HOKKAIDO UNIVERSITY

Title	Report of catalysis Summit 2008 in Sapporo
Citation	触媒サミット―触媒は地球維持のキーテクノロジー．平成20年7月7日．札幌市
Issue Date	2008-07-07
Doc URL	http://hdl.handle.net/2115/34599
Type	other
File Information	37-1.pdf

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Report of catalysis Summit 2008 in Sapporo.

The G8 summit was held in Toyako in Hokkaido from 7th to 9th July 2008, one of the main topics of which was a global environmental issue that is considered to be caused by CO2 emission by human activities. They discussed how we human beings have to take various types of actions to this issue and concluded that we should think many kinds of possible actions.

Undoubtedly, all kinds of science and technology have to work harmonically and concertedly to these issues. Particularly, chemistry should play a conductor role as well as contribute as a central player because chemistry is one of the scientific fields that have the highest responsibility for the global warming issue and that at the same time can commit fundamentally and directly to the issue. Since many of chemistry matters are central subjects of ***Catalysis Chemistry***, ***Catalysis Chemistry*** is of high importance and in high necessity for our sustainable society.

By taking this opportunity of the G8 summit, Catalysis Research Center, Hokkaido University organized “Catalysis Summit” in order to discuss what Catalysis Chemistry can do and what Catalysis Chemistry has to do. The catalysis summit was held in Hokkaido University on 7th July, 2008 by the participation of the panels from 8 countries, UK, USA, Germany, France, Russia, India, China, and Japan. The presentation given by the panels of each country are following:

Jochen Lauterbach Department of Chemical Engineering**,** University of Delaware, USA

Energy for the future of mankind – how catalysis can contribute

The 21st century brings overwhelming challenges for energy technology. Limited supplies of fossil fuels as well as the negative effects of their consumption on our climate require the discovery of new energy sources. Catalysis must play a key role in such an endeavour and can have an impact in areas such as, bio-derived chemicals, transformation of complex heavy molecular mixtures from fossil-derived chemicals, and reconversion of end-products, such as carbon dioxide.

The scientific challenge will be to achieve a more detailed mechanistic understanding of catalytic reactions for new feedstock. Such understanding will allow us to design catalysts on an atomistic level and convert complex reactants. Some research challenges associated with this target are the development of superior instrumentation that permits real-time, high-resolution chemical spectroscopy and imaging of reacting species and catalysts, the further development of theoretical tools beyond the calculation of “simple” model systems, and the directed synthesis of complex structures that utilize multifunctionality to channel reactions to highly selective pathways.

Michael Bowker, Wolfson Nanoscience Laboratory, School of Chemistry, Cardiff University, UK:

Photocatalysis for Sustainable Hydrogen Production

One important aspect of a sustainable world is the ability to produce a sustainable fuel. If hydrogen can be produced from water splitting, then we have a virtuous cycle of potentially clean fuel production/fuel use. However, such production needs an energy input and so the aim for

sustainability must be to enable water splitting with sunlight. I will describe attempts to produce hydrogen in this sustainable way using photocatalysis, and the kinds of photocatalysts that can enable this to take place.

Hans-Joachim Freund Fritz-Haber-Institut der Max-Planck-Gesellschaft, Germany

Basic Research in Catalysis to sustain Energy Supply for the Future

The contribution of chemistry to solve the energy problem cannot be overestimated. Catalysis is exceedingly important for the future of our society in this context. The Science of Catalysis embraces basic, mechanistic and conceptual studies funded both on experiment and theory, as well as strong efforts in technology. Basic research has a key role to play. A very important aspect for example is the development of in-situ techniques which needs to be pursued in many directions, e.g. spectroscopy, imaging etc. In order to achieve this goal centers for catalysis have been established in many countries world wide to pull together the necessary resources. A number of case studies directed to sustain energy supply for the future of our societies will be mentioned, selecting from activation of hydrocarbons, fuel cells, catalyst stability, carbon-dioxide reduction, enzyme catalysis and other areas.

