Assessing the Environmental Safety of Engineered Nanomaterials

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Nanotechnology research in the United States is coordinated under the National Nanotechnology Initiative with the goal of fostering development and implementation of nanomaterials and products that incorporate them and assuring that they are environmentally safe. The environmental safety of nanomaterials is assessed under a formal risk assessment framework used for several decades in assessing risk for traditional soluble chemicals and substances. The risk assessment process requires an understanding of how and in what quantities substances might be released to the environment, how they will move and be modified once released, and whether and to what extent they might affect plants, animals, or environmental systems. These processes are evaluated based on an understanding of the physical and chemical characteristics of substances, how they are incorporated into products, and their fate and behavior, from production to disposal. Nanomaterials, relative to traditional substances, present numerous challenges at every step of the risk assessment process. Because they are particles or fibers (by definition) they have characteristics and behaviors that can differ significantly from soluble chemicals. These properties can be enhanced, or altered, by quantum mechanics that can dominate physical and chemical activity at the nanometer scale. Size, alone, is also a strong determinant of nanomaterial mobility and behavior in the environment. These factors will also strongly affect, or determine, how nanomaterials will interact with biological systems, their potential toxicity, or their capacity to alter abiotic processes in the environment. A broader challenge is that nanotechnology is developing at a very rapid pace and new materials and applications are revealed on a daily basis; environmental risk may need to be assessed for a daunting variety of materials and products. These issues, and approaches to addressing them, will be discussed using examples from current research and other activities in the area of environmental safety of nanomaterials.