Nanomaterial Safety In The Workplace Pilot Project For

"Occupational safety and health issues of nanomaterials are complex. Because engineered nanomaterials are small yet have a relatively large surface area, they may have chemical, physical, and biological properties distinctly different from larger particles of similar chemical composition. Those properties may affect the ability of the nanomaterials to reach the gas exchange regions of the lung, travel from the lung throughout the body, penetrate dermal barriers, cross cell membranes, and interact at the molecular level. The types of nanomaterials and the opportunities for workplace exposure to them continue to grow rapidly. The challenge is to effectively address the safety and health issues of nanotechnology while helping society realize nanotechnology's far-reaching potential benefits. The National Institute for Occupational Safety and Health (NIOSH) is the Federal agency responsible for conducting research and making recommendations to prevent work-related injury, illness, and death. NIOSH is mandated by the Occupational Safety and Health Act to determine whether materials in a workplace constitute any harm and to provide recommendations for preventing injury and illness. NIOSH established the Nanotechnology Research

Center (NTRC) in 2004 to coordinate and promote research in nanotechnology and to develop guidance on the safe handling of nanomaterials in the workplace. The NTRC is a virtual center in which NIOSH scientists and engineers at geographically dispersed locations are linked by shared computer networks and other technologies. This approach surmounts the logistical complications that traditionally arise when scientists and engineers collaborating on common research are not physically in the same location. In 2007 the NTRC issued Progress Toward Safe Nanotechnology in the Workplace (DHHS NIOSH Publication No. 2007-123). That report describes the progress of the NTRC since its inception in 2004 through 2006. This November 2009 update describes program accomplishments achieved in 2007 and 2008, and it includes summary updates from 43 intramural projects and a comprehensive extramural program. The NTRC has, with limited resources, continued to make contributions to all the steps in the continuum from hazard identification to risk management." - NIOSHTIC-2

With any new or emerging technology, the greatest period of uncertainty about hazards and associated risks generally occurs in the early stages of development. This is true for engineered nanomaterials, where exposures to the pure and most concentrated form are most likely to occur in

the workplace during the research, manufacture, or use of these materials. In 2004, the National Institute for Occupational Safety and Health (NIOSH) established the Nanotechnology Research Center (NTRC) to address the occupational safety and health concerns that might be associated with this new technology. Through the NTRC, NIOSH forged partnerships with other government agencies, countries, academia, industry, labor, and nongovernmental organizations to conduct research on the potential workplace implications and the beneficial applications of nanotechnology. Manufactured nanomaterials are materials in which 50% or more of the particles have one or more dimensions between 1 nm and 100 nm. The smallest nanoparticles are comparable in size to atoms and molecules. Nanotechnology is developing quickly, as is knowledge about the risks involved. Therefore, workers, employers, and safety and health professionals dealing with nanoparticles in the workplace need to ensure that they keep up to date with developments. The European Agency for Safety and Health at Work (EU-OSHA) is running a Europe-wide campaign during 2018 and 2019 to promote the prevention of risks posed by dangerous substances in the workplace. The aim is to reduce the presence of and exposure to dangerous substances in workplaces by raising awareness of the risks and of effective ways of preventing them.

Nanotechnology Environmental Health and Safety, Second Edition focuses not only on the impact of nanotechnology and the discipline of nanotoxicity, but also explains each of these disciplines through in the context of management requirements and via risk scenarios — providing an overview of regulation, risk management, and exposure. Contributors thoroughly explain environmental health and safety (EHS) issues, financial implications, foreseeable risks (e.g., exposure, dose, hazards of nanomaterials), occupational hygiene, and consumer protection. Key new chapters have been included covering eco-toxicity, nanomedicine, informatics, and future threats. New case studies have also been added, including a chapter on the impact of nanosilver on the environment, as well as an assessment of how well lessons have been learned from the past, such as in the case of asbestos. The book also makes a business case for the importance of proactive EHS management - essential reading for existing or prospective producers of nanoscale products. Practical guidance on risk management and mitigation across different legislative frameworks worldwide Reviews toxicological studies and industrial initiatives, supported by numerous case studies Includes extensive new material on the implications of nanotechnology for medicine, energy and food, as well as assessing future threats.

