Stevens Institute of Technology

Nanotechnology Graduate Program

Nanoparticle Catalysis by Gold and Platinum

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For a long time gold was considered an inert material without catalytic properties. In the 1980's, however, it was discovered that the catalytic properties of gold change dramatically when one deposits gold in the form of nanoparticles on a support. As such, gold has very high activity as a catalyst for a number of reactions. For example, the oxidation of carbon monoxide over gold nanoparticles already occurs at a high rate at a temperature as low as -70°C, which is lower than for any other catalyst. This presentation will give a general introduction on gold nanoparticles and then focus on the use of gold-titania catalysts for the direct epoxidation of propene to propene oxide. Propene oxide is an important commodity chemical, produced in about 7 MTons/year, with still rising demand. Just over 10 years ago it was discovered by Haruta et al. that gold nanoparticle catalysts on a titania support are a new and convenient way to produce propene oxide in a single reaction step at mild reaction conditions. The preparation and the characterization of the gold nanoparticle catalysts will be discussed, aiming to explain the remarkable activity of this system for propene epoxidation. A second system, platinum nanoparticles for the oxidation of carbon monoxide, will also be discussed. It will be shown by means of catalytic data and spectroscopic analysis that for this system the behavior of the metal catalyst can be strongly affected by the support on which the nanoparticles are present.

T. Alexander (Xander) Nijhuis is a professor of Chemical Engineering at the Eindhoven University of Technology in the Netherlands. He is a member of the Chemical Reactor Engineering group headed by Prof. dr.ir. Jaap Schouten. Prof. Nijhuis specializes in kinetic and mechanistic studies on catalysts, kinetic and reactor modeling, mass transfer, catalyst development, spectroscopy, and multiphase reactors. Nijhuis completed his PhD research in the Industrial Catalysis group of Jacob Moulijn at Delft University of Technology, Netherlands in 1998, working on transient catalysis and direct epoxidation of propene. After obtaining his PhD, he remained in the same group, working as a tenured post-doctoral researcher on the application of monolithic catalysts in multiphase reactors until 2002. During this time, he had two sabbatical stays at the University of Utrecht, Netherlands, (working on bimetallic catalysts) and ABB Lummus (Bloomfield, NJ, USA), working on the development of a low pressure Pygas hydrogenation process. In 2002-2006, Prof. Nijhuis worked at the University of Utrecht (Inorganic Chemistry and Catalysis group of Prof. Bert Weckhuysen) where he obtained a VIDI personal grant to start his own line of research on "in-situ spectroscopy engineering".

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