

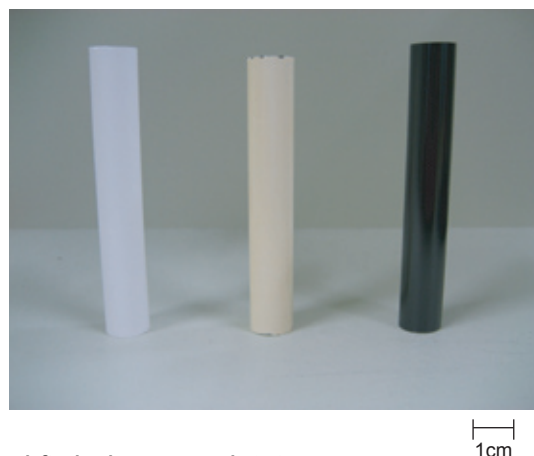
## Global Climate &amp; Energy Project (GCEP)

Chemical Research Group

The RITE has received an award for its developmental work “Sub-nano structure controlled materials: development of innovative gas separation membranes” from the Global Climate and Energy Project of Stanford University, USA. In this project, the synergy of research into both organic and inorganic materials will lead to innovative materials for gas separation membranes.

**Carbon membrane**

In the organic materials approach, sub-nanostructure controlled carbon membranes are now under research. The RITE’s novel carbon membrane would have an ideal molecular gate function, showing excellent separation performance in the wide range of feed gas conditions. The surface and/or micropores of the carbon membrane are modified with materials possessing CO<sub>2</sub> affinity such as metal carbonates to obtain the molecular gate function. Figure 1 shows a photograph of the carbon membrane that was made from cardo polyimide as a precursor on a porous alumina tube.

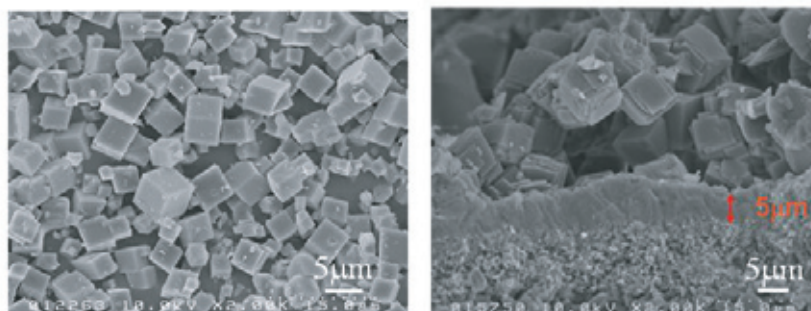


left: alumina porous substrate  
center: after cardo polyimide application on the substrate  
right: after carbonization

**Fig. 1 Carbon membrane**

**Inorganic membrane (zeolite membrane)**

We are now investigating an optimum zeolite structure and preparation of a grain-boundary/pinhole free zeolite membrane by molecular simulation. Based on the simulation results, we have selected new candidate zeolite structures for CO<sub>2</sub> separation and have begun synthesis of a new zeolite membrane. Synthetic conditions for zeolite seed crystals have been studied and, recently, we have successfully synthesized a hydrophobic zeolite seed crystal that has never previously been used as a zeolite membrane (Figure 2). In addition, a new preparation method for the zeolite membrane for growing zeolite crystals inside the pores of porous alumina substrate has been proposed and it was found that the new preparation method was effective in improving the CO<sub>2</sub> permselectivity.



**Fig. 2 Newly synthesized zeolite seed crystals and zeolite membrane**

## Development of biobutanol production technology

Microbiology Research Group

We, Microbiology research group, are currently developing microbial butanol production technology from cellulosic biomass. Butanol has been attracting attention along with ethanol as biofuels and the significant feature differing from ethanol is that it can be mixed with light-oil, which is fuel for diesel engine. In recent years, biodiesel production from vegetable oil has been active, however, biodiesel production is often associated with environmental destruction resulting from developing cultivation land. This led to growing anticipation for butanol production, which can be used as an alternative fuel to biodiesel. History of microbial butanol production is long, and the industrial production started as Acetone-Butanol-Ethanol (ABE) fermentation method at the beginning of 20<sup>th</sup> century. Although the production declined for a period of time owing to advance in petrochemical industry, active research has been carried out again as biofuel production from renewable resources is currently growing. However, as anaerobic microorganisms (*Clostridium* spp.) are employed as before, it is difficult to achieve a dramatic improvement in productivity. This led to growing interest in introducing butanol synthetic function (gene) from *Clostridium* into an industrially favorable microorganism by biotechnology.

We have introduced genes involved in butanol synthesis into industrial microorganism, *Escherichia coli*, and have confirmed their function in the host as well as butanol synthesis. Our achievement has been published in “Applied Microbiology and Biotechnology” (Vol.77:1305-1316, 2008) and we are aiming to further improve the productivity.