The NIOSH Nanotechnology Research Center

(NTRC) was established in 2004 to develop, coordinate, and deliver an organized program of research to identify, investigate, and develop science-based solutions to workplace health and safety knowledge gaps in nanotechnology. The NTRC provides overall strategic direction and coordination of the NIOSH nanotechnology cross-sector research program (http://www.cdc.gov/niosh/topics/nanotech/). The responsibilities of the NTRC are in accordance with the legislative mandate issued to NIOSH in Section 20(a) (4) of the Occupational Safety and Health Act of 1970, which states: "...conduct special research, experiments, and demonstrations relating to occupational safety and health as are necessary to explore new problems, including those created by new technology in occupational safety and health, which may require ameliorative action beyond that which is otherwise provided for in the operating provisions of this Act." Nanotechnology is a rapidly emerging material science technology that has been identified as a critical U.S. scientific and commercial enterprise with global economic benefits. Concern over the lack of knowledge about the potential health risks associated with the handling of pure, unbound engineered nanomaterials has been expressed by investors, entrepreneurs, government agencies, and public health advocacy groups. Such concerns create potential barriers to the growth of

nanotechnology and the commercialization of products and devices that could help address serious global problems concerning energy, transportation, pollution, health, and food. Issues that have been raised about worker health and safety must be add ressed to ensure responsible development, societal benefit, and associated economic growth. Vision Statement: The NTRC facilitates responsible development of nanotechnology by identifying and addressing gaps in occupational safety and health knowledge. This vision is accomplished by creating a strategic plan of research, coordinating and facilitating the delivery of results, developing and disseminating science-based risk management recommendations, and providing national and world leadership.

"Nanotechnology is the engineering and manipulation of materials at the molecular level. This new technology creates materials with dimensions ranging from 1 to 100 nanometers (1 nanometer is 1 billionth of a meter). Particles created at the nanoscale have different chemical and physical properties than larger particles of the same material. These manufactured nanoparticles are known as engineered nanoparticles. Scientists and manufacturers can use nanoparticles to create new products that would be impossible with larger particles. This brochure addresses the following questions: 1. Are nanoparticles hazardous to

workers? 2. How can workers be exposed? 3. Can nanoparticles be measured? 4. Can worker exposures be controlled?" --NIOSHTIC-2
Handbook of Nanosafety: Measurement, Exposure and Toxicology, written by leading international experts in nanosafety, provides a comprehensive understanding of engineered nanomaterials (ENM), current international nanosafety regulation, and how ENM can be safely handled in the workplace. Increasingly, the importance of safety needs to be considered when promoting the use of novel technologies like ENM. With its use of case studies and exposure scenarios, Handbook of Nanosafety demonstrates techniques to assess exposure and risks and how these assessments can be applied to improve workers' safety. Topics covered include the effects of ENM on human health, characterization of ENM, aerosol dynamics and measurement, exposure and risk assessment, and safe handling of ENM. Based on outcomes from the NANODEVICE initiative, this is an essential resource for those who need to apply current nanotoxicological thinking in the workplace and anyone who advises on nanosafety, such as professionals in toxicology, occupational safety and risk assessment. Multi-authored book, written by leading researchers in the field of nanotoxicology and nanosafety Features state-of-the-art physical and chemical characterization of engineered nanomaterials (ENM)

Develops strategies for exposure assessment, risk assessment and risk management Includes practical case studies and exposure scenarios to demonstrate how you can safely use ENM in the workplace

Covering the latest technologies, Nanotechnology in eco-efficient construction provides an authoritative guide to the role of nanotechnology in the development of eco-efficient construction materials and sustainable construction. The book contains a special focus on applications concerning concrete and cement, as nanotechnology is driving significant development in concrete technologies. The new edition has 14 new chapters, including 3 new parts: Mortars and concrete related applications; Applications for pavements and other structural materials; and Toxicity, safety handling and environmental impacts. Civil engineers requiring an understanding of eco-efficient construction materials, as well as researchers and architects within any field of nanotechnology, eco-efficient materials or the construction industry will find this updated reference to be highly valuable. Addresses issues such as toxicity and LCA aspects New chapters covering safety handling on occupational exposure of nanoparticles and the assessment of personal exposure to airborne nanomaterials Discusses the effects of adding nano-particles on the durability and on the properties of geopolymers

This document has been developed to provide a resource for stakeholders who wish to understand more about the safety and health implications and applications of nanotechnology in the workplace. The information and guidelines presented here are intended to aid in evaluating the potential hazard of exposure to engineered nanomaterials and to set the stage for the development of more comprehensive guidelines for reducing potential workplace exposures in the wide range of

tasks and processes that use nanomaterials.

