WORLD GOLD COUNCIL

ISSUE No. 5 AUTUMN 2003

CatGold NEWS

GOLD 2003

From the Chairman, Gold 2003 Organising Committee

This issue coincides with the international conference, GOLD 2003, being held in Vancouver. This is another landmark in the world of gold catalysis, both in terms of new science and its industrial application.

The first landmark was the Catalytic Gold conference held in Cape Town in April 2001 – the first time that progress in gold catalysis was the focus of discussion in an international forum. That successful conference attracted around 30 presentations and 80 delegates. It also led to the publication of CatGold News as a forum for the community to stay in touch, and the WGC Gold Reference Catalysts which are helping researchers to benchmark their catalysts (see below). CatGold News is now distributed to around 1200 people via our website and in printed form.

Now just over 2 years later, GOLD 2003 has attracted over 60 quality presentations and 5 Keynote lectures on this topic alone. We are seeing important patents and even new industrial applications beginning to emerge. Anyone interested in gold catalysis, be they researcher or industrialist cannot afford not to be in Vancouver!

The sub-title of this conference is 'New Industrial Applications for Gold' and emphasises that this is not just an exchange between scientists, but an opportunity for scientists and industrialists to meet and define possible co-operation and collaboration to develop the science into useful technology for commercial exploitation. It is important that scientists express how and where they see their research might be usefully exploited. Those in industry cannot always deduce this from just reading a scientific article in a journal.

Personally, I am very excited about this conference. Gold catalysis is now firmly on the 'science map' and hopefully about to be of industrial importance in chemical production, pollution control and fuel cells in the new hydrogen economy as it emerges. Let us make it happen!

I look forwarding to meeting many of you in Vancouver!

Christopher Corti
World Gold Council

GOLD 2003: A landmark event

GOLD 2003
NEW INDUSTRIAL APPLICATIONS FOR GOLD

At the time of writing the final preparations for this ground-breaking and unique event are beginning in earnest. Over 140 papers have been accepted for presentation at GOLD 2003. About half of these are on advances in heterogeneous and homogeneous catalysis by gold. In addition to Catalysis, there will be presentations on Gold Chemistry, Nanotechnology and Materials and the interactions between delegates from all four areas is expected to lead to innovative outcomes for catalysis as well as other areas. Leading researchers from over 20 countries will gather to present and discuss the rapid advances in the science and application of gold catalysis that have taken place since the first major conference on this topic was held in South Africa in 2001.

As well as leading researchers, many industrialists will also be present from organisations seeking to exploit the performance of gold catalysts: these will include representatives from major oil and chemical companies, utilities and catalyst manufacturers. Catalysis sessions at the Vancouver conference include: Fundamentals in Gold Catalysis, Hydrogen Processing and Fuel Cell Applications, Surface Chemistry and Catalysis, Applications for Gold Catalysts, New Routes to Chemicals via Homogeneous Catalysis, Advances in Heterogeneous Catalysis, Bimetallic Catalysts, Gold Catalysts in Chemical Processing, Catalyst Preparation and Characterisation, Electro- and Nano-Catalysts, and New Catalysts.

Please note that abstracts for additional posters describing recent results can be submitted via the conference website until 31 August: this will enable the proceedings to be kept really up-to-date! ■

Update on Gold Reference Catalysts

Gold on titania and gold on carbon Reference Catalysts are now available from World Gold Council. The gold on titania catalyst is the third and final type prepared by Süd Chemie, Japan and characterised at the laboratories of AIST, Japan. The gold on carbon catalyst has been prepared

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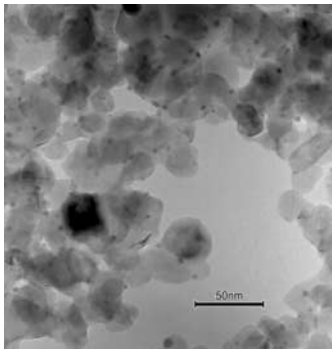


Type A Gold Reference Catalyst characterised by AIST, Japan: it is Au/TiO_2 made by deposition precipitation

