DOI: 10.1595/147106704X5708

13th International Congress on Catalysis

Reviewed by Alvaro Amieiro-Fonseca, Janet M. Fisher* and Sonia Garcia
Johnson Matthey Technology Centre, Blounts Court, Sonning Common, Reading RG4 9NH, U.K.; *E-mail: fishejm@matthey.com

The 13th ICC was held in Paris from 11th to 16th July 2004 and attracted more than 1800 delegates representing 62 different countries (1). There were 169 oral communications and well over 1000 posters. The programme of the congress was divided into 6 topical sessions:

[1] Catalyst preparation and characterisation
[2] Catalytic reaction mechanisms
[3] Catalytic reaction engineering: multi-scale approach
[4] Fuels and energy for the future
[5] Synthesis of chemicals and polymers: towards cleaner processes and atom economy, and
[6] Pollution, prevention and remediation.

It is impossible to review adequately even a part of the conference because of the sheer scale and number of parallel sessions, but we hope that what follows will provide a snapshot of a few of the topics covered.

Plenary Lecture by Noyori

Chemistry Nobel Laureate Professor Ryoji Noyori (RIKEN, Saitama, Japan) gave a plenary lecture entitled 'Molecular catalysis, today and tomorrow'. He drew particular attention to the need to carry out reactions with high atom efficiency and a low E-factor (kg waste generated/kg product produced). He described a new cleaner route to adipic acid starting with cyclohexene and hydrogen peroxide but avoiding the production of nitrous oxide (N_2O). Asymmetric hydrogenation of carbon-carbon double bonds with ruthenium (Ru) and rhodium (Rh) BINAP catalysts was also discussed.

Highlights: Nano Work and Ruthenium

Professor K. P. de Jong (University of Utrecht, The Netherlands) reviewed the physico-chemical aspects of the preparation of supported catalysts. Elegant work using carbon nanofibre materials as supports was discussed. Carboxylic acid groups on the surface are key for the nucleation of metal hydroxides. Platinum (Pt) and Ru catalysts (up to 5 wt.%) with 1 nm sized metal particles have been obtained on such supports using deposition precipitation procedures.

Professor G. Somorjai (University of California, U.S.A.) presented an interesting talk showing a new method to produce Pt nanoparticles. These particles were produced *via* size reduction photolithography. The Pt nanoparticles were prepared in aqueous solution using polymer templates and then encapsulated with silica to form mesoporous silicate structures. Both reactions occur in the same solution, giving catalysts with high surface area and offering a certain degree of control over particle size. The formation of Pt nanowires inside zeolite channels using various Pt salts and UV radiation was reported by Professor A. Fukuoka (Hokkaido University, Sapporo, Japan). The size and shape of the wires could be altered by use of various ligands and different zeolites. The zeolite was removed by leaching in HF and samples of the wires were shown to have good selectivity for the preferential oxidation of CO in H_2 streams (PROX).

Attila Wootsch (University of Poitiers, France) talked about the PROX reaction over Pt/alumina and Pt/ceria-zirconia catalysts. The benefit of using a reducible oxide such as ceria was rationalised. The role of Cl^- poisoning was discussed; Cl^- slows oxygen mobility over Pt surfaces and inhibits the water gas shift reaction.

S. Shaikhutdinov (Fritz-Haber Institute, Berlin, Germany) compared Pd(111) single crystals and Pd nanoparticles on ordered alumina films for reactions with alkenes. Hydrogenation of alkenes occurred with nanoparticles but not with single crystals. This observation was rationalised in terms of hydrogen storage on the Pd. The accessibility of subsurface hydrogen was enhanced on the particles rather than on the single crystal due to the nanoscale dimensions.

Ru catalysts supported on multiwalled carbon nanotubes (MWNTs) for the catalytic wet air oxidation of aniline were discussed by Professor J. L. Faria (University of Porto, Portugal). Ru was introduced into MWNTs by oxidation with nitric acid, which yielded carboxylic groups used to anchor the metallic Ru. The catalysts obtained showed high activities due to the high external surface area of the MWNTs that offered an efficient surface contact between the aniline and the Ru.

