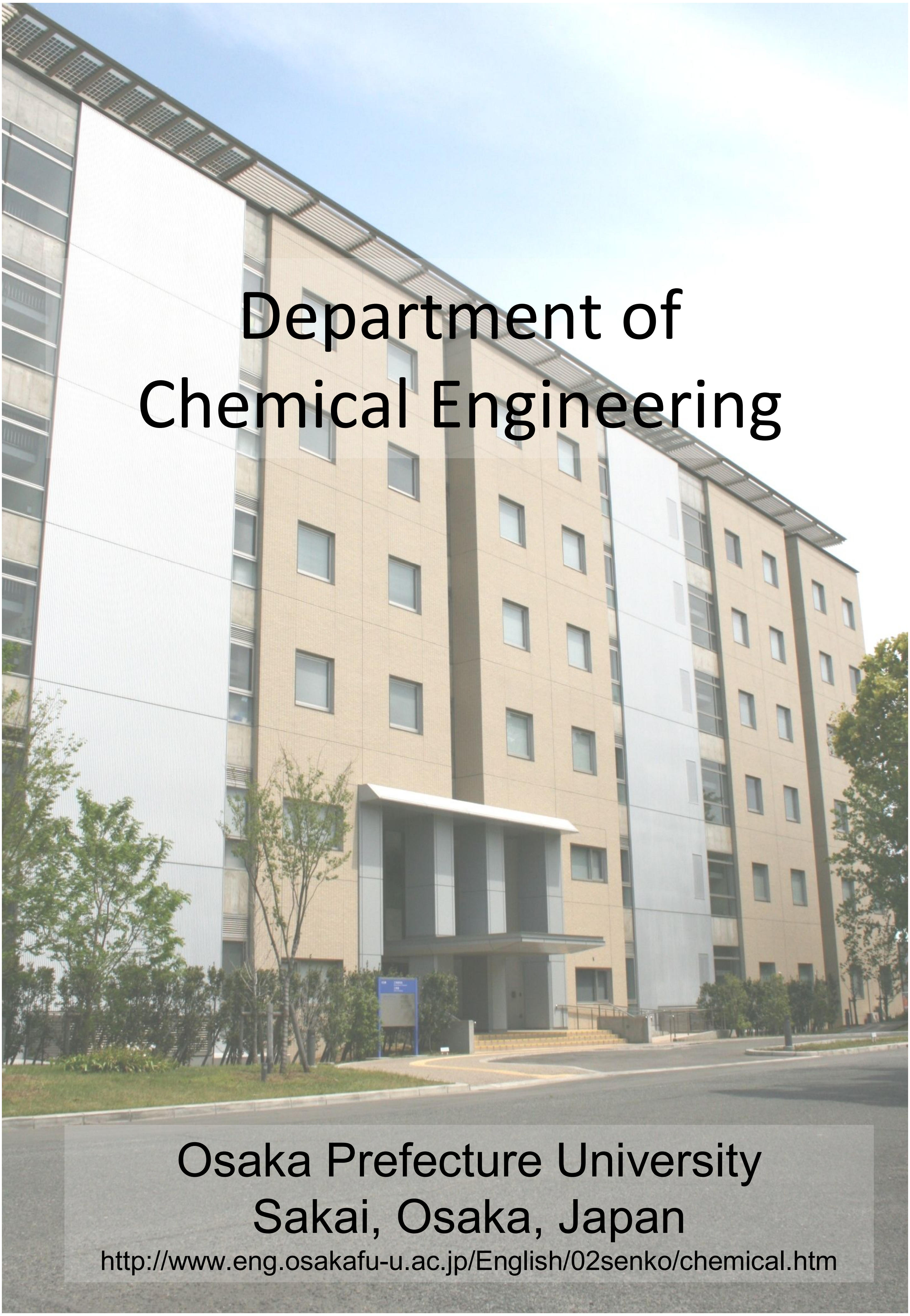


Department of Chemical Engineering

Osaka Prefecture University
Sakai, Osaka, Japan
http://www.eng.osakafu-u.ac.jp/English/02senko/chemical.htm

Academic and Research Staff

Academic Staff

As of April1, 2010

1) Particle science and technology group

Professor	Yasuhiro KONISHI
Associate Professor	Toshiyuki NOMURA
Research Associate	Takashi OGI

