Development of Innovative Gas Separation Membranes through Sub-Nanoscale Materials Control

Chemical Research Group

GCEP(Global Climate & Energy Project) was set up with a research and development project of the global warming countermeasure technology which made started in U.S.A in 2003, and operating by Stanford University.

RITE was awarded for research proposal (three years) by GCEP as the first research organization except for universities and the second one except for U.S.A in September 2005.

This project intends to develop a variety of efficient, low-cost polymeric and inorganic membranes that separate CO_2. Material structure engineering at the scale of gas molecules will be used to increase permeability and selectivity.

Since the effective size of CO_2, N_2, H_2 and other gases present in fossil fuel conversion systems are very similar, membrane pore spaces must be controlled on a scale comparable to the size differences among these gas molecules. This will be achieved for a variety of membrane types using several different techniques.

Hollow fiber cardo polymer membranes will be optimized for CO_2 permeability and selectivity, for example, by carbonizing the outer surface of the membrane. Thermal motion of organic polymers can cause variations in the morphology and effective pore size of the membrane. Carbonization by UV, plasma, or ion beam treatment could serve to restrict the thermal motion of the polymer chain and enhance the molecular gate function of the polymer. Functionalizing the polymer may change its morphology at the sub-nanoscale, allowing for fine tuning of the pore space (Fig.1).

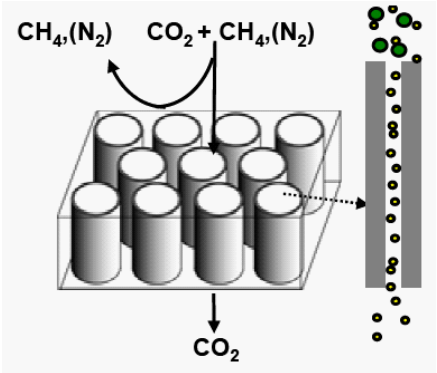


Fig.1: Porous inorganic membranes act as molecular sieves

While most zeolite membranes consist of randomly oriented crystals, a thin, mono-layer crystal with an ordered lattice of pores would demonstrate superior permeability and freedom from defects. As illustrated in Fig.2, this will be achieved by applying a coating of seed crystals on a substrate with perpendicularly oriented channels. After secondary crystal growth, the properties of the resulting pore structure reflect the morphology of the seed crystal.

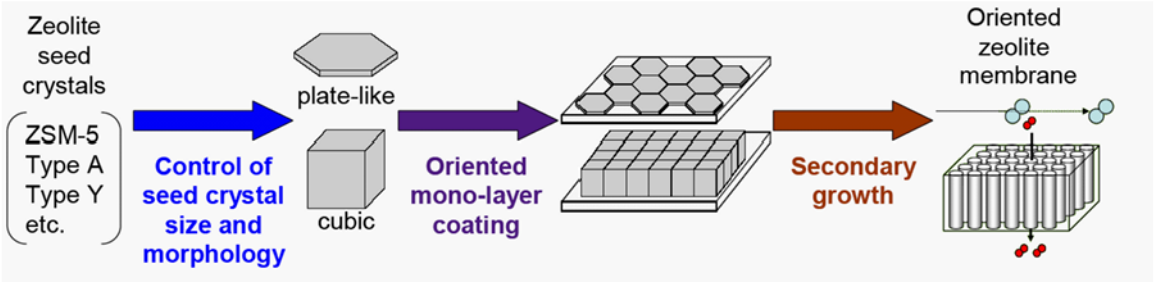


Fig.2: Functionalization process for a mono-layer crystalline zeolite pore structure

The development (It is compared with the present by the CO_2 separation cost, and a big breakthrough is realized with 1/3.) of the progressive high-performance CO_2 separation membrane which controls sub-nano structure is expected as a result of this project.

(GCEP WEB site: http://gcep.stanford.edu/)

CO_2 Capture Enabling Technologies for Coal-fired Power Generation

Chemical Research Group

A workshop entitled "CO_2 Capture Enabling Technologies for Coal-fired Power Generation" was held on September 16, 2005 at the Australian pavilion in the Aichi EXPO Japan.

This workshop was hosted by Australian Department of Industry Tourism and Resources (DITR) in cooperation with RITE, Japan. Approximately fifteen researchers from Australian side and forty participants including RITE, JCOAL, NEDO and the private sectors in Japan gathered on the day.

Firstly Mr. John Hartwell, resources director of DITR, Dr. Kaya, head of RITE and the Mr. Cliff Mallett, head representative of CSIRO made opening announcements and then three sessions on "Gasification and Gas Stream Technologies", "Oxy-Fuel Combustion" and "Post Combustion and Appropriate Gas Stream Technologies" were followed in this workshop. In their opening addresses, Mr. Hartwell highlighted the importance to cooperate with Japan for resolution of the global warming issues and Prof. Kaya mentioned the necessity of consideration about a post-Kyoto protocol and cost evaluation as well.

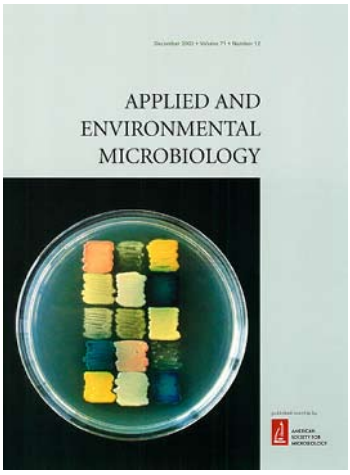
Prof. Yamada of RITE summarized that the carbon sequestration technology should be recognized as an important bridge toward the possible renewal energy period and wide range of researches from basic study to actual testing levels had been carried out. It was also mentioned that bilateral partnership in the fields of oxygen combustion and developing membrane technologies should be more promoted.

After this workshop was over, it was highly evaluated from the Australian government as an invaluable opportunity for the leading researchers of both countries in that they had lively face-to-face exchange of views about CO_2 Capture Enabling Technologies.

One of our research achievement -A cover for the journal published by American Society for Microbiology

Microbiology Research Group

In the Microbiology Group, we focus our work on devising microbiological conversion methods to produce useful substances. The keys of our research are the engineering of production strains and the development of bio-process techniques that have industrial potential. Specifically, our research group aims at harnessing coryneform bacteria, as these bacteria have a long history of biotechnological use and possess an almost unmatched set of intrinsic attributes to produce a variety of different fine chemicals, including amino acids. The ability to efficiently manipulate coryneform bacteria at the genetic level opens the possibility to apply a wide array of technologies that have been devised in other areas in the field of the life sciences.



We report our results in leading international scientific journals. For example, to illustrate the latest advancements in modifying the genomes of coryneform bacteria, we have recently published a review article revisiting the various recombinant DNA tools that are available for corynebacterial research and defining the next major objectives to accomplish in this area. The picture, which is related to this review article, is the cover of the December issue of the journal Applied and Environmental Microbiology, published by the American Society of Microbiology.