An interesting talk by K. Tominaga (National Institute of Advanced Industrial Science and Technology, Ibaraki, Japan) covered the hydroformylation of alkenes with carbon dioxide using chloride salts and ruthenium carbonyl complexes.

Professor Graham J. Hutchings (Cardiff University, U.K.) reported on the direct synthesis of hydrogen peroxide. Pd catalysts are more active than Au catalysts for this reaction but Au-Pd supported on titania is even more reactive giving 56 mol kg cat^{-1} h^{-1} of H_2O_2.

There were many other papers focused on gold catalysis, and the majority were concerned with reactivity or modelling of low temperature CO oxidation. Other gold papers covered propene epoxidation and various other organic oxidation reactions (2).

Plenary Lecture by Iglesia

Using examples of alkane activation Professor E. Iglesia (University of California, Berkeley, U.S.A.) in a plenary lecture, emphasised the importance of isotopic labelling exchange and *in situ* spectroscopy to elucidate mechanism and characterise intermediates. On Ni, Rh, Pt and Ru catalysts, kinetic and isotopic methods confirmed the relevance of the C-H bond activation step. Turnover frequency studies showed that the concentration of coreactants, such as CO_2 or H_2O, was not important in the process. Turnover frequencies were similar to those seen for the decomposition of methane to C and H_2.

G. Rupprechter (Fritz-Haber Institute, Berlin, Germany) compared CO and C_2H_4 hydrogenation over a model catalyst comprising Pd-Al_2O_3/NiAl(110) and a single Pd (111) crystal using polarised modulation IR reflection absorption spectroscopy (PM-IRAS) and thermal desorption spectroscopy. A nice example of how surface science studies on model catalysts relate to real catalyst behaviour using the most sophisticated UHV (ultra high vacuum) techniques.

Catalysis Involving Biomass

The production of H_2 from biomass offers some attractions since it is a CO_2 neutral energy supply. Professor K. Seshan (University of Twente, The Netherlands) described the steam reforming of acetic acid over a Pt/ZrO_4 catalyst. Acetic acid is one of the major components of bio-oil, which can be obtained from biomass by flash pyrolysis. The deactivation of the catalyst was found to parallel acetone formation, indicating that the surface species (coke) formed from the acetic acid decomposition blocks the reforming reaction and acts as a surface intermediate for the acetone formation.

This theme was continued by A. Efstathiou (University of Cyprus, Nicosia) who discussed a process using a CO_2 absorption step during biomass reforming to shift the equilibrium towards greater hydrogen production. This led to the use of Fe-MgO technology combined with platinum group metal/CeO_2 standard materials. A Rh-MgO catalyst exhibited very high activity.

Professor L. Schmidt (University of Minnesota, U.S.A.) described the partial oxidation of highly volatile ethanol and biodiesel using an original air and fuel injection system. The set-up allows high temperature mixing without pre-reaction pyrolysis. The hydrogen yields were good for a range of C to O ratios.

The plenary and award lectures from the 13th ICC will be published in a special issue of *Catalysis Reviews* (3). The 14th ICC is to be held in Seoul, Korea, in July 2008 (4).

References

1 13th Int. Congress on Catalysis, Paris, France, 11-16 July 2004; http://www.13icc.jussieu.fr/

2 D. T. Thompson, *Platinum Metals Rev.*, 2004, **48**, (4), 169

3 *Catalysis Reviews*; http://www.dekker.com/

4 14th Int. Congress on Catalysis, Seoul, Korea, July 2005; http://www.icc2008korea.com/

The Reviewers

Alvaro Amieiro-Fonseca is a research scientist at the Johnson Matthey Technology Centre, Sonning Common, U.K. He is interested in developing new materials and applications in heterogeneous catalysis and understanding surface mechanism.

Sonia Garcia is a Marie Curie Fellow at the Johnson Matthey Technology Centre, Sonning Common. She is interested in the synthesis of noble metal nanoparticles for catalytic applications.

Janet Fisher is a Principal Scientist at the Johnson Matthey Technology Centre, Sonning Common, U.K. Her primary interests are in catalyst preparation and characterisation.