2) Chemical reaction engineering group

Professor	Hiroyasu OGINO
Associate Professor	Masahiro YASUDA

3) Separation science and engineering group

Research Associate	Hayato TOKUMOTO

4) Resource engineering group

Professor	Masashi IWATA

5) Process systems engineering group

Professor	Satoru WATANO
Associate Professor	Tomohiro IWASAKI
Research Associate	Hideya NAKAMURA

6) Materials process engineering group

Professor	Kazuo KONDO
Associate Professor	Takeyasu SAITO
Research Associate	Naoki OKAMOTO

7) Cluster control engineering group

Professor	Motoaki ADACHI
Associate Professor	Shigeki TSUKUI
Research Associate	Takuya KINOSHITA

Professor	6 persons
Associate professor	5 persons
Research associate	5 persons
Total	16 persons

Research Staff

Faculty	16 persons
Post Doctor	1 persons
Research assistant	3 persons
Visiting researcher	2 persons

Education

Courses

Undergraduate

CE1: Laboratory; Chemical engineering Ⅰ*
CE2: Laboratory; Chemical engineering Ⅱ*
CE3: Undergraduate project in chemical engineering*
CE4: Chemical engineering practice*
CE5: Chemical engineering stoichiometry*
CE6: Transport phenomena Ⅰ*
CE7: Transport phenomena Ⅱ*
CE8: Transport phenomena Ⅲ
CE9: Chemical engineering thermodynamics*
CE10: Diffusional separation engineering Ⅰ*
CE11: Diffusional separation engineering Ⅱ
CE12: Chemical reaction engineering Ⅰ*
CE13: Chemical reaction engineering Ⅱ
CE14: Biochemical engineering
CE15: Powder technology Ⅰ*
CE16: Powder technology Ⅱ
CE17: Process control engineering
CE18: Process systems engineering*
CE19: Process equipment design
CE20: Process design*
CE21: Special topics in chemical engineering Ⅰ
CE22: Special topics in chemical engineering Ⅱ
CE23: Internship
CE24: English reading for chemical engineers*
CE25: Independent exercises for chemical engineers*
CE26: Mathematics for chemical engineering
CE27: Exercises; Chemical engineering Ⅰ
CE28: Exercises; Chemical engineering Ⅱ
CE29: Exercises; Chemical engineering Ⅲ
CE30: Analytical chemistry B
CE31: Inorganic chemistry B
CE32: Organic chemistry Ⅰ B
CE33: Organic chemistry Ⅱ B
CE34: Physical chemistry Ⅰ B
CE35: Physical chemistry Ⅱ B
CE36: Fundamentals of materials science

Education

Courses

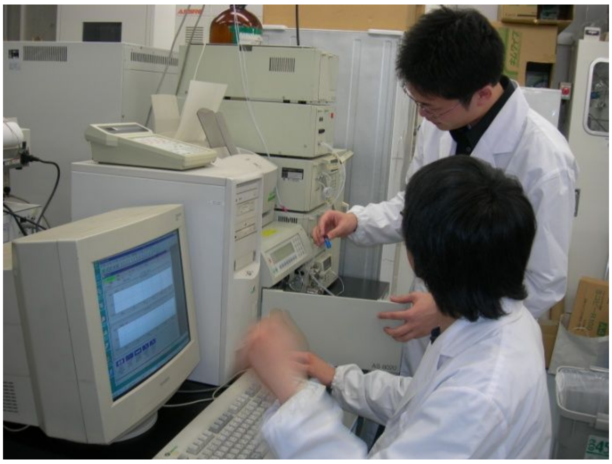
Graduate

CE1: Advanced particle science and technology
CE2: Advanced chemical reaction engineering
CE3: Advanced chemical engineering thermodynamics
CE4: Advanced heat and mass transfer
CE5: Advanced chemical engineering fluid mechanics
CE6: Advanced diffisional engineering
CE7: Advanced process systems engineering
CE8: Advanced materials process engineering
CE9: Advanced chemical engineering
CE10: Advanced science and engineering for zero emissions
CE11: Advanced science and engineering of material cycling
CE12: Advanced science and engineering of energy cycling

Number of students (foreign students)

Undergraduate	159(2)
Graduate	
Master 1	26(0)
Master 2	28(0)
Doctor	6(0)

