

CatGold NEWS

More news, More often!

As I mentioned in the previous issue of CatGold News, at World Gold Council we have been considering the best way to distribute the information contained in CatGold News and have concluded that electronic distribution (via email) is the most efficient way to provide you with news on progress in gold catalysis and its applications.

From the end of 2004 we will be offering this new service, which you can access free of charge by returning the form on page 4. Once registered we will send you each issue of CatGold News by email.

The newsletter will continue to be designed in full colour and can be printed for display on notice boards etc.

Please continue to send your news and articles – the more information we have the more frequently we will publish the newsletter!

Regards,
Richard Holliday
World Gold Council

Exploiting advances in technology



Researchers from the University of Palermo, Italy on the stand

At the 13 ICC in Paris this July, World Gold Council was proud to host a 'gold catalysis' stand. Visitors to the stand had an exciting opportunity to see real examples of prototype products and processes that harness the unique benefits of gold-based catalysts.

The items on display included:

- A domestic air cleaning device
- A mercury emission control catalyst
- A direct liquid fuel cell
- A 'self-rescuer' gas mask
- An indoor air quality control catalyst



This is the first time that the use of gold as a catalyst has been actively promoted at an international catalyst trade show. Under the banner 'Exploiting Advances in Technology', the stand was a collaboration with five partner organisations from around the world, all of which have recognised the exciting opportunities that gold catalysts offer. The partner organisations were **AIST** (Japan's National Institute of Advanced Science and Technology) who have been pioneers in developing and exploiting gold catalyst technologies, **Givaudan** (one of the largest global manufacturers of fragrances), **Tennessee Valley Authority** (the largest public power utility in the U.S.), **QinetiQ** (Europe's largest independent science and technology organisation), and **Union Chemical Laboratories** (the largest and oldest chemical research organisation in Taiwan). Visitors to the stand had the opportunity to discuss the opportunities for licensing the technologies on display as well as in-depth discussions on the potential for using gold catalysts in important chemical reactions. ■

13 ICC Programme



As well as the World Gold Council sponsored 'Gold Catalysis' stand at the 13 ICC, there were forty-eight presentations where the principal theme was catalysis by gold or gold alloys. From the presentations, there was clearly a fast developing interest in obtaining a greater understanding of the mechanistic pathways operating during the reactions catalysed by gold and better definition of the optimal catalyst preparation methods.

A significant number of different reactions catalysed by gold were described, including three each on the selective epoxidation of propene, and other aspects of hydrocarbon oxidation; two each on hydrogen peroxide formation from hydrogen and oxygen, NO_x reduction sugar processing and selective hydrogenation; and

one each on water gas shift, benzaldehyde hydrogenation, hydrocarbon isomerization and oxidation, methanol reforming, glyoxal oxidation, methanol electrooxidation, glucose oxidation, succinic acid oxidation, ethanol conversion to ethene and acetaldehyde, carbonylation of methanol and the reduction of cyanoaurate.

Two of the gold presentations attracted prizes for best abstracts: these were awarded to **Andreea Gluhoi from Leiden, The Netherlands** for 'The prominent part of base metal oxides in the performance of Au/Al₂O₃ catalysts in reactions of N-containing molecules', and to **Sophie Hermans from Louvain, Belgium** for 'Nano-sized gold as a promoter for Pd-catalysed glyoxal oxidation'. ■

International collaborations at UNAM, Mexico

The research group at the Condensed Matter Center of the National Mexican Autonomous University is doing intensive work in the area of catalyst characterization, in particular nano-sized metal particles (including gold) under the leadership of Dr. N. Bogdanchikova and in collaboration with Drs. E. Lima, P. Bosh (Autonomous Metropolitan University), Dr. V. Gurin (Belarus), Prof. A. Pestryakov (Russia).

The strength of this work group is the wide range of equipment available for structural studies, e.g., UV-Visible, XPS and Auger spectroscopy, HRTEM, XRD, SAXS, ¹²⁹Xe NMR, *ab-initio* calculations and on the basis of Mie theory, TPR, FTIR in situ, Raman, EDS, SEM, BET.

The group has established on-going collaborations with several foreign research groups, e.g., Prof. J. Margitfalvi, (Hungary), Prof. B. E. Nieuwenhuys, (Holland), Prof. A. K. Datye (USA), Dr. F. Meunier, (Northern Ireland), Prof. J. L. P. Praserthdam and Dr. S. Phatanasri, (Thailand),



Dr. N. Bogdanchikova and the group at UNAM

Dr. G. Rodriguez (Cuba), Dr. V. Pitchon (France) and Prof. P. Claus (Germany). Over the last three years nine foreign postgraduate students from seven countries have carried out structural research work under the supervision of the team at the Mexican University. ■

Gold catalysts in the food processing industry?

