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From Nano-Risk to Nano-Solutions in Drinking Waters

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Abstract

The environmental health and safety (EHS) research community has covered a lot of ground between 2000 and 2020 to help safely advance the use of nanotechnology across the entire life cycle of nano-enabled products. EHS research really followed a common progression for new technologies. The first five years really viewed nanoparticles as a potential "emerging pollutant" that had unknown exposures or hazards. Our group and many others rapidly mobilized to develop new analytical tools to measure engineered nanomaterials in complex media (air, water, soil, biota) to refine exposure estimates, informing toxicologists of reasonable dose ranges. We reported on nanosilver in textiles or titanium and silica dioxide in foods, and then their passage through sewers to wastewater treatment plants and even agricultural land receiving sewage solids. We reported nanomaterials in rivers, drinking water plants and even tap water at homes. Overall, the levels of engineered nanomaterials are usually extremely low (part per billion or lower), and lower than incidental or natural nanomaterials of similar composition. Occasionally, "hotspots" in the workplace or environment were observed but overall we concluded there are very low exposures in water. As the EHS community saw the risks from engineered nanomaterials would likely be low, and manageable, many began focusing on exploring how unique nanoscale properties could be exploited to clean-up the environment. Our group focused on discovering strategies to attach or embed nanomaterials in macroscale treatment systems to purify water using energy provided across the broad electromagnetic spectrum, rather than the conventional approach which relies upon intensive chemical addition to water which leads to numerous undesirable risks. The trajectory of research over the past decade, development of tools and discovery of reactive surfaces that emerge even in environmental matrices has begun opening new fields of research into the significance of natural nanomaterials in molecular to global-cycling processes.