ADA, we ask those requiring specific equipment or services to notify an individual at the conference registration desk.

Networking and Social Events

Welcoming Reception
Sunday, 5:30 to 7 p.m. • Fountainview Room

Enjoy hors d'oeuvres and cocktails with welcoming remarks from:
- Robert Shull, TMS 2007 President; Member of OSTP Nanoscale Science, Engineering and Technology Subcommittee
- Thomas Armstrong, Nanotech Program Manager, Pennsylvania Department of Community & Economic Development

Continental Breakfast
Monday and Tuesday, 7:30 to 8 a.m. • Grand Station I&II

Monday Breakfast Sponsored by Bayer MaterialScience

This complimentary breakfast of coffee, juice, pastries and fruit is served each day prior to the keynote address and sessions.

Conference Luncheon
Monday, 11:40 a.m. to 1:30 p.m. • Reflections Room

Sponsored by Pennsylvania Department of Community & Economic Development

Keynote Speaker:
E. Clayton Teague, Director, Federal National Nanotechnology Coordination Office

Networking Reception
Monday, 5:45 to 7 p.m. • Grand Station I&II

Sponsored by Woodcock Washburn LLP

Network with colleagues, view student posters, and learn about the latest products and services in the commercialization of nanomaterials, all at this event! Hors d'oeuvres and cocktails will be available.

The student poster competition is organized by The American Ceramic Society. Students submitted posters demonstrating a balance of cutting-edge research in nanomaterials with suggested opportunities for commercial application. Winners will be announced and receive a certificate and an award of $200 for third place, $300 for second place, and $1,000 for first place. Attend this event and support our young professionals!

Networking Breaks
Monday and Tuesday

Take advantage of these morning and afternoon breaks to network with speakers and fellow attendees involved in varying aspects of the commercialization of nanomaterials.

Exhibition

See the products and services available to you from these companies in the 2007 Commercialization of NanoMaterials Exhibition in Grand Station I&II!

Exhibition Hours: Monday, 7:30 a.m. to 7 p.m. • Tuesday, 7:30 a.m. to noon

Company	Sponsor Level
Buchanan Ingersoll & Rooney PC	*Platinum*
Pennsylvania Department of Community & Economic Development, Technology Investment Office	*Platinum / Monday Luncheon*
Pennsylvania NanoMaterials Commercialization Center	*Platinum*
Woodcock Washburn LLP	*Platinum / Monday Reception*
Bayer MaterialScience	*Gold / Monday Breakfast*
PPG Industries	*Gold Sponsor / Signage*
The Pennsylvania State University, Industrial Research Office	*Gold / Final Program*
Aldrich/Sigma-Aldrich	*Exhibition*
Bühler AG	*Exhibition*
CH2M Hill	*Exhibition*
Goodfellow Corporation	*Exhibition*
Hosokawa Micron Powder Systems	*Exhibition*
Integran Technologies Inc.	*Exhibition*
Kurt J. Lesker Company	*Exhibition*
Lehigh University	*Exhibition*
Nanoclay & Technologies Inc.	*Exhibition*
NanoDynamics	*Exhibition*
Plextronics Inc.	*Exhibition*
Science and Technology Center in Ukraine	*Exhibition*
The Pennsylvania State University, Center for NanoCellulosics	*Exhibition*
University of Pittsburgh	*Exhibition*

Commercialization of NanoMaterials 2007 would not have been made possible without the hard work and support of these individuals and organizations:

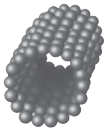
Organizing Committee

- David Briel, *Pennsylvania Department of Community & Economic Development*
- Dr. Alan Brown, *Pennsylvania NanoMaterials Commercialization Center*
- Scott Cummings, *Buchanan Ingersoll & Rooney PC, and Atlantic NanoForum*
- David Diehl, *Nanomaterials Advisor*
- Ron Maloney, *Allegheny Conference on Community Development*
- Kimberly McDonald, *Bayer MaterialScience and American Chemistry Council*
- Mark Mecklenborg, *ACerS*
- Dr. Todd Osman, *TMS*
- Dr. Daniel Rardon, *PPG Industries*
- Dr. S.K. Sundaram, *Pacific Northwest National Laboratory*
- Dr. Nigel Sanders, *Minerals Technologies*

Sunday, November 11, 2007

Monday, November 12, 2007

Tuesday, November 13, 2007



Workshop

Sunday, 4:00 PM Room: Ellwood I & II
November 11, 2007 Location: Sheraton Station Square

Instructor: Scott Cummings, Buchanan Ingersoll & Rooney PC

How to Successfully Capitalize on Your Innovations: An Intellectual Property Workshop

Any successful innovator can tell you, with an ethereal smile, exactly when and where "the big idea" hit him or her. This expression will flash to a serious battle-worn stare as they explain all the work done to get the product launched. The focus of this workshop will be on the intellectual property and corporate aspects of a typical odyssey from idea to product release.

Welcome and Monday Morning Keynote

Monday AM Room: Grand Station I & II
November 12, 2007 Location: Sheraton Station Square

Session Chair: Alan Brown, PA Nanomaterials Commercialization Center

8:00 AM Welcoming Remarks by Mike Doyle, United States Congressman (D-PA)

8:15 AM Keynote
Printing NanoMaterials Will Revolutionize the Electronics Industry: *Andy Hannah*[1]; [1]Plextronics

9:00 AM Break

Environmental, Health and Safety Panel Discussion

Monday AM Room: Brighton I & II
November 12, 2007 Location: Sheraton Station Square

Session Chair: Kimberly McDonald, Bayer MaterialScience LLC

9:30 AM Panel Discussion

Engage in a critical discussion addressing progress in nano environmental, health and safety from large scale materials producers, government agencies and analytical laboratories.