As of Aril1, 2010



Research Groups

1) Particle science and technology group

2) Chemical reaction engineering group

3) Separation science and engineering group

4) Resource engineering group

5) Process systems engineering group

6) Materials process engineering group

7) Cluster control engineering group

Particle Science and Technology Group

Professor : Yasuhiro KONISHI,
Associate Professor : Toshiyuki NOMURA
Research Associate : Takashi OGI

Current Research

Our group has been carrying out research such as: 1) synthesizing “nanoparticles and microparticles” in an environmentally-friendly way, 2) evaluating and understanding the surface characteristics of the “microparticles (microorganisms)” correctly and putting them into practical use, and 3) utilizing the “microorganisms as microparticles” for resource recycling and environmental cleanup. We will introduce the research content concerning “resource recycling of rare metals by the use of microorganisms”.

“Rare metals” is a general term which refers to metal elements that are scarce on the earth or those that are extremely difficult to extract from raw materials either economically or technically. Today, rare metals are indispensable for high-tech products such as cellular phones, liquid crystal display TVs and hybrid cars. Incidentally, Japan consumes nearly 30% of all rare metals consumed in the world, most of these metals being imported, therefore, it is imperative for Japan to secure a stable supply of these rare metals.

As shown in Fig. 1, we have been researching the technologies to effectively extract rare metals from both raw mineral ore and artificial mineral ore (waste from electric and chemical industries), condense and collect metal components extracted into a liquid solution and, furthermore, transform them to nano/micro-sized highly functional particles. We are proceeding with the research to combine these technologies in an orderly way so that a resource recycling system of rare metals consisting of raw materials, highly functional materials, industrial waste and raw materials can be established, contributing to the promotion of a recycling-oriented society. The techniques of bioleaching to extract rare metals from mineral ore by the action of microorganisms, and biomineralization to reduce and deposit metal ions existing in an aqueous solution on the surface of microorganisms as solid nanoparticles, in particular, have been given much attention as environmentally-friendly technology.

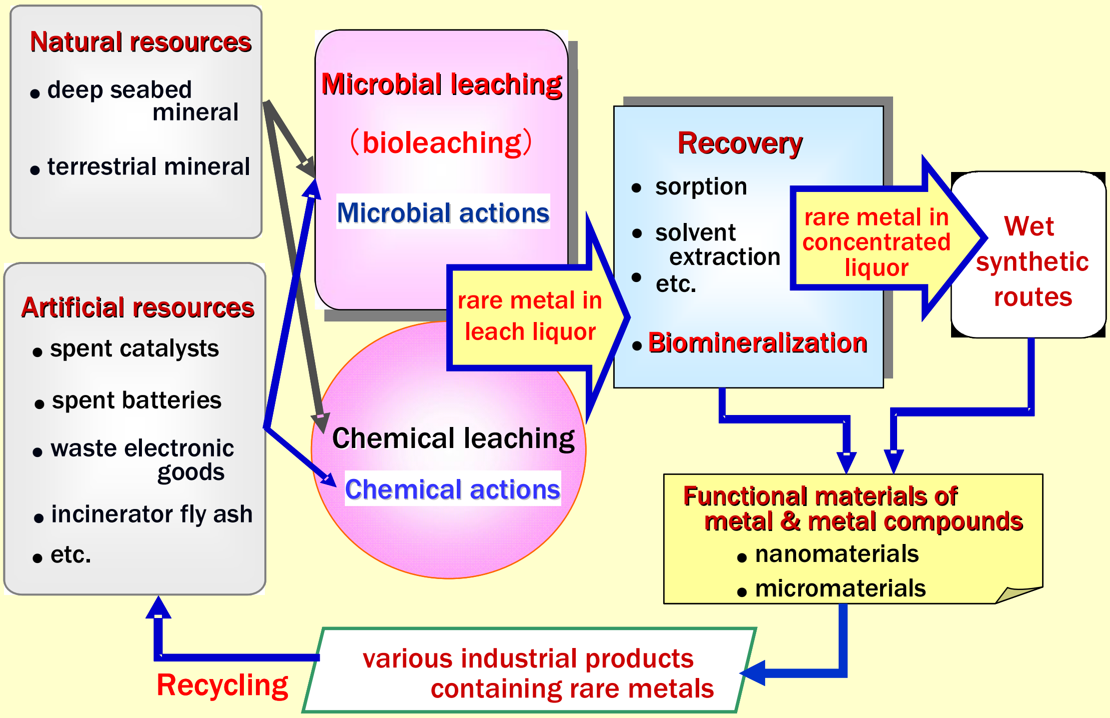
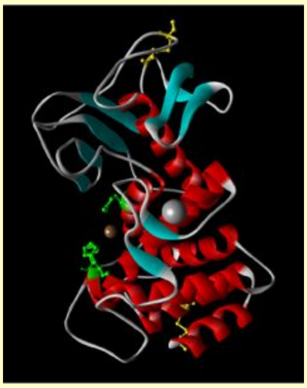


