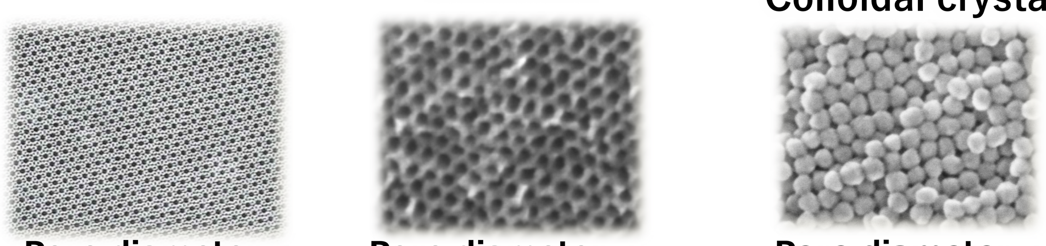
Tokyo Institute of Technology , Institute of Innovative Research

Nanospace Catalysis Unit

（School of Materials & Chemical Technology, Department of Chemical Science & Engineering, Yokoi Lab.）

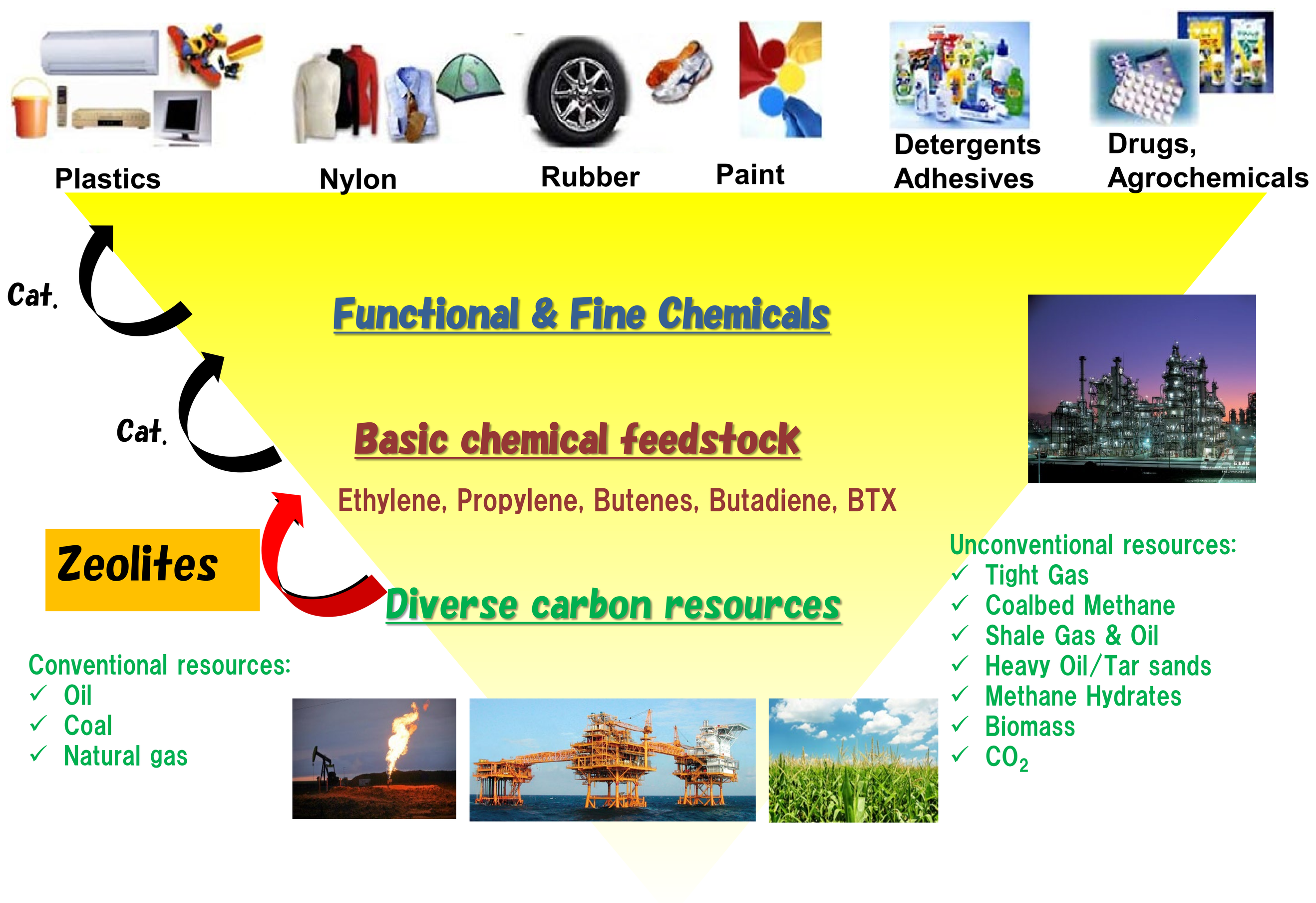
Research Unit Goals

Nanospace materials, such as zeolites and mesoporous materials, are materials with nanoscale spaces and are one of the key materials in nanotechnology that have already been widely used in practical applications and are expected to be applied in the future. Zeolites, in particular, are very unique materials with molecular-sized nanospaces in their crystal structures. Currently, nanospace materials are being actively studied for applications such as