Panelists:

Nanomaterials - HSE and Product Stewardship Considerations: *Kimberly McDonald*[1]; [1]Bayer MaterialScience LLC

Nanomaterial Production - Environmental and Industrial Hygene Considerations: *Liz McMeekin*[1]; [1]PPG Industries Inc.

Managing Nanomaterials with a Life Cycle Approach: *H. Scott Matthews*[1]; [1]Carnegie Mellon University

Application of Industrial Hygiene Practices and Control Banding in Nanoscale R&D Laboratories: *Randall Ogle*[1]; [1]Oak Ridge National Laboratory, Center for Nanophase Materials Sciences

Laboratory Workplace Safety Practices and Sampling and Analysis Considerations: *Keith Rickabaugh*[1]; [1]RJ Lee Group, Inc., Materials and Analytical Services

An Overview of NIOSH Nanotechnology Research and an Update on the Efficacy of Personal Protective Equipment for Reducing Worker Exposure to Nanoparticles: *Ronald Shaffer*[1]; [1]National Institute for Occupational Safety and Health (NIOSH), National Personal Protective Technology Lab (NPPTL)

Nanomaterials Technologies: Coatings

Monday AM Room: Brighton III & IV
November 12, 2007 Location: Sheraton Station Square

Session Chair: Daniel Rardon, PPG Industries Inc.

9:30 AM
Antimicrobial Materials for Coatings: Pyridinium Polymer/Silver Bromide Based Nanocomposites: Varun Sambhy[1]; Blake Peterson[1]; *Ayusman Sen*[1]; [1]Pennsylvania State University

Our research involves the design of polymers and polymer/inorganic nanoparticle composites with antimicrobial properties. In our work, we have sought to (a) develop new antimicrobial polymers and composites, (b) understand the structure-property relationships underlying their efficacy, and (c) bind the antimicrobials to surfaces to confer antiseptic properties to latter. Our synthesized materials have potent antibacterial activity towards both gram-positive and gram-negative bacteria. The materials form good coatings on surfaces and kill both airborne and waterborne bacteria. Furthermore, the coated surfaces resist biofilm formation. These material are potentially useful as antimicrobial coatings in a wide variety of biomedical and general use applications.

9:55 AM
Challenges and Opportunities in Developing Nanomaterials for Health Maintenance: *Alan Rae*[1]; [1]NanoDynamics Inc

In this conference there will be several papers about diagnosing, imaging and treating medical disordes. An underserved area is the prevention of health issues through providing surfaces that do not encourage the growth of bacteria, fungi and other organisms. This paper outlines some of the nano-sized solutions in this field, specifically in the coatings and building materials area and explores some of the opportunities and challenges they face as they move towards commercialization.

10:20 AM
Deposition of Superhydrophbic Coatings with Scanning Atmospheric rf Plasma: *Seong Kim*[1]; [1]Pennsylvania State University

Stable superhydrophobic coatings on various substrates are attained with an in-line atmospheric rf plasma process using CF4, H2, and He. A stable rf glow plasma was generated over a 1 cm x 16 cm area using a cylindrical electrode geometry. A typical treatment speed was 5 ~ 10 cm/min. The coating layer is composed of CFx nano-particulates and has an average roughness of ~10 nm. This roughness is much smaller than the visible light wavelength; so the coatings are transparent. The superhydrophobic coatings can be produced on both metallic and insulating substrates without any need of separate micro-roughening or vacuum lines.

10:45 AM
Non-Chrome Anticorrosion Technology Based on Nano-Sized Materials: *Noel Vanier*[1]; Cheng-Hung Hung[1]; John Schneider[1]; David Walters[1]; [1]PPG Industries Inc.

Nanoparticulate materials offer the potential advantage over conventional coating pigments of a high surface area to volume ratio. On the premise that the anticorrosion activity may be dependent on particle size, our laboratories synthesized nanoparticulate materials for evaluation as corrosion inhibitors in a variety of coating formulations. The nanoparticles for this study were prepared via a thermal plasma reactor. The materials targeted were mixed inorganic oxides of the elements known to have anti-corrosion activity, with toxic heavy metals excluded. The application of these materials in anticorrosion

coatings and comparison of their performance to conventional technologies such as zinc phosphate and strontium chromate based systems are described. Automotive and aerospace applications require corrosion control over multiple substrates that often have contradictory performance in accelerated corrosion testing. Accordingly, the experimental formulations were tested over cold rolled steel, electrogalvanized steel, and aluminum substrates. Performance was measured by ASTM B117 salt spray, humidity resistance, adhesion, and exterior exposure testing. Statistical design techniques were used to identify synergies and analyze data. The results indicated performance properties approaching that of chrome containing systems and superior to zinc phosphate inhibited systems. Some of these composite materials performed equally well over all three of our test substrates.

11:10 AM

Plasma Synthesis of Nanopigments for Anticorrosive Coatings: *Peter Kong*[1]; Jon Grandy[1]; Brent Detering[1]; Larry Zuck[1]; Cheng-Hung Hung[2]; Noel Vanier[2]; [1]Idaho National Laboratory; [2]PPG Industries Inc.

Idaho National Laboratory and PPG Industries are jointly developing a novel modular DC hybrid plasma system to produce pigment nanoparticles for use in anticorrosion coatings. The novel plasma system produces a long plasma with a long residence time. Nanoparticles of alumina and silica have been successfully synthesized using very large solid feed particles. The paint with nanopigments was applied to cold-rolled steel, electro-galvanized steel, and aluminum to form coatings. The nanopigment coatings and two other control coatings with anticorrosive additives, zinc phosphate and strontium chromate, were subjected to 1000 hours of ASTM B117 salt spray testing. After the test the nanopigment coating showed significantly better performance than the conventional zinc phosphate control samples, comparable to the chromate control. This test reveals that nanopigments can provide effective chrome-free anticorrosion properties to paint coatings. This paper will discuss the development of the modular hybrid plasma system and the nanoparticles produced.

