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Edited by
Matthew Hull
Diana Bowman

NANOTECHNOLOGY ENVIRONMENTAL HEALTH AND SAFETY

Risks, Regulation, and Management

Second Edition

Micro & Nano Technologies Series

Nanotechnology Environmental Health and Safety

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Foreword

The original idea of a book on *Nanotechnology Environmental Health and Safety: Risks, Regulation, and Management* was conceived 10 years before the publication of this second edition. Back in 2004, many were talking about the innovation power of what is sometimes called a general purpose technology (GPT), such as electricity or information technologies. Even more were talking about the potential risks associated with the giant leap forward that nanotechnologies promised to deliver.

Fast forward by 10 years, and we are now looking at the second edition of a book of the same title. This edition yet again aims to provide a mere "snapshot of perspectives on the potential environmental health and safety (EHS) risks posed [by nanotechnologies]," as was highlighted by the co-editors, Matthew Hull and Diana Bowman, in the preface to the first edition.

On first glance, it looks like not much has changed between the first edition and today's second edition. Some chapters carry the same title, and those speaking of uncertainties of the impact of nanomaterials on environmental and human health are still plentiful, and are thus continuing to fuel the ongoing debate on the potential need for nanospecific regulation. A debate, in itself is as lively as it was 10 years ago. It is in the detail and evidence brought forward to this ongoing debate, however, that progress of the last decade manifests itself. This second edition captures the very essence of the debate's current focus on "applying what we have learned about nanotechnology EHS risks to help realize the promise that nanotechnology offers in achieving a more sustainable future," as highlighted by Hull and Bowman in Chapter 1. Indeed, today's second edition illustrates the progress in understanding the potential ecotoxicological effects of nanomaterials, with a special emphasis on the role of data-mining and informatics tools to ultimately predict the hazard profile of specific types of nanomaterials. Such technological progress is echoed in the change of the labor union perspective since the last edition, supported by vivid descriptions of the careful precautionary-driven practices in some academic institutions and industrial organizations. In doing so, these organizations are contributing vastly to what we know about nanomaterials' EHS issues. Ultimately, the efforts of these leading organizations enable stakeholders to integrate the safety aspects in a more holistic view of nanotechnologies' pivotal role and contribution to more sustainable industrial processes and products.

So, as we are harvesting the fruits of the last decade's tireless research examining the safety of nanomaterials, we have begun to feel confident about working with nanomaterials. This has been achieved while maintaining a level of appropriate precaution that allows us to distinguish that which we know, based on accumulating evidence, from that which we do not yet fully know. In support of this, it is important to note that the very scope and design of regulation allows for uncertainties to be accounted for, so that not every innovative step forward requires a corresponding novel regulation. It is in front of this provision that the highly interdisciplinary research areas of nanotechnologies and nanosciences have steadily progressed, so that we are now looking upon significant advances in the understanding of nanoscale phenomena and the impact of their applications on the environment and society. We continue to improve the methodologies of measurements and tests to ultimately render them more specific to nanoscale materials—an innovation, which in itself is based on understanding gained through nanotechnologies. Relevant toxicological endpoints for nanomaterials have been confirmed to be identical with those of conventional chemicals. And expert committees around the world have repeatedly, and independently, come to the conclusion that the risk assessment paradigm currently used to assess general chemical safety also holds for the specific cases of nanomaterials.

At the same time—and seemingly in contradiction to the scientific advances described above—the demand for nanospecific regulations, and mandatory reporting schemes and registers, has developed in the opposite direction to the progress achieved in the safety assessment of nanomaterials. A number of regulatory provisions have been implemented since the publication of the first edition: the European Commission has published a regulatory definition of the term "nanomaterial"; several Regulations and Directives of the European Union now contain specific articles on nanomaterials; and manufacturers, importers, and distributors of nanomaterials in France must comply with a mandatory reporting scheme, which many other countries are now considering adapting for their own jurisdictions. By contrast, other jurisdictions have settled for the application of regulatory tools developed for chemicals, such as the Pre-Manufacturing Notices and Significant New Use Rules issued by the United States Environmental Protection Authority, and the addition of industrial nanomaterials to the Australian National Industrial Chemicals Notification and Assessment Scheme.

We have yet to see if the regulatory provisions for nanomaterials launched to date are actually reliably and effectively implementable both from a technical perspective (e.g., the European Commission's regulatory definition of nanomaterials, over three years after its publication, still lacks reference to a reliable method to establish if something is a nanomaterial), and from an economic perspective (e.g., industries estimate that over 50% of all currently produced and used materials are "nanomaterials" according to the European Commission's regulatory definition). Moreover, we have yet to see if these regulatory provisions are ultimately deemed appropriate. The latter question relies on an assessment, which in itself "will depend on past experiences, different views on risk, benefits, innovation, and broader societal considerations, and the degree to which the instruments favorably or unfavorably impact upon [our] behavior or that of others," as Diana Bowman already pointed out in this book's first edition and revisited in an updated chapter in today's second edition. These words (and indeed this book) highlight the pivotal importance of stakeholder perception (in all its culturally biased and individually formed aspects) to this ongoing debate.

Considering the conundrum of interdependent arguments and conclusions, it is not surprising that the differences between this book's first edition and today's second edition are subtle, but none-the-less important: the chapter entitled "Two steps forward, one step back" describes how many of us stakeholders that continue to participate sometimes feel in this debate aimed at maximizing the benefits and minimizing the often ill-defined risks, as the overarching question of the first edition was described by its authors.

This, however, is a dance, not a sufferer's procession. And the individual steps and movements, not the distance covered since its start, are its most important elements, in that they have resulted in the directionality toward the ultimate innovation challenge that governments, civil society organizations, and industries are now collaboratively addressing for nanotechnologies: "Safe-by-Design." This second edition is an important milestone in the advancements toward this holistic concept of innovation, in that it highlights the progress achieved in the last decade and reflects upon the very elements that form the backbone of the Safe-by-Design concept. This concept is already being adopted by both industry-led initiatives and publically funded projects, as well as several tailor-made public–private partnerships. Collectively, these efforts are now aiming to address the overarching question of this book by minimizing a product's potential risks while designing it to maximize its benefits.

Steffi Friedrichs
Director General
Nanotechnology Industries Association
February 2, 2014

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