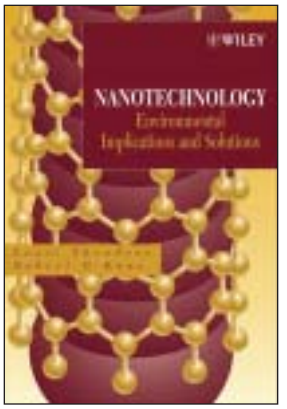
Nanotechnology — Environmental Implications and Solutions

Louis Theodore and Robert G. Kunz,
Wiley-Interscience, Hoboken, NJ, 378 pp., $99.95, 2005, ISBN: 0-471-69976-4



When Lou Theodore and Bob Kunz approached me about writing the foreword to their book on environmental nanotechnology, I was both surprised and honored. As an editor with *Chemical Engineering Progress*, the flagship publication of the American Institute of Chemical Engineers (New York, New York; www.aiche.org), I have followed the topic closely, bearing witness to its ability to solve environmental problems, monitor cellular metabolism, deliver drugs to inaccessible parts of the body, strengthen polymers, render inert materials violently reactive, and get once-impossible chemical reactions to occur. Equally powerful is its potential to act as a poison, accumulating in the environment and in animal organs.

Therein lies the seed of dissent. While some can't wait to seize the nanotechnology initiative, others won't touch it with a 40-ft pole. Activists have begun to organize against the science, calling for a moratorium on nanotechnology products until the social and environmental risks are better understood and regulations are put in place.

Indeed, if ignorance is the sickness, then knowledge must be the cure. That is why it is with such great pleasure that I introduce *Nanotechnology: Environmental Implications and Solutions* to the scientific and engineering audience. Drawing on their extensive knowledge, and experience in the field of environmental science and chemical engineering, Theodore and Kunz touch upon all the key environmental issues of which anyone involved in nanotechnology should be aware. Given their collective background in the environmental arena, the book is certain to be a benchmark in the field.

"The concerns raised by those involved with the environmental implications of nanoparticle emissions from nanoapplications appear not to be justified," writes Lou Theodore in the April 24, 2004, issue of, "As I See It," his monthly column in the *Williston Times*, a local Long Island, New York, newspaper. In their current work, the authors apply the classical works of Cunningham (1906) and Einstein (1910) to demonstrate that submicron particles are easier (for recovery and/or control purposes) than their microplus counterparts, a hypothesis for which there is limited experimental evidence. Breaking new ground, the authors present data generated with high-efficiency control devices (e.g., baghouses, electrostatic precipitators, and venturi scrubbers) in which particles in the submicron regime were collected with 100 percent efficiency.

The laws of chemistry and physics work differently when particles reach the nanoscale, as the powers of hydrogen bonding, quantum energy, and van der Waals' forces endow some nanomaterials with unusual properties. Carbon nanotubes, for instance, discovered in the sooty residue of vaporized carbon rods, defy standard physics. Stronger and more flexible than steel, yet measuring about 10,000 times smaller than the diameter of a human hair, these cylindrical sheets of carbon atoms are useful as coatings on computers and other electrical devices despite their ability to conduct heat and electricity. Nanoparticles, another manifestation of nanotechnology, are known to foster stubborn reactions because they have enormous surface area relative to their volume.

What I have learned after months of exploring the applications and implications of nanotechnology us simply that these developments are not only changing our lives every day, but they are moving so fast we have not yet grasped their tremendous impact. I commend Theodore and Kunz for embracing the challenges that come with exploring environmental opportunities of nanotechnology and the ways to pursue and mitigate the potential dangers ahead. If there's one point that authors drive home, it's that nanotechnology will revolutionize the way industry operates, creating chemical processes and products that are more efficient and less expensive. A primary obstacle to achieving this goal will be to control, reduce, and ultimately eliminate the environmental and related problems associated with nanotechnology, or dilemmas that may develop through its misuse. Nanotechnology enables control over properties of materials and structures at the atomic scale, so that engineering of materials and devices specific to a need — even a malevolent misuse (e.g., the release of nanoproducts and devices that consume water or flesh; emissions of deadly virus-like organisms; ill-suited alterations of DNA, cells, and biological beings) — is simple and inexpensive. The radical age sparked by taking a nanoscale approach to technology, or what Theodore has dubbed, "the second Industrial Revolution," is, in his own words, "so powerful that it promises to make the country that conquers nanotechnology the capital of the world."

—Foreword as written by Rita D'Aquino
Senior Editor, Chemical Engineering Progress