Nanomaterials Technologies: Nanomaterials for Energy Applications

Monday AM Room: Ellwood I & II
November 12, 2007 Location: Sheraton Station Square

Session Chair: S. K. Sundaram, Pacific Northwest National Laboratory

9:30 AM

Advances in Plexcore™ Active Layer Technology Systems for Organic Solar Cells: Andy Hannah[1]; *Troy Hammond*[1]; [1]Plextronics, Inc.

Plextronics designs and develops active layer technology for printed electronics devices - OLED displays and lighting, polymer solar cells and plastic circuitry. Active layer technology is the printed semiconductors and conductors that drive device performance. Plextronics has robust control of polymer design and ink formulation, as well as an intimate understanding of device physics and its impact on device performance. This knowledge is applied to the creation of Plexcore™ technology. Plexcore technology is designed to maximize the efficiency, lifetime and stability of printed electronic devices. This talk will emphasize advances to our Plexcore™ PV technology system for organic solar cells. This active layer system includes the hole-transport layer (HTL), and the p-type and n-type semiconductors. To date, Plexcore PV has achieved improved efficiency over standard organic solar cell technology. In addition, we will discuss both on- and off-grid applications of the technology as well as our trajectory toward commercialization.

9:55 AM

Low Cost, Nanostructured Alloy Catalysts for Fuel Cells: *Arumugam Manthiram*[1]; [1]University of Texas at Austin

Fuel cells are appealing for a variety of energy needs ranging from portable electronic devices to automobiles to stationary power as they offer clean energy. However, the commercialization of fuel cell technologies is hampered by high cost, durability, and operability problems, which are linked to severe materials challenges. For example, the limited availability of the expensive platinum catalyst poses serious problems for widespread commercialization of the technology. This presentation will focus on the design, chemical synthesis, characterization, and electrochemical evaluation of less expensive, nanostructured palladium-based alloy catalysts for fuel cells. With multiple metals involved, one of the challenges is to achieve a high degree of alloying while keeping the particle size small at the nanoscale and the surface area high. Novel synthesis approaches such as the reverse microemulsion and polyol reduction methods to obtain alloy nanocatalysts with a high degree of homogeneity at lower temperatures will be presented.

10:20 AM

Nanoscale Effects in Solid Oxide Fuel Cells: *Xiao-Dong Zhou*[1]; Subhash Singhal[1]; [1]Pacific Northwest National Laboratory

Solid oxide fuel cell (SOFC) is an electrochemical device, based on an oxide ion conducting electrolyte, which converts chemical energy of a fuel (such as hydrogen or a hydrocarbon) into electricity at temperatures from about 550 to 1000°C. SOFC offers certain advantages over lower temperature fuel cells, notably its ability to use CO as fuel rather than being poisoned by it, and high grade exhaust heat for combined heat and power, or for combined cycle gas turbine applications. Siemens has successfully operated a 100 kW combined heat and power system for more than 30,000 hours with a voltage degradation of less than 0.1% per 1000 hours; in addition, individual cells have been tested for over 8 years with ability to withstand >100 thermal cycles. The most important need to commercialize this technology is to significantly reduce the overall cost of SOFC-based power systems. Reduction of operation temperature enables use of low-cost metallic interconnects and a decrease in maintenance costs. However, at lower temperatures, greater ohmic loss due to a reduction in ionic conductivity (σi) in the electrolyte and reduced catalytic activity of electrodes results in lower cell performance. To improve cell performance at lower temperatures, employing nanoscale materials for the electrolyte and the electrodes has recently been considered. In this presentation, ionic transport in nanocrystalline electrolytes, with an emphasis on distinguishing intrinsic and extrinsic effects, is discussed with the use of space charge model, which predicts an enhanced conductivity. Maier and his colleagues(1) have provided experimental evidences, showing an increased si of more than an order magnitude in nanoscale specimens by restructuring simple ionic crystals; in a typical electrolyte material, such as yttria stabilized zirconia (YSZ), enhanced oxygen diffusivity was observed in the interfaces of nanocrystalline YSZ; si, therefore, is expected to increase based on Nernst-Einstein relationship. There exist, however, conflicting results with respect to whether or not si increases in nanocrystalline YSZ films. The size effect in Ni- based anode has been under scrutiny for a number of years because of other related research such as methane reforming. The size effect in the cathode and the seals is less well known and will also be discussed in this presentation, with an emphasis on the understanding of nano/microstructure-cathodic property relation. A crucial question that remains to be answered is whether the beneficial effect of employing nanoscale materials will persist even after long term cell operation at high temperatures, even though the initial performance may have indicated substantial enhancement. (1) N. Sata, K. Eberman, K. Eberl, and J. Maier, Nature, 408, 946-949 (2000).

10:45 AM

Nanostructured Materials: Exploring the Energy Frontier: *Prashant Kumta*[1]; [1]University of Pittsburgh

Abstract not available.

11:10 AM

Nucleating a Company on Quantum Dots: Clinton Ballinger[1]; *Dylan Spencer*[1]; [1]Evident Technologies, Inc.

Forming a new company around new technology with new products that serve a variety of markets is difficult. Growing the company is even more difficult. There are many challenges to convert a nanotechnology into money-making products. This presentation will discuss the journey of one company, Evident Technologies, and the challenges faced with commercializing products based on quantum dot technology.

