Presentation Abstracts

A Labor Perspective on the Assessment and Management of the Potential Risks of Nanotechnology

Darius Sivin (International Union, UAW)

The properties of materials at the nanoscale differ from bulk matter due to scale, surface area, and quantum effects. Engineered nanomaterials are similar to other emerging technologies in their rapid introduction, complexity and difficulty of risk characterization. Our knowledge is limited, uncertain, and indeterminate regarding cumulative and interactive effects as well as potential effects from low level exposures. Many nanomaterials are already used in the automotive industry and many more will be used soon. It is difficult to track them all in the supply chain to identify who is potentially exposed to what. Safety data sheets are short on information that would distinguish nanomaterials from similar bulk materials and that identify health risks associated with nanomaterials. Our failure adequately to manage the risks of the petrochemical revolution provides lessons for nanotechnology. We should investigate potential hazards of a new technology before it gets widely introduced, and assume that hazard information will always be incomplete. We should act on partial and/or accumulating knowledge. In addition, we should design technologies with an eye towards potential health, safety, environmental implications. Control banding may offer methods for dealing with incomplete information and uncertainty.

The Role of Standards in Addressing Issues Relating to Risk

Ajit Jillavenkatesa (National Institute of Standards and Technology)

Standards are important role for technology development and maturation. Standards, when developed in an open and transparent manner, using consensus based processes, help define agreed upon approaches that can help reduce uncertainty and variability. Thus standards can provide value for business, consumers and governments. Standardized approaches to terminology, measurement, reporting of data, characterization, sharing of information and an overall approach to risk management frameworks can provide greater confidence in the robustness of data being used to evaluate and assess risk. Thus standards can play an important role in addressing the challenges associated with the perception, assessment and management of the potential risks of nanotechnology. In order for this to happen there is a pressing need for the development of relevant standards at the right points of time. Communication and exchange between experts developing the standards and the user community is essential to inform the process of developing needed and relevant standards.

This presentation will engage workshop participants by providing an overview of standards and highlighting some relevant nanotechnology standards activities currently underway. By looking at approaches to how standards are being used to help address risk in other technological areas, this presentation will pose some questions and suggestions that can inform standards development activities to produce needed standards that can help address many of the questions relating to the potential risks of nanotechnology.

Assessment and Management of Nano Risk: A Regulatory Perspective

Timothy Malloy (University of California Los Angeles)

The presentation provides an overview of the decision needs of regulatory agencies and maps them against available and emerging methods and tools for meeting those needs. It will focus on four needs in particular: identifying materials/processes of concern; prioritizing materials/processes of concern; risk/hazard

assessment; and risk management/risk prevention. The assessment will address the relative value and limitations of different methods and tools, particularly in light of factors unique to the regulatory setting. It will close with a discussion of structural and administrative issues affecting agencies' capacity to regulate effectively.

A Greenscreen™ Hazard Assessment Approach for Nanomaterials – Case Study of Nanosilver

Jennifer Sass (Natural Resources Defense Council)
Author List: Jennifer Sass (presenting author), Lauren Heine+, Nancy Linde^, Joanne Caroline English^, Teresa McGrath^*
**Natural Resources Defense Council, + Clean Production Action, ^ NSF International*

The objectives of this project were to evaluate the ability of the Greenscreen™ for Safer Chemicals (GS), a comparative chemical hazard assessment framework, to evaluate nanomaterials. The goal was to see how size influences hazard results, and recommend changes to the GS method so it would better accommodate the properties unique to nanomaterials. GS builds on the US EPA Design for the Environment (DfE) approach, along with global OECD Globally Harmonized System (GHS) and other accepted systems. The use of comparative chemical hazard assessments can support informed decision making by regulators, policymakers, product designers and chemists.

GS assesses chemicals according to eighteen hazard endpoints (including chronic and acute toxicity, ecotox, and physical characteristics such as flammability and reactivity), scores each endpoint according to the available data or identifies a data gap, and then uses this information to assign a Benchmark score (BM) from 1 to 4, with 1 being the most hazardous. Where there are no data for an endpoint, GS can use analogs, modeled data, or other available reasonable substitutes to inform that endpoint. Confidence in the score is identified as high (a bold letter), low (an italics), or very poor (DG, data gap). Chemicals that are carcinogens, mutagens, reproductive and developmental toxicants, endocrine disruptors, and PBTs (persistent, bioaccumulative, and toxic) would be considered substances of high concern, with a BM 1.

The specific materials evaluated for this case study were nanoscale metallic silver, a nano silica-silver nanocomposite, and conventional silver dispersed low-solubility dispersed silver and silver salts).The extent of nanoscale test material characterization was considered in assessing the adequacy of the studies used. Both silver and nanoscale silver were classified as BM1 (highest concern), based primarily on high aquatic toxicity, persistence, and acute inhalation toxicity for nanosilver (for conventional silver, there were no data on this endpoint). The silica-nanosilver composite, a form recently conditionally approved by EPA for use in textiles as an antimicrobial agent, was unassigned (BM Unspecified (U)) due to data gaps. The form of these materials mattered more than size for acute inhalation hazard, where nanosilver was much more hazardous than the silica-nanosilver composite, likely because there is more silver in the nanosilver than in the composite. For eye irritation hazard the form also influenced the outcome, with the reverse result that the silica-nanosilver composite was more hazardous than both the nanosilver and conventional silver, with the latter two being about equal. In this case, the larger size of the composite (micron scale) may be driving its irritation hazard. For aquatic toxicity, size matters in that particle aggregation reduced the hazard, likely by reducing surface area and thereby reducing reactivity of the silver. This suggests that high aquatic hazards may be mitigated if the bioavailability of the material is reduced in natural waters, for example by agglomeration or by product design to reduce the release of silver ion from products such as textile products.

Some of the challenges and limitations for the GS when assessing nanomaterials include: each nanomaterial may represent different substances whereas conventional chemicals are a single entity with a unique CAS#; nanomaterials are characterized by at least ten physical-chemical properties that can influence hazard, whereas conventional particulate chemicals are characterized by four; it's unclear whether data from standardized test protocols are always appropriate for nanomaterials; the "dose-response" for nanomaterials may be better reflected by alternative metrics, such as surface area or particle number, rather than by mass;

the current state of knowledge of nanomaterial toxicology is too limited to reliably use analogs and predictive models to fill data gaps. This is an area of active research, and given the limitations and challenges for this evaluation, it is likely that future evaluations may yield different results. More information on this project and results can be found here: *http://switchboard.nrdc.org/blogs/jsass/greenscreen_hazard_assessment.html*

Keynote: *Risk Analysis*
Baruch Fischhoff (Carnegie Mellon University)

The field of risk analysis emerged in the 1960s as a family of related approaches for understanding and improving the reliability of complex, uncertain technical systems, such as nuclear power, liquid natural gas, chemical manufacturing, and the space program. At its best, risk analysis integrates scientific knowledge from all relevant disciplines, provides guidance on improving a technology's design so as to increase its benefits and reduce its risks, and summarizes the quality of the evidence, so that stakeholders can make effective decisions. Realizing that potential requires skillful analysis embedded in a thatechnology management process that ensures the relevance and the credibility of its results. That process requires sustained commitment from senior industry, firm, scientific, and government leaders.

Fischhoff, B., & Kadvany, J. (2011). Risk: A very short introduction. Oxford: Oxford University Press.
Fischhoff, B., Brewer, N., & Downs, J.S. (eds.). (2011). Communicating risks and benefits: An evidence-based user's guide. Washington, DC: Food and Drug Administration. http://www.fda.gov/AboutFDA/ReportsManualsForms/Reports/ucm268078.htm
Morgan, M.G., & Henrion, M. (1990). Uncertainty. New York: Cambridge University Press.