catalysts for exhaust gas purification, catalysts for chemical production, separation materials, adsorption materials, fuel cells, and photovoltaic power generation, through flexible control of nanospace structures and functionalization of nanospaces.

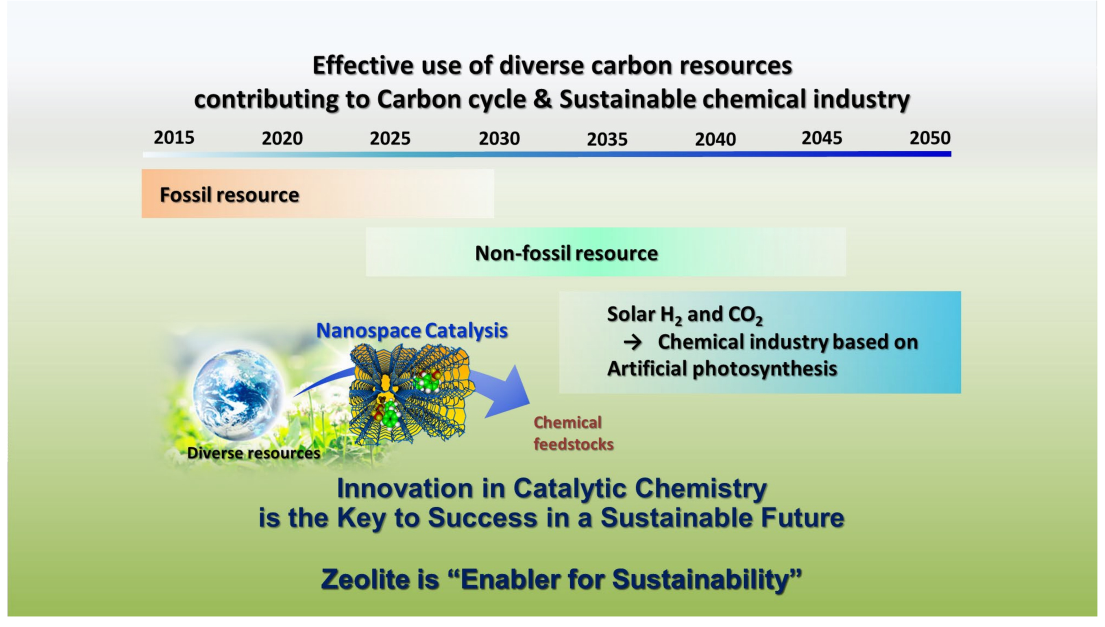


Toward Carbon Recycling and Sustainable Chemical and Energy Industries

Catalytic Chemistry** for effective utilization of **diverse resources



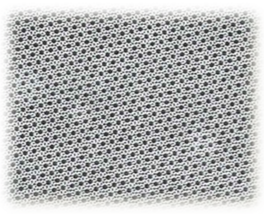
Creation of innovative "**Nanospace Catalysts**" and development of catalytic processes that can convert various carbon resources, water, air, and other resources on the earth into energy and useful chemicals with high selectivity and efficiency using green methods.



