Small Particle Chemistry: Reasons for differences and related experimental and conceptual challenges

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ABSTRACT

Although much research attention has focused on synthesis methods and physical properties of nano-sized objects, the chemical reactivity of nano-materials is often quite different from that of either bulk material or the individual atoms that comprise it. Nano-particles are often polymorphs of the bulk material with different physical (and electronic) structures including those related to surfaces and defects. Some properties of nanoparticles (such as solubility) change simply with size assuming that other properties of the material do not change, but often these other properties also change with size. Understanding the chemistry of nanoparticles requires knowledge of which properties of the particles impact the chemistry as well as the characteristics of specific nanoparticles.

Nature makes a wonderful variety of stable nanoparticles, unfortunately they are often very complex in structure and composition as well as difficult to adequately characterize. Although artificial nanoparticles are readily made in many ways, they can be equally hard to truly characterize. In addition, they are often unstable as a function of time, easily influenced by contamination during synthesis or handling and have properties that can be significantly altered by interactions with their environment. Although it is appropriate to ask how nanoparticles impact our environment, it is also appropriate to ask how the environment changes the nanoparticles and their properties. The presentation will include discussion of different aspects of small particles that can alter reactivity, observations of nanoparticle stability and measures of reactivity. Examples will be drawn from our program on the "Reaction Specificity of Nanoparticles in Solution: Application of the Reaction of Nanoparticulate Iron with Chlorinated Hydrocarbons and Oxyanions." In particular, we are examining the possibility that Fe nanoparticles alter the branching ratio between a desirable and an undesirable reaction path in the reductive dechlorination of CCl_4.