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Characterization and Properties of Nanoparticles¹

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Nanoparticles and other nanostructured materials are increasingly subject to a wide variety of studies. Although it is often ignored, in many circumstances the character and properties of nano-structured materials vary as a function of time, are altered by coatings and are environmentally dependent. This talk will outline some of the general issues related to characterization of nanoparticles and show measurements of the time and environmentally dependent behaviors of iron metal-core oxide-shell and ceria nanoparticles. Iron nanoparticles are of interest for several reasons including their potential use for medical applications and reduction of environmental contaminants such as chlorinated hydrocarbons or chromates. A study of the changes that occur when iron nanoparticles are exposed to water and the impact of the changes on particle reactivity and reaction pathway will be discussed. For this work, XPS, TEM, BET and XRD have been used to obtain information about the changes that take place in the particles as a function of time. Because of an ability to store and release oxygen, ceria is important for catalytic, fuel cell and possibly health applications. Other researchers have shown that as CeO₂ particles decrease in size, the Ce valence state changes from a Ce⁺⁴ to a Ce⁺³. We have found that this transformation is environmentally dependent. Five nm particles can change from +4 to +3 and back to +4, as the environment is altered from oxidizing to reducing conditions and back. These changes can be observed in solution using optical adsorption and may have impacted measurements intended to examine band-gap changes due to particle size. XPS measurements of particles fully corroborate the real time solution measurements. These time and environmentally dependent measurements create important sample and characterization handling challenges.

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