Tokyo Tech Research Units

Nanospace Catalysis Unit

Overview

In order to realize a low-carbon society, it is essential to reduce dependency on fossil fuels, utilize fossil resources more effectively, and reduce CO_2 emissions. The Nanospace Catalysis Unit aims to establish innovative production processes for nanospace catalysts and chemical substances utilizing diverse carbon resources. Nanospace catalysts have a number of super-fine pores (nanospaces) at the nanometer level in crystals. This unit focuses on the catalytic properties of zeolite,* one of the porous crystalline materials that controls the catalytic active site at the atomic level, and works to develop breakthrough catalysts that contribute to the realization of a low-carbon society.

*Zeolites are aluminosilicates with molecular-size pores in their crystal structures

Research Unit Leader **Toshiyuki Yokoi**

Profile

- 2016 Assistant Professor, Institute of Innovative Research, Tokyo Institute of Technology
- 2006 Assistant Professor, Chemical Resources Laboratory, Tokyo Institute of Technology
- 2004 Assistant Professor, Department of Chemical System Engineering, School of Engineering, University of Tokyo
- 2004 Doctor of Engineering, Department of Materials Science and Engineering, Yokohama National University

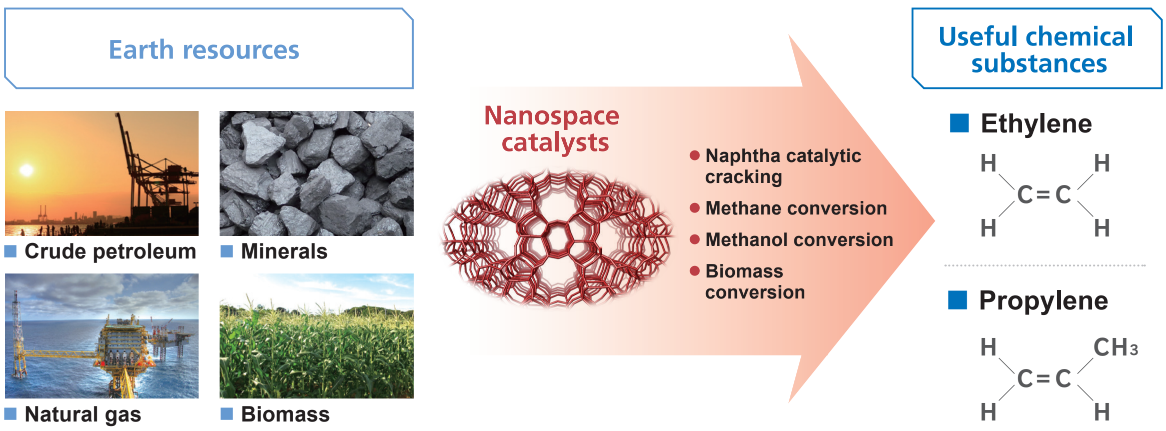
Unit members

- Adjunct Assistant Professor Yong Wang
- Adjunct Assistant Professor Yunan Wang
- Adjunct Assistant Professor Sungsik Park

Research goals

The diameter of zeolite pores is one nanometer or less. Larger molecules cannot pass into these pores. Therefore, zeolite can select smaller molecules such as methane and methanol, and promote their chemical reactions. Utilizing the characteristics of zeolite, this unit places catalytic active sites in optimal positions in pores at the atomic level with the goal of establishing catalytic reaction processes designed to synthesize useful chemical substances such as methanol and ethylene from methane, which until now has only been used as a fuel, and to synthesize basic chemical substances such as ethylene and propylene from methanol obtained from CO_2 and water.

Innovative nanospace catalysts that produce useful chemical substances utilizing diverse carbon resources



Realizing a low-carbon society with nanospace catalysts and effective use of diverse carbon resources

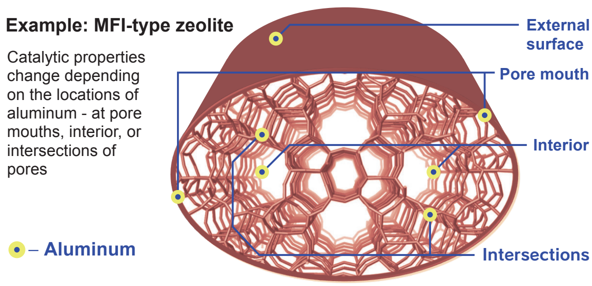
Why was this research unit established?

A sustainable low-carbon and recycle-oriented society requires that we reduce the use of conventional fossil fuels such as crude petroleum and find more effective ways to use these resources. It is also necessary to develop production processes that synthesize fine chemicals such as plastics, fibers, coatings, pharmaceuticals, and agrichemicals utilizing shale gas, biomass, and other unconventional resources. To address these challenges, it is essential to develop innovative catalysts. Therefore, we focus on the establishment of the world's first optimal production processes for nanospace catalysts. In addition to zeolites, we are expanding our research targets to include other nanospace catalysts to achieve our goals.

What are the strengths of this research unit?

Zeolite is a porous crystalline material composed of silicon, aluminum, and oxygen. The aluminum in the framework of zeolite crystal directly influences catalytic properties. Zeolite has been used as a catalyst to produce gasoline from crude petroleum. However, changing the molecular structure, strictly controlling the position of the aluminum, or changing the size of pores can produce new catalytic reactions. Chemists were particularly interested in the strict control of the position of aluminum, which we achieved for the first time in the world in 2015. The unique method of control is one of the strengths of our research.

Selective production of chemical substances by controlling the position of aluminum at the atomic level



What is the path to achieving the unit's goals?

While over 200 zeolites have already been synthesized, we will develop a new zeolite catalyst that is superior to existing ones due to the nanospace structure and control of the position of catalytic active sites. Next, we will develop catalytic reaction processes that allow the synthesis of basic chemical substances with a high selectivity to contribute to the effective use of a wide range of carbon resources. We will also establish methods of structural analysis and evaluation of nanospace catalysts, including zeolite, by utilizing advanced NMR and electron microscopy techniques. In addition, we will participate in national projects organized by the New Energy and Industrial Technology Development Organization, Japan Science and Technology Agency, etc. to further the development of a broad range of innovative catalysts.

Contact us

Tokyo Institute of Technology
Nanospace Catalysis Unit

R1 Building 9 Floor
4259 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8501 Japan
Tel : +81-45-924-5238 Email : yokoi@cat.res.titech.ac.jp
www.nc.iir.titech.ac.jp/