This monograph summarizes the current knowledge on potential health hazards induced by nanomaterials from different sources and sort such as food, drugs and silver nanoparticles. Methods to assess toxicity as well as known effects on the genome, neuronal and respiratory system are discussed. Besides the impact on human and animal life the books also addresses aquatic toxicity.

What are the challenges the National Institute for Occupational Safety and Health (NIOSH) and related federal agencies face when allocating limited resources so that worker health and safety go hand in hand with innovation and technical progress? This was the central issue addressed at a workshop on nanotechnology and occupational safety and health hosted by the RAND Corporation on October 17, 2005. The workshop focused on policy and planning issues (as opposed to scientific issues) that are key to understanding the options available to NIOSH in formulating and implementing its strategic objectives to protect the safety and health of workers exposed to nanoscale materials. This document of the conference proceedings draws on discussions during the workshop and places the discussions within a policy framework for further consideration by NIOSH.

The focus of this document is to identify and describe strategies for the engineering control of worker exposure during the production or use of engineered nanomaterials. Engineered nanomaterials are materials that are intentionally produced and have at least one primary dimension less than 100 nanometers (nm). Nanomaterials may have properties different from those of larger particles of the same material, making them unique and desirable for specific product applications. The consumer products market currently has more than 1,000 nanomaterial-containing products including makeup, sunscreen, food storage products, appliances,

clothing, electronics, computers, sporting goods, and coatings. As more nanomaterials are introduced into the workplace and nano-enabled products enter the market, it is essential that producers and users of engineered nanomaterials ensure a safe and healthy work environment. The National Institute for Occupational Safety and Health (NIOSH) is charged with protecting the safety and health of workers through research and training. An area of current concentration is the study of nanotechnology, the science of matter near the atomic scale. Much of the current research focuses on understanding the toxicology of emerging nanomaterials as well as exposure assessment; very little research has been conducted on hazard control for exposures to nanomaterials. As we continue to research the health effects produced by nanomaterials, particularly as new materials and products continue to be introduced, it is prudent to protect workers now from potential adverse health outcomes. Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective control solutions. Elimination; Substitution; Engineering Controls; Administrative Controls; Personal Protective Equipment. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury has been substantially reduced. Engineering controls are favored over administrative and personal protective equipment for controlling existing worker exposures in the workplace because they are designed to remove the hazard at the source, before it comes in contact with the worker. However, evidence of control effectiveness for nanomaterial production and downstream use is scarce. This document is a summary of available technologies that can be used in the nanotechnology industry. While some of these have been

evaluated in this industry, others have been shown to be effective at controlling similar processes in other industries. The identification and adoption of control technologies that have been shown effective in other industries is an important first step in reducing worker exposures to engineered nanoparticles. Our hope is that this document will aid in the selection of engineering controls for the fabrication and use of products in the nanotechnology field. As this field continues to expand, it is paramount that the health and safety of workers is protected.

Occupational safety and health issues of nanomaterials are complex. Because engineered nanomaterials are small yet have a relatively large surface area, they may have chemical, physical, and biological properties distinctly different from larger particles of similar chemical composition. Those properties may affect the ability of the nanomaterials to reach the gas exchange regions of the lung, cell membranes, and interact at the molecular level. The types of nanomaterials and the opportunities for workplace exposure to them continue to grow rapidly. The challenge is to effectively address safety and health issues of nanotechnology while helping society realise nanotechnology's far-reaching potential benefits. This book explores the issue of safe nanotechnology and progress in the workplace.

RAND researchers develop a preliminary logic model to help the Nanotechnology Research Center identify and assess its contributions to improving the safety and health of workers who could be affected by engineered nanomaterials.

