ACCOUNTS
of chemical research

GUEST EDITORIAL

Environmental Health and Safety Considerations for Nanotechnology

An important conceptual advance in nanotechnology environmental and health (nano-EHS) assessment has been the recognition that the dynamic physicochemical properties of engineered nanomaterials (ENMs) play a key role in their fate and transport, human and environmental exposure, and hazard generation. Thus, it is imperative to develop robust *in vitro* and *in vivo* safety assessment approaches that relate specific material properties to possible mechanisms of biological injury, pathophysiology of disease, dosimetry, and exposure of humans and environment life forms. This requires critical knowledge acquisition about the unique interactions of organic, inorganic, and hybrid ENMs, as well as the commercial nanocomposites and derivative materials at the nano/bio interface, including the use of this information to establish structure–activity relationships (SARs) and risk reduction strategies. We have come to recognize that, because of the diverse and unique properties of ENMs, safe implementation of nanotechnology and the governance of nano-EHS is a multidisciplinary exercise that goes beyond traditional hazard, exposure, and risk assessment strategies. This requires cooperation between academia, industry, government, and the public to allow for the proper coordination of nano-EHS activities, rational decision-making tools, and the development of sustainable technology approaches. These processes could be accelerated by implementation of predictive toxicological approaches and rapid throughput screening platforms, as well as exploiting computational methods to assist in the establishment of quantitative SARs and safer-by-design approaches. While basic knowledge is being gathered, it is important to develop appropriate incremental regulatory approaches for safe nano-EHS implementation and advancement of materials to the marketplace with public acceptance and support.

In this special issue, we have brought together the views of experts in a variety of nano-EHS fields to illustrate, through brief review of impactful personal research, the current state-of-the-art in these novel scientific areas. Examples of the major nano-EHS topics that are covered in this issue include (i) delineation of the mechanisms of biological/chemical injury at the nano/bio interface from the perspective of ENM physicochemical properties, including how those properties could be changed to develop potentially safer materials, (ii) use of ENM libraries for hazard assessment, establishment of nano-SARs, and development of predictive *in vitro*/*in vivo* toxicological approaches, (iii) assessment of the environmental impact of nanotechnology, from both the perspective of hazard assessment and utility toward environmental remediation, (iv) assessment of nanomaterial fate, transport, exposure, and bioaccumulation, (v) occupational safety assessment and performance of lifecycle analysis, (vi) risk assessment and formulation of the principles on which to base nano-EHS regulatory decision-making and governance, (vii) implementation of high-throughput screening, computational decision-making tools and the establishment of a nanoinformatics platform, and (viii) implementation of safer-by-design and "green nano" strategies.

All considered, the above advances demonstrate that knowledge gathering and implementation of safe nanotechnology approaches are making incremental advances and nano-EHS is now being regarded as integral to the development of a sustainable technology rather being pursued as a *post hoc* cleanup exercise. Equally important, we trust that this special issue will stimulate new research and breakthrough ideas in how to use this transformative technology toward the betterment of human and environmental safety while allowing the commercial enterprise to grow to the benefit of society. We also envisage that the knowledge gathering at the nano/bio interface will introduce new tools to treat human disease as well as to remediate the environment through multidisciplinary

Published on the Web 03/19/2013 www.pubs.acs.org/accounts
10.1021/ar400005v

research between chemistry, nanomaterial science, medicine, biology, and environmental sciences.

Disclosure: Views expressed in this editorial are those of the authors and not necessarily the views of the ACS.

Andre Nel
University of California, Los Angeles, USA

Yuliang Zhao
Chinese Academy of Science, Beijing, China

Lutz Mädler
Institute of Materials Science, University of Bremen, Germany
Guest Editors