Pierre Pichat "Photocatalyse et Environnement", CNRS/Ecole Centrale de Lyon (STMS) , France.

An overview of present and potential contributions of heterogeneous photocatalysis to a sustainable society

Despite being a sub-discipline of heterogeneous catalysis, photocatalysis is growing in importance to society, contributing substantially to both environmental and energy sustainability. The major commercial application of photocatalysis today (titania-based, self-cleaning coatings used in building facades) saves water, cleaning products, energy, and can extend the lifetime of construction materials. Photocatalytic air purification/deodorization in confined spaces is not only vital for health and comfort, but saves energy by lowering the rate of air cycling required. Photocatalytic water purification is potentially eco-friendly (stable photocatalyst and possible use of sunlight), while saving on traditional oxidants and disinfectants. Moreover, intense and extremely challenging research is underway for the photocatalytic/photoelectro-chemical production of hydrogen from water and organic fuels from recycled carbon dioxide.

V.N. Parmon and V.I. Bukhtiyarov Boreskov Institute of Catalysis SB RAS, Novosibirsk, Russia

New Technologies of the Boreskov Institute of Catalysis for Conversion and Utilization of Light Hydrocarbons

One of the largest socio-economical problems of nowadays Russia is the useless incineration of ca. 35 million tons of oil associated gases extracted together with mineral oil in remote and undeveloped areas of Siberia. The problems arise mostly due to extremely serious difficulty of transportation of C3–C4 paraffins. Thus, the development of catalytic technologies for light hydrocarbon (natural gas included) conversion into valuable products seems one of the main challenges for the Russian catalysis scientists.

In the presentation, under discussion are some approaches which are currently elaborated in BIC for resolving the above problems. These are a non-traditional BIMF technology for the one-step catalytic conversion of wide paraffin fraction simultaneously into both high-octane gasoline and high quality diesel fuel; new zeolite catalysts for aromatization of C3–C4 paraffins; a non-traditional approach to produce liquid hydrocarbons via direct insertion of C1 and/or C2–C4 paraffins into heavier hydrocarbons; the Fischer-Tropsch synthesis over thick catalytic membranes; selective water sorbents on the base of nanocomposites materials “hydroscopic salt in porous matrix” for drying hydrocarbons, etc. Some of the mentioned developments have been already tested on the semi-industrial level and there are expectations for their valuable contribution to the Russian economy.

Rajiv Kumar Head, Green Chemistry and Catalysis, Innovation Center, Tata Chemicals Ltd., India

Carbon dioxide and water as sustainable source for production of chemicals, fuels and energy

The energy generation from fossil fuels is invariably associated with co-production of CO_2. The only non-carbon natural source of H_2 is water. The reduction of CO_2 in the atmosphere can be achieved (i) proactively by production of H_2 from water and (ii) by consuming CO_2 for the production of fuels, chemicals and energy on carbon neutral basis. Both of these routes require central role of catalysis. This presentation focuses on (i) the catalytic dry reforming of methane with CO_2 to produce syn gas, which can easily be converted to chemicals/fuels; and (ii) hydrogen production from water. Lastly the role of new generation solid catalysts in the production of chemicals under solvent-free eco-safer conditions will be highlighted.

Photocatalytic hydrogen production utilization Solar Energy

Can Li State Key Laboratory of Catalysis**,** DICP, CHINA

Wataru Ueda Catalysis Research Center, Hokkaido University, JAPAN

Collaboration between Catalysis and Nature for Sustainable Development

Global warming and other environmental issues have become a matter of serious concern, and researchers and educators are now expected more strongly than ever to contribute to the realization of sustainable development in the society that balances the economy with the natural environment. Catalytic chemistry and related technologies have undergone remarkable development to support the petroleum industry, significantly contributing to the growth of human civilization over many decades. Now, catalysis is again regarded as a key technology with the potential to solve many of the problems emerging in the global community in term of resource and energy consumption and environmental degradation. Catalysis Research Center (CRC) has devoted the majority of its efforts to the development of new environmentally benign catalytic process with the potential to contribute to the realization of sustainable society. Achieving a form of collaboration between catalysis and nature is one of our key strategies.