Research content

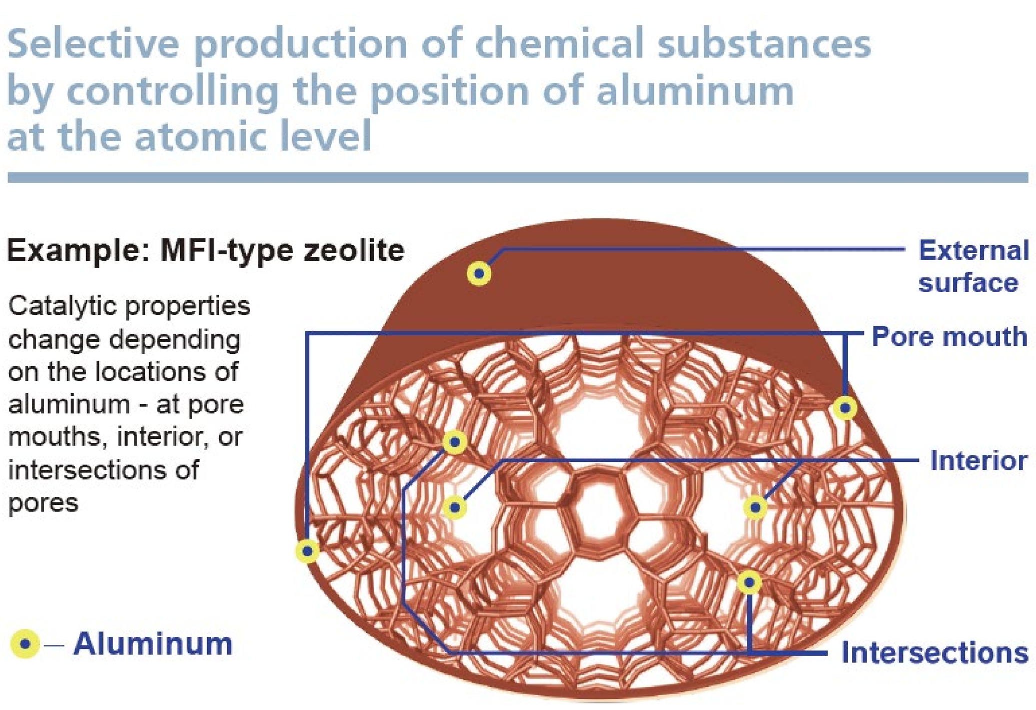
「Nanospace Catalysts」Development

➢Zeolites

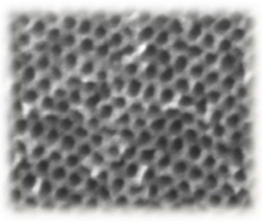


0.3-1.0 nm

- Hydrothermal synthesis
- Zeolite transformation
- Template-free synthesis
- Core-Shell structure
- Distribution of heteroatom
- Hydrothermal stability



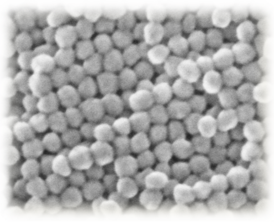
➢Mesoporous Materials



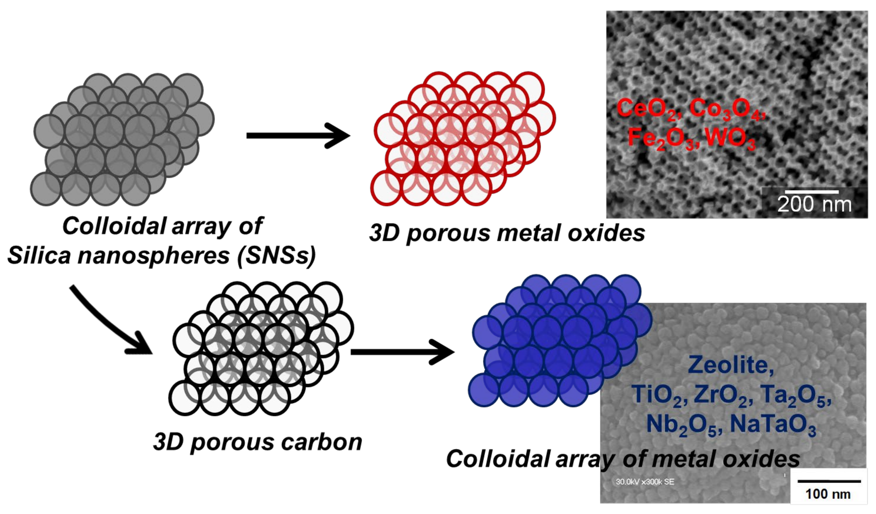
1-20 nm

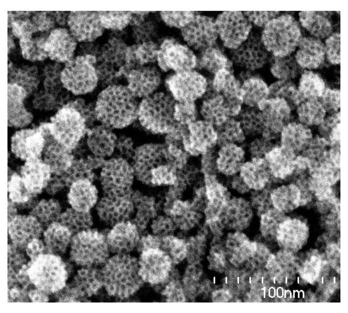
- Monodisperse spherical mesoporous silica
- Porous silica with chiral mesospace