Fig. 1 Recycling system of rare metals

Chemical Reaction Engineering Group

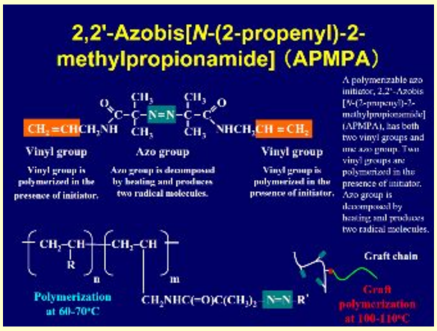
Professor : Hiroyasu OGINO
Associate Professor : Masahiro YASUDA

Biocatalysts such as enzymes and microorganisms have high catalytic activities under mild condition without generating by-products. When the enzymes and the microorganisms are used as catalysts in chemical processes, it becomes possible to develop environment-friendly processes with resource-saving and energy-saving. Aiming at the development of such bioprocesses, from the viewpoints of chemical reaction engineering and biochemical engineering we are engaged both in basic and applied researches, such as exploration of enzymes and microorganisms that are useful as industrial catalysts, development of industrial biocatalysts using gene engineering, protein engineering, and enzyme engineering, characterization of the biocatalyst, the design and development of bioreactors, and synthesis of functional polymers useful for the bioprocesses. Furthermore, we are also developing environment-friendly bioprocesses based on these researches. Especially, we are involved in development of organic solvent tolerant biocatalysts (enzymes and microorganisms), generation of the hydrogen using the microorganisms, synthesis of functional polymers and particles, and the development of their bioprocesses.

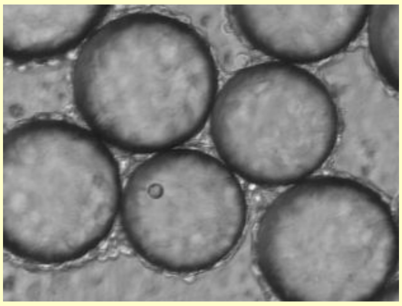


Organic solvents are generally used as reaction solvents at fine chemical industry, because many of fine chemical products such as the pharmaceuticals are water-insoluble. In generally, most biocatalysts lose their catalytic activities in the presence of organic solvents. Our research group succeeded in discovering organic solvent-tolerant microorganisms which produce organic solvent-stable enzymes. They and their enzymes are organic solvent-tolerant biocatalysts which are stable and active in the presence of organic solvents. We are involved in the screening and development of new organic solvent-tolerant biocatalysts, molecular design of organic solvent-tolerant enzymes for function improvement, and development of environment-friendly processes using organic solvent-tolerant biocatalysts.

Hydrogen is a clean and eco-friendly energy source, because it does not release carbon dioxide, which contributes to global warming. Then hydrogen has attracted a great deal of attention as next-generation energy. However, it is not sustainable energy because it is manufactured from the fossil fuel in present. Therefore, we are trying to produce hydrogen from biomass using microorganisms. It already succeeds in producing hydrogen continuously by the microorganism using glucose which can be generated from biomass. The problem for practical use in the future is to produce it promptly and efficiently. We are involved in the development of microorganisms which produce hydrogen promptly and efficiently, by gene engineering, metabolic engineering, protein engineering, and cell engineering. Exactly, it aims to produce clean energy by a clean method.