After the stimulated discussion from many aspects, we announced the following statement at the end of the catalysis summit.

Statement of Catalysis Summit 2008

It is now clear that global warming is a result of human activities and the phenomenon is no longer in doubt. Many remedial actions have been proposed, including the development of better methods of chemicals and energy production. Such developments will be enabled by the application of the scientific skills of scientists and engineers to the reduction of CO_2 emissions, and perhaps, in the longer term, to the reduction of absolute CO_2 levels in the atmosphere. A diversity of scientific disciplines need to be engaged together for this purpose, but Chemistry is essential to new developments in these fields, since the production of CO_2 often involves rather primitive chemical transformations which need to be evolved to clean technologies for a developing world.

Chemistry has been at the centre of the developments of our modern society, particularly over the last century. In the past, much of this technology produced large amounts of pollution, often resulting in far more undesired by-products than desired ones. This has changed in recent years and we have entered the era of “Green Chemistry”. For the sake of our children’s children’s children this development has to be accelerated at the global level and applied to the energy production sector with the utmost urgency.

Hence, this summit will concentrate it’s focus on international efforts in this direction. An essential aspect of chemistry to achieve these objectives is the application of **CATALYSIS** to this problem. The whole petrochemical industry is based on the application of catalysis to chemical transformations of low grade materials into useful products (automotive fuels, plastics, pharmaceuticals), which we all need and use everyday. During this summit, we will discuss what catalysis can contribute to a new, greener world and especially to the evolution of a sustainable fuels economy.

Catalysis for the Hydrogen Economy:
Hydrogen production using the combination of solar energy and photocatalysts
Electrocatalysis and fuel cells
Hydrogen storage facilitated by catalytic materials

Catalysis for Environmental Protection:
Catalytic gas emission control
Catalytic water purification

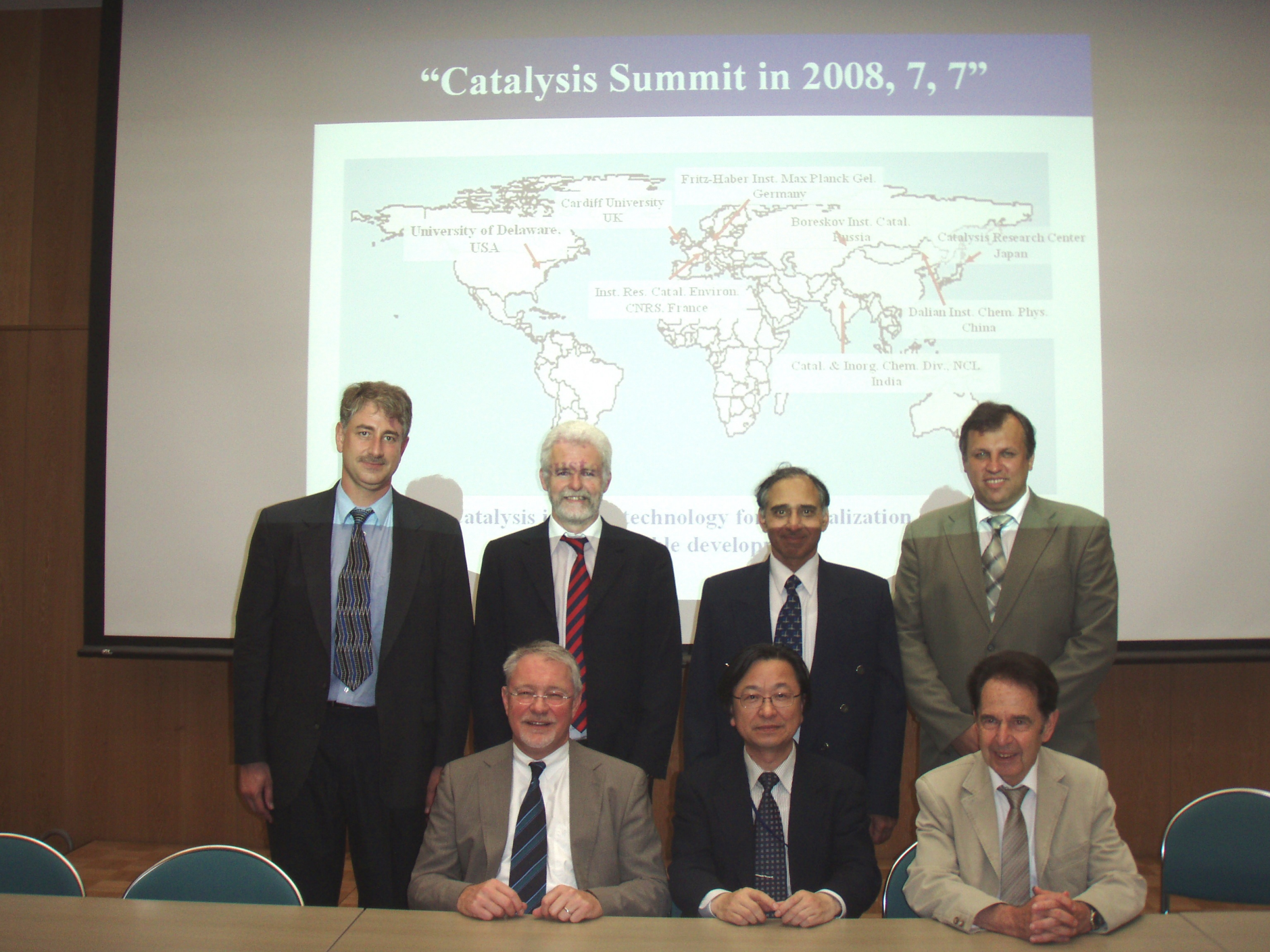
Catalysis for Chemicals Production:
Catalysts with ultimate product selectivity
Catalysts with ultimate energy efficiency

