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SNO letter

NEWSLETTER OF SUSTAINABLE NANOTECHNOLOGY ORGANIZATION

Sustainable Nanotechnology Organization

Research | Education | Responsibility

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SNO Newsletter Submissions

Please send news, conference announcements, job postings, letters to the editor, and other contributions to the newsletter to the Dr. Sadik or Dr. Karn (osadik@binghamton.edu or bkarn@nsf.gov)
The next newsletter will appear in December 2012.

MESSAGE FROM THE CO-FOUNDER

It is a pleasure to welcome you all to SNO. I take this opportunity to present to all the mission and objectives of the organization.

Wunmi Sadik

1. **Goals and objectives of SNO:**

The goal of SNO is to create an international professional society dedicated to advancing sustainable nanotechnology around the world through education, research, and the promotion of responsible applications of technology. A major objective of SNO is to provide platforms where scientists, engineers, and other professionals would exchange information and ideas for the development and responsible applications of nanotechnologies that would lead to overall sustainability. There would be annual SNO conferences, training workshops, educational outreaches for the lay public, membership events, publications & newsletters, awards, legislative guidance, industrial partnership and student travel grants. The long-term goal of SNO is to address the issues of sustainability for all other emerging contaminants and technologies.

2. **Organization open-to-all for membership**

Membership of SNO is open to all individuals, as well as institutions that are engaged in research and development of nanotechnologies such as applications, implications, methods & protocols. Others include instrumentation development, green energy and synthesis, characterization and metrology, as well as education and society. Sustainable nanotechnology strives to ensure that industrial growth is sustainable while maximizing benefits and societal acceptance. To this end, SNO invites nanotechnology related industries to participate in the advancement of the organization and its multifaceted activities.

Continued on page 2

If any presenters plan to announce new discoveries at the conference, please let Dr. Sadik (osadik@binghamton.edu) or Dr. Karn (bkarn@nsf.gov) know by October 5, 2012. The organization can help promote the announcement.

MESSAGE FROM THE CO-FOUNDER

Continued from page 1

3. **Organization is poised to make an impact on the future of nanotechnology**

Among SNO's most important roles are the advancement of application, implication and societal benefits of nanotechnology. SNO will be the authoritative voice for the wider nanotechnology related disciplines and will advocate for the value of nanotechnology to society. It will communicate *objectively with and* respond *to US and* international *governme*nt agencies. Through its industrial members, SNO will engage companies and key corporate leaders of the nanotechnology revolution. It will also identify and act on common interests that will further advance nanoscience and engineering, including the enhancement of public health and welfare. SNO is *promoting inter-society relationships,* (e.g. ACS, RSC, MRS, SETAC, AIHA etc), *as well as inspiring young, future leaders about the* benefits of nanotechnology to society. Through its award program, SNO will recognize and honor those who have made significant contributions to society and can help educate the public on how nanotechnology affects us all.

4. **SNO is different from other organizations that are currently serving as a platform for the industrial and academic communities**

SNO provides a unique model in that it focuses on sustainability and nanotechnology. SNO is the culmination of several meetings and surveys held after the 1st Gordon Research Conference on Environmental Nanotechnology held at Waterville Valley, NH, in 2011.

As a follow up to this GRC meeting, we conducted a survey to determine the need for an independent professional organization that will promote the sustainability of nanotechnology. The overwhelming responses pointed to the need for the establishment of SNO. About 80% of the respondents observed that professional organizations were generally aware of the importance of the interdisciplinary nature of nanotechnology, but there was no single professional society to engage scientists and engineers involved in research and development of nanotechnology.

Every society takes its societal view on nano: For example virtually every session of the ACS meetings has some nano-components with the viewpoints of chemists. Other professional societies consider nanotechnology from multiple view points: The Materials Research Society (MRS) considers nano with respect to materials; The Society of Environmental Toxicology and Chemistry (SETAC) takes the environmental and toxicological viewpoints on nano, whereas the American Industrial Hygiene Association (AIHA) has done a pretty good job of separately dealing with nanotechnology. But AIHA only deals with the occupational environments. Some of the respondents in our surveys observed that as part of a natural evolution of a maturing field, the practitioners of nanotech should carve out an identity within their discipline, so that nanotech information/advances could flow back into the existing professional organizations and advisory groups. Therefore, SNO fulfills that need by creating a formal, interdisciplinary structure that provides a higher level of integration for sustainable nanotechnology, which is currently not available through existing organizations and societies.

