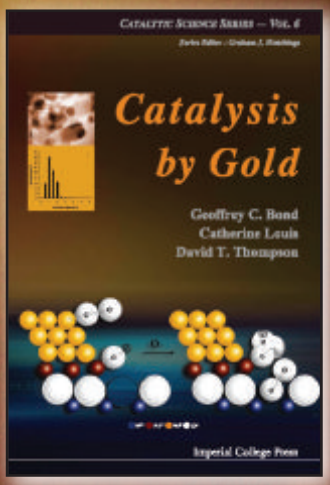
CatGold

A newsletter on developments and progress in gold catalysis and its applications



Winner – Catalysis by Gold Book!

Congratulations to **Valérie Caps** from **IRCELYON, CNRS, Lyon,** France on being the winner of a copy of the Catalysis by Gold book recently published by Imperial College Press. Visitors to the World Gold Council stand at the EuropaCatVIII conference in Turku/Åbo, Finland were invited to submit their business card for this prize draw and Dr Caps' card was drawn at random from those entered.

CatGold News is available at www.goldbulletin.org

WORLD GOLD COUNCIL

NEWS

ISSUE No. 14

WINTER 2007

Gold Oxidation Catalyst Named One of the Year's Most Innovative Products

Nanostellar, Inc., a nano-engineering catalyst materials company, recently announced that its NS Gold™ catalyst has been named one of the most innovative products of 2007. In their annual Micro/Nano 25 Awards touting the 'technologies of tomorrow,' the editors of R&D Magazine and Micro/Nano Newsletter recognized Nanostellar for its innovation in developing a first in diesel emissions technology: the use of gold as an oxidation catalyst. Nanostellar finds itself in very elite company as other winners of this year's award include: Georgia Institute of Technology, HP Laboratories, Oak Ridge National Laboratory and Sandia National Laboratories. "This award provides further validation of what our customers are experiencing and independent labs have proven: that our NS Gold product is poised to make a profound impact on the automotive industry as manufacturers use our product to meet emissions-control compliance regulations more efficiently than ever before," said Pankaj Dhingra, CEO of Nanostellar.

Nanostellar and the other award recipients are featured in the July 2007 issue of Micro/Nano Newsletter and the August 2007 issue of R&D Magazine. For more information visit: www.rdmag.com/pdf/RD0707_Materials.pdf.

In a subsequent development, Nanostellar has also just been named as a 2008 Technology Pioneer by the World Economic Forum. Nanostellar is one of 39 visionary companies from around the globe to receive this prestigious award as nominated by leading technology experts from the academia, media, venture capital and corporate technology communities. See www.weforum.org for more information. ■

Gold Catalysis at EuropaCatVIII

26-31 August in Turku, Åbo, Finland

Attendance at this conference was around 1,500 delegates from 56 countries. The European countries were strongly represented and there were significant numbers of participants from Japan.

A selection of the 59 posters and 15 talks scheduled on various aspects of catalysis by gold is given in a separate article in *Gold Bulletin*, especially where they indicate potential for applications or insights into the mechanism of the catalysed reactions.
Details of the scientific programme are given on http://www.europacat.org/scientificprogramme.html

In the exhibition at EuropaCat, Project AuTEK collaborated with the World Gold Council demonstrating the opportunities for applications for gold and gold alloy catalysts, and AuTEK catalysts were distributed to participants interested in evaluating their performance in a range of reactions, for details of these catalysts, see www.mintek.co.za/autek/CustomMadeCatalysts.htm ■

People Profile:

Dr Jose A Rodriguez

Jose A Rodriguez is a Senior Scientist in the Chemistry Department at Brookhaven National Laboratory.