➢Nano Particles



5-500 nm

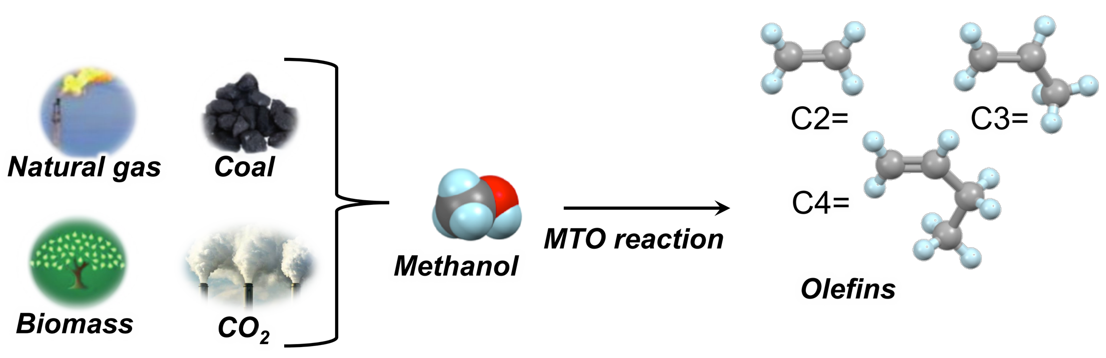




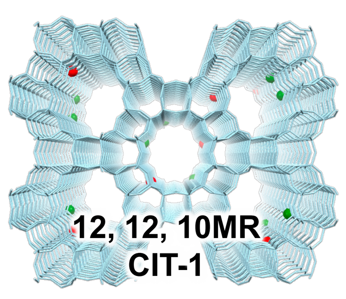
Ti-containing mesoporous silica nanospheres

Catalytic process

- FCC process (naphtha cracking)
- Methanol to olefins (MTO)
- Methane to methanol (MTM)
- Methane to olefins
- CO_2 conversion
- Selective Catalytic Reduction of NO_x with NH_3 (NH_3-SCR)
- Benzene to phenol (BTP)
- Biomass catalysis
- Baeyer-Villiger oxidation
- Epoxidation over titanosilicate
- Base catalysis



Pathway for olefins production from various carbon resources



CON-type boroaluminosilicate zeolite
- ✔ Good hydrothermal stability
- ✔ High propene selectivity

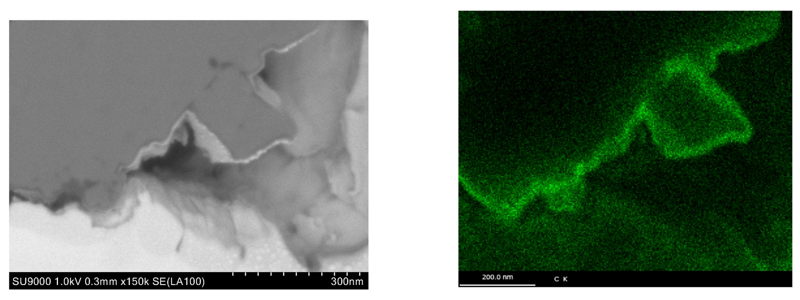
Application example
- ✔ MTO reaction
- ✔ Hydrocarbon trap

etc.

Characterization methods

- Solid state NMR (JEOL ECA600)
- In-situ FT-IR, UV-vis,
- Raman
- SEM/STEM（Hitachi SU9000）

Deactivated ZSM-5



Cross-section image　Distribution of coke

Japan Technological Research Association of "Artificial Photosynthetic Chemical Process (**ARPChem**)"