PEOPLE PROFILE

Chuan-Jian Zhong

Dr. Chuan-Jian Zhong is an Assistant Professor at the State University of New York at Binghamton. His graduate studies at Xiamen University and early research appointments at Fritz-Haber-Institute, University of Minnesota and Iowa State University covered topics in analytical, materials, surface chemistry and electrochemistry. His interdisciplinary interests are reflected in more than 70 publications on a wide range of topics including electrocatalysis, conducting polymers, molecular assemblies, microfluidics, and sensors. Following his early studies on the interfacial chemistry of self-assembled monolayers on gold surfaces, he has in the past several years expanded part of his research interest to the exploration of gold nanoparticles and nanotechnology. He emphasizes the importance of a balance between basic and applied research, and considers the exploration of gold-based nanotechnology as a paradigm of such a balance in view of the unique electronic, optical, and catalytic properties of nanoscale gold now becoming apparent. His research laboratory has developed new methods and insights to address both fundamental and practical issues in exploring the viability of nanostructured gold and alloy materials for fuel cell catalysis and chemical/biological sensing applications. He is inventor/co-inventor of three US patents, with several pending that are related to gold-based nanoparticles. In his interests outside science, CJ enjoys basketball and soccer games.

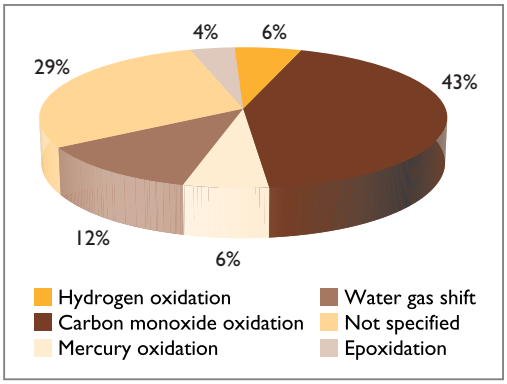
Update on Gold Reference Catalysts

Continued from front page

by Prof Michele Rossi of the University of Milan (see article on page 3). This means that all four different types of Gold Reference Catalysts can now be ordered from the Council's website at http://www.gold.org/discover/sci_indu/gold_catalysts/refcat.html

There has been great enthusiasm to the availability of the catalysts and organisations supplied with samples at the time of writing have included:

Tennessee Valley Authority, USA
Darmstadt University of Technology, Germany
Engelhard, USA
GE Technology Centre, India
University of Pisa, Italy
BP Amoco, USA
University of Messina, Italy
Johnson Matthey, UK
ETH Zurich, Switzerland
University of Bochum, Germany
Cardiff University, UK
University of Torino, Italy
Shell Chemicals, The Netherlands
University of Catania, Italy
Tufts University, USA
Inst. Technologia Quimica (CSIC), Spain
Mintek, South Africa
Charles University, Czech Republic
3M, USA
Dow Chemical Company, USA



Recipients of the Gold Reference Catalysts have indicated that they will be used for studying a number of reactions, shown above as a proportion of the total number supplied.

The purpose of the Reference Catalysts is to allow researchers worldwide to benchmark the performance of their own prepared catalysts against a common standard. See Issue 4 of CatGold News for further information or contact Dr Richard Holliday, email Richard.holliday@gold.org ■

In Brief:

- **Professor Geoffrey Bond and Dr David Thompson,** Consultant to World Gold Council, are planning to compile a monograph on gold catalysis during 2004. Those individuals and organisations with relevant material (recently published papers, patents, reviews etc, or manuscripts soon to be published) for consideration for inclusion are invited to contact David at DTThompson@aol.com (Fax +44 118 984 5717).
- **Mr Marco Conte** will shortly begin a World Gold Council GROW supported one year MSc programme at Cardiff University. This project will study novel carbon-carbon bond coupling reactions catalysed by gold, under the direction of Prof Graham Hutchings.
- **Dr Susumu Tsubota,** who has characterised the World Gold Council's Gold Reference Catalysts, has moved his laboratories from the National Institute of Advanced Industrial Science and Technology, Kansai, Japan to Dr Masatake Haruta's research unit at the National Institute of Advanced Industrial Science and Technology in Tsukuba. He is continuing his work on gold catalysis.
- **Professor Wayne Goodman,** whose research on gold catalysis continues to make significant progress on a number of fronts, has been spending three months at the University of Cambridge, UK as a Fulbright Scholar.
- The EU funded network on gold catalysis, **AURICAT** now has a website, see http://www.cf.ac.uk/chemy/staff/willock/Welcome.html
- The latest update to the **World Gold Council's Technical Database** is now available at http://www.gold.org/discover/sci_indu/techdatabase/index.html containing over 450 new references and patents on gold science and technology including catalysis.
- A website containing information of the recently established **NRF-NSF** collaborative project between South Africa and USA on gold catalysis can be found at http://www.chms.ucdavis.edu/research/web/catalysis/index.htm ■