### Expression of *Clostridium acetobutylicum* butanol synthetic genes in *Escherichia coli*

Masayuki Inui · Masako Suda · Sakurako Kimura ·  
Kaori Yasuda · Hiroaki Suzuki · Hiroshi Toda ·  
Shogo Yamamoto · Shohei Okino · Nobuaki Suzuki ·  
Hideaki Yukawa



## Systems biology of the RITE strain (Coryneform bacteria)

Microbiology Research Group

The microbiology group is involved in developing biorefinery technology to produce biofuels and chemicals of use using “Growth-arrested bioprocess” with Coryneform bacteria. “Growth-arrested bioprocess”, which is our unique core-technology, employs growth-suppressed microbial cells as chemical catalyst for production and is innovative production technology differing from the conventional methods. Currently, we are conducting analyses on the cell metabolism and gene-networks under various conditions to apply the valuable information gathered by the analyses to further improve the productivity and to increase the variety of chemicals produced by the process. The genome sequence of the RITE strain has already been analyzed (Microbiology Vol.153, p1042-1058, 2007) and, with that information, we are carrying out investigations into expression control mechanisms of specific genes and interactions among genes and proteins by proteome and transcriptome analyses. As stated above, we are conducting research in the field of systems biology which elucidates cell activity of the RITE strain as gene-networks and systems. Our research achievement, which illustrated one aspect of cell division mechanism of RITE strain, has been published in a scientific journal recently, and the image of RITE strain undergoing the cell division was shown on the front cover (Molecular Microbiology, Vol. 67, p597-608, 2008).



## International Workshop “Carbon Dioxide Geological Storage”

### CCS Workshop 2007 CCS Workshop Tokyo 2007

CO<sub>2</sub> Sequestration Research Group

The workshops, where the test results of and trends related to the carbon dioxide storage technology demonstration were reported, were held in the Keihanna Plaza, Kansai Science City over two days, February 15 and 16, 2007, and in the Hotel Grand Palace, Tokyo, on November 19, 2007. The CSS related laboratory tour was also held at the RITE Kyoto Headquarters on February 16.



These workshops were held by RITE with the purpose of promoting understanding as a part of our carbon dioxide geological storage technology research and development, and approximately 200 and 300 people from both home and abroad participated in the respective workshops. The participants came mainly from companies and research institutions, and about 20 individuals from abroad, as well as environmental NGOs and NPOs, attended the workshops.

In the workshops, invited speakers from home and abroad introduced commercial projects, experimental projects, collaborative capture & recovery projects in the Europe, CCS project status and perspectives in China, Norway, and Australia, as well as Japan's CCS related policies and technology development status. A panel discussion was conducted by foreign invitees and Japanese researchers under the theme of "Goals and Challenges of Large Scale Demonstration Projects", which invited proactive opinions from the floor.

For detailed information, see the event report on the RITE home page.

## 2008 RITE International Symposium - IPCC 4th assessment report and challenges to mitigate global warming -

### Planning, Survey, and Public Relations Group

The symposium entitled “2008 RITE International Symposium - IPCC 4th assessment report and challenges to mitigate global warming -” was held on 24 January 2008, at Nadao Hall in Tokyo.

This symposium was organized by RITE, co-organized by NEDO (New Energy and Industrial Technology Development Organization), and supported by METI (Ministry of Economy, Trade and Industry), SCEJ (The Society of Chemical Engineers, Japan), JSER (Japan Society of Energy and Resources), JIE (The Japan Institute of Energy), JSBBA (Japan Society for Bioscience, Biotechnology, and Agrochemistry).

There was a high attendance of 437 at this symposium, including participants from the press, various ministries such as Ministry of Economy, Trade and Industry, Ministry of the Environment, Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Agriculture, Forestry and Fisheries, Ministry of Education, Culture, Sports, Science and Technology, and also participants from embassies and foreign organizations from Australia, Finland, France, Holland, South Korea, Sweden, the U.K., and the U.S.

In the symposium, Dr. Leo Meyer, the head of the Technical Support Unit of the Working Group 3 of IPCC from the Netherlands Environmental Assessment Agency, Dr. Sally M. Benson, the executive director of the Global Climate and Energy Project (GCEP) at Stanford University, Dr. Itaru Yasui, senior fellow at the Center for Research and Development Strategy of Japan Science and Technology Agency, and Mr. Nobukichi Nakamura, project general manager at BR Energy Affairs Department of Toyota Motor Corporation, delivered their updating lectures.

Dr. Hideaki Yukawa, the leader of Microbiology Research Group of RITE, presented “Current World-wide Status of Biofuels and Research and Development at RITE”. And Mr. Yasunobu Mizuno, the leader of CO<sub>2</sub> Geological Storage Project of RITE, presented “Geological CO<sub>2</sub> Storage Technology Issues to be Solved towards Practical Application”. Dr. Yoichi Kaya gave his lecture entitled “Long Term Strategy for Mitigating Global Warming” at the end of the symposium.



## Symposium on Innovative Environmental Technologies - Research and development in anticipation of the Post Kyoto Protocol -

### Planning, Survey, and Public Relations Group

The symposia entitled “the Innovative Environmental Technology - Research and development in anticipation of the Post Kyoto Protocol - ” were held on 20 September 2007 at Hotel Nikko Osaka in Osaka, and 2 November 2007 at Nadao Hall in Tokyo.

The symposia were organized by RITE, and supported by METI, NEDO, METI Kansai, CSJ (The Chemical Society of Japan), SCEJ, JSBBA, JSER, Kankeiren (Kansai Economic Federation).

We had 282 attendances in Osaka and 338 in Tokyo, total of 620 which emphasizes the great interest in our activities, including participants from METI, Ministry of the Environment, Ministry of Agriculture, Forestry and Fisheries and various fields of industry and academia.



The symposium started with Dr. Yoichi Kaya’s keynote speech on the outlook on the technologies counteracting against the global warming and then the experts from each research groups reported the outcome of their researches, such as scenarios for mitigating global warming, CCS technology, biorefinery technology, and the technologies for the forestation by elite plants, with the current trends of the world.