Monday Luncheon Keynote

Monday AM Room: Reflections
November 12, 2007 Location: Sheraton Station Square

Session Chair: Tom Armstrong, Pennsylvania Department of Community and Economic Development

11:40 AM Keynote
National Nanotechnology Initiative: *E. Clayton Teague*[1]; [1]Federal National Nanotechnology Coordination Office

International Forum

Monday PM Room: Grand Station I & II
November 12, 2007 Location: Sheraton Station Square

Session Chair: Alan Brown, PA Nanomaterials Commercialization Center

1:30 PM
Jong-Goo Park, Director, KIST, South Korea

1:55 PM
Peter Hauptmann, Director, Saarland Economic Promotion Corporation, Germany

2:20 PM
Tatsuro Ichihara, Project Manager, ASTEM, Japan

2:45 PM
Mehdi Moussavi, Chief, Department of Nanomaterials Technologies, France

3:10 PM
Nils Petersen, Director General, National Institute for Nanotechnology, Canada

3:35 PM Break

Nanomaterials Technologies: Functional Nanomaterials I

Monday PM Room: Brighton I & II
November 12, 2007 Location: Sheraton Station Square

Session Chair: Jeffrey Rosedale, Woodcock Washburn

4:00 PM
Developing Bright and Color-Saturated Light Emitting Diodes and Displays Based on Colloidal Nanocrystal Quantum Dots: *Jian Xu*[1]; Jerzy Ruzyllo[1]; Suzanne Mohney[1]; Ting Zhu[1]; Andrew Wang[2]; [1]Pennsylvania State University; [2]Ocean NanoTech LLC.

Semiconductor NQDs have recently commanded considerable attention from photonics researchers due to their interesting optical characteristics and easy processibility. Semiconductor NQDs are nanocrystals that are smaller in size than the diameter of a Bohr exciton in a bulk crystal of the same material. The small dimensions of NQDs can, therefore, apply extremely strong quantum confinement to their electronic structures and the optical processes occurring inside. This is reflected by the sharp exciton absorption features and the high photoluminescence (PL) efficiency observed for many compound NQDs. The NQD-emission can be easily tuned by varying the size and/or the material composition of nanoparticles to cover a broad range of the spectrum, i.e. 0.4–0.8µm for CdSe/(Cd,Zn)S core-shell NQDs and 0.8-4.0µm for Pb(S, Se) NQDs.

4:20 PM
Flexible PVC Nanocomposites: Opportunities for Improvement: *Daniel Schmidt*[1]; [1]University of Massachusetts at Lowell

PVC finds use in applications from siding and plumbing to gloves, blood bags, and electrical insulation. PVC also has an image problem, due to the use of inexpensive and effective but potentially toxic additives (phthalate plasticizers, lead-based thermal stabilizers). Alternatives exist, but are generally more expensive/less effective. The capacity of polymer/clay nanocomposites to improve many polymer properties has generated much interest, with a number of nanocomposite products on the market today. Still, few studies have been performed on PVC nanocomposites, and fewer with realistic formulations and processing conditions. We are developing PVC (FPVC) nanocomposites based on industrially relevant formulations and equipment with the goal of identifying safe, practical additives packages giving high performance via synergistic additive interactions. In the first stage, nanocomposites prepared via melt-compounding of medical grade FPVC were shown to retain their transparency, mechanical properties, and process profile and displayed substantial reductions in permeability. In the second stage, nanocomposites have been prepared based on realistic (lead-stabilized, phthalate-plasticized) PVC wire and cable formulations and "greener" alternatives (lead-free, epoxidized vegetable oil plasticized). We confirm additive compatibility, show retention or improvement of mechanical and electrical properties, and describe our most current results with these materials.

4:40 PM
Plasmonics Based Ultra Compact, Low Cost Spectrometer-on-a-Chip for Personal and Everyday Applications: *Bill Choi*[1]; [1]nanoLambda

NanoLambda is presenting a commercialization effort to develop Spectrum Sensor™, an ultra-compact low-cost spectrometer-on-a-chip, based on the newly discovered plasmonic nano-optic phenomena occurring when a light meets metallic nanoscale structures. By introducing novel metallic nanoscale structures, the devices can provide a unique way to control polarization, phase, and wavelength of light passing through the structures. Unlike the highly integrated semiconductor chips, most of the optical components have the limitation on scaling down the size and lowering the cost because of the diffraction limit and the manufacturing process. Recently, plasmonic technology has opened a new paradigm in scaling down optical components below the diffraction limit. One of the notable properties of surface plasmons is that their spatial dimension can be made significantly smaller than that of the optical wavelength. Surface plasmons with this novel characteristic enable subwavelength-scale optical components and thus dramatic size reduction of optical systems, modules, and circuits. Equally importantly, the devices can be fabricated by utilizing currently available wafer processes, which reduce the cost of the devices dramatically by multiple orders of magnitude. With these breakthrough in size and cost, the Spectrum Sensor™, an ultra-compact low-cost spectrometer-on-a-chip, can open up huge new volume markets in personal and everyday applications, such as 1) high resolution color sensor for consumer electronics and bio applications 2) mobile wearable non-invasive health monitors, and 3) simultaneous detection of multiple toxic gases/hazardous materials for security and safety.

5:00 PM
Nanostructured Thin Films as Coatings for Energy Efficient Glazing in the Building and Transportation Industry: *Jim Finley*[1]; [1]PPG Industries Inc.

Nanostructured thin films have transformed the glass industry from a commodity supplier of flat glass into a producer of performance glazing products for the building and transportation industry. The primary commercial application of nanostructured thin films in the glass industry is for energy efficient glazing, especially in light of escalating energy costs which has led to worldwide growth in the use of low emissivity and solar control coated products. Over the past 25 years, PPG has made significant investment in large area physical (PVD) and chemical vapor deposition (CVD) processes to produce these products cost effectively and to meet the growing demand. The CVD process which takes place on the glass float line is accountable for the production Sungate® 500 glass, a low emissivity, high transmittance coating for thermally insulated glazing that is durable enough to be handled like glass in the window fabrication process. The MSVD (magnetron sputtering

vacuum deposition process), which is a type of PVD that takes place off the float line, enables the production of high performance low emissivity and solar infrared reflecting coatings. Architectural products such as Solarban® 60 glass provide high visible light transmittance while blocking solar infrared energy. The newly introduced Solarban 70XL glass, having the highest visible light to solar heat gain ratio of any product, enables a building owner, for example, to reduce requirements on A/C systems which results in lower construction costs. Vehicle transparencies such as the Sungate Windshield reduce solar heat load, and offer additional functionality such as heated and antenna applications. This presentation will describe the nanostructure thin films and the processes to produce them, and PPG products and processes that incorporate these coatings into glazing applications.