Assessing Nanoparticle Risks to Human Health provides a systematic overview of nanoparticle risks and considers the limitations of this paradigm in a context where extreme uncertainties prevail. As well as exploring conventional risk assessment

methodology, the contributing authors investigate several alternate approaches. The adequacy of current frameworks for risk management and regulatory oversights, including corporate approaches in the US and EU, are explored, and suggestions are made as to how these frameworks can be modified to make them more efficient and effective. Presenting a coherent framework for analysis of the available information, this book presents the latest scientific understanding of the toxicity and health effects of nanoparticles, the technical issues relating to exposure assessment and management, and the ways in which the current risk paradigm can be used/modified to deal with the challenges of nanoparticle risks. All chapters of this new edition have been thoroughly updated to reflect the many changes in the field since the first edition. Additions and updates in the second edition of the book include: New exposure assessment strategies for nanomaterials including life cycle exposure assessment approaches and detailed information on nanoparticle exposure control and protection in the workplace. A state-of-the-art scientific update on the hazard and risk assessment of nanomaterials: discussion of key additional publications on the toxicology and biokinetics of nanomaterials; available data and methods to characterize the health hazard and risk of exposure to nanomaterials in the workplace; additional examples of the use of

such data and methods to develop occupational safety and health guidance; and discussion of progress to date, ongoing efforts, and remaining challenges in nanomaterials hazard and risk characterization. New studies on the use of expert judgment in nanotechnology. Quantitative data from Lawrence Berkeley National Laboratory's 4-phase study. A description and evaluation of new CB tools and new ISO technical specifications. A comprehensive update of the legal frameworks in the US and the EU. With the second edition of Assessing Nanoparticle Risks to Human Health Prof. Ramachandran provides researchers and practitioners producing or using nanoparticles, or those involved in nanomaterials risk assessments, technology, health science, policy, safety, environment and regulatory aspects an invaluable reference to adopt the right technologies and strategies and to comply to legal frameworks and regulations. For policy makers and advisory firms it provides the knowledge needed to advise on compliance with or development of new regulations on nanomaterials. Makes essential reading for risk assessment professionals, companies working with nanoparticles, nanotechnology research groups and regulators Explores the use of risk assessment methodologies in an occupational health setting, and their limitations Provides a framework for evidence-based decision making in a context with many

uncertainties

The National Institute for Occupational Safety and Health (NIOSH) is the Federal agency responsible for conducting research and making recommendations to prevent work-related injury, illness, and death. As such, NIOSH is active in (1) identifying critical issues related to possible health hazards of nanomaterials, (2) protecting the safety and health of workers involved in this emerging technology, and (3) implementing a strategic plan to develop and disseminate methods for safely advancing the technology through workplace controls and safe handling procedures, and (4) investigating the possible applications of nanotechnology to solve workplace safety and health issues. Because of their small size and large surface area, engineered nanoparticles may have chemical, physical, and biological properties distinctly different from larger particles of similar chemical composition. Those properties may include the ability to reach the gas exchange regions of the lung, travel from the lung throughout the body, penetrate dermal barriers, cross cell membranes, and interact at the molecular level. NIOSH is investigating all of these properties, as it would with any new technology or material in the workplace, to provide the necessary guidance to ensure a safe and healthy workplace.

This book describes the different methodologies for producing and synthesizing silver nanoparticles

(AgNPs) of various shapes and sizes. It also provides an in-depth understanding of the new methods for characterizing and modifying the properties of AgNPs as well as their properties and applications in various fields. This book is a useful resource for a wide range of readers, including scientists, engineers, doctoral and postdoctoral fellows, and scientific professionals working in specialized fields such as medicine, nanotechnology, spectroscopy, analytical chemistry diagnostics, and plasmonics.