Keynote: *Nanotechnology Multi-Stakeholder Risk Perception: Implications for Risk Analysis, Management and Communication*
Barbara Herr Harthorn (University of California Santa Barbara)

Key stakeholders in nanotechnology risk analysis and management include: academic scientists and engineers synthesizing novel materials and incorporating them in increasingly complex molecular devices and systems; toxicologists working to characterize the hazards of numerous manufactured nanomaterials and nano-enabled products in a large range of environmental contexts; industry leaders and workers concerned with safety and quality control in larger volume production conditions; and regulators attempting to decide a safe course forward that ensures public safety without impeding economic development. Simultaneously there exist multiple 'publics', for example, those who are members of NGOs with specific active concerns about workplace safety, environmental contamination, and consumer products, as well as lay members of the public whose views on responsible development may affect market success or failure. This talk examines the views of these diverse groups, and considers where their views align and diverge and the implications of this for risk management and decision making. Together, it presents a comparative overview of the state of social scientific knowledge about the risk values, beliefs, and 'intuitive logics' across nanotechnology stakeholders and the challenges and opportunities such views pose for nanotechnology risk management.

Nanotechology in Medicine
Frank Malinoski (Liquidia Technologies, Inc.)
Lawrence Tamarkin (Cytimmune Sciences, Inc.)

Why use nanotechology in medicine? Join industry experts to explore the biological and medical rationale for incorporating potent therapeutics into or onto nanoparticles that many believe will be a core design of 21st century drugs, significantly improving patient outcomes. Discussions will focus on questions such as: "Are all

nanoparticles comprised of the same materials?" and "Can all nanomaterials be administered safely to people?"

This panel will illustrate the scope and breadth of nanoparticles being used or developed for therapeutic use, addressing the risks and benefits in using some of these nanoparticles in medicine, considering technical challenges in making a drug with improved safety and efficacy. This panel will also review the regulatory pathway, overseen primarily by the U.S. Food and Drug Administration (FDA), whereby new medicines are approved for human use. The panel will focus on issues that distinguish nanomedicines from other drugs, while also recognizing that currently the FDA evaluates all drugs, including nanomedicines, on a case-by-case basis. Questions to be considered include: "How does one manufacture a complex drug on the nanoscale?" "What quality control measures need to be established to insure that every nanoparticle contains all the critical components?" Essentially answering the fundamental question, "How do you know what's in the bottle is what you think is in the bottle?" "Are there unique manufacturing procedures that need to be established for worker safety?" "What lessons may be learned from other industries that use nanotechnology?" This panel will discuss how companies developing nanoparticle-based medicines address human exposure and how they have established or are establishing methods to interrogate their nanomedicines. The panel will also discuss financial and business challenges in bringing nanomedicines to the marketplace. And, finally, the panel will focus on how the use of nanotechnology in medicine might impact healthcare costs.

Poster Abstracts

Potential Inhalation Exposure to Nanoparticles from the Use of Nanotechnology-enabled Consumer Products

Leonardo Calderón, Prasad Subramaniam, Kibum Lee, Paul Lioy, Klan F. Chung, Junfeng (Jim) Zhang, and Gedi Mainelis
Department of Environmental Sciences, School of Environmental and Biological Sciences
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The objective of this work was to investigate potential inhalation exposures due to the use of nanotechnology-enabled sprays and clothing. Potential exposures to 19 nanotechnology-enabled consumer sprays, 13 containing silver and 6 with zinc oxide, were examined using built-in sprayers and commercial C-Flow and Collison nebulizers. Particle release from nanotechnology-enabled clothing with Nano-Tex™ technology and silver nanoparticles was characterized using a specially constructed chamber. The size distribution and concentration of released particles were characterized using a Scanning Mobility Particle Sizer (SMPS) and Aerodynamic Particle Sizer (APS). A Transmission Electron Microscopy (TEM) was utilized to examine the shape and agglomeration of particles captured from the airborne state using an electrostatic precipitator built in-house. A release of nano-sized and micro-sized particles by the two nebulization methods and by the product sprayers was observed. Depending on a spray product, the normalized airborne particle concentration (particles per instrument channel width per volume) ranged from 10 to 10^6 particles/cm^3 for Ag products and 10^2 to 10^5 particles/cm^3 for ZnO products. Built-in sprayers produced more of the supermicron particles than the two commercial nebulizers. Release of particles ranging in size from 14 nm to 20 µm was also observed from nanotechnology-enabled clothing at normalized concentrations ranging from 10^{-1} particles/cm^3 to 10^3 particles/cm^3. After the clothing items were washed about half a dozen times, particle release in the supermicron range increased by almost a factor of 2. TEM analysis of airborne particle images from various products showed presence of individual nano-sized particles and micron-sized agglomerates. The results show that the highest deposition by number of inhaled nanomaterial particles would occur in the alveoli. Considerable amount (in some cases 80-90%) of inhaled particles in terms of surface area and volume would deposit in the upper airways in the form of agglomerates, while some deposition would occur in the tracheobronchial and alveolar regions.

Effect of Nanosized CeO_2 Catalyst on Particulate and Gaseous Components of Diesel Emissions

Yevgen Nazarenko, Leonardo Calderon, Lin Zhang, Paul J. Lioy, Kian F. Chung, Junfeng (Jim) Zhang, and Gedi Mainelis
Department of Environmental Sciences, School of Environmental and Biological Sciences
Rutgers, The State University of New Jersey

Nanosized CeO_2 fuel catalyst is increasingly being used to improve the diesel combustion efficiency. However, it is unknown what effects the addition of nano CeO_2 into diesel fuel has on physicochemical and toxicological properties of diesel exhaust and the resultant health effects. In this study we characterized diesel exhaust emissions due to the combustion of diesel fuel with nanosized CeO_2 additive. Envirox™ CeO_2 additive (Energenics Ltd., UK) was mixed with regular ultra-low sulfur diesel fuel at 0, 0.1, 1, and 10 times the manufacturer recommended doping amount to produce fuels with the following CeO_2 concentrations, respectively: 0 (0X of CeO_2), 0.9 µg/ml (0.1X), 9.0 µg/ml (1X), and 90 µg/ml (10X). We used a one-cylinder electrical generator (Yanmar) under 100% load and characterized the size and concentration of exhaust particles at a constant exhaust mass concentration (approximately 400 µg/m^3). CO, CO_2, and NO_x emission for different fuels were analyzed. Exhaust particles were also collected on filters to analyze their physical and chemical properties. We found that engine performance increased by 6% when using 1X fuel compared to 0X. The total exhaust particle number concentration increased with increasing CeO_2 concentration in the fuel: from 1.5 ×105 cm^{-3} for diesel only (0X) to 3.6×10^5 cm^{-3} for 10X CeO_2. The mean particle diameter by number

decreased from 160 nm for diesel only (0X) to 100 nm for 10X CeO_2. At the same time, CO_2 emission rate decreased from 4.8 kg/hr at 0X fuel to 4.3 to kg/hr at 10X fuel. However, increasing CeO_2 concentration increased NO_x emission rate by 30%: from 11.1 kg/hr at 0X to 14.2 kg/hr at 10X. While CeO_2 additive was found to improve engine performance, increased emissions of ultrafine (nanoparticles) and NO_x complicate the risk-benefit analysis of ceria-based fuel additives and this warrants further studies into their environmental and health impacts.

Quantitative Decision Support Tools for the Nanotechnology Industry

Matthew E. Bates, Igor Linkov
Army Engineer Research and Development Center, Department of Defense

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There is a need for transparent and quantitative analytical decision tools that can streamline nanotechnology decisions and add rigor to nanotechnology decision; this poster outlines several methods.

Program Participants Bios

David Andrews, Ph.D.
Senior Scientist
Environmental Working Group

David is using his chemistry background to investigate public health issues at Environmental Working Group. Recent work has included an investigation into sunscreens products, collaborating on the design and construction of EWG's consumer databases and highlighting the overuse of confidentiality claims submitted to EPA. David was previously on the planning committee for the 2009 NNI conference on Nanomaterials and the Environment & Instrumentation, Metrology, and Analytical Methods. He holds a B.A. in chemistry from Wesleyan University and a Ph.D. in chemistry from Northwestern. He has authored more than 15 peer-reviewed publications and currently has one patent on quantum interference devices.

