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Editorial

The ongoing quest for understanding the novel environmental applications and implications of nanotechnology

The efflorescent development of engineered nanomaterials (ENMs) over the last three decades has elucidated the transformative potential of nanotechnology for solving many environmental challenges and problems. Existing technological solutions for treating environmental contaminants and reducing environmental risks have been enhanced by introducing ENMs, controlling their size, structure, and surface functionality, and tailoring their electrical, optical, catalytic, magnetic and sorptive properties. The small size of ENMs and greater number of surface exposed atoms, compared to bulk materials, have enabled the development of novel technologies that harvest the quantum, synergistic, and hyper-catalytic effects associated with these promising materials. As such, they have contributed towards the development of transformative solutions for simultaneous treatment of diverse environmental pollutants and pathogens, while providing for cheaper, smaller, modular, and more energy effective commercial products.

The novel physicochemical properties of ENMs, however, which may be associated with one or more unique functionalities, have also the potential to induce inherent environmental and health hazards. The intentional or unintentional release of ENMs into the environment amplifies the existing significant uncertainties associated with the risks prediction or management stemming from nano-enabled technologies and products across their life cycles. Elucidation of property-exposure and property-hazard relationships from a life cycle perspective represents the foundation for developing predictive models for unintended consequences of ENMs. Consequently, it compels the design of improved nano-enabled technologies and products by informing researchers and product developers of the potential environmental implications.

The development of novel nano-enabled technologies and assessment of their environmental implications are inadvertently accompanied by uncharted barriers and challenges. These could be overcome only by pursuing extensive research and educational endeavors that include participants from different science, engineering, and management disciplines. Only by examining ENMs as part of relevant environmental systems and through multidisciplinary holistic approaches, could many of the nanomaterial-enabled design, property-exposure, and property-hazard challenges be addressed. Although significant progress in addressing these challenges has been made in the last decade, focusing the ENM related research to yield actionable answers remains an imperative if integrative regulatory framework is to be developed to adequately manage the environmental applications and implications of nanotechnology.

This compilation of studies in a form of a special issue exemplifies the ongoing effort for integrating and focusing the novel research related to environmental applications and implications of engineered nanomaterials and contributing to the existing global body of knowledge. It also represents a platform for dissemination of specific information about new discoveries and findings associated with development and use of nano-enabled technologies. We hope that the new knowledge presented in this special issue will initiate imaginative research questions, good dialogue, and well-founded answers.

The Special Issue Editors

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