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Environmental Implications and Applications of Engineered Nanomaterials: Fullerene and Magnetite Case Studies

By

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Industrial scale production, coupled with unique material properties, underpin rising concerns of engineered, nanoscale materials inadvertently affecting the health and function of natural systems. Conversely, novel material properties may be utilized to uniquely address current environmental issues. Key to both sides of the 'nano-envi' paradigm is the fundamental understanding of the material(s) behavior and properties in both natural and engineered systems. I will discuss both sides of the issue using two model systems as examples:

First, nanoscale material implications will be discussed for carbon fullerenes. Fullerenes, C_{60} in particular, have been proposed for a variety of applications and will be produced at the industrial scale in the near future. Research presented addresses C_{60} in aqueous systems, with emphasis placed on physical/chemical characterization, reactivity, and biological interactions. Results indicate that the behavior and reactivity of C_{60} in water significantly deviate from what is expected based on molecular properties, thus providing valuable information for material risk and life cycle analyses in addition to potential aqueous-based applications.

Second, the application of engineered, iron oxide materials for radioisotope sensing, quantification, and remediation will be presented. Nanoscale iron oxides, such as magnetite, effectively adsorb a number of heavy metals including uranium and allow for unique separation (based on magnetic susceptibility) and remote analytical strategies (based on α-particle counting). Research demonstrates that by controlling the size and surface chemistry (including water-stabilizing agents), nanoscale magnetite can be optimized for enhanced uranium sorption and subsequent separation. Furthermore, these materials increase uranium detection sensitivity via α-particle counting, as they are suitable monomers for ordered, nanoscale film formations, which minimize particle shielding.

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