Craig Bandes
President & CEO
Pixelligent Technologies

Craig Bandes has nearly 20 years of experience as a CEO, entrepreneur, and angel investor building companies in the technology, defense and professional services industries. Since joining as CEO, Pixelligent has been refocused, raised $14M in equity and has been awarded nearly $11M in new U.S. government grants, has entered into joint development efforts with Fortune 500 and leading technology companies in the electronics and industrial markets, has introduced PixClear™ its first standard product family, and has booked it's first commercial win in 1Q2013. Prior to Pixelligent, Mr. Bandes was the President & CEO of Global Secure Corp, a high tech company focused on providing homeland security solutions. He grew Global Secure from a start-up to 175 people, raised $25M, and acquired four companies. Mr. Bandes has negotiated over $300 million in financial transactions and completed acquisitions and strategic partnerships in the United States, Asia and Europe. Mr. Bandes sits on the Board of Directors of Pixelligent, the University of Baltimore Merrick School Advisory Board, and is a member of the NanoBusiness Alliance Advisory Board. Mr. Bandes has been a guest speaker on the topics of entrepreneurship, venture capital, and strategic partnerships at numerous MBA programs. He has also presented at several industry and investment banking conferences and was a guest speaker at the House of Lords in the UK. Mr. Bandes received degrees in Finance and Entrepreneurship from Babson College.

David Berube, Ph. D.
Director-PCOST
North Carolina State University

David Berube is the Founding Director of PCOST and a Professor in the Department of Communication and an Affiliated Professor in the Environmental Science; Science, Technology, and Society; and Communication, Rhetoric, and Digital Media programs at North Carolina State University. As Principal Investigator, Dr. Berube recently completed a NSF NIRT grant to study how the public unpackages toxicological information on the health and safety of nanoparticles, and publishes on the role of the public in science and technology policy.

Ahmed Busnaina, Ph. D.
William Lincoln Smith Professor and Director
Northeastern University

Ahmed Busnaina is the William Lincoln Smith Chair Professor and founding Director of National Science Foundation's Nanoscale Science and Engineering Center (NSEC) for High-rate Nanomanufacturing and the NSF Center for Nano and Microcontamination Control at Northeastern University, Boston, MA. Prior to joining

Northeastern University in 2000, he was a professor and a director of the Microcontamination Control Lab at Clarkson University from 1983-2000. Dr. Busnaina is internationally recognized for his work on nano and micro scale defects mitigation and removal in semiconductor fabrication. He specializes in directed assembly of nanoelements and in the nanomanufacturing of micro and nanoscale devices. He developed many techniques for directed assembly and nanomaterials based manufacturing of nanoscale structures for energy, electronics, biomedical and materials applications. His research support exceeds $47 million. He authored more than 600 papers in journals, proceedings and conferences. Organized and chaired more than 175 conferences, workshops, sessions and panels for many professional societies. He is an associate editor of the Journal of Nanoparticle Research. He also serves on many advisory boards including Samsung Electronics; Chemical Industry Nanomaterials Roadmap, International Technology Roadmap for Semiconductors, Journal of Particulate Science and Technology, Journal of Environmental Sciences, Semiconductor International, Journal of Advanced Applications in Contamination Control. He is a fellow of the American Society of Mechanical Engineers, and the Adhesion Society, a Fulbright Senior Scholar and listed in Who's Who in the World, in America, in science and engineering, etc.). He was awarded the 2006 Nanotech Briefs National Nano50 Award, Innovator category, the 2006 Outstanding Faculty, SØren Buus Outstanding Research Award, Northeastern University 2006, the 2005 Aspiration Award, Northeastern University.

Carolyn Cairns
Consultant

Carolyn Nunley Cairns is a leading expert in safety and sustainability science, currently in private practice as a consultant on product testing and design, risk assessment and public policy research. In her career that spans nearly three decades, she has pioneered effective strategies to characterize and reduce risks and achieve more sustainable patterns of consumption. She has held leadership positions in industry, governmental agencies and non-profit organizations, most recently Consumers Union, where she built a program of original test projects for the Consumer Reports publishing franchise. Her work covered a wide range of product safety topics including food irradiation, toxics, electronic waste, antibiotic resistant bacteria in foods, and nanotechnology. She is also a frequent adviser to intergovernmental agencies and international consumer and multi-stakeholder groups working on product safety, trade and sustainable development policy. She holds undergraduate degrees in Chemistry and Government from Skidmore College, and a Masters in Public Health from Yale University.

Rick Canady, Ph. D.
Director
International Life Science Institute

Rick Canady is Director for the Center for Risk Science Innovation and Application of the ILSI Research Foundation, which fosters collaborative research supporting sustainable product development and risk management needs. He is a leading expert in regulatory risk assessment having led multidisciplinary teams of policy and technical experts in the resolution of a wide range of cutting edge health risk management issues over a 20+ year teaching and public policy career. The topics covered by Dr. Canady included genomics, nanotechnology, biotechnology, obesity, contaminants in the environment and in foods, and medical product development.

Dr. Canady was a senior policy advisor to the Office of the Commissioner of US FDA and the Office of Science and Technology Policy of the White House. Dr. Canady taught risk assessment at Emory University School of Public Health, was chief of a branch dealing with hazards in food at FDA's Center for Food Safety and Applied Nutrition, and for nearly a decade assessed toxic risks at superfund sites with the Centers for Disease Control and Prevention in Atlanta. He also served as a senior advisor for the law firm McKenna, Long & Aldridge in health risk assessment serving major industrial and pharmaceutical clients.

He has led and served on FDA and White House policy coordination groups on nanotechnology environmental health and safety, led OECD guidance development on testing of nanomaterials, led WHO/FAO expert groups in evaluation of food contaminants, developed and led numerous workshops, panels and peer reviews on topics ranging from nanomaterial toxicity assessment to nanotechnology standard reference materials, research needs, and nanomaterial characterization both in US and in EU.

Altaf Carim, Ph. D.
Assistant Director for Nanotechnology
Office of Science and Technology Policy (OSTP)

Altaf (Tof) Carim is Assistant Director for Nanotechnology at the White House Office of Science and Technology Policy (OSTP). He has been detailed to this position from the Office of Science in the Department of Energy (DOE/SC) since June 2011. He serves as the OSTP Co-Chair of the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee of the National Science and Technology Council (NSTC), which is the body responsible for the $1.7B/yr National Nanotechnology Initiative (NNI). He served earlier (2006-2009) as the Federal agency Co-Chair for NSET. Dr. Carim also participates on behalf of OSTP in the Physical Sciences Subcommittee, the Life Sciences Subcommittee, the Subcommittee on the Materials Genome Initiative, and other sub-bodies of the NSTC. He represents OSTP on the Emerging Technologies Interagency Policy Coordination Committee's (ETIPC) nanotechnology subgroup. Dr. Carim has led U.S. representation at, and co-chaired, several bilateral governmental meetings including those of nanotechnology subgroups under the Transatlantic Economic Council and under the Science and Technology Working Group of the US-Russia Bilateral Presidential Commission. He also provides input and support for policy decisions relating to broad materials issues, scientific facilities and projects, high-performance computing, reporting and management for interagency initiatives, mid-scale instrumentation, and science agency budgets.

From 2009 through 2011, Dr. Carim led the management team within the DOE/SC Office of Basic Energy Sciences (BES) for the Energy Frontier Research Center major collaborations. Prior to that (since 2001) he managed construction and operation aspects of the BES-supported Nanoscale Science Research Centers, Electron Beam Microcharacterization Centers, and other user facilities, and previously oversaw grant and DOE laboratory programs in the structure and composition of materials. Before joining DOE, Dr. Carim was for over a decade on the faculty at The Pennsylvania State University in the Department of Materials Science and Engineering, including service as Chair of the Electronic and Photonic Materials program. Earlier he was a faculty member at the University of New Mexico and had research posts and activities at the Philips Natuurkundig Laboratorium in The Netherlands, Philips Research Laboratories Sunnyvale, Bell Laboratories, and the Xerox Palo Alto Research Center. He also was a visiting (sabbatical) investigator at the Carnegie Institution of Washington. He received his Ph.D. and M.S. at Stanford University and S.B. at the Massachusetts Institute of Technology, all in Materials Science and Engineering.

