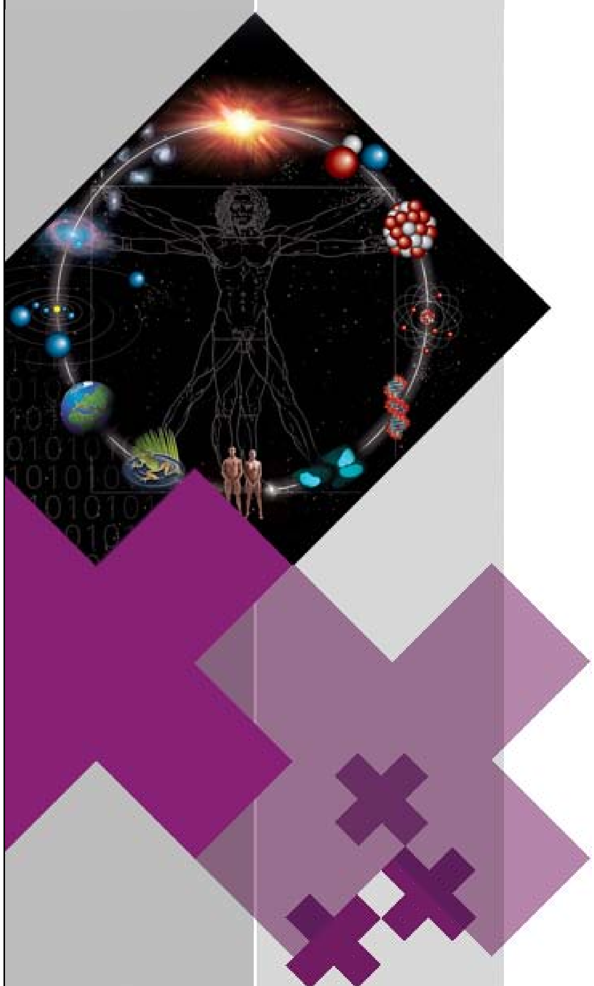
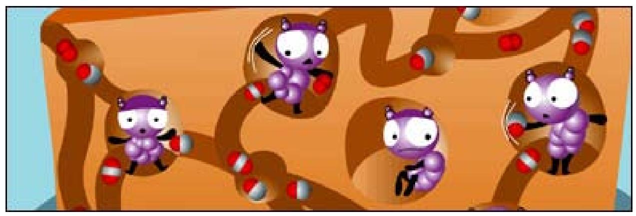


Faculty of Science

Trapping metal nanoparticles in "smart silica" cages



Details of the cover of 'Journal of Materials Chemistry'. Metalparticles trapped in silica-cage

The collaboration between the research groups of Gadi Rothenberg (UvA) and Hubert Koller (Westfälische Wilhelms Universität Münster) has resulted in a new catalyst synthesis method. An article on this was recently published and featured on the cover of Journal of Materials Chemistry.

Sintering

Many heterogeneous catalysts are made of metal nanoparticles on a porous support. In general, the smaller the particles, the better, because smaller particles mean higher surface area, and catalysis occurs on the particles' surface. Some chemical reactions work only on nano-sized particles. The latter have more unsaturated coordination sites, that exhibit much higher activity. This is the case for gold catalysis, where particles larger than five nanometer are generally inactive (indeed, prior to the synthesis of small gold nanoparticles in the 1990s, gold was known as catalytically inert). These heterogeneous catalysts are often exposed to high temperatures and redox cycling. The metal nanoparticles often aggregate under such conditions, forming large metal chunks with a lower activity. This process is called 'sintering'.

Porous size-specific cages

Dr. Nina Wichner (Münster) has proposed an original solution for this problem during her PhD work, by trapping the metal nanoparticles in tailor-made cages of silica. The cages are just large enough for the particles to move and catalyse reactions, but they cannot grow further or aggregate. Wichner has made in Rothenberg's lab gold and silver nanoparticles coated with an amphiphilic "shell" covered in phenyl groups. She then synthesised porous silica via the sol-gel approach using a mixture of silica precursors that also contained phenyl groups. The phenyl-phenyl interactions resulted in a silica polymer with metal nanoparticles closely embedded in phenyl-phenyl shells. Calcining the materials at high temperature burned off the organic groups, leaving the metal nanoparticles trapped in the inorganic silica cages.
This synthesis method yielded a unique catalyst, with small metal nanoparticles that can catalyse reactions but cannot clump together and sinter. The application was demonstrated by Dr. Jurriaan Beckers (UvA), who showed that the 'trapped' gold and silver nanoparticles could catalyse CO oxidation under realistic process conditions without sintering.

Collaboration between Amsterdam and Münster

The researchers of the two universities collaborated as part of the IRTG (International Research and Training Group) program, funded jointly by NWO and DFG. The program's objective is strengthening the collaboration between universities by exchanging lecturers and PhD students, and arranging special courses and 'summer schools'. Rothenberg and Koller received research funding from this program for designing and making robust solid catalysts. The IRTG is represented in the Netherlands by the

Holland Research School for Molecular Chemistry (HRSMC).

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