5:20 PM

Rapid Screening of Engineered Nanomaterials for Toxicity: *S. K. Sundaram*[1]; [1]Pacific Northwest National Laboratory

Engineered nanomaterials are entering the market place at a rapid pace. This challenges researchers and regulators alike. Exposure to nanomaterials may occur by oral, dermal, inhalation, and injection routes, depending on use patterns. Three basic elements of the toxicity screening are 1) physicochemical characteristics, 2) in vitro (cellular as well as non-cellular) assays, and 3) in vivo assays. In vitro techniques allow specific biological and mechanistic pathways to be isolated and tested under controlled conditions. Tests will be needed for portal-of-entry toxicity for lungs, skin, and the mucosal membranes, and target organ toxicity for endothelium, blood, spleen, liver, nervous system, heart, and kidney. Additionally, non-cellular assessment of nanoparticle durability, protein interactions, complement activation, and pro-oxidant activity will also be needed. The in vivo testing would include evaluations of various types of exposures and the the effects of multiple exposures, potential effects on the reproductive system, placenta, and fetus, alternative animal models, and mechanistic studies. Therefore, fast, accurate, cost-effective, and portable technologies are essential for understanding and regulating the exposure and risk. Vibrational spectroscopy is a viable tool that can be used in combination with established and new toxicological and biological tools. Preliminary results of screening silica nanoparticles for toxicity will be presented.

Nanomaterials Technologies: Structural Nanomaterials I

Monday PM
November 12, 2007

Room: Ellwood I & II
Location: Sheraton Station Square

Session Chair: Nigel Sanders, Minerals Technologies Inc

4:00 PM

Nano-izing Polymers with Nanoclays: Evolving Products and Applications: *Karl Kamena*[1]; [1]CLOISITE Nanoclays

Layered smectite nanoclays with very large surface areas (750 m^2/gram) are being developed for incorporation into a variety of host polymer systems. Nanoscopic phase distribution can impart enhanced stiffness and strength at low levels of addition as well as improving barrier and flame retardant properties. Traditionally, the focus has been on the development of nanocomposites with nanoclays being the principal non-polymer ingredient. In the early stages of the nano "revolution", nanoclays appeared to be a quick route to breakthrough product performance, but as we learn time and again, there is no shortcut to success. Increasingly, product developers are combining nanoclays with other inorganic and organic modifiers to generate nano-ized polymers with the desired formulation properties and cost/performance characteristics. Developments with existing nanoclay products using conventional amine chemistries are leading the way for future composite technologies involving thermoplastic, thermoset, and rubber formulations. Nanoclays are demonstrating unique, multi-dimensional capabilities to synergistically enhance overall polymer performance.

4:20 PM

New Techniques for Carbon Nanotube Quality Control: *Stephanie Hooker*[1]; [1]National Institute of Standards and Technology

Carbon nanotubes are currently synthesized by many different routes, resulting in often significant variations in the extent of chemical impurities and the types of nanotubes produced (e.g., metallic vs. semiconducting). New methods are needed to quickly and reliability analyze bulk nanotubes providing material producers and product developers with a qualitative measure of material purity and homogeniety. This paper describes one such technique which utilizes a quartz crystal microbalance as a platform for rapid thermal analysis of small bulk samples. By monitoring weight changes at only a few key temperatures, materials can be quickly compared from lot to lot and within a given batch. The results of demonstration tests involving seven different material suppliers will be reported, illustrating the effectiveness of this method for quality control applications.

4:40 PM

On the Use of Nanoparticles to Toughen Epoxy Resins: *Raymond Pearson*[1]; Robert Oldak[1]; Yi-Ling Liang[1]; [1]Lehigh University

Epoxies have been traditionally toughened using either micron size rubber particles or micron size fillers. In some cases both types of particles have been used to produce tough, hybrid composites. In this paper we will discuss the use of nanosize particles to toughen epoxy resins. The fracture toughness was as high as 2.7 MPa-$m^{1/2}$ for the nanosilica filled epoxies and up to 4.8 MPa-$m^{1/2}$ for the epoxies toughened with nanosize rubber particles (high loadings). Interestingly, the combination of the two types of nanosize toughening particles at low loadings produced an epoxy that was synergistically toughened to a fracture toughness of 4.4 MPa-$m^{1/2}$. The toughening mechanisms will be discussed.

State and Local Development

Monday PM
November 12, 2007

Room: Brighton III & IV
Location: Sheraton Station Square

Session Chair: Alan Brown, PA Nanomaterials Commercialization Center

4:00 PM

Creative Self-Assembly – Focusing on "Applications" of Nanotechnology in Oklahoma: *Jim Mason*[1]; [1]The Oklahoma State Chamber

Oklahoma passed the Oklahoma Nanotechnology Sharing Incentive Act in 2006 which provides funds for companies to commercialize an new or established product utilizing a nanotechnology process. Seven companies were awarded funds in 2007. Oklahoma has grown from 6 nanotech companies to 40 companies utilizing nanotechnology. The Oklahoma Nanotechnology Initiative (ONI) was created in 2003 by a legislative resolution and is related to the Oklahoma NanoNet that was initiated and funded in 2002 by Oklahoma EPSCoR (Experimental Program to Stimulate Competitive Research). The ONI is coordinated by The Oklahoma State Chamber via a contract with the Oklahoma Center for the Advancement of Science and Technology (OCAST). The Objectives of the ONI are to 1) Create a statewide awareness of the emerging nanotechnology industry and its potential impact on the state; 2) Promote Oklahoma and its resources as a valuable site for nanotechnology-related industry location; 3) Serve as a clearinghouse of information on nanotechnology to the academic, financial, industrial, and business communities; 4) Work toward the creation of an Oklahoma Center of Excellence in Nanotechnology and 5) Support the creation of undergraduate nanotechnology training programs.