Gold Catalysis Research in Italy

A wide range of high quality gold catalysis research is currently being pursued in Italy

The research group directed by Dr. Anna Maria Venezia (anna@pa.ismn.cnr.it) at **CNR, Palermo** has been studying the preparation and characterization of gold deposited on different supports, particularly amorphous aluminosilicate. They are also interested in the application of these catalysts to hydrodesulfurization (HDS) reactions. Recent results in the HDS of thiophene performed at 340°C and atmospheric pressure indicated an inertness for gold but a cooperative effect between this element with palladium, particularly in the case of Au rich alloys (Au_{80-90} Pd $_{20-10}$). Surprisingly, in the HDS of dibenzothiophene at 280-320°C and 30 bar, Au/SiO_2 was more active than Pd/SiO_2 and a synergistic effect between the metals was observed with a maximum for $Au_{50}Pd_{50}$. The gold-based catalysts show an activity comparable to CoMo catalysts but they produce more complete hydrogenation of the aromatic rings. Different impregnation techniques permit the production of gold particles of controlled size allowing a comparison between particle dimensions and catalytic activity. As expected, smaller particles are more active in the HDS reaction.

The research team of Prof Rossi (on far right)

Prof. Rossi's group (michele.rossi@unimi.it) at **Milan University** was a pioneer in the application of gold catalysis to the liquid phase oxidation of organic molecules. With an appropriate Au/C catalyst, alcohols and aldehydes can be oxidized to the corresponding carboxylates in aqueous solution under mild conditions. These researchers have developed a method of deposition from colloid to design carbon supported catalysts containing gold particles of optimum dimensions (2 - 6 nm) using suitable molecules as protectors. Studies related to new industrial applications of gold for clean catalytic processes are in the field of polyols where a comparison between traditional oxidation methods and gold-promoted oxidation indicates the competitiveness of this latter technology in the case of glycolic, lactic and gluconic acid production. A new application of gold catalysis studied at Milan is the gas phase oxidation of primary and secondary alcohols to the corresponding aldehydes and ketones where a selectivity of close to 100% at total conversion has, in many cases, been obtained. This team is engaged in the preparation of the Au/C reference catalyst sponsored by the World Gold Council.

The research group of Prof. Flora Boccuzzi (flora.boccuzzi@unito.it) at the **University of Turin** has developed FTIR spectroscopy for *in situ* or *quasi in situ* conditions, in order to investigate surface species (adsorbed reactants, intermediates, products) and molecular processes (surface transformation of co-adsorbed reactants) on gold catalysts. With this technique, often coupled with mass spectrometry analysis, the adsorption and the reactivity of different molecules, such as CO, O_2, H_2, H_2O, CO_2, C_6H_6 and CH_3OH, involved in various important reactions such as selective CO oxidation, water-gas shift, benzene total oxidation and methanol decomposition, on gold supported on various oxides (SiO_2, ZrO_2,TiO_2, CeO_2, TiO_2/V_2O_5, Fe_2O_3, ZnO) have been studied. Important insights into the mechanism of CO oxidation have been obtained: e.g. that oxygen activation occurs more effectively on Au sites present on the edges of larger and smoother gold particles supported on silica, and in the oxidative dehydrogenation of methanol on Au/TiO_2 and Au/ZnO, the crucial role of oxygen adsorbed on gold particles near oxygen vacancies of the support has been proposed.

