Title: Designing Well-Controlled Nanocatalysts for Chemical Transformations

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Abstract:
Catalysts are materials that enable chemical transformations and are essential for advancing the energy efficiency of chemical processes. Precise synthetic control over material compositions and structure at the atomic scale has demonstrated great potential in designing efficient catalysts. Currently, catalysts prepared by conventional synthetic methods often exhibit low reactivity and stability during chemical reactions due to uncontrolled particle compositions and nonuniform particle morphologies. Recent advances in colloid chemistry have led to the development of new design strategies to prepare catalysts with well-controlled particle sizes, shapes, and compositions, enabling improved stability and catalytic performance during reactions. To demonstrate the tunability of the colloidal synthesis method, we report the design of two bimetallic nanoparticle systems, one with a core-shell structure and the other with a randomly alloyed structure. In particular, core-shell ruthenium-copper (RuCu) nanoparticles with varying Ru compositions and platinum-nickel (PtNi) alloy nanoparticles are synthesized by the colloidal method. The particle morphologies and size distributions of the as-prepared samples are characterized by transmission electron microscopy. Additionally, the metal compositions and distributions in both bimetallic systems are probed by scanning transmission electron microscopy coupled with energy dispersive X-ray spectroscopy. These techniques reveal well-controlled nanoparticles in both systems, enabling their use as viable catalysts for broader catalysis applications.