Following the demonstration that gold and gold on carbon catalysts can be used to oxidize glucose to gluconic acid (Michele Rossi, Proc. Gold 2003, Vancouver, Canada; http://gold.dev.cfp.co.uk/discover/sci_indu/gold2003/index.html), an important food additive, made on the 60,000 tonnes per annum scale, we are asking whether there could be further opportunities for gold in the food industry?

At the recent 13 ICC in Paris there were two presentations on sugar chemistry. The first by Agnes Mirescu, Ulf Pruesse and Klaus-Dieter Vorlop (Proc. 13 ICC, Paris, July 2004; <http://icc2004.catalyse.cnrs.fr/CDROM/P5-059.pdf>) on the selective oxidation of lactose and maltose with Au/TiO₂ catalysts, which was used to give 100% selectivity to lactobionic acid and maltobionic acid respectively, which also have potential uses in the pharmaceutical and detergent industries, as well as in food; and the second was by Sabine Schimpf, B. Kusserow, Y. Önal, and Peter Claus (Proc. 13 ICC, Paris, July 2004; <http://icc2004.catalyse.cnrs.fr/CDROM/P5-060.pdf>) who have studied the catalytic conversion of glucose under hydrogenation and oxidation conditions to produce sorbitol and gluconic acid respectively. Sorbitol is also manufactured on a 60,000 tonnes per annum scale.

Some time ago, L. Caceres, L.L. Diosady, W.F. Graydon and L.J. Rubin, J. Amer. Oil Chem. Soc., 1985, 62, 906 reported the use of Au on SiO₂ or Al₂O₃ for the hydrogenation of canola oil. It was shown that the complete reduction of linolenic acid could be achieved at a lower trans-isomer content in the products than that obtained using the American Oil Chemists standard nickel catalysts. Nickel catalysts have of course been used for over a century for the hardening of natural oils. Could it be that gold catalysts, using the much more advanced methods of preparation available today, will have a future role in this application? If so, this would have the appeal that any gold residues in the products would be completely harmless since gold is environmentally benign.

We would like to challenge our readership to think of innovative projects for gold catalysis in the food, pharmaceutical and related product areas. ■

David Thompson

DTThompson@aol.com

People profile

Dr. ir. Michiel Makkee,

Associate Professor, Reactor and Catalysis Engineering,
Department of Chemical Technology, Faculty of Applied Sciences,
Delft University of Technology

Dr Makkee's main research activities include hydroprocessing in the oil refinery, catalytic cracking of heavy oil fractions, diesel soot abatement technology, production of propene oxide and CO oxidation over gold catalysts. The epoxidation of propene to propene oxide over Au on titania based catalysts is an important area of focus and he has published a number of papers in this area. The current catalyst formulations give only a limited amount of propene oxide of only 2 wt % with a selectivity of 95+ % in the presence of hydrogen and oxygen. Use of new types of gold on titania based catalyst showed that this limited yield can be increased by 5 times up to 10 w % propene oxide with the same selectivity. The oxidation of CO in the presence of hydrogen is under mechanistic investigation with advance step-response equipment. Partners in the research were Huntsman and ICI/Synetix. Together with Prof. Graham Hutchings, Michiel is co-ordinating the EU Auricat project, the network of eight postdoc's at Cardiff University in Wales, Fritz Haber Institute in Berlin, University of Valencia (Spain), University of



Delft (The Netherlands) University of Stuttgart (Germany), University of Salford (England) University of Glasgow (Scotland), University of Milano (Italy) and industrial partners Johnson Matthey, Sud Chemie and Degussa.

Away from university research, Michiel enjoys all types of practical work around the house (construction, electricity, plumbing, redecorations, etc.), gardening and spending time with his family. ■



Collaborators required: Catalytic wet air oxidation research

Waste water is made environmentally acceptable by oxidizing the organic compounds it contains using oxygen or air at 180-315°C and (2-15 MPa) [1, 2]. The organic material present is first converted into simpler organic compounds, which are then further oxidized to carbon dioxide and water. [The last residues are organic acids, especially acetic acid. Nitrogen organic compounds are easily transformed into ammonia.] Catalysts provide the possibility of using milder conditions; and 'catalytic wet air oxidation' (CWAO) processes studied to date have been based on Pt and Pd catalysts deposited on titania or titania-zirconia [1]. Gold catalysts could prove to be advantageous and there is already an article by M. Besson et al [3] (see <http://icc2004.catalyse.cnrs.fr/CDROM/P6-157.pdf>), who reports preliminary results on the catalytic wet air oxidation of succinic acid as a representative organic compound using Au on TiO₂ at 190°C and 50 bar air pressure. Moreover, several groups in academia have demonstrated that Pt, Pd and Ru on carbon or TiO₂ are active catalysts for the CWAO [4,5,6].

For some time now, we have been synthesising bimetallic systems on different oxide supports and we have found that Au-M (M=Pt, Ru) are far more

active for the liquid phase oxidation of alcohols than their monometallic components, and we therefore intend to evaluate these catalysts for catalytic wet air oxidation.