The nanotechnology sector, which generated about $225 billion in product sales in 2009, is predicted to expand rapidly over the next decade with the development of new technologies that have new capabilities. The increasing production and use of engineered nanomaterials (ENMs) may lead to greater exposures of workers, consumers, and the environment, and the unique scale-specific and novel properties of the materials raise questions about their potential effects on human health and the environment. Over the last decade, government agencies, academic institutions, industry, and others have conducted many assessments of the environmental, health, and safety (EHS) aspects of nanotechnology. The results of those efforts have helped to direct research on the EHS aspects of ENMs. However, despite the progress in assessing research needs and despite the research that has

been funded and conducted, developers, regulators, and consumers of nanotechnology-enabled products remain uncertain about the types and quantities of nanomaterials in commerce or in development, their possible applications, and their associated risks. A Research Strategy for Environmental, Health, and Safety Aspects of Engineered Nanomaterials presents a strategic approach for developing the science and research infrastructure needed to address uncertainties regarding the potential EHS risks of ENMs. The report summarizes the current state of the science and high-priority data gaps on the potential EHS risks posed by ENMs and describes the fundamental tools and approaches needed to pursue an EHS risk research strategy. The report also presents a proposed research agenda, short-term and long-term research priorities, and estimates of needed resources and concludes by focusing on implementation of the research strategy and evaluation of its progress, elements that the committee considered integral to its charge. Nanotechnology safety is the practice of handling engineered nanomaterials in production and manufacturing. Good practice consists of understanding and interpreting Material Safety Data Sheets, behaving safely when working with yet unknown nanomaterials, understanding health effects, and proactively creating safety measures against potential hazards. This book introduces

nanotechnology risk management to readers from academia and industry.

Addresses health and safety issues associated with workplace Nanoparticle exposures • Describes methods to evaluate and control worker exposures to engineered nanoparticles • Provides guidance for concerned EHS professionals on acceptable levels of exposure to nanoparticles • Includes documentation on best practices to be followed by all researchers when working with engineered nanoparticles • Describes current knowledge on toxicity of nanoparticles • Includes coverage on Routes of Exposure for Engineered Nanoparticles

The Construction Chart Book presents the most complete data available on all facets of the U.S. construction industry: economic, demographic, employment/income, education/training, and safety and health issues. The book presents this information in a series of 50 topics, each with a description of the subject matter and corresponding charts and graphs. The contents of The Construction Chart Book are relevant to owners, contractors, unions, workers, and other organizations affiliated with the construction industry, such as health providers and workers compensation insurance companies, as well as researchers, economists, trainers, safety and health professionals, and industry observers.

With any new or emerging technology, the greatest

period of uncertainty about hazards and associated risks generally occurs in the early stages of development. This is true for engineered nanomaterials, where exposures to the pure and most concentrated form are most likely to occur in the workplace during the research, manufacture, or use of these materials. In 2004, the National Institute for Occupational Safety and Health (NIOSH) established the Nanotechnology Research Center (NTRC) to address the occupational safety and health concerns that might be associated with this new technology. Through the NTRC, NIOSH forged partnerships with other government agencies, countries, academia, industry, labor, and nongovernmental organizations to conduct research on the potential workplace implications and the beneficial applications of nanotechnology. A critical element of the research program is to conduct research on the potential health effects of worker exposure to engineered nanomaterials and to develop guidance in preventing exposure. In 2007 and 2009, NIOSH published progress reports detailing the accomplishments of the NTRC, including the results of ongoing laboratory and field research and the publication of technical and other guidance documents on the safe handling of engineered nanomaterials. This 2012 update presents the program accomplishments of the NTRC from its inception in 2004 through 2011. It includes an analysis of the progress made toward accomplishing the goals and objectives of the NIOSH Strategic Plan for Nanotechnology Research and toward addressing the goals and research needs identified in the U.S. National Nanotechnology Initiative (NNI) Environmental, Health,

and Safety (EHS) research strategy. The NTRC continues to support and promote the responsible development of nanotechnology through its ongoing research program and its contributions to the development of guidelines for hazard identification, exposure assessment, and risk characterization that can be used to develop and implement effective risk management practices.