There are two ordinary methods to synthesize functional polymer materials. One is polymer alloy and the other is copolymerization. These two methods are restricted by the compatibility of two different polymers and the monomer copolymerization reactivity. To overcome these problems, we develop a new method to produce grafted polymer using macroazo initiator. 2,2'-Azobis [*N*-(2-propenyl)-2-methylpropionamide] (APMPA), has both two vinyl groups and one azo group. Copolymerization of APMPA and co-monomer produces macroazo initiator and the product is used for grafted polymerization as an initiator. Produced grafted polymers have much potential for use of the immobilization support of enzyme in industrial bioprocess, the cell cultivation tool for tissue engineering and the 3D tissue support for regenerative medical techniques, the functional nano electronics devices, and the diagnostic agents for cytoscreening.



Various functional polymer particles are developed for cell cultivation support *in vitro*. We study molecular design, synthesis, and functional evaluation of these functional polymer particles. For tissue cultivation and regenerative medical techniques, we use these functional polymer particles as a tool to clarify the mechanism of bone and blood diseases and to establish a new treatment of these diseases. This picture shows the three-dimensional cell cultivation of osteoblast using hydrophilic functional polymer particles having special macromolecular brushes.

The establishment of human three-dimensional cell cultivation system of osteoblast can recreate cell environment in human bone and result in the mechanism clarification of cell-cell interaction, induction of differentiation, and induction of secretion of humoral factor. We contribute to the further development of the regenerative medical techniques

Separation Science and Engineering Group

Research Associate : Hayato TOKUMOTO

Anaerobic digestion is consisted series of complex metabolic interaction (Fig.1). The series of complex metabolic interaction can be classified into three major processes. The first process is the hydrolysis of polymer substrates such as carbohydrates, fat, and proteins into simpler soluble compounds. The second process is that hydrolyzed organic materials are converted to hydrogen and carbon dioxide, along with volatile fatty acids (VFAs) and alcohols. The third process is

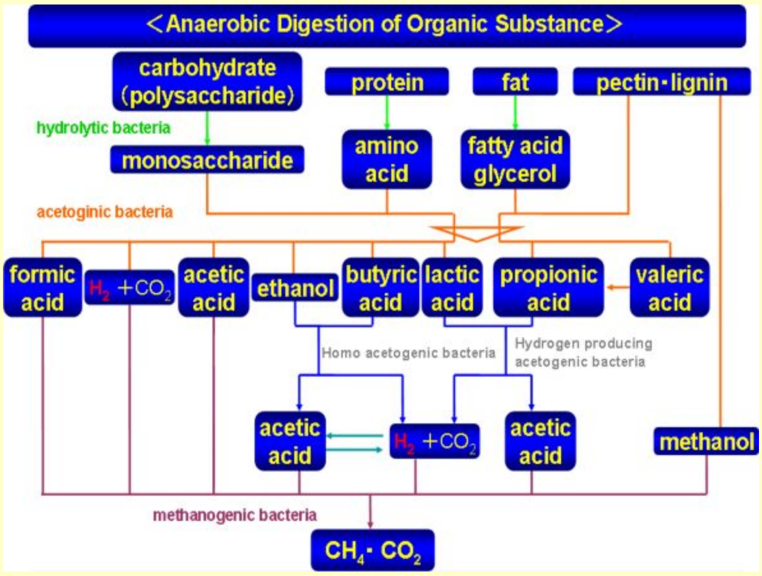


Fig.1 Methane fermentation scheme.

that intermediate metabolites are further degraded by methanogens and are then converted into methane with chemical oxygen demand (COD) reduction. The intermediate metabolites were only obtained a small amount in methane fermentation process since they were finally utilized by methanogens to produce only methane as valuable substances. However, there are many attractive intermediate metabolites in an anaerobic fermentation process. For example, hydrogen is a clean and efficient energy carrier because it produces only water after combustion and can be directly converted to electricity via fuel cells. Recently, environmental issues have come to the forefront, with global warming, regional air pollution and economic/ecological sustainability all being major driving forces behind the renewed interest in alternative energy sources. Therefore, hydrogen as a potential clean energy source of the future can be a possible alternative energy to fossil fuels. Hydrogen production through biological processes, such as photosynthesis and fermentation, has caught great attention recently since it is more environmentally friendly, sustainable, and less energy intensive as compared to the conventional thermal/chemical processes. Attractive materials are in the intermediate metabolites in liquid phase too. For example, the 1,3-propanediol (1,3-PDO) produced through glycerol fermentation has a wide range of potential uses, in particular as a monomer for polycondensations to produce plastics with special properties, i.e. polyesters, polyethers and polyurethanes, as a monomer for cyclic compounds, as a polyglycol-type lubricant and it also may serve as a solvent.