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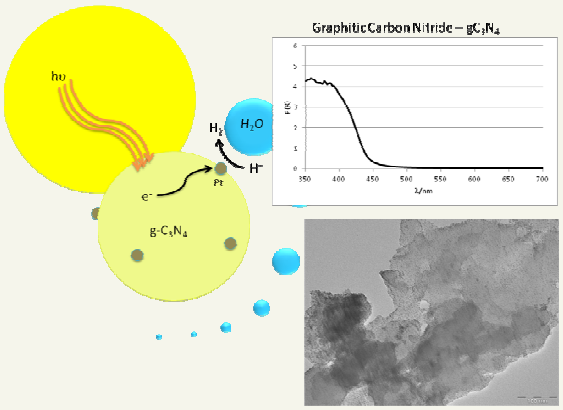
CONFERENCE PREVIEW

Incorporating Life Cycle Thinking into Risk Assessment for Nanoscale Materials: Case Study of Nanocellulose. *Jo Anne Shatkin. CLF Ventures.*

Sustainability science and nanotechnology share the characteristic of being relatively new areas of investigation. They also represent fields where multiple standardization efforts are developing independently, creating confusion in the marketplace, and among governmental and non-governmental organizations, even simply on definitions. In order to facilitate the sustainable development of nanotechnology, there is a need to measure the sustainability of nanoscale materials and products of nanotechnology, in a consistent and meaningful way. With dozens, if not hundreds, of different metrics to measure the sustainability of materials, products or companies, there exists a wealth of options to choose from, and a need to refine the core concepts as they are applied across the many sectors where nanotechnologies are used. This presentation will discuss the state of standards development for sustainability measurements and metrics and evaluate existing alternatives and needs for developing these measurements for nanoscale materials and nanotechnologies.

Titanium Dioxide Photo-Oxidation Efficiency in Small-Scale Photothermal Waste Degradation Reactors.
Christopher Bremer; Arizona State University

With the increase in demand for industrial production and efficiency, comes the demand for increasingly efficient downstream treatment of toxic waste. Nanoscale titanium dioxide (anatase titania) is very promising in fulfilling this role because it requires no support processing units, requires no non-natural energy input or heat input, making it safer and greener than incineration or other common techniques. A prototype photothermal reactor which uses only concentrated solar energy was tested using methylene blue as the waste. The gaseous products were identified and the reaction efficiency was determined to prove the validity of using a throughflow photodegradation reactor for small scale industrial settings. The issues of (a) nanoparticle separation, (b) light penetration, and (c) reaction dependence upon light concentration are addressed. Nanoparticle separation is made possible through a phase separation with the nanoparticles left in the reactor vessel; the reactor core is calculated to be of the proper diameter to enable ultraviolet penetration through the entirety of the titania fluid, and the optimum light concentration to promote (a) and (b) is also determined. While titania reactor systems do not treat as much waste (mass per unit time) as traditional methods, it is still a nascent technology; future research into functionalized nanoparticles show great promise in increasing the reaction rate.



Towards Solar Fuel Generation with a Carbon Nitride Photocatalyst. *Timothy L. Shelton,, University of California, Davis*

Graphitic carbon nitride (g-C3N4) is a visible light

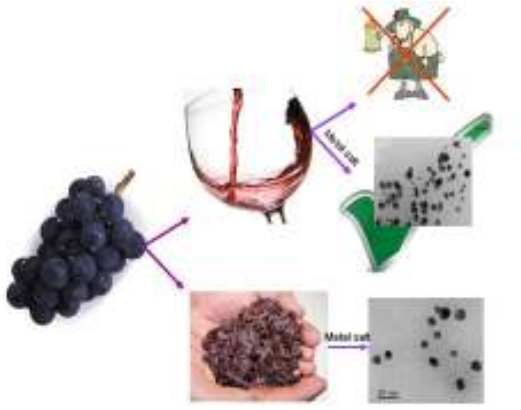
driven photocatalyst for water reduction - a pathway to hydrogen fuel from solar energy. The material is interesting because it does not require precious elements and can be made from abundant precursors (xxx, xxx) through simple heating (xxx deg C). Problems of g-C_3N_4 are low activity and photocorrosion in the absence of sacrificial agents. This study tries to solve these problems through a three pronged strategy involving nanoscaling, addition of water reduction cocatalysts, and interfacing with a suitable photoanode material for water oxidation. Toward these goals, results on the synthesis of nanoscale and Ni-modified g-C3N4 are presented. The materials were characterized with transmission electron microscopy and UV vis spectroscopy. The effect of the modifications on phototalytic activity was measured during irradiation tests in the presence of methanol as sacrificial electron donor. Surface photovoltage spectroscopy (SPV) was employed to analyze charge separation of electron and holes at the material-cocatalyst interface. The implications of these findings on the development of sustainable catalysts for solar energy to fuel conversion will be discussed.