"Background: The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention (CDC), is the leading federal agency conducting research and providing guidance on the occupational safety and health implications of exposure to engineered nanomaterials. As part of its nanotechnology research agenda, NIOSH created a field research team to assess workplace processes, materials, and control technologies associated with nanotechnology and conduct on-site assessments of potential occupational exposure to a variety of nanomaterials. Purpose: The purpose and goals of the field research team are to: 1) characterize processes and identify potential nanomaterial emissions that could result in worker exposures, 2) evaluate potential workplace exposures using a variety of measurement techniques, 3) recommend safe work practices, and 4) evaluate exposure control measures. Through this effort, NIOSH will gather baseline data to assist in determining potential occupational safety and health implications of exposure to engineered nanomaterials and developing guidance to ensure safe working conditions. Who can participate: Research

laboratories, producers, and manufacturers working with engineered nanomaterials (1 to 100nm) are invited and encouraged to collaborate with NIOSH. Those who are interested, or unsure of whether they qualify, should contact NIOSH. Contact information is listed at the end of this document. Benefits: Participants will be able to utilize and have access to the expertise of the field research team. Participants will also receive an unbiased, scientific baseline assessment of the potential sources of workplace exposure to nanomaterials using advanced instrumentation. Participants with a strong occupational safety and health (OSH) program could be used as role models for others in the nanotechnology field. For participants who are not sure about the strength of their OSH program, NIOSH can assist in prioritizing areas of improvement, such as engineering controls, and strengthening the overall program. What is required of participants: The investment of the participants' time, availability, and access to participating worksites is required. Someone from the field research team will contact those who express interest in participating to determine if they meet the necessary qualifications. For those who qualify, a site visit will be scheduled. If new work practices or engineering control suggestions are implemented, or if modifications of existing practices or controls are made, then a return visit by NIOSH may occur to examine the effectiveness of those changes. Use of the data: The data collected by the field research team will be communicated back to the participant. It may then be used in a general manner by NIOSH to update its guidance on occupational safety

and health implications of exposure to nanomaterials, and made available in technical documents, scientific presentations, or on the NIOSH Web site. Participants will not be identified in any NIOSH documents that are disseminated publicly without their permission. For more information: To learn more about the NIOSH field research effort, or to express interest in participating, contact Charles Geraci, Ph.D., at (513) 533-8339, cgeraci@cdc.gov, or by mail at 4676 Columbia Parkway, Mail Stop C-32, Cincinnati, OH 45226. For information about other nanotechnology research efforts underway at NIOSH (such as the study of fine [0.1-microm to 2.51-microm diameter] and ultrafine [

While invaluable for their uses in medicine as a drug delivery system or as an imaging agent in cancer detection, nanoparticles do present possible medical and environmental dangers. Due to the thousands of commercial and medical applications for engineered nanoparticles currently available or under development, guidelines for evaluating and controlling exposure to engineered nanoparticles are essential. Designed for EHS professionals working with nanoparticles, this important reference outlines the acceptable levels of exposure to nanoparticles and describes methods for evaluating and controlling worker exposure to engineered nanoparticles. With case studies on various nanoparticle exposures, the book sheds light on the toxicity of such nanoparticles as carbon nanotubes, fullerenes, TiO2, and metal nanoparticles as well as routes of exposure, such as skin and the respiratory system.

Nanomaterials are of interest in many biomedical applications for potential enhancements in structural strength of bone implants, controlled drug release, improved chemical interactions, and scaffolding for cell in-growth and tissue replacement. Unfortunately, the key changes in material properties that enhance performance seem to lead in some cases to increased toxicity. By shifting the distribution of wear particle sizes to smaller individual particles, adverse effects may be created, either directly from the nanoparticle interactions or through intermediary species, such as reactive oxygen. Either way, biological activity often seems to be dependent on particle size, and deleterious side effects and workplace hazards must be evaluated and avoided. This volume, a reprint from a special issue of the Journal of Nanoparticle Research, draws on work presented at The Second International Symposium on Nanotechnology and Occupational Health, held in Minnesota in 2005. It presents an interdisciplinary approach to nanotechnology and occupational health and offers an overview of recent developments toward assessment and management of hazards and risks associated with engineered nanomaterials.

