

# Nanotechnology essay

Business, Management



NanotechnologyIntroductionNanotechnology is defined by the National Nanotechnology Initiative of NSF as “ the understanding and control of matter at dimensions of roughly 1 to 100 nanometers (nm), where unique phenomena enable novel applications” (National Nanotechnology Initiative, 2007). Nanotechnology is one of the most talked about topics of discussions today. These materials are the start of many new and remarkable products becoming available. Companies have been developing and researching such products for years and it is only recently that they are starting to be manufactured for commercial use. With the wide spread use of nanomaterials, some are questioning the safety in producing them.

Many people fear the unknown, and it is not un-founded since past “ wonder” products have proven to be very toxic (National Nanotechnology Initiative, 2007). Exposure to these particles can occur by various routes: dermal, ingestion, injection; but this study will focus on the potential for inhalation as a route of exposure to nanoparticles of lithium titanate. Lithium titanate is a powder made from various sources of precursors that can not be disclosed in this paper due to their proprietary nature. Such products along with the various chemical intermediates, such as titanium dioxide, will be investigated and tested in a nanotechnology company to make an exposure risk assessment (Royal Society, 2007).

NanotechnologyNanotechnology could one day impact the production of virtually every human made object- everything from automobiles, tires, and computer circuits to advanced medicine and tissue replacement.

Nanotechnology will fundamentally restructure the technologies currently used for manufacturing such as medicine, defense, energy production,

environmental management, transportation, communication, computation, and education (Rejeski, 2005). The National Science Foundation (NSF) predicts that the world market for nanotechnology will grow to \$1 trillion by 2015. Lux Research calculated that in 2004, there was \$13 billion in the global market used in some form for nanotechnology.

It is estimated that there are already 700 products in the market made from or with nanotechnology and worldwide about \$9 billion spent annually on nanotechnology research by both the private sector and governments (Rejeski, 2005). Compared to the amount of investment on nanotechnology, there is very little public knowledge on the topic. A study in 2004, funded by the NSF and carried out by North Carolina State University, showed that 80-85% of the American public has heard little or nothing about nanotechnology (Rejeski, 2005). This number is very high and can cause many problems for nanotechnology in the future. In speculating, most often when products are released to the market without much public knowledge there can be huge feeling of deception among the public.

Without this understanding of the materials, the public is left to draw their own conclusions which for the most part are negative. More recently the FDA and EPA have been under extreme scrutiny for allowing nano sunscreens to be sold. Toxicity studies are raising issues and the media is running many nano-scare articles. In order for the public to understand how important nanoparticles (NP) could be for the future, they must learn more about what nanotechnology is. For most people it is extremely hard to imagine how small a nanoparticle is. A nanometer is one billionth of a meter ( $10^{-9}$  m). For

comparison purposes a single human hair is about 80, 000 nm wide, a red blood cell is approximately 7000 nm wide, and a water molecule is almost 0.3 nm across (Royal Society, 2007).

No international standard yet exists for the definitions of nano-technology, but the most agencies such as NIOSH, EPA, and nano-tech organizations have a general understanding that nanoscale is defined as 0.2 nm to 100 nm in size. Figure 1: Diagram is from the NNI website, courtesy Office of Basic Energy Sciences, Office of Science, U. S. Department of Energy.

Source: [http://www.nano.gov/html/facts/The\\_scale\\_of\\_things.html](http://www.nano.gov/html/facts/The_scale_of_things.html)

Nanoscience can be defined as the study of manipulation of materials at atomic, molecular, and macromolecular scales, where properties differ significantly from those at the larger scale (Royal Society, 2007).

Nanotechnologies can be defined as the design, characterization, production, and application of structures, devices, and systems by controlling shape and size at the nanometer scale (Royal Society, 2007). There are two distinct types of manipulating matter: bottom up and top down (EPA, 2007). “Bottom up” refers to the deliberate engineering of particles by certain chemical and physical processes (EPA, 2007).

“Top down” is the milling or grinding used to produce nanosized particles which may or may not have different properties than the bulk material they were developed from (EPA, 2007). Different types of Nanotechnology There are two reasons materials differ at the nanoscale. The larger surface area compared to the larger form makes materials more chemically reactive. The second reason is that quantum effects can begin to dominate the behavior of

the matter and begin to affect the optical, electrical, and magnetic behavior of the materials. There are one, two, and three dimension materials that can currently be produced: one dimension (thin surface coatings), two dimensions (nanowires and nanotubes), and three dimensions (nanoparticles) (Royal Society, 2007). Each one of these dimensions has different attributes. Nanomaterials are so beneficial because of their unique properties at these small levels. However, some of these properties that make them so beneficial also could add to its toxicity.

Part of the confusion with whether or not nanomaterials are toxic lies in the fact that there are many very different types of materials. Some of these different categories include: nanotubes, fullerenes, and metal oxides or nanostructured products, which will be the focus of this paper. Nanotubes defined more clearly as extremely thin (their diameter is about 10, 000 times smaller than a human hair), hollow cylinders made of carbon atoms, show physical characteristics similar to that of asbestos making them potentially toxic. Preliminary studies have shown that they may not escape into the air as individual fibers which are the mechanism of toxicity for asbestos (The Royal Society, 2007). Overall it has been shown that various types of nanomaterials, including C-60 fullerenes, single-walled nanotubes, and quantum dots, have been found to mobilize to mitochondria in cells potentially interfering with antioxidant effect (Rejeski, 2005).

Studies have especially shown that fibrous and tubular nanostructures show toxicity associated with fibrotic lung responses and result in inflammation and an increased risk of carcinogenesis, at high concentrations (Oberdorster

et al, 2005). At high doses, wildlife studies have demonstrated minimal dermal and oral toxicity. Fullerenes have to be administered at relatively high doses to achieve acute toxicity; the median lethal dose for a water soluble fullerene was 600 mg/kg (Colvin, 2003). Although the exposure of largemouth bass to fullerenes leads to lipid peroxidation in the brain and glutathione depletion in their gills, it is unclear why these biological effects disappeared at higher concentrations (Oberdorster et al, 2005). There are many studies showing different measures of toxicity for all these substances, but for the purposes of this study the sole focus will be on nano-structured metal oxide particles. Nano-structured Materials The nano-structured particle is “ a particle with a physicochemical structure on a scale greater than atomic/molecular dimensions but less than 100 nm, which exhibits physical, chemical, and/or biological characteristics associated with its nanostructure.

” (Oberdorster et al, 2005). It can be more than 100 nm but the biological activity of the particle as a whole is determined by the nano-scale substructure. Since the small size, NP’s have been assumed to be inert; however this property has increased concern recently. It has been shown that the nanoparticles can re-distribute from their site of deposition. Meaning following a person’s inhalation of NP, they have been reported to travel via the nasal nerves to the brain in a similar fashion to how the polio virus is described (Kreuter, 2002).

From this point NP is reported to gain access to the blood and other organs (Kreyling, 2004). References Colvin, V. (2003). The Potential Environmental

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