Dr. Carim's primary scientific contributions have been in microstructural and microchemical characterization of materials, including semiconductor interfaces, superconducting and ferroelectric oxide thin films and ceramics, crystal structure determination, crystalline defects, joining of ceramics and composites, development of anisotropic microstructures, electron holography, and morphology of nanoparticles and nanowires. He has authored or coauthored over 85 research publications in these areas and has given over 120 conference, seminar, and other presentations. His awards and honors include recognition as an Office of Naval Research Young Investigator, receipt of an AIST Foreign Researcher Invitation to lecture in Japan, and participation in project teams recognized with several of the Secretary of Energy's Project Management Excellence Awards.

Janet Carter
Health Scientist
OSHA

Janet Carter is a Health Scientist, Program Manager for Nanotechnology and Acting Director of the Office of Biological Hazards with the Occupational Safety and Health Administration (OSHA). Janet received a B.S. in Zoology from Miami University, M.S. in Molecular and Cell Biology from the University of Cincinnati and is currently attending Emory University Rollin's School of Public Health in Epidemiology. Prior to joining OSHA she spent 15 years at Procter & Gamble as a Sr. Scientist and Respiratory Toxicologist researching the mechanisms of inflammation/tumorigenesis and nanoparticle toxicity. Janet has authored or co-authored over 35 publications and technical reports with more than 40 presentations and invited-talks at national and international conferences. She has participated on numerous review panels for nanomaterials with the National Academies Institute of Medicine, EPA, NSF and USDA. She is the former Vice-Chair of the International Life Science Institute/Health and Environmental Science Institutes Nanomaterials Safety Committee and member of the organizing committee for the SOT Nanotoxicology Specialty Section. Janet currently serves on the steering committee for the ILSI NanoRelease Project and is co-chairing the Inter-laboratory Testing Group for NanoRelease, serves on the board as a technical expert for the Woodrow Wilson Nanotechnology Consumer Products Inventory and is part of the ILSI-HESI Risk 21 project developing an exposure database for nanomaterials.

Doyle Edwards
Director of Business Development
Brewer Science, Inc.

Doyle Edwards is the Director of Business Development for Brewer Science, Inc. He drives the emerging technology development functions of the company and engages with industry, business, and government organizations to promote the adoption of policies and support for leading-edge technologies. Brewer Science, headquartered in Rolla, Missouri, with locations in the U.S. and abroad, is a global leader in developing and manufacturing advanced materials and equipment for cutting-edge microdevices used in electronics such as tablet computers, smartphones, digital cameras, televisions, and LED lighting. Previously, Doyle managed the marketing, communications, and product development process systems for the company. He serves on several industry boards: SEMI, the Nanotechnology Enterprise Consortium, Tech 44, and the Jordan Valley Innovation Center.

Before joining Brewer Science, Doyle developed online training programs for A.G. Edwards in St. Louis, Missouri, was an account manager for Century Resources in Columbus, Ohio, and taught computer programming and mathematics. In 1987, Doyle earned his B.S. degree in Education, and he earned his MBA in 2000. He and his family reside in Rolla, Missouri.

Baruch Fischhoff, Ph. D.
Howard Heinz University Professor
Carnegie Mellon University

Baruch Fischhoff is the Howard Heinz University Professor in the departments of Social and Decision Sciences and of Engineering and Public Policy at Carnegie Mellon University, where he heads the Decision Sciences major. A graduate of the Detroit Public Schools, he holds a B.S. in mathematics and psychology from Wayne State University and an M.A. and Ph.D. in psychology from the Hebrew University of Jerusalem. He is a member of the Institute of Medicine of the National Academy of Sciences and is the past President of the Society for Judgment and Decision Making, the Society for Risk Analysis, and recipient of its Distinguished Achievement Award. He was founding chair of the Food and Drug Administration Risk Communication Advisory Committee and recently chaired the National Research Council Committee on Behavioral and Social Science Research to Improve Intelligence Analysis for National Security, and currently co-chairs the National Research Council Committee on Future Research Goals and Directions for

Foundational Science in Cybersecurity, and the National Academy of Sciences Sackler Colloquium on "The Science of Science Communication."

He is a former member of the Eugene, Oregon Commission on the Rights of Women, Department of Homeland Security's Science and Technology Advisory Committee, the World Federation of Scientists Permanent Monitoring Panel on Terrorism, and the Environmental Protection Agency Science Advisory Board, where he chaired the Homeland Security Advisory Committee. He is a Fellow of the American Psychological Association, the Association for Psychological Science, the Society of Experimental Psychologists, and the Society for Risk Analysis. He has co-authored or edited seven books, Acceptable Risk (1981), A Two-State Solution in the Middle East: Prospects and Possibilities (1993), Elicitation of Preferences (2000), Risk Communication: A Mental Models Approach (2002), Intelligence Analysis: Behavioral and Social Science Foundations (2011), Risk: A Very Short Introduction (2011), Communicating Risks and Benefits: An Evidence-Based Guide (2011), Judgment and Decision Making (2011), Risk Analysis and Human Behavior (2011), and Counting Civilian Casualties (2013).

Charles Geraci, Ph. D.
Senior Scientist
National Institute for Occupational Safety and Health

Charles (Chuck) Geraci is a Senior Scientist and Coordinator of the Nanotechnology Research Center at National Institute for Occupational Safety and Health (NIOSH). He provides overall strategic guidance to a portfolio of projects that make up the nanotechnology research program at NIOSH and is recognized internationally for his leadership in the field. Dr. Geraci has 38 years of Industrial Hygiene practice experience that has included the federal government, consulting, and private industry. Dr. Geraci earned a B.S. in chemistry from the University of Cincinnati and a Ph.D. in chemistry from the Michigan State University. He is certified by the American Board of Industrial Hygiene in both the Comprehensive Practice and the Chemical Aspects of Industrial Hygiene and is a Fellow of the American Industrial Hygiene Association. He has authored or co-authored many of the papers that have helped set the direction for proactive thinking in nanotechnology safety and health. He directly manages a number of nanotechnology projects in the Institute that focuses on the development and dissemination of workplace risk management guidelines, including the document "Approaches to Safe Nanotechnology". Dr. Geraci serves as a subject matter expert on various panels and advisory boards, including representing NIOSH on the U.S. NNI Nanoscale Science, Engineering and Technology Subcommittee, and the Nanotechnology Environmental and Health Implications workgroup; several projects in the ISO Technical Committee 229 on Nanotechnology; and the Organization for Economic Cooperation and Development Working Party on Manufactured Nanomaterials.

Stephen Gibbons, Ph.D.
Director, Carbon Electronics
Brewer Science

Stephen Gibbons currently serves as the Director of Technology, Carbon Electronics Division, for Brewer Science, Inc., located in Rolla, Missouri, USA. From 2009 to 2012, Steve served as Brewer Science's Analytical & Characterization Laboratory Manager. Prior to 2009, his responsibilities included material and wafer process engineering, quality assurance, new business development, and customer support. Before joining Brewer Science in 2000, Steve served in the U.S. Armed Forces. In 1995, Steve earned his B.S. degree in Mathematics, and in 2010, he earned his Ph.D. in Analytical Chemistry.

Terry Gordon, Ph. D.
Professor, Environmental Medicine
NYU School of Medicine

Terry Gordon is a Professor of Environmental Medicine at the NYU School of Medicine whose broad research interest is in inhalation toxicology and one focus of his research lab is the identification and understanding of the role of genetic host factors in the pathogenesis of the adverse pulmonary effects produced by inhaled environmental and occupational agents. Another major research focus is identifying PM components which contribute to the adverse effects of PM observed in vitro and in vivo. With a network of collaborators, test samples of PM have been collected throughout the U.S. at both urban and rural sites in both winter and summer.