New C1-chemistry-CO2 utilization
Alkane chemistry
Catalysts for new chemicals

Catalysis for the Conversion of Biomass:
Biomass conversion to fuels and chemicals

In order to be successful in such research areas a much better fundamental understanding of catalytic processes on the molecular level is necessary. Such understanding can only be obtained through the concerted development of novel experimental and theoretical technologies and approaches. Efforts in those areas are under way, but need to be enhanced and accelerated in order to move towards a sustainable future society on our planet.

Have no doubt about it, catalysis will play a pivotal role in the new global economy which MUST arise in the next 20 years or so. It is essential that you know about this technology.


"Catalysis Summit in 2008, 7, 7"
Fritz-Haber Inst. Max Planck Gel. Germany
Cardiff University UK
University of Delaware, USA
Boreskov Inst. Catal. Russia
Catalysis Research Center Japan
Inst. Res. Catal. Environ. CNRS, France
Dalian Inst. Chem. Phys. China
Catal. & Inorg. Chem. Div., NCL India


Catal. & Inorg. Chem. Div., NCL, India
talysis is a key-technology for the realization of
sustainable development
Prof.
Hans-Joachim
Freund
GERMANY
Prof.
Wataru UEDA
Prof.
V.I.Bukhtiyarov
Cool the Earth!

Statement of Catalysis Summit in 2008

Theme: Catalysis as a key enabling technology for a Sustainable Society

The panel members of the catalysis summit would like to announce the following statement regarding the impact of science and technology, and particularly catalytic chemistry, on our evolution towards a sustainable society for future generations.

It is now clear that global warming is a result of human activities and the phenomenon is no longer in doubt. Many remedial actions have been proposed, including the development of better methods of chemicals and energy production. Such developments will be enabled by the application of the scientific skills of scientists and engineers to the reduction of CO_2 emissions, and perhaps, in the longer term, to the reduction of absolute CO_2 levels in the atmosphere. A diversity of scientific disciplines need to be engaged together for this purpose, but Chemistry is essential to new developments in these fields, since the production of CO_2 has often involved rather primitive chemical transformations, but at the same time, chemistry also has the potential to provide novel solutions for the use of alternative feedstock.

