TerranearPMC Safety Share

Week of February 27, 2012 – Nanotechnology

If someone would have mentioned the term, nanotechnology ten years ago, chances are the only response would have been something similar to a deer in headlights. Nanotechnology was far from being a household word. And while it still may not be as recognizable as other scientific terms, it has gained widespread recognition and acknowledgment as something that will have a far reaching impact on our lives.

Nanotechnology is the engineering at the molecular scale. It promises scientific advancement for many sectors such as medicine, consumer products, energy, materials and manufacturing. Nanotechnology entails the application of many fields of science, employing surface science, organic chemistry, molecular biology, semiconductor physics, and microfabrication. As such, this is very diverse field of study, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly. The results allow for the development of new materials with dimensions on the nanoscale which directly control matter on the atomic level.

Here's a surprising fact: When you take an ordinary substance (say, for example, carbon), break it down into individual molecules, and rebuild it into a tiny tube-link structure, its chemical behavior is entirely different from the same substance in a larger form. If you rub it on your skin, the tiny structure, or "nanoparticle" because it's measured in nanometers or billionths of a meter - is small enough to enter your body through your pores. By comparison, typical carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range 0.12–0.15 nm, and a DNA double-helix has a diameter around 2 nm. If ingested, it can be absorbed through your intestines. Inhaled, it may not behave the same way that larger airborne particles would.

So while this new technology may allow for advancements within many fields, there's a concern that engineered nanoparticulates may have human health effects that are different from, and potentially more severe than, the effects of their larger counterparts. Plus, there are no occupational exposure limits, such as OSHA's permissible exposure limits, for nanoparticles, as the technology is too new. Evidence that the likely effects of inhaling nanoparticles include:

- Inflammation and tissue damage in the lungs, potentially leading to chronic obstructive pulmonary disease, reduced lung capacity, and other respiratory problems
- Lung cancer
- Circulatory problems

Studies have indicated that low solubility nanoparticles are more toxic than larger particles on a mass for mass basis. There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are also indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs. Research is continuing to understand how these unique properties may lead to specific health effects. This suggests that when handling these materials, it is important to be cognizant that we

are NOT 100% knowledgeable of how we may be effected, and therefore, need to apply controls in a very conservative manner.

The first use of the concept found in 'nano-technology' (but pre-dating use of that name) was in "There's Plenty of Room at the Bottom", a talk given by physicist Richard Feynman at an American Physical Society meeting at California Institute of Technology (Caltech) on December 29, 1959. Feynman described a process by which the ability to manipulate individual atoms and molecules might be developed. He also noted specific issues that would arise from the changing magnitude of various physical phenomena: gravity would become less important, while surface tension and van der Waals attraction would become increasingly more significant. The term "nanotechnology" was defined by Tokyo University of Science Professor Norio Taniguchi in a 1974 paper where he states, "'Nano-technology' mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule." In the 1980s the basic idea of this definition was explored in much more depth by Dr. K. Eric Drexler, who promoted the technological significance of nano-scale phenomena and devices through speeches and publications. Nanotechnology and nanoscience got started in the early 1980s with two major developments; the birth of cluster science and the invention of the scanning tunneling microscope (STM), which lead to the development (or discovery) of fullerenes (any molecule composed entirely of carbon, in the form of a hollow sphere, ellipsoid, or tube) in 1985 and carbon nanotubes a few years later. In another development, the synthesis and properties of semiconductor nanocrystals was studied; this led to a fast increasing number of metal and metal oxide nanoparticles and quantum dots. In 2000, the United States National Nanotechnology Initiative was founded to coordinate federal nanotechnology research and development and is evaluated by the President's Council of Advisors on Science and Technology.

Besides health effects, safety has also been recognized as a considerable issue. Scientists are reporting that dust generated during processing of nanomaterials may explode more easily than dust from wheat flour, cornstarch and most other common dust explosion hazards. Research has indicated that nanomaterial dust could explode due to a spark with only 1/30th the energy needed to ignite sugar dust.

So it seems that with this new technology, we may be faced with hazards that demand new or more protective methods to control such exposures during the handling and processing of these materials. Where once respiratory protection would not be considered, it may now be a necessity. Keep in mind that high efficiency air particulate (HEPA) filters are designed to filter out particles that have a mean aerodynamic diameter of 0.3 microns, while having greater efficiencies for particulate both greater and smaller. In addition, new health standards and sampling methods to properly assess worker exposures may be necessary. Already, health organizations throughout the United States (such as National Institute for Occupational Safety and Health and the Centers for Disease Control) are evaluating the effects of nano particulate on humans and the techniques that may be necessary to properly protect us. In the meantime, when our work may involve contact with such materials, we need to involve our Safety and Health professionals so they may investigate the best way to perform our work tasks without compromising our health and safety.

“I have never in my life learned anything from any man who agreed with me.”

Dudley Filed Malone (American attorney, politician, actor and activist: 1882-1950)