Screening for Potential Toxicity of Engineered Nanomaterials: Its Utility in Developing Responsible Nanomanufacturing

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Presentation

Abstract: Rapid developments and commercialization of nanotechnologies has resulted in a rapid increase in the production rates and variety of novel engineered nanomaterials (ENMs). The potential adverse effects of these materials on human health and the environment are largely unknown. Great concerns have been raised for some classes of ENMs, most notably carbon nanotubes, which have fueled a recent flurry of regulatory initiatives as well perceived high risk among several stakeholders and the public. It is important that the recognition of potential toxicity of certain ENMs should precede commercialization of nanotechnologies. Simple yet reliable and predictive approaches to screen ENMs for potential toxicity are urgently needed. Biological oxidative damage (BOD) has been recognized as a key mechanism of toxicity of particulate matter and has been proposed as a global metric for rapid toxicity screening. A 'Ferric Reducing Ability of Serum (FRAS)' assay was recently optimized by our group as a screening tool to quantitate the degree of biological oxidative damage imparted by ENMs in human blood serum. This approach was used to screen several classes of ENMs (several carbon nanotubes, fullerenes, carbon blacks, titanium dioxide, alumina, and nanosilver) for their ability to cause BOD. Further relationships between FRAS-determined BOD and several measured physico-chemical parameters of ENMs were explored in an effort to explain the observed BOD results, to identify candidate exposure metrics for ENMs, as well as targets for material redesign. The free radical generation capacity of this same group of ENMs was also measured with the commonly used dichlorofluorescin (DCFH) assay. The concordance between the FRAS-measured BOD and toxicity was evaluated for this set of ENMs. We present these results here and discuss the potential utility of these findings for toxicity screening and the greening of nanomanufacturing processes. Biological oxidative damage potential of ENMs as measure by FRAS in human serum appears to be a valid approach for screening purposes.