Dr Rodriguez's research programme couples sophisticated synchrotron-based techniques and state-of-the-art theory to investigate the behaviour of active sites in several important catalytic systems. Complexities stemming from the inherent multi-component aspects of heterogeneous catalysts are explored using both ultra-high vacuum surface science investigations of well-defined model systems, and *in-situ* powder diffraction and x-ray absorption studies of 'real-world' systems. Quantum-chemical calculations based on density-functional theory are performed to help in the interpretation of experimental results and to study basic aspects of catalytic reactions.

Au-ceria systems have previously been shown to be very efficient catalysts for the low-temperature water-gas shift reaction (WGS, $CO + H_2O \rightarrow CO_2 + H_2$). There are unique phenomena associated with the performance of these WGS catalysts. Using *in-situ* catalyst characterization techniques at Brookhaven's National Synchrotron Light Source (NSLS), Rodriguez and coworkers Xianqin Wang , Jonathan Hanson and Jan Hrbek found that the active phase of many powder catalysts contains nanoparticles of gold dispersed on partially reduced ceria. The deposition of Au nanoparticles on a $CeO_2(111)$ support produces surfaces that have a WGS catalytic activity much larger than that of $Cu/ZnO(000\bar{1})$ surfaces used to model industrial catalysts. Theoretical studies done in collaboration with Brookhaven's scientist Ping Liu indicate that the high activity of the $Au/CeO_2(111)$ surfaces is associated with the low-coordinated corner and edge sites as well as the fluxionality of the gold nanoparticles.

Recently, Jose Rodriguez has won a HENAAC Award for Outstanding Technical Achievement. When he is not doing research or attending meetings, Jose can be found reading a good book, analyzing 'weird' artistic movies, or discussing with his friends the many virtues of "fútbol" (soccer). ■

Unique Behaviour of Gold Catalysts in Catalytic Asymmetric Reactions

One of the milestones in catalytic asymmetric synthesis was the very first example of an asymmetric aldol addition reaction, reported by Ito, Sawamura and Hayashi in 1986 (Y. Ito, M. Sawamura, T. Hayashi, J. Am. Chem. Soc., 1986, 108, 6405). They used cationic gold(I) complexes of chiral diphosphanes as catalysts and by so doing opened up a whole new aspect of catalytic asymmetric synthesis : the results were of fundamental importance and the principle could ultimately be extended to other metals. In these reactions the chiral information from the ligand is multiplied and induces chirality in the products.

In a new publication Toste and co-workers now report for the first time that even a chiral counter-ion with cationic gold-phosphane complexes can be very efficient in inducing chirality (G. L. Hamilton, E. J. Kang, M. Mba, F. D. Toste, *Science*, 2007, **317**, 496). This is a change of paradigm; so far the influence of the ligand, which is close to the substrate, was the dominating one and little success could be achieved with the more remote counter-ions. Toste's reactions depend on the use of a non-coordinating solvent of low polarity, then the formation of contact ion pairs bring the chiral counter-ion in close proximity to the substrate, since the linear coordination at gold(I) enables it to be even closer than the coordinated ligand.

Two remarkable facts are that the influence of the chiral counter-ion can be more efficient than the influence of a directly co-ordinated chiral ligand and that a synergistic influence of the chiral counter-ion and the chiral ligand is possible.

Future investigation has to show whether this effect is restricted to gold with its linear co-ordination or can be extended to other metals, as well (see comments in A. S. K. Hashmi, *Nature*, 2007, **449**, 292).

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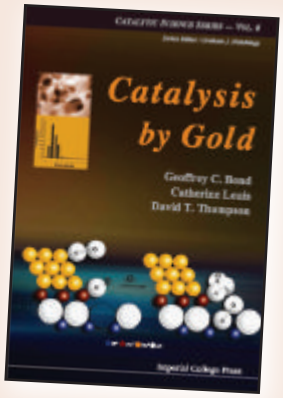
Congratulations to Geoffrey Bond!