Prof. Benedetto Corain (benedetto.corain@unipd.it) at the **University of Padova** is engaged in the synthesis, chemical and structural characterization

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Materials Research Society Gold Award

Gold catalysis has recently attracted increasing interest in chemistry and materials science, and has also brought excitement to many graduate students. At the Materials Research Society (MRS) Fall Meeting in December 2002 at Boston, Mathew Maye, a graduate student at the State University of New York at Binghamton received the MRS Graduate Research Gold Award for his presentation on nanogold catalysis research. This international award is given to about 20 graduate students each year, and is intended to honour and encourage graduate students whose academic achievements and current materials research display a high order of excellence and distinction.

Mathew's research, under the direction of Dr CJ Zhong, focuses on design and synthesis of core-shell gold nanostructures as active catalysts. The core-shell construction and activation of gold nanoparticles in 1 - 5 nm diameter size range were found to exhibit catalytic activity for carbon monoxide and methanol oxidation, an area that holds potential applications in fuel cell technology. He employs an array of advanced techniques to tune and characterize the unique properties of gold nanoparticles and their catalytic properties.

"It's an honour to be recognized internationally, but a bigger thrill is the exciting opportunity of gold catalysts in industrial applications", said Maye after receiving the Gold Award. He hopes that the nanostructured gold catalysts will soon find applications in fuel cell catalysis. Maye is also a graduate fellow of the US Department of Defense's National Defense Science and Engineering Graduate Fellowship Program.

Gold Catalysis Research in Italy

Continued

of gold nanoclusters supported on designed gel-type resins. His group has gathered in recent years considerable experience with nanoclustered Pd and is now applying the relevant know-how to the catalytic chemistry of Au. They currently synthesize hydrophilic, amphiphilic and lipophilic resins with controlled primary chemical structure and overall nanomorphology suitable to provide a template for the formation of 3 nm metal nanoclusters. Resins (as size-defined submillimetre particles) are metallised under quite moderate conditions, after swelling in convenient solvents, to get macromolecular metal complexes suitable to be reduced with $NaBH_4$ to eventually produce metal/resin composites in which metal nanoclusters are evenly dispersed throughout the body of each resin particle. The rationale of this metal nanoclusters Template Controlled Synthesis is fully illustrated in their papers.

Prof. Galvagno (galvagno@ingegneria.unime.it) is a pioneer in research on gold catalysis, being involved since 1975 when he joined the research group of Prof. Parravano. These early investigations were focused on the catalytic properties of gold and correlations between the surface and structural properties of the gold catalysts. In particular, the influence of the nature of the support and of the preparative conditions was investigated in isotopic exchange reactions and in the selective reduction of NO by hydrogen.

More recently his Research Unit at the **University of Messina** has extensively investigated the properties of gold in gas phase reactions (CO oxidation and catalytic combustion of Volatile Organic Compounds), liquid phase reactions (selective oxidation of alcohols, selective reduction of α,β–unsaturated carbonyl compounds) and as gas sensors (Au doped oxides have been studied as CO, NO and humidity sensors).

In addition to the investigation of the catalytic properties, a detailed characterization of the Au samples has been carried out by FTIR, XRD, XPS, Mössbauer, XPS, TPR, TPD, etc.

An interesting result achieved recently by this research group has been the synthesis of the first heterogeneous catalyst, based on Au supported on iron oxide, capable of hydrogenating α,β–unsaturated ketones to the corresponding α,β–unsaturated secondary alcohols using molecular hydrogen.

The team led by Prof. Anna Maria Caporusso (capored@dcci.unipi.it) at **Pisa University** is mainly interested in the preparation of nanostructured supported and unsupported Au catalysts, using Au vapour as a reagent, and on studies of their activity in reactions such as the oxidation of organic substrates and the hydrosilylation of acetylenic compounds. Use of their vapour phase method ensures the generation of very small and reactive Au nanoparticles (3 - 4 nm). The unsupported and supported gold have a high catalytic activity in the oxidation of sulfides to disulfides and in the hydrosilylation of acetylenes. In this latter reaction, gold catalysts have been compared with catalysts showing that Au is more active for the addition of less polarized silanes and Pt more active for polarized silanes.

