


FY2014

# Development of Key Chemical Processes of Extremely High Efficiency with Super-Performance Heterogeneous Catalysts

## Developing catalysts that achieve effective chemical synthesis in water

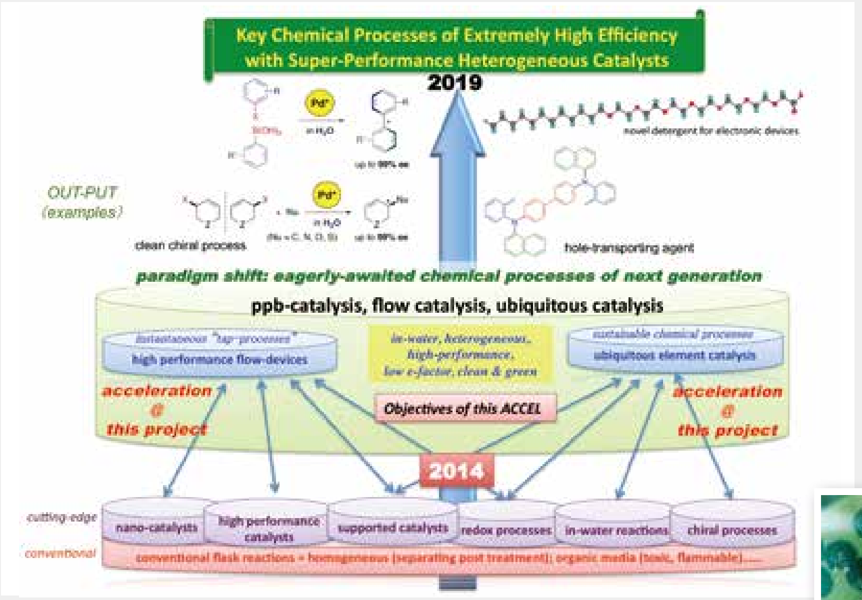
The 20th century brought many different chemical products to enrich our lives. Their manufacture is intimately connected with chemical synthesis. Many chemical syntheses are conducted using catalysts in organic solvents that can dissolve insoluble materials. However, we have succeeded in carrying out synthesis in water.

In our previous research, we developed many high-performance heterogeneous catalysts combining amphiphilic polymers that can dissolve in both water and organic solvents with ligands* and special metals such as palladium that show high catalytic activity in water. These catalysts are supported on polymers and so will virtually never be mixed into the products. This permits separation, recovery, and reuse of the catalyst through filtration, resulting in a reduction in the use of rare metals that are often used in catalysts.

* Molecules that attach to a metal atoms to alter their properties or functions.

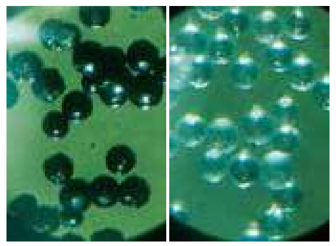
## Radically streamlining different chemical processes

The ACCEL project aims to develop safe and clean chemical reactions carried out in water with a minute level of catalyst. We will find out how much the use of rare precious metal catalysts can be reduced, and bring this to fruit through fundamental research. In addition, taking advantage of the catalyst being supported on polymers, we will develop methods to supply very pure products, and to recover and reuse the catalyst. This will allow world-wide sales of the catalyst, leading to the dissemination of the new era's energy-saving, extremely high-efficiency, and environment-friendly chemical processes.




### Umbrella effect

When water-insoluble organic molecules are added into water containing amphiphilic polymers, they will spontaneously concentrate around the amphiphilic polymers. As it is almost like hiding from the rain under an umbrella, this behavior is called the "umbrella effect." If we load catalysts in advance around the places where these organic molecules gather, chemical reactions can proceed effectively.


SEM image of a polymer catalyst

Research Director

**Yasuhiro Uozumi**

Professor, Institute for Molecular Science, National Institutes of Natural Sciences

For some hundred years, it has been commonsense in modern organic synthesis to use organic solvent to dissolve organic molecules that are not easily water soluble. The most popular, safe, and harmless media, however, is water, and all chemical reactions in life forms occur in water. Curious as to whether this could be done artificially, I discovered this **umbrella effect,** and eventually succeeded in achieving organic synthesis in water.

In the ACCEL project, our goal is to achieve chemical synthesis with a reduced amount of catalysts, a millionth, or even a billionth. The ideal goal of our research is the development of a thoroughly streamlined processes where, when the raw materials are injected from the inlet, the products will flow out from the outlet after passing through the cartridge filled with the catalyst.

Having organic molecules, which are *oil-based* react in *water* is theoretically impossible. However, the umbrella effect makes it possible.

Program Manager

**Toshiaki Mase**

ACCEL Program Manager, Japan Science and Technology Agency

Prof. Uozumi uses his very unique ideas to advance research that opens up new fields of chemical synthesis. We need this because of the growing call for green chemistry, which means reducing risks and minimizing environmental loads in R&D, and so super-performance heterogeneous catalysis technology will play an important role in industry. My role is to draw up a business design for this super-performance heterogeneous catalyst technology.

In the ACCEL project, we will consider what needs to be demonstrated for research that helps the world, and continue discussions and FS with companies. Currently, we are proposing raising the performance of the catalyst we developed to practical levels, which will allow the results to be applied to manufacturing processes not only for pharmaceuticals for human or animals, and for agrichemicals, but also for organic electronic materials. The development of key chemical processes with extremely high efficiency has the potential to greatly advance the world's chemical technology.

We will establish these processes not only in the laboratory flask but as a technology that is actually useful to mankind, spreading it to the world.


PROFILE YASUHIRO UOZUMI

1986: M.S. (Pharmacology), Graduate School of Pharmaceutical Sciences, Hokkaido University; 1997: Professor, Nagoya City University after Hokkaido University, Columbia University, and Kyoto University; in current post since 2000. Research into catalytic organic transformation in water, nano-metal catalyst, highly performance transition metal complex catalysts, etc. Ph.D. (Pharmacology)

PROFILE TOSHIAKI MASE

1983: M.S. (Pharmacology), Graduate School of Pharma-Science, Teikyo University. Joined Sagami Chemical Research Institute; University of Michigan, Banyu Pharmaceutical Co., Ltd., and Meiji Seika Kaisha, Ltd. Has created a track record as the person responsible for pharmaceutical research and development of manufacture processes. Ph.D. (Pharmacology)