Oil-Water Separation by Wrap-and-Pull Using Superparamagnetic Carbon Nanotubes.
Chongzheng Na, University of Notre Dame

Water contaminated by oil and gas productions poses challenges to the management of America's water resources. We report the design, fabrication, and laboratory evaluation of multi-walled carbon nanotubes decorated with superparamagnetic iron-oxide nanoparticles for oil-water separation. As revealed by confocal fluorescence microscopy, superparamagnetic carbon nanotubes (SCNTs) remove oil droplets through wrap-and-pull, in which SCNTs first disperse at the oil-water interface and then drag oil droplets out of water under an external magnetic field. Measurements of removal efficiency show that wrap-and-pull obeys the kinetics and equilibrium described by the Langmuir model. The separation capacity is a function of the SCNT dose, mixing time, the emulsion volume, and the equilibrium oil concentration. Regressions using experimental data estimate a maximum separation capacity of 1.47(+/-0.05) g-diesel per g-SCNT, a wrapping rate constant of 2.5(+/-0.9) L per g-diesel per min, and a wrap-and-pull equilibrium constant of 3.2(+/-0.1) L per g-diesel. For used MCNTs, we further show that over 80% of the capacity can be restored by a quick ethanol wash. Wrap-and-pull using reusable MCNTs provides an alternative strategy for water treatment in addition to existing ones represented by coagulation, adsorption, filtration, and membrane processes.

Greener Pathways to Nanomaterials and Their Sustainable Applications.
Rajender Verma, US EPA

Sustainable synthetic efforts involving alternate energy input, and greener reaction medium will be summarized wherein vitamins B1, B2, C, and tea and wine polyphenols, which functionboth as reducing and capping agents, provide simple, one-pot, green synthetic methods to bulk quantities of nanomaterials. Shape-controlled synthesis of noble nanostructures via MW-assisted spontaneous reduction of noble metal salts using sugars will be presented including a general methodology for the cross-linking reaction of poly (vinyl alcohol) (PVA) with metallic systems; bimetallic systems, and SWNT, MWNT, and C-60. The strategy is extended to the formation of biodegradable carboxymethylcellulose (CMC) composite films with noble nanometals; such metal decoration and alignment of carbon nanotubes in CMC is possible using MW approach which also enables the shape-controlled bulk synthesis of Ag and Fe nanorods in poly (ethylene glycol). MW hydrothermal process delivers magnetic nanoferrites and micro-pine structured catalysts are obtainable in water from readily available metal salts. Sustainable route to nanoparticles using polyphenols from winery waste or agricultural residues, their applications in catalysis, toxicity and environmental remediation will be highlighted.



Ceria Nanoparticles: Planned and Unplanned Preparation, Delivery, and Environmental Impacts on Particle Properties. *Donald R. Baer, Pacific Northwest National Laboratory*

Cerium oxide nanoparticles are widely studied for their use in catalytic, energy, environmental protection and biomedical applications. These applications often depend on

the ability of cerium to switch between +3 and +4 oxidation states. Our research examines the impacts of sample preparation, storage, processing and environment on the properties of ceria nanoparticles as they apply to materials science and biological systems. Published biological impacts of ceria nanoparticles suggest that larger faceted ceria particles that have been heated are more likely to have adverse consequences, while smaller particles synthesized at room temperature and never removed from solution often have anti-oxidative behaviors. Smaller particles are highly dynamic in nature changing their oxidation state not just as a function of size, but also as a function of aging (time) and environmental conditions. During particle nucleation and growth in solution, both the particle size and oxidation state change with time. Because synthesis, analysis and operational conditions often place particles in different environments, understanding how particles change as a function of time in different environments is essential to predicting their properties. Aging time and environmentally induced changes in particles may play a significant role in the discrepancies reported in various studies.