Chemistry has been at the centre of the developments of our modern society, particularly over the last century. In the past, much of this technology produced large amounts of pollution, often resulting in far more undesired by-products than desired ones. This has changed in recent years and we have entered the era of "Green Chemistry". For the sake of our children's children this development has to be accelerated at the global level and applied to the energy production sector with the utmost urgency.

Hence, this summit will concentrate it's focus on international efforts in this direction. An essential aspect of chemistry to achieve these objectives is the application of **CATALYSIS** to this problem. The whole petrochemical industry is based on the application of catalysis to chemical transformations of low grade materials into useful products (automotive fuels, plastics, pharmaceuticals), which we all need and use everyday. During this summit, we will discuss what catalysis can contribute to a new, greener world and especially to the evolution of a sustainable fuels economy. The following are areas upon which catalytic science can have particular impact

Catalysis for the Hydrogen Economy:
Hydrogen production using the combination of solar energy and photocatalysts
Electrocatalysis and fuel cells
Hydrogen storage facilitated by catalytic materials

Catalysis for Environmental Protection:
Improved and New Catalytic gas emission control
Catalytic and photocatalytic water and air purification

Catalysis for Chemicals Production:
Catalysts with ultimate product selectivity
Catalysts with ultimate energy efficiency
New C1-chemistry-CO2 utilization (including the use of solar photons and atmospheric CO_2)
Alkane chemistry
Catalysts for new chemicals

Catalysis for the Conversion of Biomass:
Biomass conversion to fuels and chemicals

Novel Catalytic Materials
The development of new materials which use more sustainable and available raw materials. Catalyst recycling.

In order to be successful in such research areas a much better fundamental understanding of catalytic processes on the molecular level is necessary. Such understanding can only be obtained through the concerted development of novel experimental and theoretical technologies and approaches. Efforts in those areas are under way, but need to be enhanced and accelerated in order to move towards a sustainable future society on our planet.

Have no doubt about it, catalysis will play a pivotal role in the new global economy which MUST arise in the next 20 years or so. It is essential that you know about this technology.

7th July, 2008

Jochen A. Lauterbach
Michael Bowker
Hajo Freund
Pierre Pichat
V.I. Bukhtiyarov
Rajiv Kumar
Can Li
Wataru Ueda

Catalysis Summit in 2008

Date: July 7th, 2008 From 13:00 to 18:00
Place: Conference Hall of Hokkaido University

13:00 Opening

13:10 Prof. Jochen A. Lauterbach (CCST, University of Delaware, USA)**"Energy for the future of mankind - how catalysis can contribute"**

13:40 Prof. Michael Bowker
(Surface Chemistry, Cardiff University, UK)
"Photocatalysis for Sustainable Hydrogen Production"

14:10 Prof. Hajo Freund (Fritz-Haber-Institut der Max-Planck Gesellschaft, Germany) **"Basic Research in Catalysis to sustain Energy Supply for the Future"**

14:40 Prof. Pierre Pichat (CNRS, France)
"An overview of present and potential contribute of heterogeneous photocatalysis to a asustainable society"

15:30 Prof. V. N. Parmon/ Prof. V. I. Bukhtiyarov (Boreskov Institute of Catalysis, Russia) **"New Technologies of the Breskov Institute of Catalysis for Conversion and Utilization of Light Hydrocarbons"**

16:00 Prof. Rajiv. Kumar (Catalysis & Inorganic Chemistry, NCL, India) **"Carbon dioxide and water as sustainable source for production of chemicals, fuels and energy"**

16:30 Prof. Wataru Ueda (Catalysis Research Center, Hokkaido Univ. Japan) **"Collaboration between Catalysis and Nature for Sustainable Development"**

17:00 Prof. Can Li (State Key Laboratory of Catalysis, DICP, China)
"Photocatalytic hydrogen production utilization solar energy"

17:30 Statement and closing remarks by Prof. W. Ueda

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