経済産業省
Supported by METI, Ministry of Economy, Trade and Industry

NEDO Green Japan, Green Innovation

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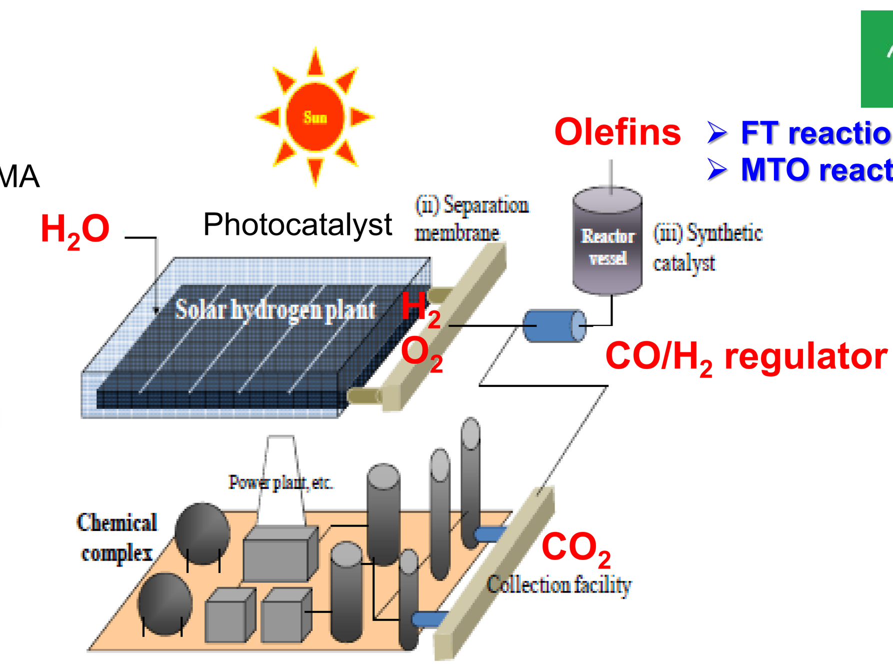
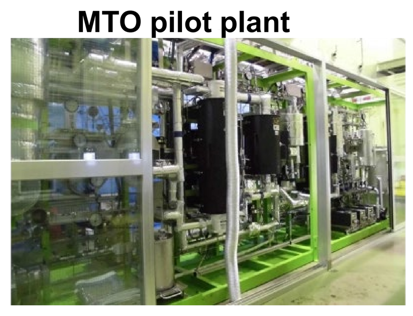


MTO pilot plant



CO_2 could be the best raw material for producing chemicals, provided that H_2 can be produced by solar energy (solar H_2).

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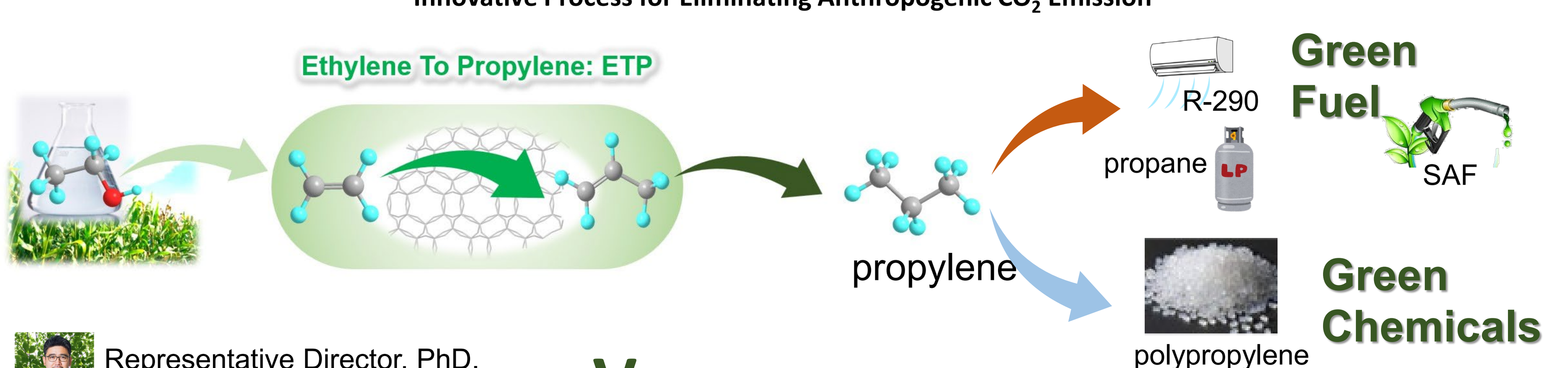
Innovative Process for Eliminating Anthropogenic CO_2 Emission



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Vision

Achieve Carbon neutrality of energy and chemicals through conversion of raw materials from fossil resource-derived to biomass-derived.

Mission

Introduce the ETP process to the society,、
- Establish a highly efficient biopropylene production process from bioethanol.
- Establish a green fuel production process from biopropylene to replace LPG.
- Establish processes to produce various olefins, polypropylene, and other chemical products from biopropylene.

These will provide the innovative technologies essential to achieve carbon neutrality.

Innovation in Catalytic Chemistry is the Key to Success in a Sustainable Future

Nanospace Catalysis Unit – Enabler for Sustainability

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