Dr. Gordon has served as a consultant/author to the U.S. EPA on a number of issues of pulmonary toxicology related to the development of various documents and on ad hoc CASAC advisory panels. Dr. Gordon is currently an Associate Editor for Environmental Health Perspectives and the Chair of ACGIH's TLV committee.

Michael Hansen, Ph. D.
Senior Staff Scientist
Consumers Union

Michael Hansen is a Senior Staff Scientist with Consumers Union (CU), publisher of Consumer Reports and currently works primarily on food safety issues. He has been largely responsible for developing CU's positions on safety, testing and labeling of genetically engineered food and "mad cow" disease. Since 2003, he has worked on a multi-state effort to ban the use of food crops to produce pharmaceutical drugs and industrial chemicals. Dr. Hansen has testified at hearings in Washington, D.C., many states, and Canada, and has prepared comments on many proposed U.S. governmental rules and regulations on food safety issues. He also represents Consumers International, a federation of more than 250 organizations in 110 countries, at Codex Alimentarius and other international fora on issues. Dr. Hansen speaks on CU's concerns on mad cow disease, GMOs, pest management, and antibiotics in animal feed, at meetings and conferences throughout the world. He is widely quoted in the media. Dr. Hansen served on the USDA Advisory Committee on Agricultural Biotechnology from 1998-2002, and on the California Department of Food and Agriculture Food Biotechnology Advisory Committee, from 2001-2002. He was appointed to a FAO/WHO Joint Consultation on Genetically Engineered Animals in 2003. In June 2005, he joined the Board of ETC Group, previously known as RAFI.

Dr. Hansen authored the Consumers Union book Pest Control for House and Garden, published in 1992, and co-authored Pest Management at the Crossroads, a 1996 policy study on integrated pest management. He has also written reports on alternatives to agricultural pesticides in developing countries, and the pesticide and agriculture policies of the World Bank and the UN Food and Agriculture Organization. He wrote CU's 1990 report on recombinant bovine growth hormone, Biotechnology and Milk: Benefit or Threat? In 2004, he co-authored Pharmaceutical Rice in California: Potential Risks to Consumers, the Environment and the California Rice Industry.

Dr. Hansen received his undergraduate degree with Highest Distinction from Northwestern University and his doctorate in Ecology and Evolutionary Biology from the University of Michigan. He did post-graduate study at the University of Kentucky on the impacts of biotechnology on agricultural research. He conducted field research on pest management in Mexico and is fluent in Spanish.

Christine Hendren, Ph. D.
Executive Director, CEINT
Duke University

Christine Hendren is a Research Scientist and Executive Director of the Center for the Environmental Implications of NanoTechnology (CEINT). In the role of Executive Director, Dr. Hendren synthesizes CEINT's research across the various disciplines and entity members of the Center, with a focus on facilitating timely feedback between disciplines. This targeted feedback between investigators in different institutions and different areas of expertise, informs future research directions to continually drive toward environmentally relevant approaches. She leads the Data Management efforts of the Center to establish data and metadata collection protocols, to manage data sharing internally within the Center, and to disseminate and integrate data externally with the scientific community at large. Dr. Hendren's research interests include combining risk assessment with decision analysis, and linking and leveraging emerging data to support decisions under conditions of great uncertainty. Current efforts include designing targeted collective judgment processes to facilitate interdisciplinary decision making about research and risk management priorities, and investigating the key parameters to represent potential environmental risk profiles of engineered nanomaterials and other emerging technologies.

Barbara Herr Harthorn, Ph. D.
Director, CNS-UCSB; Professor of Anthropology
UC Santa Barbara

Barbara Herr Harthorn is Professor of Anthropology at the University of California at Santa Barbara, where she serves as Director of the Nanoscale Science and Engineering Center: Center for Nanotechnology in Society, funded by the US National Science Foundation as one of two national centers addressing research, education and outreach on the societal implications of nanotechnologies. She also serves as a member of the Executive Committee and a research group leader in the NSF- and Environmental Protection Agency-funded University of California Center for Environmental Implications of Nanotechnology, based at UCLA. In both centers she leads international teams of researchers using mixed quantitative and qualitative social science research methods to study risk and perception regarding new technology development among diverse stakeholders in the US and abroad. Prof. Harthorn is a medical and psychological anthropologist and has published widely on issues of health inequality, public participation, and risk. She is author with John Mohr of The Social Life of Nanotechnology (2012, Routledge) and with Laury Oaks of Health, Culture and Risk: Shifting Perceptions of Danger & Blame (2003, Greenwood/Praeger), in addition to authoring numerous articles, chapters and reports in diverse social science, environmental science, and nanoscience journals and publications. Her past research includes work on Latina/-o farmworker health in California, on spatial analytic methods in the social sciences, on US primary care physicians as gatekeepers to mental health care, and on gender and health in the South Pacific and East Africa. She is a co-founder of the international Society for the Study of Nanoscience and Emerging Technologies (S.NET). She was elected to Fellowship in the American Association for the Advancement of Science in 2008, and has served as an expert witness to the President's Council of Advisors on Science and Technology, the National Academies of Science, the Congressional Nanotechnology Caucus, as well as other national and international bodies concerned with the responsible development of new technologies.

Matthew Hull, Ph. D.
Program Manager
Virginia Tech's ICTAS

Matthew Hull is Program Manager for the NanoScale Science and Engineering and Nano-Bio Interface Research Thrusts at Virginia Tech's Institute for Critical Technology and Applied Science (ICTAS). He is also President and Owner of NanoSafe, Inc., a provider of nanotechnology human and environmental health and safety (EHS) services founded in 2007 and headquartered in Blacksburg, VA. Hull developed NanoSafe, Inc.'s NanoSafe Tested™' program, which provides independent verification of nanomaterials and

nanotechnology products. Hull's background in nanotechnology EHS risk management includes co-editing, Nanotechnology Environmental Health and Safety: Risks, Regulation, and Management (Elsevier, London, 2009); a 2007 appointment to the White House Office of Science and Technology Policy's (OSTP) Nanotechnology Technical Advisory Group (nTAG); and a decade of experience developing federal/commercial research programs focused on topics ranging from web-enabled nanotechnology EHS risk management systems, nanotechnology waste recovery and recycling processes, and life-cycle ecotoxicological studies of nanomanufacturing. Hull obtained his Ph.D. in Civil and Environmental Engineering and M.S. in Biology from Virginia Tech (Blacksburg, VA), and his B.S. in Environmental Science from Ferrum College (Ferrum, VA).

Jacqueline Isaacs, Sc.D.
Professor, Mechanical and Industrial Engineering
Northeastern University

Jacqueline Isaacs is a Professor of Mechanical and Industrial Engineering at Northeastern University, having recently served as department chair. As an Associate Director for the NSF Nanoscale Science and Engineering Center for High-rate Nanomanufacturing (CHN), she leads the research thrust on responsible nanomanufacturing. CHN is a collaborative effort among several university partners (Northeastern University, the University of Massachusetts Lowell, the University of New Hampshire, and Michigan State University) and the Boston Museum of Science. Interdisciplinary collaborations on societal implications have led to the formation of the Nanotechnology and Society Research Group (NSRG) at Northeastern, which works to address the impact and ramifications of nanomanufacturing technology. Dr. Isaacs' research focuses on economic and environmental assessment of nanomanufacturing processes including life cycle assessment as well as development of related educational games. She leads an NSF Scalable Nanomanufacturing project on Designing and Integrating LCA Methods for Nanomanufacturing Scale-up. Her 1998 NSF Career Award was one of the first that focused on environmentally benign manufacturing. She received a B.S. from Carnegie Mellon University and S.M and Sc.D. degrees in Materials Science and Engineering from the Massachusetts Institute of Technology. She has been recognized by Northeastern University, receiving the President's Aspiration Award in 2005 and a University-wide Excellence in Teaching Award in 2000.