Detection of Heavy Metals by Quantum Dot Based Fluorescent Biosensor Via Nanometal Surface Energy Transfer. *Nick Wu, West Virginia University*

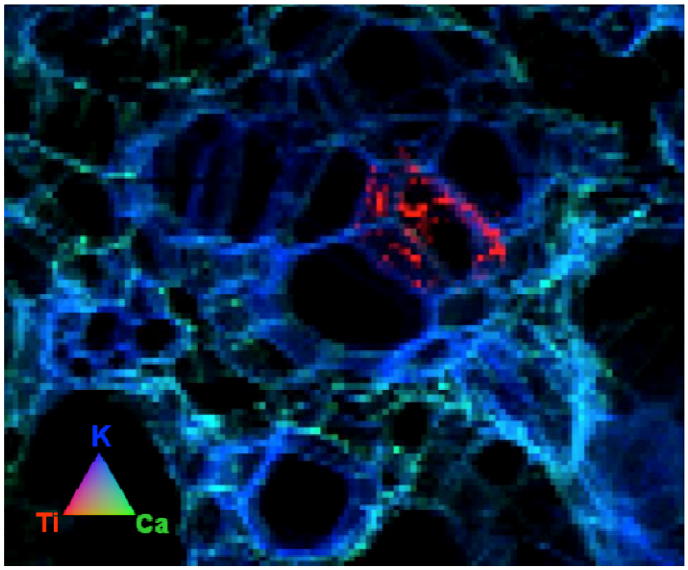
An ultra-sensitive and highly selective nanosensor, which is based on the nanometal surface energy transfer (NSET) in the quantum dots/DNA/Au nanoaprticle ensemble, has been successfully developed for Mercury(II) detection in water. In this sensor, complementary oligonucleotide strands are linked to quantum dots (QD) and gold nanoparticles, respectively. When specific heavy metal ions (such as Hg^{2+}) are present in the aqueous solution that contains the oligonucleotide-conjugated QDs and Au nanoparticles, the heavy metal ions selectively bind to the oligonucleotides, which drives the formation of DNA helixes. As a result, a quantum dot and the gold nanoparticles are brought into a close proximity, leading to the NSET from the QD to the Au nanoparticles. Consequently, the fluorescence emission of the QD is quenched by the Au nanoparticles. The target ion selectivity can be achieved by selected DNA sequences. This sensor has showed a limit of detection of 0.4 ppb in the buffer solution. The excellent selectivity toward Hg^{2+} has been demonstrated in an aqueous solution in the presence of the other environmental metal ions.

Risk Assessment for Nanoparticles during Lithium-ion Battery Pre-recycling Processes
Xue Wang, Rochester Institute of Technology

Lithium-ion batteries (LIBs) have been widely used in consumer electronics (e.g. cellular phones, laptop computers, digital cameras, etc.) and anticipated use in electric vehicles will likely accelerate consumption over the next several years. Nanomaterials are also being integrated into these batteries at an increasing scale, specifically, nano-iron phosphate in cathodes (already commercialized), single-wall carbon nanotubes in anodes, and silicon nanowires in anodes. Environmental and health risks associated with the end-of-life (EOL) processing of these LIBs containing nano-particles has not been well studied yet. This work focuses on providing an initial characterization of nano-particulate risk for several pre-recycling processes including shredding and sorting. Batteries of several cathode chemistries and the same form factor were industrially shredded and sorted by particle size. Presence, size, concentration, and composition of nano-particles were determined using electron microscopy, x-ray fluoresce, and spectroscopy. Results indicate the potential for release and exposure during these recycling activities. This initial work will help to fill life cycle inventory data gaps for airborne nanoparticle emission that would affect both human health and safety impact assessment as well as ecotoxicity.

