

Nanotechnology Health and Environmental Risks, 2nd Edition

Contents

List of Figures	vii
List of Tables	ix
Preface.....	xi
Acknowledgments	xiii
Editor.....	xv
Contributors.....	xvii

1. Introduction: Assessing Nanotechnology Health and Environmental Risks	1
<i>Jo Anne Shatkin</i>	
2. Defining Risk Assessment and How It Is Used for Environmental Protection, and Its Potential Role for Managing Nanotechnology Risks	31
<i>Jo Anne Shatkin</i>	
3. Sustainable Nanotechnology Development Using Risk Assessment and Applying Life Cycle Thinking.....	61
<i>Jo Anne Shatkin</i>	
4. The State of the Science: Human Health, Toxicology, and Nanotechnology Risks	79
<i>Richard C. Pleus</i>	
5. The State of the Science: Environmental Risks	117
<i>Jo Anne Shatkin</i>	
6. Nano LCRA: An Adaptive Screening-Level Life Cycle Risk-Assessment Framework for Nanotechnology	149
<i>Jo Anne Shatkin</i>	
7. Comprehensive Environmental Assessment and Other Life Cycle-Based Approaches for Assessing Nanotechnology.....	171
<i>J. Michael Davis</i>	
8. Managing Risks in Occupational Environments	191
<i>Thomas M. Peters</i>	

Francis Group
Ken Sound Parkway NW, Suite 300
on, FL 33487-2742

Taylor & Francis Group, LLC
is an imprint of Taylor & Francis Group, an Informa business

to original U.S. Government works

in the United States of America on acid-free paper
Date: 2012928

onal Standard Book Number: 978-1-4398-8175-0 (Paperback)

k contains information obtained from authentic and highly regarded sources. Reasonable efforts
n made to publish reliable data and information, but the author and publisher cannot assume
bility for the validity of all materials or the consequences of their use. The authors and publishers
mpted to trace the copyright holders of all material reproduced in this publication and apologize
ght holders if permission to publish in this form has not been obtained. If any copyright material
een acknowledged please write and let us know so we may rectify in any future reprint.

permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, trans-
or utilized in any form by any electronic, mechanical, or other means, now known or hereafter
including photocopying, microfilming, and recording, or in any information storage or retrieval
without written permission from the publishers.

ission to photocopy or use material electronically from this work, please access www.copyright.com.
p://www.copyright.com/) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood
anvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and
ion for a variety of users. For organizations that have been granted a photocopy license by the
eparate system of payment has been arranged.

ark Notice: Product or corporate names may be trademarks or registered trademarks, and are
y for identification and explanation without intent to infringe.

Library of Congress Cataloging-in-Publication Data

Nanotechnology : health and environmental risks / [edited by] Jo Anne Shatkin. --
Second edition.

pages cm. -- (Perspectives in nanotechnology)

Includes bibliographical references and index.

ISBN 978-1-4398-8175-0

1. Nanotechnology--Risk assessment. 2. Nanotechnology--Health aspects. 3.
Nanotechnology--Environmental aspects. I. Shatkin, Jo Anne, editor of compilation.

T174.7.S52 2013

620'.5--dc23

2012028126

e Taylor & Francis Web site at
www.taylorandfrancis.com

CRC Press Web site at
www.crcpress.com

Nanotechnology Risk Communication.....	215
<i>Ann Bostrom and Ragnar Löfstedt</i>	
Ongoing International Efforts to Address Risk Issues for Nanotechnology	231
<i>Jo Anne Shatkin</i>	
ex	255

List of Figures

Figure 1.1	C ₆₀ fullerene.	17
Figure 1.2	Carbon nanotubes.	18
Figure 1.3	Pathways for nanomaterials to move in the environment... ..	22
Figure 2.1	Basic four-step process of risk assessment.	42
Figure 2.2	Technologies are developed in response to human wants and needs.	43
Figure 2.3	Proposed framework for risk management.	46
Figure 3.1	Movement of contaminants into a water body.	69
Figure 4.1	Diagram of the representation of the hypothetical event after exposure to ultrafine particles.	81
Figure 4.2	Percentage of neutrophils in lung lavage of rats (A,B) and mice (C,D) as indicators of inflammation 24 hours after intratracheal instillation of different mass doses of 20-nm and 250- nm TiO ₂ particles in rats and mice.	94
Figure 4.3	The physicochemical characteristics of a nanoparticle influence biocompatibility.	95
Figure 6.1	Proposed NANO LCRA framework for nanotechnologies.	155
Figure 7.1	Comprehensive environmental assessment (CEA) framework.	174
Figure 7.2	Comprehensive environmental assessment (CEA) process.	176
Figure 8.1	Electron microscopy images from filter samples depict a range of particle sizes and morphologies for particles collected in a manufacturing facility that produces high-surface-area metal oxide (lithium titanate) nanomaterials for fuel cell applications.	195
Figure 8.2	Electron microscopy images depict different airborne particles sampled in a facility that produces CNT-epoxy nanocomposites.	196
Figure 8.3	A classical industrial hygiene framework for managing risks in the occupational environment.	199