Nanomaterials and nanoparticles: Sources and toxicity

A nanometer is one-billionth of a meter, and the minute size of nanoparticles is key to understanding the interest in them. On the nanoscale, common substances take on entirely new chemical, optical, magnetic, electrical, and mechanical properties, thereby opening up brand new possibilities for scientists. Nanotechnology is now a top research priority in most of the industrialized world, offering enormous prospects for progress in a wide range of areas including life sciences and information technology. Among the general public however, mere mention of nanotechnology is often enough to cause misapprehension and fear. In *Nanomaterials and nanoparticles: Sources and toxicity*, Buzea, Pacheco and Robbie outline the origin, activity, and toxicity of nanoparticles. They point out that while there is cause for concern about the safety of nanoparticles, the public's fear may in part be due to media outlets making no distinction between various types of nanomaterials, of which some (such as those in computer processors) are considered benign, whilst others (detachable or free nanostructures) are likely to cause adverse health effects. Some nanoparticles are even beneficial to human health.

Human exposure to nanoparticles is not new: nanoparticulate pollution caused by dust storms, volcanic ash, forest fires, erosion, and similar events has always been part of human existence. Virus and bacteria, also nanosized, have been around since pre-historic times as well. What is new is the rapid increase in human exposure to nanoparticles. Contrary to popular belief, this is not primarily due to engineered nanomaterials: the bulk of nanoparticulate pollution stems from engine exhaust and industrial manufacturing. In addition, indoor pollution caused by cooking and heating on poorly ventilated stoves using biomass fuels (wood, crop residue, dung, and coal) are responsible for the death of an estimated 1.6 million people annually and affects the environment negatively, e.g. by contributing to climate change and destruction of the ozone layer.

However, it is a fact that engineered nanoparticle materials are now produced at an increasing rate. We are exposed to nanoparticles every day of our lives through common consumer products such as food additives, cosmetics, functional fabrics, sunscreens, microelectronic devices, batteries, and more. This nanoparticle pollution is expected to increase rapidly and may pose a serious threat to public health.

It has been shown that nanosized particles are able to enter the body and rapidly migrate to our inner organs, where they may enter cells and influence basic cellular processes, such as proliferation, metabolism, and death. Many diseases, such as cancer, Parkinson's, and Alzheimer's, are associated with dysfunction of these basic processes. Some nanoparticles are able to cross the blood-brain barrier and may cause damage to the brain. The minute size of nanoparticles makes it more difficult for the body to rid itself of them, which means they stay in the body longer than larger particles would. While the body seems to adapt and get better at protecting itself against harmful nanoparticles over time, long-term effects of nanoparticles on human health and on the environment need to studied further.

To stop nanoparticles from becoming a serious threat to human health, we must learn what the most important parameters are in deciding the toxicity of nanoparticles, and what measures can be taken to lessen particulate pollution and the toxic effect of nanoparticles in our bodies. Simply taking dose, mass, and duration of exposure into account, as in traditional materials toxicology, has proven to be insufficient. Rather, each nanoparticle type must be examined with regards to these and additional factors, such as shape. In addition, methods for reducing nanoparticle toxicity must be studied further. Buzea et. al. call for dietary and cosmetic nanoparticles, as well as other products incorporating nanoparticles, to be strictly regulated as distinct materials from their bulk constituents. At the same time, they emphasize that the nanotoxicology field should focus not only on engineered nanomaterials, but also on those generated by nature and pollution. A reduction in traffic combustion would have a large impact on global human exposure to nanoparticles, as would limiting deforestation and desertification. The authors suggest that national governments and international organizations should enact stringent air quality policies with standardized testing methods and low exposure limits.

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”Nanomaterials and nanoparticles: Sources and toxicity”, Cristina Buzea, Ivan I. Pacheco and Kevin Robbie