Synchrotron confirmation of the uptake and transloca-

tion of TiO2 nanoparticles in cucumber plants. *Jorge Gardea-Torresdey, The University of Texas at El Paso*



Nanotechnology includes the fabrication and use of different nanomaterials (NMs), including nanoparticles (NPs). Properties derived from NPs surface area, chemistry, shape, and surface charges, among others, allow their utilization in numerous goods and consumer products. Reports indicate that the number of nanoproducts worldwide increased by 521% since March 2006 to August 2011. TiO_2 NPs are among the most used nanomaterials . These NPs are used in sunscreens, surface antibacterial and antiviral disinfectants , organic pollutant removers, gas sensors, solar cells, food coloring in powdered doughnuts, skim milk as a fat substitute to provide the white color, and in paints. However, this variety of uses and the release of TiO_2 NPs from paints by weather conditions, increase the possibility of environmental dispersion of TiO_2 NPs with unknown consequences. Thus, advances in nanotechnology have raised concerns about possible effects of NMs in the environment, especially in terrestrial plants. In this research, the impacts of TiO2 nanoparticles (NPs) were evaluated in hydroponically grown cucumber (Cucumis sativus) plants. Seven day old seedlings were treated with TiO_2 NPs at concentrations varying from 0 to 4000 mg L-1. At harvest, the size of roots and shoots were measured. In addition, micro X-ray fluorescence (micro-XRF) and micro X-ray absorption spectroscopy (micro-XAS), respectively, were used to track the presence and chemical speciation of Ti within plant tissues. Results showed that at all concentrations, TiO_2 significantly increased root length (average >300%). By using Synchrotron micro-XRF it was found that Ti was transported from the roots to the leaf trichomes, suggesting that trichomes are possible sink or excretory system for the Ti. The micro-XANES spectra showed that the absorbed Ti was present as TiO_2 within the cucumber tissues, demonstrating that the TiO_2 NPs were not biotransformed.

Teaching Ethics through Role Playing in a Nanotechnology Class for First Year College Students. *Kurt Winkelmann, Florida Institute of Technology*

This presentation describes an interactive method for first-year college students to learn about ethical issues related to nanotechnology. Modeled after the PBS show, "Nanotechnology: The Power of Small", this activity asks students to play the roles of fictional characters who debate how nanotechnology might improve or impair their own lives and their community. Students are given background information about a fictional but realistic scenario that involves their characters, along with a character's description and point of view. Each student researches his or her position to provide facts that support the character's opinion. Playing their character roles, students debate the issues during class. Following this, each student writes a reflection paper in which the student describes his or her own view of the issue and how the activity may or may not have changed that view. A pilot-study of this activity occurred during the spring 2012 semester with success. Debate topics included the use of nanotechnology for (1) improving consumers' experience by providing their shopping preferences and tendencies to retailers, (2) monitoring the public by the police to improve safety at the expense of public privacy, and (3) providing high-tech jobs with questionable impact on the environment.

Antimicrobial Properties of Fullerene Derivatives as a Function of Structure and Aggregation State
Samuel Snow, Georgia Institute of Technology

As fullerene technologies continue to expand, there is an increasing need for understanding the relationships between the physical and chemical structure and the biological and photochemical activity of functionalized fullerene nanomaterials. To initiate the process of establishing quantitative structure-activity relationships (QSAR), three series of mono-, bis- and tris- adducted fullerene materials were selected and studied. Dispersion of the derivatives in the aqueous phase via sonication resulted in stable colloidal aggregates. Physicochemical properties of these derivatives and their aggregated forms have recently been characterized. Antimicrobial activity, from both innate and photosensitizing properties, of the materials was measured using E. coli and MS2 bacteriophage virus. Minimum Inhibitory Concentration experiments and Inhibition Zone tests were performed for E. coli to evaluate the innate antimicrobial properties of the fullerene aggregates. Inactivation kinetics were measured for E. coli and MS2 bacteriophage to assess the phototoxicity of the fullerenes under UVA, fluorescent, and natural sunlight. Toxicity mechanisms were probed using a

Bridging the Gap Between the Nanotechnology Consumer Products Inventory and Life Cycle Assessment (LCA) *Sean McGinni, Virginia Tech*

Many benefits, issues, and constraints for applying Life Cycle Assessment (LCA) to nanotechnology were identified in the 2006 Nanotechnology and Life Cycle Assessment Workshop and summary publication, Nanotechnology and Life Cycle Assessment: A Systems Approach to Nanotechnology and the Environment. The Virginia Tech Center for Sustainable Nanotechnology (VT SuN) and the Project on Emerging Nanotechnology (PEN) are collaborating to address these issues. Three specific activities are underway which will bridge some of the gaps that exist between the current Nanotechnology Consumer Products Inventory (NCPI) and the widespread application of LCA to these products. First, specific NCPI product data is under critical review to better characterize the compositions, dimensions, and concentrations of the constituent nanomaterials. Additionally, ranking schemes are being developed to help stakeholders understand the uncertainties in the nanomaterials' inventory. Second, lab-scale nanomaterial manufacturing processes are being inventoried to provide case studies and process inventory data to share with the LCA and nanotechnology community. Third, the transport, fate, and environmental effects for specific nanomaterials are being studied to improve impact assessment methods. This talk will provide an overview of this research and offer suggestions to this research community for research methodologies and networks to more quickly close these important gaps.