4:25 PM

"Benign by Design": Adopting Proactive Design Strategies for Developing Inherently Safer Nanomaterials: *Bettye Maddux*[1]; [1]ONAMI

Nanotechnology is an emerging field that has great potential for use in commercial applications. Nanomaterials and its manufacturing methods, however, may pose adverse environmental, health and safety effects. One of the challenges facing this new industry is the design of nanomaterials

and nanomanufacturing methods that provide maximum efficiency while minimizing these hazards. Merging green chemistry and nanoscience will provide opportunities to meet these challenges and to develop sustainable technologies and materials. The Oregon Nanoscience and Microtechnologies Institute (ONAMI) promotes research excellence and fuels economic development in the Pacific Northwest. The Safer Nanomaterials and Nanomanufacturing Initiative is one of ONAMI's major research areas whose objectives are to: [1] design environmentally-benign nanoparticles for use in electronic and optical applications (toxicological testing is incorporated into our proactive design strategies), [2] develop greener methods for large-scale nanoparticle manufacturing, and [3] discover efficient approaches for interfacing nanoparticles to nano- and macro-structures for device applications.

4:50 PM
The *Small Times* Perspective on State Nanotech Development: *Barbara Goode*[1]; [1]*Small Times*

Soon after it was launched in 2001, *Small Times*, the premiere publication covering MEMS and nanotechnology, began doing an annual state ranking to quantify and compare "small tech" progress across the nation. This presentation will discuss the findings and methodology for *Small Times'* state rankings.

5:15 PM
From Concept to Commercialization: The Commonwealth's Role in Nanotechnology's Next Step: *Rebecca Bagley*[1]; [1]Pennsylvania Department of Community Economic Development, Pennsylvania Initiative for Nanotechnology

Abstract not available.

Networking Reception and Student Poster Session

Monday PM
November 12, 2007

Room: Grand Station I & II/Lobby
Location: Sheraton Station Square

5:30-7:00 PM
Program to be announced.

NOTES

Tuesday Morning Keynote

Tuesday AM Room: Grand Station I & II
November 13, 2007 Location: Sheraton Station Square

Session Chair: Alan Brown, PA Nanomaterials Commercialization Center

8:00 AM Keynote
Investing for Commercialization: Wall Street, Venture Capital and Nanomaterials: *Scott Livingston*[1]; [1]Axiom Capital Management

Nanomaterials Technologies: Functional Nanomaterials II

Tuesday AM Room: Grand Station V
November 13, 2007 Location: Sheraton Station Square

Session Chair: Joe McDermott, Air Force Research Laboratory

8:50 AM
Luminescent Quantum Dot Nanomaterials: *Stéphane Petoud*[1]; [1]University of Pittsburgh

Abstract not available.

9:15 AM
Nanomaterials-Based Technology Development Using Nanosilver and Nano-ZnO: *Tata Rao*[1]; G. Sundararajan[1]; [1]International Advanced Research Centre for Powder Metallurgy and New Materials

International advanced research centre for powder metallurgy and new materials (ARCI) has been focusing its research in nanomaterials synthesis and application development. One of the technologies ready for commercialization is the development of nanosilver-coated ceramic candle filters for drinking water disinfection, which are very useful especially in rural areas. The technology is a value addition to the existing candle manufacturing and is cost efficient. The filters developed by ARCI have been successfully field tested for more than eight months in several villages, where the locals depend on pond water and locally treated water that contains significant levels of coliform bacteria. Another proven technology is the development of varistors based on ZnO composite nanopowders synthesized by a novel method. A single step process to make composite powders together with the low sintering temperature makes the technology economic. The varistors made by this process exhibit much better properties than the conventional ones.

9:40 AM
Nanowire Devices: Heat Pipes, Photovoltaics and Sensors: *Youssef Habib*[1]; [1]Illuminex Corporation

Illuminex produces aligned arrays of metallic and semiconducting nanowires for device applications. Engineering the nanowire arrays geometrical and material configurations leads to unique optical, electrical, and mechanical properties of the materials not observed in their bulk counterparts. The observed physical phenomena that occur in nanowire arrays are being exploited for a variety of device applications. Current R&D activities are focused on three areas of product development: Nanowire enabled Heat Pipes for superior thermal management in high-power electronics, Photovoltaics that are highly efficient and cost competitive, and Sensors for ultra-high accuracy medical diagnostics.

10:05 AM Break

Nanomaterials Technologies: Structural Nanomaterials II

Tuesday AM Room: Grand Station IV
November 13, 2007 Location: Sheraton Station Square

Session Chair: Nigel Sanders, Minerals Technologies Inc

8:50 AM
Treatment of Carbon Nanotubes for Enhanced Dispersibility and Industrial Applications: *Rick Simons*[1]; Tania Beltich[1]; [1]NanoRDC

Carbon nanotubes (CNT) are intriguing new materials which have been highly publicized for their exceptional mechanical, thermal, optical and electrical properties. The electronic properties of carbon nanotubes are currently favored for use as electrically conductive fillers for thermoplastics. Like their carbon black predecessors, carbon nanotubes can impart electrically conductive properties into plastics. Current methods for dispersing carbon nanotubes include chemically treating the surface of the CNT with dispersion reagents. Typically, these reagent and techniques are expensive and in some cases alter the electronic properties of the CNT. NanoRDC LLC has proprietary patent pending technology that produces treated CNT for increased dispersibility into solvent and polymer matrices and promises to overcome these problems. The presentation will focus on technology developed at NanoRDC for treating CNT for increased dispersibility into polymer matrices.