Ajit Jillavenkatesa
Senior Standards Policy Adviser
NIST

Ajit Jillavenkatesa is a Senior Standards Policy Adviser with the Standards Coordination Office at the National Institute of Standards and Technology (NIST), U.S. Department of Commerce. He specializes in standards and conformity assessment related policy issues in South Asia, Asia-Pacific and the Mid-East Asia regions and in emerging technologies such as nanotechnology and information and communication technologies. His primary responsibilities include providing standards and conformity assessment related expertise to NIST staff and leadership, the U.S. Department of Commerce, other U.S. Government agencies and the private sector. Ajit contributes documentary standards and conformity assessment expertise to intra- and inter-governmental groups, bridging the worlds of standards, technology, innovation, trade and regulation.

He has also provided standards policy expertise to the House Committee on Science and Technology during a detail to the Committee in 2010, and was a resource to Committee staff during the development and reauthorization of the America COMPETES Act, signed into law as the America COMPETES Reauthorization Act of 2010 (P.L.111-358). Ajit also serves in the Under Secretary of Standards and Technology & NIST Director's Program Coordination Office as a senior policy adviser, and is currently the Executive Secretary of the Subcommittee on Standards, part of the National Science and Technology Council's Committee on Technology.

Dr. Jillavenkatesa is a materials scientist by training, having joined NIST in 1997 as a post-doctoral fellow, with a Ph.D. in Ceramics from Alfred University in New York. He has authored and co-authored books and

peer reviewed publications related to physical and chemical characterization of materials. He received the American National Standards Institute's Next Generation Award in 2008, and U.S. Department of Commerce's Bronze Medals in 2009 and 2011.

Todd Kuiken
Senior Research Associate
Woodrow Wilson International Centre for Scholars

Todd Kuiken is a Senior Program Associate with the Science and Technology Innovation Program at the Woodrow Wilson International Centre for Scholars where he explores the scientific and technological frontier, stimulating discovery and bringing new tools to bear on public policy challenges that emerge as science advances. He currently is collaborating with DIYbio.org on a project to ensure safety within the rapidly expanding community of amateur biologists and analyzes the potential bio-security threats associated with such a diffuse community. In addition he has numerous projects evaluating and designing new research and governance strategies to proactively address the environmental risks associated with synthetic biology as part of the Wilson Centre's Synthetic Biology Project. He also works with the Project on Emerging Nanotechnologies, also at the Woodrow Wilson Centre, where he focuses on public policy and the environmental health and safety aspects of nanotechnology.

Dr. Kuiken is a regular speaker on public policy issues related to nanotechnology and synthetic biology and has published a number of articles on nanotechnology, synthetic biology, and mercury cycling. After completing his B.S. in Environmental Management and Technology at Rochester Institute of Technology he worked directly with renowned scientists on the biogeochemical cycling of mercury at the Oak Ridge National Laboratory. He earned an M.A. in Environmental and Resource Policy from The George Washington University concentrating on the scientific, economic and community development aspects of environmental issues. While there he worked at various environmental non-profits including the National Wildlife Federation where he worked within the Clean the Rain campaign that dealt with the environmental and public health threats associated with mercury pollution. Dr. Kuiken earned his Ph.D. from Tennessee Tech University where his research focused on the air/surface exchange of mercury associated with forest ecosystems. As part of his dissertation, he synthesized these results with other studies associated with mercury cycling, public health threats, and policy alternatives to bring attention to the threats and need for an improved public policy dealing with mercury pollution.

Igor Linkov, Ph.D.
Risk and Decision Science Focus Area Lead
U.S. Army Engineer Research and Development Center

Igor Linkov is the Risk and Decision Science Focus Area Lead with the U.S. Army Engineer Research and Development Center and an Adjunct Professor of Engineering and Public Policy at Carnegie Mellon University. Dr. Linkov has managed multiple risk assessments and risk management projects in the areas of emerging materials, environmental health, climate change, homeland security, energy, infrastructure, and Cybersecurity. He has published widely on environmental policy, environmental modeling, and risk analysis, including thirteen books and over 200 peer-reviewed papers and book chapters. Dr. Linkov has organized more than twenty national and international conferences and continuing education workshops. He is the recipient of the 2005 Society for Risk Analysis Chauncey Starr Award for exceptional contribution to Risk Analysis and was elected SRA Councilor (2009-2012).

Bruce Lippy, Ph.D.
Director of Safety Research
CPWR, the Center for Construction Research and Training

Bruce Lippy has a Ph.D. in policy from the University of Maryland, with coursework concentrated in regulatory economics and quantitative measures of management. He is a Certified Industrial Hygienist and Certified Safety Professional. He serves on the American Industrial Hygiene Association's nanotechnology working group and has spoken on the worker health and safety issues of nanotechnologies at the Mount Sinai School of Medicine, the University of Massachusetts at Lowell, the University of Puerto Rico, The University of Cincinnati, the Society for Chemical Hazard Communication, the American Society of Safety Engineers and at the 2008 EPA's international conference on nanomaterials in Chicago. He has participated in webinars on nanotechnology for the National Safety Council with Dr. Chuck Geraci from NIOSH and for NIEHS with Dr. Andrew Maynard of the University of Michigan. In 2011, he completed a guidance document with Kristen Kulinowski of Rice University on training workers about the risks of exposures to engineered nanomaterials. Also in 2011, Drs. Kulinowski and Lippy developed, with OSHA funding, an 8-hour awareness course on protecting nanotechnology workers. The course is available for free on the GoodNanoGuide where the modules have been downloaded over 30,000 times. Drs. Kulinowski and Lippy also wrote the nanotechnology chapter for the recently published third edition of the AIHA's, The Occupational Environment: Its Evaluation, Control, and Management. Dr. Lippy recently served on an expert panel reviewing NIOSH's strategic plan for nanotechnology research through 2016.

Frank Malinoski, M.D., Ph.D.
Chief Medical Officer
Liquidia Technologies

Frank Malinoski is Liquidia Technologies' Chief Medical Officer. In this role, he oversees the medical and regulatory development of Liquidia's nanotechnology programs based on the PRINT nanotechnology platform. Dr. Malinoski joined Liquidia in 2009. Prior to joining Liquidia, Dr. Malinoski was Senior Vice President for medical and scientific affairs at MedImmune. In this role, he managed medical and scientific activities relating to marketed products, including clinical trials and medical information. Dr. Malinoski joined MedImmune as Vice President- Infectious Disease, Medical Affairs in December 2005. Prior to that Dr. Malinoski worked at Wyeth as Vice President of medical affairs and Vice President of global business development for vaccines. Dr. Malinoski was also Senior Vice President at Nabi and president of an independent consultant company, TD Consultancy, Dr. Malinoski has worked with and advised a number of biotechnology companies working in vaccines and immunotherapy, and has advised government and nongovernment agencies in multiple projects related to finding solutions for important global infectious diseases.

Dr. Malinoski earned his Ph.D. in microbiology from Rutgers University and his M.D. from Albany Medical College. He holds a bachelor of arts degree from Colby College in Waterville, Maine.

Timothy Malloy
Professor of Law
UCLA

Timothy Malloy is a Professor of Law at the UCLA School of Law with a joint appointment in the School of Public Health. He is a member of the UCLA Center for Environmental Implications of Nanotechnology, and is Faculty Director of the interdisciplinary UCLA Sustainable Technology and Policy Program. After receiving his law degree at the University of Pennsylvania, Professor Malloy clerked for Judge Donald W. VanArtsdalen of the U.S. District Court for the Eastern District of Pennsylvania. He joined the UCLA faculty in 1998, after spending a combined 11 years in practice at private firms and at the United States Environmental Protection Agency, Region III. Professor Malloy's research interests focuses on environmental, chemical and nanotechnology policy, regulatory policy, and organizational theory and decision analysis, with particular

emphasis on the relationship between regulatory design and implementation and the structure of business organizations. In addition, he has worked and written extensively in the area of risk governance and prevention-based regulation, melding together his academic interests with his work in the Sustainable Technology and Policy Program. He teaches Environmental Aspects of Business Transactions, Regulatory Lawyering, Regulation of the Business Firm, Environmental Policy and Politics, and Contracts.

