

Effects of the Environment and Time on Properties of Nanoparticles in Solution

D. R. Baer*, JE Amonette, M. H. Engelhard, S. V. Kuchibhatla, P. Nachimuthu, C-M. Wang,
Pacific Northwest National Laboratory, Box 9999-9 Address, Richland, WA, USA

(*don.baer@pnl.gov)

J. T. Nurmi, V. Sarathy, P. G. Tratnyek
Oregon Health and Sciences University, Beaverton OR, USA

A. S. Karakoti, S. Seal
University of Central Florida, Orlando FL, USA

In many cases the character and properties of nano-structured materials vary as a function of time and are environmentally dependent. Because both natural and artificial nanostructured materials are prevalent in the environment it is important to understand both the challenges in measuring environmentally sensitive materials and how the properties of these particles actually change in natural conditions. This talk will outline both some of the general issues and show measurements of the time and environmentally dependent behaviors of iron metal-core oxide-shell and ceria nanoparticles will be examined. Iron nanoparticles are of interest for several reasons including their potential use for reduction of environmental contaminants such as chlorinated hydrocarbons or chromates. We have previously shown that the specific type of nanoparticles examined play a significant role in the reactions that occur in solution. In current work we have examined the changes that occur when these nanoparticles are exposed to water and the impact of that exposure on the particles reactivity and reaction pathway. In this work, XPS, TEM, BET and XRD are 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 changes from a Ce⁺⁴ to a Ce⁺³ chemical state. 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 and back to oxidizing conditions. These changes can be observed in solution using optical adsorption. XPS measurements of particles in different conditions fully corroborate the real time solution measurements. These time and environmentally dependent measurements create important sample handling challenges, especially for surface analysis.

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