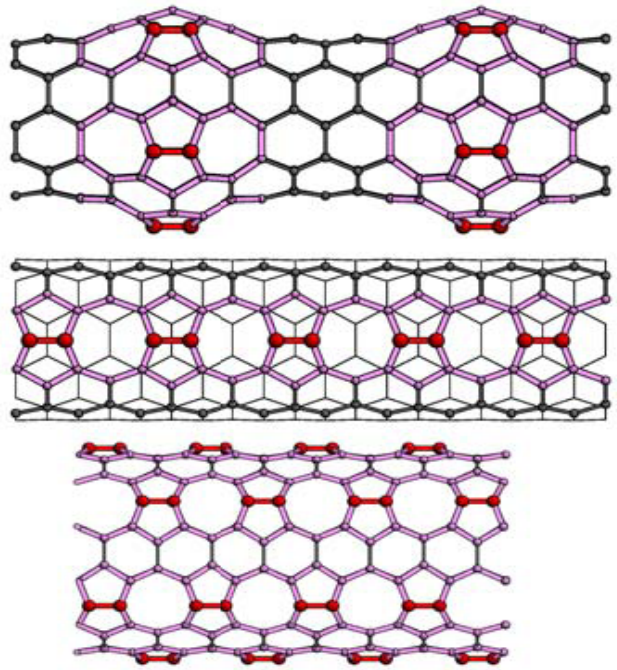
Environment, Safety, and Health Considerations for Nanotechnology

Nanotechnology — the manipulation of matter at the near-atomic size scale to produce new structures, materials, systems, and devices that exhibit novel phenomena and properties — has the potential to yield far-reaching changes in virtually everything that affects our lives. At the nanoscale level, (a nanometer is one billionth of a meter), materials exhibit unique properties that affect their physical, chemical, and biological behaviors. These properties, which make nanoscale materials attractive for countless applications in energy, medicine, transportation, environmental remediation, and other fields, may, at the same time, pose for environment, safety, and health (ES&H concerns). However, little is known about these potential ES&H risks, and there are no ES&H regulations or standards for nanotechnology.

PROBLEM/OPPORTUNITY

The number of organizations involved in nanotechnology research and development (R&D) is burgeoning. In 2005, there were $32 billion worth of products incorporating nanotechnologies, and the market is expected to reach a trillion dollars in the next few years. A significant component of the nanotechnology R&D effort is funded through the U.S. Department of Energy (DOE), which receives about 20% of the total National Nanotechnology Initiative budget. Five of the DOE national laboratories are or will host Nanoscale Science Research Centers (including the Center for Nanoscale Materials at Argonne), and the Department stands to benefit from nanotechnology applications in environmental remediation and energy efficiency. If an ES&H incident related to nanotechnology were to occur, liability costs and damaged reputations would likely result, and the pace of development could slow significantly. Recognizing that such concerns apply to all involved with nanotechnology, regulatory agencies, standards development organizations, individual companies, and departments are beginning to develop policies, regulations, and standards to help ensure the safe development of this promising new technology.

EVS sees helping to ensure that any new regulations are based on sound science as a way to help balance the need for ES&H protection with the need to maintain national leadership in nanotechnology development. EVS also sees the potential for nanotechnology applications to add value to its other program areas.



Nanotube Designs

APPROACH

EVS is taking a three-pronged approach to addressing nanotechnology ES&H efforts. At the Argonne laboratory-wide level, EVS has initiated intra-laboratory awareness and communication

vehicles to share information regarding nanotechnology ES&H and policy issues. These include hosting informal conference calls to share information; developing an intra-laboratory web site for information exchange; briefing interested parties on ES&H challenges and regulatory status; and participating in the laboratory-wide Nanotechnology ES&H Workgroup. Second, EVS has introduced the topic and its implications to its DOE sponsors including the Office of Policy and International Affairs and the Office of Health, Safety, and Security. Third, EVS is identifying opportunities to add value to existing EVS programs by considering the application of nanotechnology where appropriate.

RESULTS

Using start-up funding from DOE to help develop a technical knowledge base of government-wide nanoscale science efforts, EVS has prepared issue papers on nanotechnology and ES&H concerns. Findings from this research indicate that some nanomaterials display toxic effects, but the mechanisms of these effects and the roles of size versus other variables such as form and composition are not yet known. There has been little if any research on exposure, and there are virtually no data on the potential ecological effects of nanomaterials. While no laws or regulations address nanotechnology specifically, some existing regulatory structures could apply to nanotechnologies. However, because of definitions, exclusions, and other factors, many nanomaterials may escape formal regulation. The understanding of nanotechnology ES&H risks is likely to come slowly because of relatively low federal funding levels. Only about 4% of the billion dollar annual budget for nanotechnology R&D has been for ES&H research. Other countries and organizations are grappling with these same issues, but sometimes their approaches differ.

For example, some are waiting for more information before writing regulations, while others (e.g., some nongovernment organizations) advocate eliminating all research and production until risks are known. Regarding the incorporation of nanotechnology into other EVS programs, we have identified ways in which nanotechnology could reduce infrastructure requirements for conveying energy along transmission lines, and we have reviewed nanotechnology-based remediation technologies for groundwater contamination, as possible alternatives to pump-and-treat technologies.

FUTURE

EVS plans to keep abreast of key new developments and to provide support as appropriate in the areas of Argonne laboratory-wide ES&H communication efforts, and policy–related support to DOE and other sponsors. EVS also intends to integrate nanotechnology assessment in other EVS programs.

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