The two-phase anaerobic digestion system has several advantages over the traditional single-phase system, e.g., shorter detention time, higher gas conversion efficiency, and higher methane concentration in the produced gas (Fig. 2). Furthermore, it may allow a reduction in total reactor volume. The metabolic pathways of the two-phase anaerobic digestion process are the same as those of conventional digestion; however, they are physically separated in (i) hydrolytic and acetogenic phase and (ii) methanogenic phase.

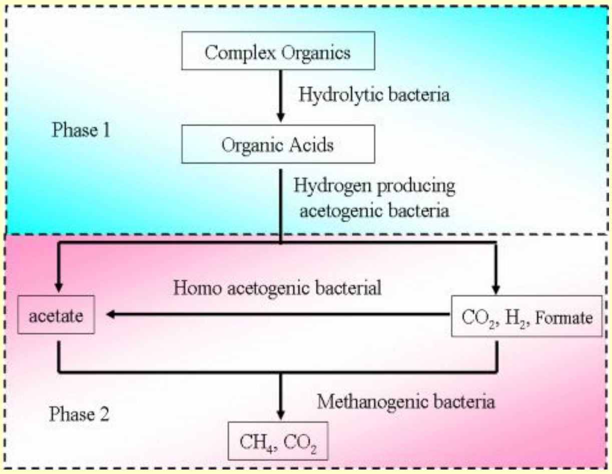


Fig. 2 The two-phase anaerobic digestion system.

The first phase can be used as an independent hydrogen production unit but not as a pretreatment for the methanogenic reactor. The short hydraulic retention time (HRT) is applied in the first phase in order to separate acidogenesis from methanogenesis. The long HRT in the first phase is resulting in no effective separation of hydrogen production from methane production to convert hydrogen into methane.

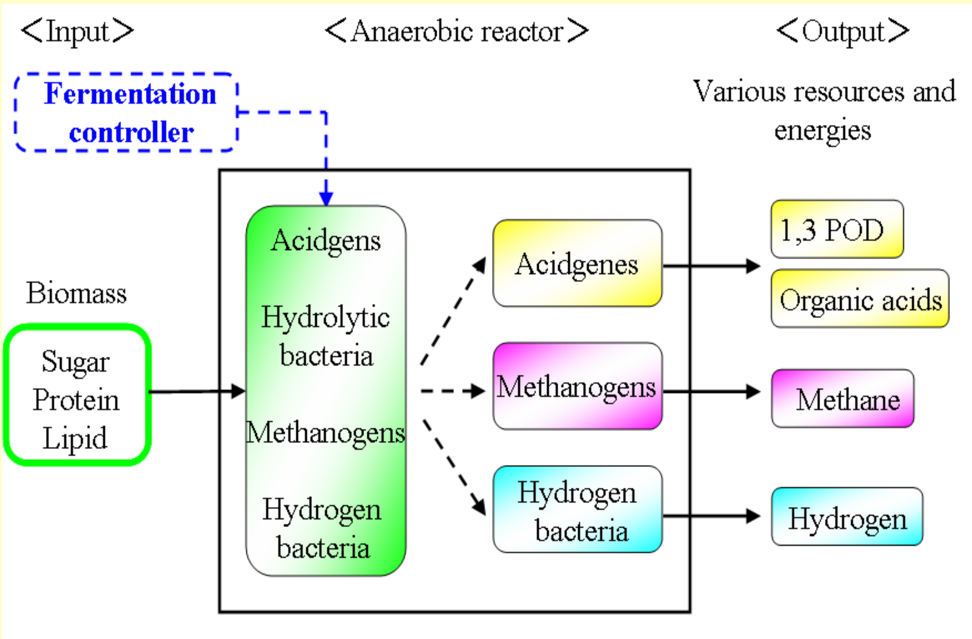


Fig. 3 Novel bioprocess concept. Various resources and energies production.

