Highly active ceria-supported Au clusters for butadiene hydrogenation

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Emiel Hensen obtained his PhD degree in Heterogeneous Catalysis in 2000 at the Eindhoven University of Technology. He has been at the University of Amsterdam (2000-2001) and since 2002 at the Eindhoven University of Technology. He was appointed full Professor in Inorganic Materials Chemistry in 2009. He was awarded NWO-VENI (2003) and NWO-VIDI (2007) awards. He has worked at Shell Research and Technology Center Amsterdam from 2006 till 2008 via a Casimir grant. Currently, he is parttime lecturer at the KU Leuven in Belgium. Hensen has authored over 80 technical papers and 5 book contributions. His main research interests are in the field of molecular heterogeneous catalysis with an emphasis on applications relevant to sustainable energy technologies. Synthesis and mechanism of heterogeneous catalysts as studied by combinations of experiment and theory are the main thrust of the work.

Abstract

Gold nanoparticles display unique catalytic properties not exhibited by bulk gold in CO oxidation, epoxidation of propylene and the selective oxidation of alcohols. Although metallic gold is generally considered to be inert towards hydrogen, gold also displays high activity in the hydrogenation of unsaturated compounds. The nature of the gold active sites for hydrogenation (metallic Au vs. Au^{3+} ions) has not been established yet. Despite the availability of methods to synthesize supported gold particles in the nanometer size domain in a controlled manner, the preparation of catalysts containing very small, subnanometer gold clusters with a high thermal stability remains a challenge. Here we present results for gold catalysts prepared by leaching nanometer-sized gold particles from ceria-supported gold. In situ X-ray absorption spectroscopy shows that such a leached Au/CeO_2 material contains isolated Au ions. These ions are ideal precursors to subnanometer metallic gold clusters upon reduction. Their activity in 1,3-butadiene hydrogenation is extremely high, at least one order of magnitude higher than the nanometer sized gold particles in the unleached precursor catalyst.