The article written by Prof Geoffrey C Bond for Catalysis Today entitled 'Gold: a relatively new catalyst' (see Catal. Today, 2002, 72, 5 and Gold Bull., 2001, 34, 117: http://www.goldbulletin.org/downloads/Bond_4_34.pdf) has led to Geoff being awarded a congratulatory gift and certificate by Elsevier as the most cited author for the period 2002 – 2006. This paper was based on a talk given by Prof Bond at the international conference entitled 'New Industrial Uses for Gold: Catalytic Gold' held in Cape Town, 2 – 5 April 2001.

Catalysis by Gold Reprinted

Stimulated by the increasing demand for knowledge on this topic, this book written by Geoffrey Bond, Catherine Louis and David Thompson, and published in August 2006, has now been reprinted. For those of you interested in purchasing a copy of the book, please go to http://www.icpress.co.uk/chemistry/p450.html



'The Riches of Gold Catalysis' in C&E News

In an article entitled 'The riches of gold catalysis', published in C&E News on 24 September 2007 (Vol **85** (39), 87 – 91), Raychelle Burks highlights various aspects of the excitement caused by the emergence of gold as an important catalyst in both homogeneous and heterogeneous reactions (see http://pubs.acs.org/email/cen/html/092507055816.html). She indicates that "Chemists are using this precious metal to catalyse a treasure trove of reactions". Gold catalysts are used in organic synthesis as well as reactions relevant to pollution control, including respirators and control of mercury emissions from coal-fired power stations, and purification of hydrogen for use in fuel cells. Other likely commercial applications are also highlighted.

Recent Papers and Patents

Nanocrystalline Cerium Oxide Produced by Supercritical Antisolvent Precipitation as a Support for High-activity Gold Catalysts

In a paper by Z-R Tang, JK Edwards, JK Bartley, SH Taylor, AF Carley, AA Herzing and GJ Hutchings, *J Catal*, 2007, **249**(2) 208 – 219, high activities for Au/CeO_2 catalysts are reported. The CeO_2 was prepared using supercritical CO_2 and this has lead to very finely dispersed Au nanoparticles (no discrete Au particles could be observed) and catalysts had good activity. The activity quoted for the most active Au/scCO_2-2 (3.7wt%Au) catalyst is equivalent to 1.49 x 10^5 μmol_{CO}/gAu.s at 25°C. At 5°C it is 7.9 x 10^4 μmol_{CO}/gAu.s.

The space velocities used when these rates were obtained were 1880 times higher than used in previous Au/CeO_2 studies (22.5 ml/min per 15mg catalyst was typical). An Au/scCeO_2 catalyst became deactivated during 3 h using a space velocity of 448,000 ml 0.5%CO in air/gcat.h. With a 90,000 SV, a gas flow rate typical of that required for use in respirators, the CeO_2-supported materials all gave stable catalytic performances but the WGC Au/Fe_2O_3 catalyst was found to deactivate rapidly. ■

Selective Oxidation of Glycerol over Carbon-supported Au-Pd Catalysts

WC Ketchie, M Murayama and RJ Davis, *J Catal*, 2007, **250**(2) 264 – 273 report that the activity of the Au-Pd catalysts varied with the amount of Au present but was not higher than for Au alone (fairly unusual amongst Au-Pd catalysts!) Au-Pd catalysts had higher selectivity to glyceric acid than the monometallic Au. The TOF quoted for Au alone is17 s^{-1}.

The presence of Pd with the Au decreased the amount of hydrogen peroxide present and this is thought to decrease the amount of C-C cleavage products. Au-Pd catalysts are described where the gold was on the outside of the Pd. Both Michael Wong and Graham Hutchings have prepared catalysts where the Pd is on the outside of the Au. ■

Stop Press!

World Gold Council and Nanostellar Inc. have agreed to a long-term strategic partnership to enable the introduction of gold into the auto catalyst market. Under the terms of the agreement WGC has joined Nanostellar's other equity investors and will provide the company with significant marketing and business development support. More details in the next CatGold News. ■

If you have a contribution for CatGold News please email industry@gold.org