We would therefore like to identify some partners either from academia or industry, who can help us by providing use of a suitable reactor (pressure range from 1 to 100 bar and temperature from 30-300°C and having the facility for withdrawing samples), and look forward to hearing from potential collaborators. ■

Nikos Dimitratos and Laura Prati,
University of Milan, Italy.

E-mail: laura.prati@unimi.it

References

1. F. Luck, *Catal. Today*, **27** (1996) 195.
2. F. Luck, *Catal. Today*, **53** (1999) 81.
3. M. Besson, A. Kallel, P. Gallezot, R. Zanella, C. Louis, *Catal. Comm.*, **4** (2003) 471.
4. S. Cao, G. Chen, X. Hu, P.L. Yue, *Catal. Today*, **88** (2003) 37.
5. J. Trawczynski, *Carbon*, **41** (2003) 1515. J.-C. Beziat, M. Besson, P. Gallezot, S. Durecu, *J. of Catalysis*, **182** (1999) 129.

In Brief

- **Gold catalysis researchers** are reminded that David Thompson, Geoffrey Bond and Catherine Louis are in the process of writing a monograph on catalysis by gold and would like to receive copies of any papers that are recently published on gold catalysis. Contact David Thompson at DTThompson@aol.com.
- **Prof Jack Fletcher** at the University of Cape Town is seeking a well qualified researcher to lead his department's gold catalysis research. Interested individuals should contact Jack directly at jcwf@chemeng.uct.ac.za
- **Au black catalysts** for electrochemical sensors are available for purchase from UK company Dart Sensors Ltd at prices starting from £27.00 per gramme. Dart Sensors will consider adding Au supported on Cabot carbon to their product list if approached. See www.dart-sensors.com/pages/aublack.html for further details.
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World Gold Council has decided to update the service it provides to gold research community by creating www.goldbulletin.org, a unique website for accessing the papers published in the journal Gold Bulletin. From 2005, Gold Bulletin will become a wholly electronic publication. Current recipients of Gold Bulletin should register now at www.goldbulletin.org to receive email notification of each quarterly issue.

Catalysis by gold/PGM alloys

The recent surge of new interest in catalysis by gold nanoparticles has now led researchers to investigate the effects of addition of other metals to the gold. As a result, there are a number of reactions with industrial applications potential where gold/PGM combinations have been shown to have advantages over either gold or PGM alone. These findings will lead to applications in chemical processing, pollution control and fuel cell applications.

Examples include the established processes for reaction of ethene with acetic acid and oxygen to produce vinyl acetate monomer using Au/Pd/KOAc catalyst on oxide supports; and new potential processes for direct hydrogen peroxide production from hydrogen and oxygen, the decomposition of methanol to CO and hydrogen, and for hydrodesulfurization reactions using oxide-supported Au/Pd. There is potential for oxide-supported Au/Pt catalysts in controlling gaseous pollution and also in reducing CO poisoning in fuel cells, with the added advantages that Au is more plentiful and less expensive than Pt. Increased activity for gold when Pt or Pd is added was reported in six presentations at 13 ICC in Paris in July for a number of different reactions in the liquid and gas phase (see Gold Bulletin, 2004, 37) and Plat. Metals. Rev., 2004, 48). ■

David Thompson

DTThompson@aol.com

Quoting Gold Reference Catalysts



One of the key aims of the Gold Reference Catalysts distributed by World Gold Council is to provide catalyst researchers with the opportunity to benchmark the performance of their own catalyst formulations against a common standard. This allows comparison to the work of other laboratories. A number of papers have now been published that quote the performance of the Gold Reference Catalysts in direct comparison with researcher's own catalyst formulations, two examples being:

- S. Carrettin, P. Concepcion, A. Corma, J.M. Lopez Nieto and V. F. Puentes, Angew. Chem. Int. Ed., 2004, 43, 2538 – 2540
- C. Milone, R. Ingoglia, A. Pitstone, G. Neri, F. Frusteri and S. Galvagno, J. Catal., 2004, 222, 348 - 356

World Gold Council would like to encourage other recipients of the catalysts to similarly quote comparative performances. If you have recently published work quoting the Council's catalysts please let us know! In addition, interaction between researchers who have received catalysts from World Gold Council is encouraged and contact details of recipients can be found on our website at http://www.gold.org/discover/sci_indu/gold_catalysts/refcat.html ■

IMPORTANT ! Last postal/mailed issue of CatGold News



This is the last postal/mailed issue of CatGold News. At World Gold Council we believe that an all electronic publication is the most effective way to get the latest gold catalysis news to the community.

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CatGold News is published by World Gold Council. Please send submissions/correspondence to Dr Richard Holliday, Industrial Applications Manager, World Gold Council, 55 Old Broad Street, London EC2M 1RX, United Kingdom. Tel: +44 (0)20 7826 4700; Fax: +44 (0) 20 7826 4799. E-mail: richard.holliday@gold.org