9:15 AM
Nanostructured Commercial Alloys via Large-Strain Extrusion Machining: *Kevin Trumble*[1]; Wilfredo Moscoso[1]; Mert Efe[1]; James Mann[1]; M. Ravi Shankar[1]; Srinivasan Chandrasekar[1]; W. Dale Compton[1]; [1]Purdue University

Despite common perceptions, plane-strain machining offers a well-controlled process for producing and studying grain refinement by large-strain deformation in metals and alloys. While homogeneous shear strains in the range of 1 to 15 can be imposed in a single stage of deformation, even in alloys of high initial strength, the geometry of the deformation and resulting 'chip' is not determined a priori. Large-Strain Extrusion Machining (LSEM), combining grain refinement by large-strain machining with simultaneous shape and dimensional control by 'extrusion,' is introduced. Application to the production of ultrafine grained (UFG) foils, plates and bars of controlled dimensions is demonstrated for a variety of commercial alloys, including OFHC copper, Al-6061-T6, CP-titanium and Inconel 718. The LSEM process is compared with other so-called Severe Plastic Deformation (SPD) processes in terms of the mechanics, microstructure development, resulting mechanical properties and commercial attributes.

9:40 AM
Large-Scale Production of Nanostructured Particulate by Modulation-Assisted Machining: *J. B. Mann*[1]; C. J. Saldana[1]; S. Chandrasekar[2]; W. D. Compton[2]; K. P. Trumble[2]; [1]M4 Sciences Corporation; [2]Purdue University

A method for large-scale production of nanostructured particulate metals is demonstrated. The method uses modulation-assisted machining wherein a controlled modulation is superimposed onto a machining process to create discrete particles. Powder particles with controlled size distributions and specified shapes such as equiaxed, platelet, and needle are created in various material systems (e.g., aluminum, titanium) by varying the machining and modulation conditions. Furthermore, the large plastic strains imposed in the particles create an ultra-fine grained (UFG) microstructure and enhanced mechanical properties. Applications in discrete products manufacturing and re-manufacturing will be highlighted.

10:05 AM
Next Generation Composites Opportunities for Commercial Aircrafts: *Samra Sangari*[1]; Russ Maguire[1]; [1]The Boeing Company

Composites play a crucial role in many aerospace applications and there is a huge amount of activity underway globally to produce new composites that can revolutionize performance capabilities for these applications. With the emergence of nanomaterials, there will be more opportunities to design high specific strength materials that reduce the aircraft weight while maintaining

airframe structural integrity. Nanocomposites have proven to provide increased modulus and tensile strength, gas barrier, thermal performance, resistance to small molecule permeation and improved electrical performance when compared to typical traditional carbon-fiber-reinforced polymeric composites. This presentation describes the role of composites in aerospace industry and provides insights into nanocomposites that may be used for novel aerospace applications.

10:30 AM Break

Venture Capitalist and Investor Panel Discussion

Tuesday AM Room: Grand Station III
November 13, 2007 Location: Sheraton Station Square

Session Chair: David Diehl, Nanomaterials Advisor

8:50 AM Panel Discussion

Review commercial needs from the perspectives of venture capitalists and investors.

Mark Brandt, Capital Works

Vincent Caprio, NanoBusiness Alliance

Melissa Hart, Former Member of US Congress

Robin Mansukhani, Axiom Capital Management

Sean Murdock, NanoBusiness Alliance

Sean Sebastian, Birchmere Ventures

10:30 AM Break

Nanomaterials Technologies: BioNano

Tuesday AM Room: Grand Station V
November 13, 2007 Location: Sheraton Station Square

Session Chair: Anthony Green, Ben Franklin Technology Partners

10:45 AM

Dual Polarisation Interferometry – An Accessible Means of Metrology in Bionanotechnology: *Neville Freeman*[1]; [1]Farfield Scientific Inc

The field of bionanotechnology is a rapidly growing area both here and in Europe. Functional biomolecules are inspiring work in a wide range of areas from molecular motors to drug release materials. One key element in the development and exploitation of these materials is the ability to measure their structure both during the development phase and in their production. Dual Polarization Interferometry (DPI) offers a method by which the structure and behavior of bionano systems can be measured using straightforward methodologies which are relevant both to R&D activities and to manufacturing processes. In this talk the technique of DPI will be introduced and some relevant applications discussed.

11:10 AM

Materials and Processes at the Nano/Bio Interface: *Sang Beom Lee*[1]; [1]NanoDynamics Life Sciences, Inc.

NanoDynamics Life Sciences, Inc., a NanoDynamics Inc. subsidiary, is a company dedicated to develop and commercialize innovative nanomaterials and technologies with commercial applications in the biomedical field. ND Life will introduce its technologies for preparing antimicrobial materials based on nanotechnology. ND Life is driving rapid innovation and commercialization of nanomaterials for antimicrobial, biosensors, and pharmaceutical applications. NanoDynamics is a fully integrated technology and manufacturing company utilizing nanoscale engineering and materials to address some of the world's biggest challenges.