Graduate Students Receive Awards

Congratulations to the 20 graduate students who won $500 to attend the SNO conference. 49 students were judged on their resume, poster, and short essay. The winners are listed below:

Adeleye	Adeyemi	UC Santa Barbara
Anaya	Nelson	Univ. of Rhode Island
Bai	Chunmei	UNL
Bremer	Christopher	Arizona State Univ.
Cohen	Joel	Harvard (SPH)
Doudrick	Kyle	Arizona State Univ.
Dowding	Janet	Univ. Central Florida
Garner	Kendra	UC Santa Barbara
Garvey	Therese	Rochester Inst.of Tech
Huynh	Khanh An	John Hopkins Univ.
Lau	Xinbo	NJIT
Louie	Stacey	Carnegie Mellon Univ.
Mikelonis	Anne	Univ. Texas at Austin
Nyberg	Leila	Purdue University
Okello	Veronica	SUNY Binghamton
Rico	Cyren	Univ.of Texas El Paso
Snow	Samuel	Georgia Tech
Tiwari	Andrea	Virginia Tech
Wehmas	Leah	Oregon State Univ.
Wu	Stephen Gang	Washington University

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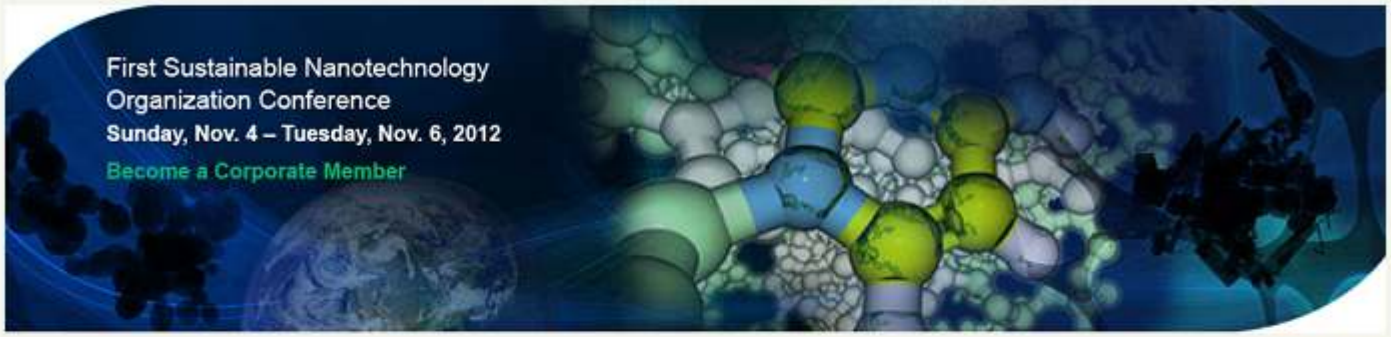
FIRST SUSTAINABLE NANOTECHNOLOGY ORGANIZATION CONFERENCE



The objective of this conference is to bring together scientific experts from academia, industries, and government agencies from around the world to present and discuss current research findings on the subject of nanotechnology and sustainability.

The conference program will address the critical aspects of sustainable nanotechnology such as life cycle assessment, green synthesis, green energy, industrial partnership, environmental and biological fate, and the overall sustainability of engineered nanomaterials. In principle, this involves the fundamental/applied research on the chemistry of producing new green nanomaterials; eco-manufacturing processing of nanomaterials and products. The conference will also foster new collaboration between academic and industrial participants.

FOR FURTHER DETAILS, CONFERENCE REGISTRATION AND PROGRAM INFORMATION VISIT THE WEB AT WWW.SUSNANO.ORG

DEADLINES

Early Registration	: Monday, September 10
Hotel Registration	: Thursday, October 4

CONFERENCE FEES

Sept. 11 to Nov. 4, 2012

Regular: $425
Government: $400
Student: $375

The first year's membership (ending December 2013) is included in the conference fee.