



Christopher L. Kitchens

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Chris Kitchens received a B.S. in Chemistry from Appalachian State University in 1999 and a Ph.D. in Chemical Engineering from Auburn University in 2004 under the guidance of Prof. Christopher Roberts. Following a 2-year post-doc appointment at Georgia Institute of Technology with Chuck Eckert, he joined the Chemical Engineering faculty at Clemson University in 2006. Since then, he has established a research group that is focused on advanced materials development for technological advancement in the fields of nanotechnology, renewable resources, green building products and stimuli responsive composite materials. Specific research interests include the synthesis, processing, and application of surface modified nanomaterials for drug delivery and catalysis applications, the fate of engineered nanomaterials in the environment, nanocomposites derived from renewable resources, and development of next-generation green cement building products. We also

employ materials processing with tunable fluids and neutron scattering characterization techniques. Dr. Kitchens has many educational and outreach activities focused on Nanotechnology, Green Chemistry, and Green Engineering.

Gold Nanoparticle Colloidal Catalysts: Role of Ligands and Strategies for Recovery and Reuse

Abstract

The field of catalysis is estimated to account for 5% of the world GDP. This field is largely divided between homogeneous and heterogeneous catalysis. Homogeneous catalysis can offer superior yield and selectivity for a wide variety of reactions, but 99% of industrial catalysis applications uses heterogeneous catalysis. This is driven by the post-reaction separation and ability to recover and reuse the catalyst. Colloidal catalysis has the potential to take advantage of both fields, where ligand stabilized nanoparticles are homogeneously dispersed within the reaction media but have the ability to be easily recovered and reused in subsequent reaction. Our research focuses on the design of colloidal nanoparticles for catalysis applications.

Gold nanoparticles (AuNPs) have attracted enormous attention as of late due to their unique catalytic activities. Colloidal AuNPs provide benefits of selectivity, greater surface area per mass of catalyst compared to supported catalysts, activity under mild conditions and potential for chiral catalysis. We have demonstrated that colloidal AuNPs have higher catalytic activity than the supported counterparts on a per metal basis. The caveat is that colloidal AuNPs require surface ligand functionalization in order to prevent aggregation and loss of activity. This results in surface passivation and significant reduction in catalytic activity. Colloidal catalytic activity is strongly dependent on ligand packing and conformation on the AuNP surface. High molecular weight polymer ligands provide increased available surface area owing to decreased surface coverage due to steric hindrance. This leads to increased catalytic activity, while low molecular weight ligands lead to complete AuNP surface passivation. A major challenge for colloidal AuNP catalysts is the catalyst recovery and reuse. To alleviate this, we have developed pH responsive ligands that enable recursive recovery and reuse of colloidal AuNP catalysts by altering the pH to selectively precipitate or phase transfer catalyst into organic solvents. This was achieved by employing poly(acrylic acid) as benchmark polymer ligand where a specific number of acid groups can be grafted to with thiol moieties for surface binding. In this case there is a fine balance between providing adequate nanoparticle colloidal stability, recoverability, and maintaining catalytic activity.

Thursday Oct. 25th, 2018 | 368 Ritchie Hall | 11:00 – 11:50AM