This volume provides an overview of the determinants of the release of and exposure to airborne nanoparticles. Whether intentionally manufactured or unintentionally generated during industrial processes, the release of nanoparticles can result in significant worker exposure, which must be dealt with adequately by means of dedicated risk assessments to ensure workplace health and safety. The book extensively discusses a number of

measurement and modelling strategies available for this purpose. It also reviews the health hazardous potential of nano-sized particles and fibres, and follows the flow of engineered nanomaterials from production and use to disposal and the environment. It appeals to a wide readership, from specialists already working in the field to newcomers aiming to gain insights into this topic.
The Royal Commission's decision to study novel materials was motivated by concern about the potential for releases to the environment arising from increasing industrial applications of metals and minerals that have not previously been widely used and, secondly, by the embodiment of nanoparticles and nanotubes in a wide range of consumer products and specialist applications in fields such as medicine and environmental remediation. Most of the evidence received focused on nanomaterials - particles, fibres and tubes on the scale of a few billionths of a metre. Chapters 2 and 3 explore the extent to which novel substances are currently being deployed, the plausible pathways by which they might enter the environment, their likely environmental destinations in use or disposal and the possible consequences of their release to those destinations. Chapter 4 considers what arrangements would be most appropriate for the governance of emerging technologies under two conditions that pose serious constraints on any regulator. First is the condition of ignorance about the possible environmental impacts in the absence of any kind of track record for the technology. Second is the condition of ubiquity - the fact that new technologies no longer develop in a context of local experimentation but

emerge as globally pervasive systems - which challenges both trial-and-error learning and attempts at national regulation. Both new governance approaches and modifications to existing ones are likely to be called for. They will need to be rooted in ideas of adaptive management that require multiple perspectives on the issues. The Commission's recommendations are based on the premise that it is the functionality of the material, not particle size or mode of production, which is critical for evaluating its potential impact on the environment or human health.

Nanotechnology is a new and emerging discipline that is multidisciplinary and interdisciplinary. The usage of nanosystems, nanomaterials, nano-devices, etc. permeates all aspects of society. Cancer targeting and curing nanosystems are being introduced into the biomedical and pharmaceutical industries; so are lightweight energy absorbing or blast-proof nanohybrid material in the aerospace, automotive and marine industries and high-efficiency energy harvesting nanomaterials, etc. Society has a vested interest in knowing how these new materials, devices and systems are changing the economy and similar landscapes. The book outlines the regulatory and environmental issues related to nanotechnology per industry, offers guidelines in assessing the risks and discusses the legal and socioeconomical issues involved. Case studies will be utilized to provide examples of the positive and negative impacts of nanotechnology. Provides an overview and the basis for understanding the critical importance of the reactivity and efficacy of nanomaterials and the emerging

role of nanotechnology in society Explains the fundamentals, ethics, regulatory and environmental issues of nanosafety and how they shape the emerging nanotechnology industry and markets and includes extensive lists of glossary terms, terminologies and concepts needed for Material Data Safety Sheets Discusses the relevance and specificity of nanosafety issues per industry and includes discussions on the "Homeland Security and Infrastructure Industries" of interest to society in general Includes nanotechnology risk assessment and delineates and quantifies the risk assessment process for nanotechnology safety of paramount importance to most industries and systems Outlines the legal and intellectual property ramifications of nanotechnology and its impact on productivity and society

In this modern era, the science of safety mainly concerns all possible danger associated with the utilization of existing and/or developing technologies. Through development of the Occupational Safety and Health Act (OSH Act) of 1970, the U.S. Congress created the Occupational Safety and Health Administration (OSHA) to assure safe and healthy working conditions for workers by setting and enforcing standards and providing necessary training, outreach, education, and assistance. Occupational safety and health (OSH) primarily deals with cross-disciplinary areas for the safety, health, and welfare of workers. The goal of OSH programs is to foster a safer and healthier work environment for workers, engineers, students, and other participants. This chapter focuses on the fundamental

aspects of safety, accidents and their occurrence and prevention, accident recordings, and social and economic implications of accidents. With the advancement of nanotechnology, the exposure to nanomaterials, as well as to the packaging, transportation, handling, storage, and consumption of these materials, poses higher risks and hazards to people engaged in this and related technologies. This chapter emphasizes the possible dangers of nanomaterials and their harmful effects on human health. The guidelines for working with nanomaterials are also summarized in detail.

