NIRT Highlight

Dendrimer-Stabilized Nanoparticles for Next-Generation Catalysts

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We are developing the next generation of catalysts through the use of poly(amidoamine) dendrimers (PAMAM) for controlling the synthesis and structure of catalytically active bimetallic nanoparticles. PAMAM's tree-like structure forms internal pockets that have both chemical functionality for binding metal ions and the right size for growth and stabilization of sub-2 nm metal nanoparticles. The novelty of our work lies in the use of PAMAM as a template for synthesis of bimetallic nanoparticles as well as the agent for delivering these particles to a porous support for activation and evaluation as heterogeneous catalysts. The ultimate objective is a deeper understanding of the relationships among synthesis procedures, nanoparticle structure, and catalytic activity, enabling first-principles design of nanoparticle-based catalysts for specific applications.

In the first year of this project, we have demonstrated proof-of-principle of our concept. For the first time, PAMAM dendrimers have been used to synthesize and deliver monometallic (Pt, Pd) and bimetallic (Pt/Pd) nanoparticles onto a high surface-area support material (alumina), creating an active heterogeneous catalyst. The dendrimer-templating method was used to prepare all of the catalysts. FTIR studies of CO adsorption revealed adsorbed CO species that appeared to be unique to the Pt/Pd bimetallic system (Figure 1). Kinetic studies of CO oxidation, revealed that the activity of the bimetallic catalyst was intermediate between the activities of the monometallic catalysts (Figure 2). Much work needs to be done to reproduce these results, make comparisons with catalysts prepared through more conventional routes, and correlate activity with size, composition and morphological characteristics of the constituent nano-particles. Nevertheless, the CO oxidation results prove that the dendrimer-templating route for synthesis of mono- and bimetallic

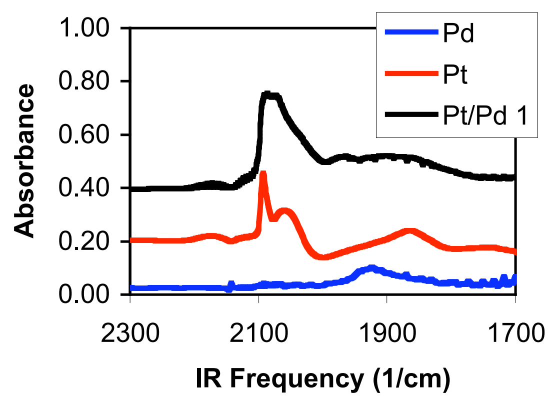

Figure 1. IR spectra of CO adsorbed on dendrimer-templated catalysts.

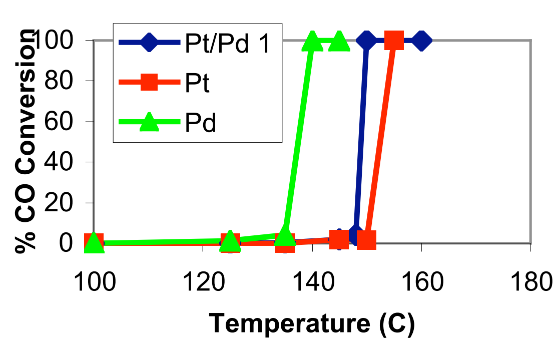

Figure 2. Kinetic study of CO oxidation.

nanoparticle can be used to prepare active heterogeneous catalysts.

This accomplishment was achieved by two undergraduate researchers: Crystal Childers, a participant in the USC Department of Chemical Engineering NSF-REU program, and Michelle Casper, an USC Chemical Engineering student, both working under the guidance Prof. Chris Williams, and assisted by graduate student Sam Deutsch, Prof. Hossein Nanaie (Claflin College), and Prof. Michael Amiridis.