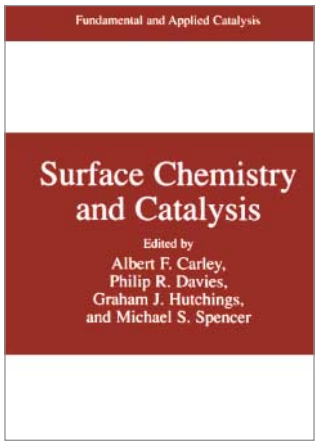
The research activity of the **Venice Research Unit,** led by Prof. Alvise Benedetti (benedett@unive.it), is mainly focused on the characterization of supported metal catalysts. The techniques available and used by this research unit are: Wide Angle X-ray Powder Diffraction (WAXS), Small Angle X-ray Scattering (SAXS), Transmission Electron Microscopy (TEM) and High Transmission Resolution Electron Microscopy (HREM) equipped with micro-analysis (EDS). The WAXS measurements are made under a controlled atmosphere and SAXS measurements are also made in the liquid phase to determine gold nanocluster sizes and to study cluster aggregation. The WAXS analysis combined with the Rietveld method can be used to separate the scattering contribution of metallic nanoclusters from that of the supports, and to quantify the fraction of metal nanoclusters having different sizes.

The research unit also employs synchrotron radiation facilities at ESRF in Grenoble, Desy in Hamburg, LNLS in Campinas, and Elettra in Trieste to carry out *in-situ* measurements on gold catalysts under working conditions. Anomalous scattering techniques, selective at the atomic level, both at wide angle (AWAXS) and small angle (ASAXS), are also used to eliminate scattering from the support and give high signals from the metal phase. ■

Professor Michele Rossi

New Catalysis Book Features Gold Catalysis

A new book, *Surface Chemistry and Catalysis* features 2 chapters on gold catalysis, thus demonstrating that gold is now firmly on the mainstream catalysis 'map'. The latest book in the series, *Fundamental and Applied Catalysis* is edited by Albert Carley, Philip Davies, Graham Hutchings and Michael Spencer and is dedicated to Professor Wyn Roberts to mark his 70th birthday and fifty years working in surface science and catalysis. Of the 12 chapters, each written by expert scientists who have worked in some way with Prof. Roberts, two are specifically on gold catalysis: Chapter 7, by Wayne Goodman and co-authors at Texas A & M University is titled 'Surface chemistry of model oxide-supported metal catalysts: an overview of gold on titania'. Chapter 8 is titled 'Nanoscale catalysis by gold' and is authored by G.U. Kulkarni, C.P. Vinod and



C.N.R. Rao of the Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore, India. Other experts active in gold catalysis and surface chemistry, Graham Hutchings and Hajo Freund, have also written chapters.

Published by Kluwer Academic/Plenum Publishers, New York, 2002, the 400 page book (ISBN 0 306 47393 3) costs $150/£100.50/€157.50. A book review will appear in Gold Bulletin. ■

The 18th Meeting of the North American Catalysis Society, Cancun, Mexico, *1-6 June 2003*

David Thompson at the NAM meeting

This conference proved to be an important event, with many stimulating talks on the applications for catalyst technology in pollution control, chemical processing and fuel cells. A significant new profile emerged for gold catalysis with a realization of its potential for new applications, many of which may take advantage of its unique low temperature performance characteristics. There were 14 oral and 7 poster presentations where the principal theme was catalysis by gold (including one from WGC which was well received and stimulated much discussion); and there is an increasing realization that gold is an exciting new topic. A full listing of the presentations where catalysis by gold was discussed is included in Issue 3, Vol 36 of Gold Bulletin.

A broader range of useful methods for the preparation of gold catalysts is now emerging and, for example, a two step impregnation procedure developed by Datye et al (**University of New Mexico, USA**) gives activities comparable with catalysts prepared by deposition precipitation. There is clear evidence that the presence of halide inhibits the activity of gold catalysts and non-halide routes are therefore under investigation (e.g. by Bruce Gates et al, **University of California, Davis**). Both the nanoparticulate and metal-support interaction aspects seem to play a part in activating the gold on the support surface and the relative importance of these and pre-treatment factors such as optimal calcination temperature and choice of gases are under investigation.

Significant new results included the report by José Rodriguez et al (**Brookhaven National Laboratory**, USA) that Au/TiO_2 is 5-10 times more active than pure TiO_2 for the Claus reaction ($SO_2 + 2\ H_2S \rightarrow 2\ H_2O + 3S_{solid}$) and for the reduction of SO_2 by CO, and these results could have significant relevance to the development of new catalysts for pollution control.