Nanoengineering: Global Approaches to Health and Safety Issues provides a global vision on the impact of engineered nanomaterials both for the consumer/general public and in occupational settings. The book also presents a hint on what can be expected for the future from nanomaterials and their effects on our lives, both at home and at work. In addition, users will find valuable information on nanomaterials' irreplaceable value and their risks for health, safety, and environmental issues. Case studies illustrate key points and provide information on important processes. Provides a global vision on the different aspects related to nanosafety and a synthesis of the information available Gives all the information required for precision decision-making in a single book, offering both general public and occupational aspects Contains separate chapters on each subject written by world-renowned contributors Presents a complete vision of the problem, with perspectives on global approaches Includes case studies that illustrate important processes

Handbook of Functionalized Nanomaterials: Environmental Health and Safety discusses the reactive properties of FNMs used in a range of applications, and their toxic impact on the environment. Nanomaterials have unique properties that can make them highly reactive. This reactivity can cause unwanted interactions with living cells, an increase in oxidative stress or damage to genetic material - resulting in damage to the environment and local wildlife. This negative impact is often further increased after surface functionalization of nanomaterials with other materials which offer unique properties of their own. To ensure environmental safety and ecological balance, rigorous toxicity testing of functionalized nanomaterials (FNMs) is necessary. This book discusses the toxicological uncertainties of FNMs and the limitations of FNMs in a range of applications. Later chapters propose methods to reliably assess the harm that functionalized nanomaterials can cause to the environment and wildlife, as well covering recent developments in the field of environmental health safety. The book concludes with a discussion on the future prospects of safe functionalized nanomaterials. Offers a novel, integrated approach, bridging the gap between FNMs and environmental health and safety Analyses the reactive properties of FNMs and their toxicological potential Provides an in-depth look at the impact of functionalized nanomaterials on the environment

As with any new technology, the earliest and most extensive exposures to engineered nanoparticles are most likely to occur in the workplace among the workers who produce and use nanoparticles. The National

Institute for Occupational Safety and Health (NIOSH) is mandated by law to conduct research and develop guidance on worker safety and health. NIOSH and its partners in other government agencies, countries, academia, industry, labor, and nongovernmental organizations have been conducting research and developing guidance to address the occupational safety and health of workers exposed to nanomaterials. In February 2007, NIOSH issued its report on Progress Toward Safe Nanotechnology in the Workplace. That report described the progress of the NIOSH Nanotechnology Research Center (NTRC) since its inception in 2004 through 2006. In this November 2009 update, we describe program accomplishments achieved in 2007 and 2008. The NTRC has, with limited resources, continued to make contributions to all the steps in the continuum from hazard identification to risk management. Occupational safety and health issues of nanotechnology are complex. The types of nanomaterials and the opportunities for workplace exposure continue to grow rapidly. The challenge is to effectively address the safety and health issues of nanotechnology while helping society realize the far-reaching potential benefits. NIOSH will continue to respond to this challenge.

The first edition of Health and Environmental Safety of Nanomaterials: Polymer Nanocomposites and Other Materials Containing Nanoparticles was published in 2014, but since that time, new developments in the field of nanomaterials safety have emerged, both at release and exposure, along with the expanding applications of

the nanomaterials side. Numerous studies have been dedicated to the issue of biophysical interactions of nanoparticles with the human body at the organ, cellular, and molecular levels. In this second edition, all the chapters have been brought fully up to date. There are also four brand new chapters on the biophysical interaction of nanoparticles with the human body; advanced modeling approaches to help elucidate the nanorisks; safety measures at work with nanoparticles; and the health and environmental risks of graphene. It provides key knowledge and information needs for all those who are working in the research and development sector and need to learn more about the safety of nanomaterials. • Focuses on the health and safety of polymer nanocomposites and other materials containing nanoparticles, as well as their medical and environmental implications • Discusses the fundamental nature of various biophysical interactions of nanoparticles with the human body • Looks at the physico-chemistry of nanoparticles and their uptake, translocation, transformation, transport, and biodistribution in mammalian and plant systems • Presents the structure–activity relationships and modeling of the interactions of nanoparticles with biological molecules, biochemical pathways, analysis of biomolecular signatures, and the development of biomarkers.