Martha Marrapese
Partner
Keller and Heckman

Martha Marrapese facilitates the registration of new technologies in the global economy with a particular emphasis on biotechnology and nanotechnology applications. Ms. Marrapese has an expertise in the Toxic Substances Control Act and its counterparts in Canada, the European Union, and China, and provides counsel related to the Center for Veterinary Medicine clearances and other associated regulatory needs.

Ms. Marrapese is a member of the Environmental Law Institute Leadership Council and is the Chair of the ABA Section of Environment, Energy and Resources Pesticides, Chemical Regulation and Right-to-Know Committee. She serves on the Advisory Board for the Nanomaterials Registry, a curated repository designed to deliver authoritative information on the biological and environmental interaction of well-characterized nanomaterials. Ms. Marrapese also chairs Working Group 1, Nomenclature and Terminology, for the U.S. Technical Advisory Group to the International Standards Organization TC-229 Committee on Nanotechnologies. She is a recipient of the American National Standards Institute Next Generation Leadership and Service Award.

Richard Pleus, Ph.D.
Managing Director
Intertox, Inc.

Richard Pleus is the Managing Director of Intertox, Inc., an independent and internationally recognized scientific consulting and research organization. He has over 25 years' experience as a toxicologist assessing the risk to humans exposed to chemical and biological agents via water, air, soil, therapeutic agents, and consumer products. Dr. Pleus' current focus is on developing environmental health and safety (EHS) standards for nanomaterials, and assisting in the evaluation of EHS risks from exposure to engineered nanoparticles, through his work as a U.S. delegate on the International Organization for Standardization (ISO) Technical Committee (TC) 229, Nanotechnologies. Dr. Pleus lead the U.S. Technical Advisory Group (TAG) Working Group 3 to develop a comprehensive list of physical and chemical characterization parameters of engineered nano-objects for toxicologic assessment. Additionally, Dr. Pleus is working in the area of nanoinformatics. This includes developing scientific content to estimate possible risk from products and industrial nano-related chemicals.

Dr. Pleus is the Chair of the Science Advisory Board of the Development and Launch of an Interoperable and Curated Nanomaterial Registry, a program funded by NIH and other federal agencies. He is a U.S. delegate for the U.S.-Russia Bilateral Presidential Commission on Science and Technology. He was selected for his expertise on nano-related EHS issues. Dr. Pleus is a Steering Committee member for the upcoming 2015 Environmental Nanotechnology Gordon Conference, and was a Steering Committee member for the 2013 Gordon Conference in the same series. He served on the NIOSH Nanotechnology Research Center review panel for intramural proposals, and he served as a co-chair and panel member during National Nanotechnology Initiative workshops in 2009, 2012, and 2013. Dr. Pleus is co-founder of the Nanotechnology Health and Safety Forum, and is a Scientific Advisor to the NanoSafety Consortium for Carbon. Dr. Pleus has been invited to speak at numerous environmental health and safety issues pertinent to nanotechnology, including the 6th International Conference on Nanotechnology, the 40th Annual Conference of the Israel Society for Ecological & Environmental Sciences, and the 2012 TAPPI International Conference on Nanotechnology for Renewable Materials.

Dr. Pleus is co-founder and Chief Scientist of Intertox Decision Sciences, LLC, a risk management company offering software and database solutions for several industries, including nanotechnology. Dr. Pleus is assisting with a number of product-related nanotechnology issues with companies around the world. His credentials include a B.S. in Physiology, with honors, from Michigan State University; an M.S. in Environmental Health and a Ph.D. in Environmental Toxicology from the University of Minnesota; and postdoctoral research in neuropharmacology at the University of Nebraska Medical Center.

Rick Reibstein
Manager, Outreach and Policy
Massachusetts OTA

Rick Reibstein is the Massachusetts Office of Technical Assistance's (OTA) Environmental Analyst, and Policy and Outreach Manager. He performs program and policy analysis, conducts outreach and events, and develops special initiatives and publications for the office. Rick is OTA's resource on regulatory affairs. He has been with OTA since its inception and has participated in the design and launch of services for new industrial sectors, schools, hospitals, government agencies, homeowners and purchasers. Rick is a founder of the Northeast, North Central and Central Business Environmental Networks and the first national conference on Electronic Products Recovery and Recycling. A graduate of Hampshire College and Brooklyn Law School, he teaches environmental law at Boston University.

Jennifer Sass, Ph.D.
Senior Scientist
National Resources Defense Council

Jennifer Sass is a senior scientist in the Health and Environment program of the Natural Resources Defense Council (NRDC), an environmental non-profit organization dedicated to protecting the planet's wildlife and wild places and to ensuring a safe and healthy environment for all living things. Dr. Sass is also a professorial lecturer at George Washington University. For NRDC, she oversees the U.S. government regulations of industrial chemicals and pesticides and assesses the data underlying the regulatory decisions. Dr. Sass has degrees in anatomy and cell biology from the University of Saskatchewan, Canada, and in toxicology from the University of Maryland. She has published over three dozen articles in peer-reviewed journals, presented testimony to the U.S. Congress, and participated on U.S. government scientific advisory and stakeholder committees.

Christie Sayes
Program Manager
RTI International

Christie Sayes is the Program Manager for Nanotoxicology & Nanopharmacology in the Center for Aerosols and Nanomaterials Engineering at RTI International. She was formerly a professor of toxicology at Texas A&M University. Dr. Sayes maintains her adjunct faculty appointment at Texas A&M in the Department of Biomedical Engineering and the Interdisciplinary Program in Toxicology. She has more than a decade of experience in the fields of nanotechnology and nanotoxicology. She has authored numerous publications, including original research, invited reviews and book chapters. She is a member of the Society of Toxicology, the American Chemical Society, and the Society of Environmental Toxicology and Chemistry. She serves on the Scientific Advisory Board for the EPA's FIFRA Program and on the Editorial Board of the journals Nanotoxicology and Toxicology Letters. Recently, she was elected onto the Executive Committee of the North Carolina Chapter Society of Toxicology. Dr. Sayes has proven abilities in providing technical guidance and leadership to students, technicians, and colleagues; a high aptitude for development of complex particle toxicological and biocompatibility basic and applied research projects in cell culture based and animal based models; substantial training in nanomaterial & nanotoxicology research techniques & instruments; significant experience working independently & collaborating across disciplines and organizations; excellent

communication and interpersonal skills with colleagues in science and engineering, senior management, and new and existing clients and other funding sources.

The goal of the research performed in her laboratory is to investigate the fate, transformation, and biological effects of nanoparticles and nanomaterial systems. Her group addresses several fundamental issues relevant to the development safe and effective nanomaterials in biological and environmental applications. These issues include, but are not limited to, the following parameters: the importance of material characterization, dose-response & time-course, correlation of in vitro findings to in vivo results, mechanistic & synergistic analyses, developing mathematical and computational models for predicting nanoparticle toxicities, and defining appropriate endpoints in hazard identification and exposure conditions for risk evaluation.

Paul Schulte, Ph.D.
Director, Education and Information Division
National Institute for Occupational Safety and Health

Paul Schulte is the Director of the Education and Information Division, and Manager of the Nanotechnology Research Center, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Dr. Schulte has 35 years experience in conducting research and developing guidance on occupational cancer, nanomaterials, risk communication, and genetics. He is the co-editor of the textbook entitled, "Molecular Epidemiology: Principles and Practices." He has served as guest editor of the Journal of Occupational Medicine and the American Journal of Industrial Medicine and was on the initial editorial board of Cancer Epidemiology, Biomarkers and Prevention. He currently is on the editorial board of the Scandinavian Journal of Work and Environmental Health, and the International Advisory Board of the Annals of Occupational Hygiene.

Thomas Seager, Ph.D.
Associate Professor
Arizona State University

Thomas Seager is an Associate Professor in the School of Sustainable Engineering and Director of the Sustainable Energy and Environmental Decision Sciences (SEEDS) studio at Arizona State University, where he studies the systemic environmental consequences of nano-enabled materials, processes, and technologies in renewable energy applications. Working with graduate students and other collaborators in the studio, Dr. Seager has pioneered a decision-driven approach to comparative environmental life-cycle assessment of emerging technologies that allows reorientation of the research and development trajectory towards improved environmental outcomes. Previously, Dr. Seager served as a faculty member of Rochester Institute of Technology and Purdue University. He earned his Ph.D. in Civil and Environmental Engineering from Clarkson University in 2001.