Now that gold has been established as a catalyst in its own right the addition of other metals is being used to increase the activity and selectivity of gold catalysts. The advantageous use of Au/Pd catalysts in commercial processes for the manufacture of vinyl acetate is now well established. Anna Maria Venezia et al (**Palermo, Italy** and **Madrid, Spain**) have found that conversion in the hydrodesulfurization of dibenzothiophene increases by a factor of >6 for 1:1Au/Pd on SiO_2 compared with Pd/SiO_2, and that Au/SiO_2 is more active than Pd/SiO_2. A dendrimer template approach is being investigated for the compositional control of Au/Pt by Bert Chandler et al (**San Antonio, Texas**).

Ways of increasing the durability of gold catalysts is a topic which needs more study but there are encouraging signs that the activity can be preserved even at a few hundred degrees. There is also clear evidence that deactivated catalysts can be regenerated for CO oxidation and Water Gas Shift activity.

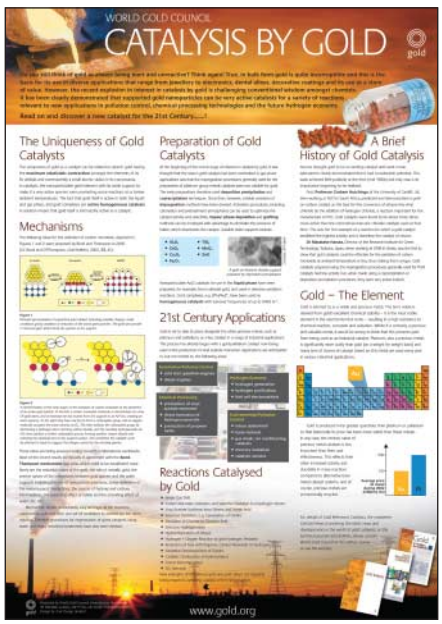
Harold and Mayfair Kung's group (**Northwestern University, USA**) has done some very interesting mechanistic work with gold on alumina catalysts for CO oxidation. Water and hydrogen treatment have been used to revive deactivated catalysts. The role of water is particularly intriguing. The fact that very small amounts of chloride deactivate the catalyst implies that the intrinsic activity of gold is probably higher than has yet been recorded: more experiments with non-halide preparative routes are called for! The relative importance of metallic and oxidized gold in the mechanism was discussed by several speakers.

The activity of supported gold at ambient temperatures and below remains a unique feature of catalysis by gold. The fact that gold is much more plentiful than the platinum group metals and its price is more stable and lower than that of platinum also augers well for the future of applications for gold catalysts (see CW Corti, RJ Holliday and DT Thompson, *Gold Bull.*, 2002, **35**, 111).

For the first time in a major multi-faceted international catalysis conference, it was apparent that catalysis by gold has become respectable amongst catalysis practitioners and many of them are optimistic about the likely number of new industrial applications. ■

David Thompson

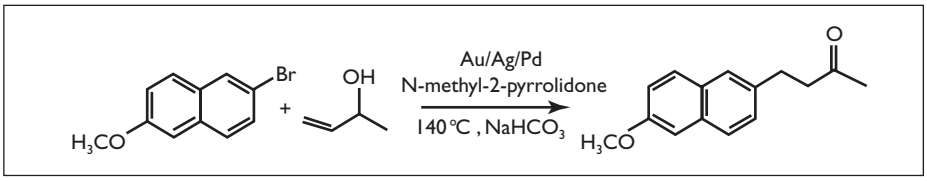
Gold Catalysis Poster for Universities!



World Gold Council has received a number of requests from University researchers for display material that could be used on departmental notice boards to attractively present the science of gold catalysis and the work that is underway to develop new industrial applications in this field. We have therefore commissioned the production of a poster that we are now able to offer at no cost to University Departments with a research interest in this area. The posters are 840mm by 594mm and are printed in full colour. Those researchers interested in receiving and displaying a poster are invited to contact industry@gold.org

Trimetallic Au/Ag/Pd Nanoparticles as Catalysts in the Heck Reaction

Research workers at the National Cheng Kung University in Tainan, Taiwan have described a new catalyst for the Heck reaction. 1:1:1 Au/Ag/Pd trimetallic nanoparticles were found to be more efficient than the traditional palladium complex catalysts for the following coupling reaction:



Using a recently developed method, laser irradiation of colloidal mixtures of the three metals, S.-H. Tsai, Y-H. Liu, P.-L. Wu and C.-S. Yeh, J. Mater. Chem., 2003, 13, 978, dispersed Au/Ag/Pd nanoparticles with average diameters 4.4 ± 1.5 nm were obtained. These trimetallic nanoparticles were assessed for activity in the synthesis of nabumetone [4-(6-methoxy-2-naphthalenyl)-2-butanone], a non-steroidal anti-inflammatory drug that has greater activity than aspirin and is comparable to naproxen and indomethacin. 0.45 mol% Au/Ag/Pd was sufficient to catalyse the coupling of the 3-buten-2-ol to 2-bromo-6-methoxynaphathalene with a product yield of at least 90%. Following identical procedures, use of a traditional Heck reaction catalyst, i.e. $[(PPh_3)_2PdCl_2]$, resulted in a yield of only 64% of nabumetone. Further optimisation studies on the catalytic cycle and immobilizing the Au/Ag/Pd particles on a solid support are continuing. ■

David Thompson

PROJECT AuTEK

Update

Project AuTEK is a joint initiative between Mintek (Council for Minerals Technology in South Africa) and three South African mining houses, AngloGold, GFL Mining Services, and Harmony. The aim of Project AuTEK is to investigate new industrial uses for gold. A significant need exists to expand the basis of gold usage worldwide. Currently more than 80% of produced gold is used in jewellery manufacture and the prime significant industrial use is ca 8% in the electronics sector (GFMS Gold Survey 2002).

Project AuTEK began early in 2000 with the emphasis on Au catalysis (potentially a large industrial application), but subsequently has grown following interest from the gold mining industry. Mintek has formed equal funding partnerships with each of the mining houses in the research areas of catalysis (AngloGold), materials (GFL Mining Services), and biomedical applications (Harmony). Although most of the R&D work is done at Mintek, a significant amount is contracted out to some seven local universities and a total of about 46 people work on the programme. Another aim of Project AuTEK is to catalyse, in the wider research community, R&D on new industrial uses of gold. To this end Project AuTEK has established several collaborations, including the funding of two PhD studies, at some 5 European universities.

Areas of interest within the Au catalysis programme include air quality (CO oxidation), pollution control (NOx reduction for lean-burn engines) and chemical processing (oxidation reactions). The last of these is a collaborative project with Sasol. Specific applications have been targeted that will make use of the excellent CO oxidation activity of Au catalysts, particularly in humid conditions and at ambient temperatures. Under Project AuTEK some very active gold catalyst formulations have been developed and scale-up of catalyst production (few kg batches) has commenced in order to test these catalysts in commercial products. NOx reduction under lean-burn conditions remains a significant technical challenge and Au catalysts have shown some promise here. Work in Project AuTEK has focused on the use of gold in combination with platinum group metals and has received additional funding from AngloPlatinum and from the World Gold Council's GROW programme. Furthermore, collaborations with researchers at the University of Strasbourg and with Anglo American Research Laboratories (AARL) have been established. The latter to develop further AARL's gold-based automotive catalyst resulting from an earlier programme. ■

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Call for Papers:

13th International Congress on Catalysis, Paris, 11-16 July 2004

Those working in the field of gold catalysis should be aware of the following major conference planned for 2004. The International Association of Catalysis Societies (IACS) and the Catalysis Division of 'Société Française de Chimie' invite all scientists in the field of catalysis and related sciences to participate in the 13th International Congress on Catalysis. It will be held in 'Palais des Congrès de Paris' from 11 to 16th July, 2004. The main objective of the Congress is to discuss all types of catalysis (homogeneous, heterogeneous and others) related to innovative and current topics, with emphasis on prediction of catalyst performance and characteristics. Abstracts submission: 15th September - 5th November 2003. Notification of acceptance: 1st March 2004. At World Gold Council, we trust that many of you will submit papers to make gold catalysis a key subject at the conference, and this will help to indicate the potential of the recent advances for new applications. ■

PARIS 13 ICC 11 - 16 July, 2004

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