Perspectives on Commercialization

Tuesday AM Room: Grand Station III
November 13, 2007 Location: Sheraton Station Square

Session Chair: John Caldwell, Woodcock Washburn

10:45 AM

Commercialization Aspects of Nanotechnology at Bayer: *Péter Krüger*[1]; [1]Bayer MaterialScience AG

Nanotechnology is widely considered as one of the key technologies in the upcoming century. Materials and systems enabled by nano-scaled structures offer an enormous variety of new properties and functions leading to diverse new emerging applications in material and in life sciences as well. This presentation will discuss nanotechnology along the value chain in general and it will also illuminate the platform character of nanotechnology for innovation and growth areas of Bayer. Examples with respect to material sciences, such as nano-enabled intermediates for intelligent materials and surfaces with new and improved properties will be given and it will also refer to life sciences and to responsible care issues. In addition to that, commercialization aspects of nano enabled polymeric intermediates within Business Units and of Carbon Nanotubes (Baytubes®) as an internal start up organization within Bayer MaterialSciences will highlighted.

11:10 AM

The Realization of Nanocomposite Products: An Integrated Approach to Technological Innovation: *Clare Allocca*[1]; [1]National Institute of Standards and Technology

While nanotechnology is spreading throughout the international community, the field of nanocomposites has arisen as one of a number of common themes. The allure is the expectation of dramatic improvements in properties in areas important to a diverse set of industries, including Aerospace, Automotive, Semiconductor, and Chemicals. Yet, despite significant resources devoted to research and development, there are still major technical barriers to be surpassed in order to transfer nanocomposites from research to commercialization. Following an October 2006 NIST workshop on *Instrumentation and Metrology for Nanomanufacturing*, an informal Working Group, representing Industry, Academia, and Government, formed to identify issues that are key to the development of nanocomposites over the next ten years. The realization of the nanocomposites vision would contain a framework to enable industry to add nanomaterials to its products in a manner that is consistent, safe and dramatically enhancing to product performance. Toward this end, the following key criteria have been identified: ·reliable and accurate *modeling*, ·*characterization* instrumentation/techniques/protocols providing critical quality control, ·materials synthesis and *processing* techniques that are reproducible and tailored to the end-product., and ·*nanometrology* tools to validate and integrate all of the above. This presentation will summarize both the preliminary findings and future path for the working group and its product.

11:35 AM

Where are the First Customers?: *Samuel Brauer*[1]; [1]Nanotech Plus, LLC

There are two key factors in the commercialization of a new material (nanoengineered or not):First, it has to be able to be produced in the volumes necessary for an application, and have consistent performance and quality. Equally important, there must also be a first customer for this new material. First customers have several common characteristics: 1) Willing to pay for improved performance. 2) Has deep pockets to afford significant order volume. 3) Willing to take risks. 4) Not immediately responsible to shareholders. Identifying the first customers of previous generations of advanced materials and how they funded their purchases will help us identify possible new first customers for today's nanoengineered materials. By examining the history of how four advanced materials, steel, aluminum, carbon fiber, and aramid fiber, were first commercialized, new insights into the challenges facing manufacturers today will be illuminated.

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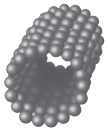

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TMS2008
137th Annual Meeting & Exhibition

March 9-13, 2008
New Orleans, Louisiana, USA

Over 2,200 presentations with 340 in "nano" symposia:

- 2008 Nanomaterials: Fabrication, Properties and Applications
- Ultrafine-Grained Materials: Fifth International Symposium
- Hael Mughrabi Honorary Symposium: Plasticity, Failure and Fatigue in Structural Materials – from Macro to Nano

For more information: www.tms.org/annualmeeting.html

The American Ceramic Society
www.ceramics.org

32nd International Conference and Exposition on Advanced Ceramics and Composites
January 27-February 1, 2008
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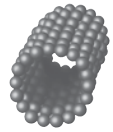
This event features 11 symposia and two focused sessions with more than 780 presentations on topics in advanced structural and functional ceramics, including the 2nd International Symposium on Nanostructured Materials and Nanotechnology: Development and Applications.

For more information: www.ceramics.org/daytona2008

Program-at-a-Glance



Room	Sunday PM	Monday AM	Monday PM	Tuesday AM
	Registration, located in the Lobby *Sunday, 2:00-6:00 PM* *Monday, 7:30 AM-5:00 PM* *Tuesday, 7:30-11:00 AM*		*Exhibit, located in Grand Station I & II* *Monday, 7:30 AM-7:00 PM* *Tuesday, 7:30 AM-12:00 Noon*	
Brighton I & II		Environmental, Health and Safety Panel Discussion 9:30-11:35 AM	Nanomaterials Technologies: Functional Nanomaterials I 4:00-5:40 PM	
Brighton III & IV		Nanomaterials Technologies: Coatings 9:30-11:35 AM	State and Local Development 4:00-5:40 PM	
Ellwood I & II	How to Successfully Capitalize on Your Innovations: An Intellectual Property Workshop 4:00-5:00 PM	Nanomaterials Technologies: Nanomaterials for Energy Applications 9:30-11:35 AM	Nanomaterials Technologies: Structural Nanomaterials I 4:00-5:00 PM	
Fountainview	*Welcoming Reception* *5:30-7:00 PM*			
Grand Station I & II		*Continental Breakfast* *7:30-8:00 AM* Welcome and Monday Morning Keynote 8:00-9:00 AM	International Forum 1:30-3:35 PM *Networking Reception* *5:45-7:00 PM*	*Continental Breakfast* *7:30-8:00 AM* Tuesday Morning Keynote 8:00-8:45 AM
Grand Station I & II Lobby			*Student Poster Session* *5:45-7:00 PM*	
Grand Station III				Venture Capitalist and Investor Panel Discussion 8:50-10:30 AM Perspectives on Commercialization 10:45 AM-12:00 Noon
Grand Station IV				Nanomaterials Technologies: Structural Nanomaterials II 8:50-10:30 AM
Grand Station V				Nanomaterials Technologies: Functional Nanomaterials II 8:50-10:05 AM Nanomaterials Technologies: BioNano 10:45-11:35 AM
Reflections		Monday Luncheon Keynote 11:40 AM-1:30 PM		