Clayton Shoup
Workers' Compensation Line of Business Director
Zurich North America Risk Engineering

Clayton Shoup is the Workers' Compensation Line of Business Director for Zurich North America Risk Engineering. Clayton has over 30 years of experience in the areas of industrial hygiene, worker safety, and auditing site and corporate safety and health programs. He provides training on industrial hygiene and safety topics. Clayton has also written and published several articles in the field of employee health and safety. Clayton holds a B.A. in Chemistry from Augustana College and a Masters degree in Business Administration from Benedictine University. He is a certified industrial hygienist (CIH) and certified safety professional (CSP). He also holds the associate in loss control management (ALCM) designation.

Darius Sivin, Ph.D.
Industrial Hygienist
International Union, UAW

Darius Sivin is an Industrial Hygienist with the International Union, UAW. He serves on the World Health Organization's Guideline Development Group for Protecting Workers from Potential Risks of Manufactured Nanomaterials and on the Chemical Substances Threshold Limit Value Committee of the American Conference of Governmental Industrial Hygienists. He has testified before the U.S. House of Representatives and the Senate about the security of chemical facilities. He has been a Governing Counselor of the American Public Health Association served on the Chemical Emergencies Work Group of the National Conversation on Public Health and Chemical Exposures. Dr. Sivin holds a PhD from the Johns Hopkins University School of Public Health.

Jeffery Steevens, Ph.D.
Senior Scientist
U.S. Army ERDC

Jeffery Steevens is the Senior Scientist in Biotechnology for the U.S. Army within the Environmental Laboratory at the U.S. Army Engineer Research and Development Center in Vicksburg, MS. He obtained his bachelor's degree in biochemistry from the University of Missouri at Columbia in 1994 and his doctorate degree in pharmacology and toxicology from the University of Mississippi in 1999. As the ERDC's lead scientist in biotechnology, he is responsible for leading the basic and applied research that focuses on innovation in science and engineering to support the peaceful and wartime mission of the soldier. In addition to this research, he also leads environmental research for the U.S. Army Corps of Engineers. His research activities include risk assessment and management of contaminated sediments, bioavailability and biological effects of military-relevant materials (e.g., explosives, nanomaterials, metals). One of his current responsibilities is leading a multi-disciplinary ERDC research cluster focusing on the fate, transport, and toxicology of military nanomaterials and nano-enabled technologies. In addition to his research on nanomaterials, he is also a technical advisor to the World Bank on international projects, EPA Superfund Program, and provides expertise on many contaminated sediments projects throughout the U.S. His recent research activities have included leading a technical response to the recent Deepwater Horizon oil spill, response to the TVA fly ash spill in Tennessee, red mud spill in Hungary, and several Superfund sites.

Dr. Steevens has actively published the results of his work and has over 40 peer-reviewed journal publications and 20 book chapters and technical reports. In addition he is on the editorial board for the journal Environmental Toxicology and Chemistry. He is an active member of several national organizations including the Society of Environmental Toxicology and Chemistry, American Chemical Society, and Society of Toxicology. Dr. Steevens is a Technical Advisor for nanomaterials work group for the Chemical and Material Risk Management Directorate (CMRMD), Office of the Deputy Under Secretary of Defense. Currently he is a technical advisor to the National Nanotechnology Initiative and is a coauthor of the U.S. Nanotechnology Initiative Strategic plan. He has directed international advanced research workshops for NATO on sustainability and nanomaterials.

Lawrence Tamarkin, Ph.D.
President & CEO
CytImmune

Lawrence Tamarkin has lead CytImmune from its founding in 1988 as a diagnostic company to its current focus on cancer therapeutics. Dr. Tamarkin is the co-inventor of the gold nanoparticle-based, tumor-targeted platform technology, which is covered in 49 allowed and 42 pending patents both domestically and internationally. The Company's first cancer nanomedicine, CYT-6091 (Aurimune), which targets and destroys cancer blood vessels, has been successfully tested in a Phase I advanced-stage cancer patient study, and Phase II testing in combination with approved chemotherapies is planned. Recognizing that cancer isn't a

single disease, under Dr. Tamarkin's leadership a pipeline of nanotherapeutics is being developed, and the second-in-a-family of cancer nanomedicines, CYT-20000 (AuriTol) adds an analog of Taxol to the CYT-6091 platform. Dr. Tamarkin succeeded in leading CytImmune to enter into an agreement with AstraZeneca to rescue an AstraZeneca proprietary cancer drug using the CYT-6091 platform and the chemistries used for CYT-20000. Dr. Tamarkin graduated from SUNY at Stony Brook receiving a B.S. degree and received his Ph.D. degree from the University of Connecticut.

Treye Thomas, Ph.D.
Toxicologist
U.S. CPSC

Treye Thomas is a toxicologist and leader of the Chemical Hazards Program team in the U.S. Consumer Product Safety Commission's (CPSC) Office of Hazard Identification and Reduction. His duties include establishing priorities and projects to identify and mitigate potential health risks to consumers resulting from chemical exposures during product use. Dr. Thomas has conducted comprehensive exposure assessment studies of chemicals in consumer products and quantified the potential health risks to consumers exposed to these chemicals. Specific activities have included conducting exposure and/or health hazard assessments of flame retardant (FR) chemicals, combustion by-products, indoor air pollutants, and compounds used to pressure-treat wood. Dr. Thomas is the leader of the CPSC nanotechnology team, and is responsible for developing agency activities and policy for nanotechnology. Dr. Thomas has served as a CPSC representative on a number of nanotechnology committees including the ILSI/HESI Nanomaterial Environmental, Health, and Safety Subcommittee, the Federal NSET and NEHI sub-committees, and the International Council on Nanotechnology (ICON).

Dr. Thomas received a Bachelor's degree in Chemistry from the University of California, Riverside, an M.S. in Environmental Health Sciences from UCLA, and a Ph.D. in Environmental Sciences at the University of Texas, Health Science Center, Houston. He completed a post-doctoral fellowship in Industrial Toxicology at the Warner-Lambert Corporation (now Pfizer Pharmaceutical).

Mark Wiesner, Ph.D.
Director, CEINT
Duke University

Mark Wiesner serves as Director of the Center for the Environmental Implications of Nanotechnology (CEINT) headquartered at Duke. He holds the James L. Meriam Chair in Civil and Environmental Engineering with appointments in the Pratt School of Engineering and the Nicholas School of Environment. Dr. Wiesner's research pioneered the field of environmental nanotechnology, the application of nanoscience to improve and protect public health and the environment. He co-edited/authored the book "Environmental Nanotechnologies" and serves as Associate Editor of the journals Nanotoxicology and Environmental Engineering Science and Coeditor of the journal Desalination. In 2004 Dr. Wiesner was named a "de Fermat Laureate" by the French Polytechnic Institute and French National Institute for Applied Sciences. Dr. Wiesner is a Fellow of the American Society of Civil Engineers and a Fellow of the American Association for the Advancement of Science.

Jay West
Senior Director
American Chemistry Council

Jay West is Senior Director, Chemical Products and Technology, at the American Chemistry Council (ACC) in Washington, DC. He manages ACC's Nanotechnology Panel, which advocates for responsible development of nanomaterials and scientifically sound approaches to nanotechnology policy. Mr. West coordinates the panel's advocacy at the national, state, and international levels and research projects related to exposure

assessment, nanomaterial characterization, and other topics. Mr. West also serves as Vice-Chairman of the Chemicals Committee of the Business and Industry Advisory Council (BIAC) to the 34-country Organization for Economic Cooperation and Development. In that role he works globally with industry colleagues on diverse issues such as nanotechnology, chemical test guidelines, exposure assessment, alternatives analysis, and others.

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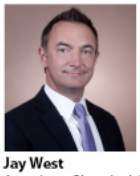

Jay West
American Chemical Council