As shown in Fig. 3, if bacteria are inhibited with adding in small amounts fermentation controller to an anaerobic digestion process, there is a possibility that various resources and energies are obtained. The aim of our study has been the development of hydrogen and methane fermentation bioprocess in one reactor by controlled anaerobic digestion process such as divided acidogen and methanogen. In our research, anaerobic fermentation is carried out using glycerol as a biomass and bacteria or sugars as a fermentation controller.

Cluster Control Engineering Group

Professor : Motoaki ADACHI
Associate Professor : Shigeki TSUKUI
Research Associate : Takuya KINOSHITA

Research Contents

For the syntheses of thin film and nanostructure, the control of clusters has become an important task. A cluster is an aggregate of a countable number of atoms and molecules. The phenomenon whereby molecules and atoms repeatedly collide with each other in the gas phase and liquid phase, and where the cluster grows into nanometer and submicron particles is called nucleation. It becomes possible to synthesize nanoparticles, functional particles and films by the control of the nucleation.

Gas-phase Synthesis of Nanoparticles

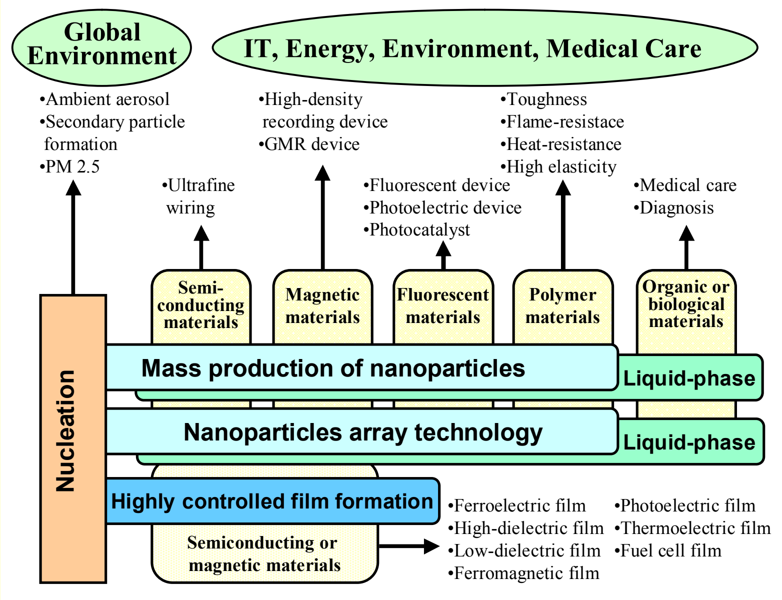
In nanotechnology, it is required that non-agglomerated-nanoparticles of less than 10 nm are synthesized in large quantity and they are aligned. We are attempting to settle this task by giving an electric charge on the particles. The SEM photographs on the right show magnetic nanoparticles synthesized and aligned by the ionization CVD method. Furthermore, we are also attempting to synthesize fluorescent semiconductors nanoparticles, fuel cell materials and catalyst nanoparticles.

Liquid-phase Synthesis of Nanoparticles

We are developing functional nanoparticles with controlled size and structure, which is an advantage characteristic of liquid-phase synthesis, and composite nanoparticles with multiple material phases in one particle. The figure on the right shows composite nanoparticles consisting of gold and magnetic iron oxide, which is intended for applications in medical care and diagnosis.

Multi-Phase Synthesis of Functional Thin Films and Particles

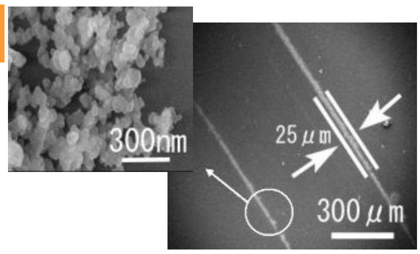
For use in hydrogen based society, functional thin films and particles have been developing by physical or chemical reactions. These targets are follows; (1) Hydrogen generation; electrolysis of water by hollow photocatalysts using visible light or by renewable energy sources as solar cell and thermoelectric devices, which are fabricated by gas-phase or sol-gel methods, (2) Hydrogen use; compact, low temperature and high-efficiency solid oxide fuel cells (see right figure), (3) Hydrogen storage; light and compact hydrogen absorbing alloy.



Research Outline

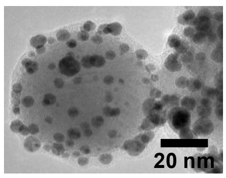
Nanoparticles Array

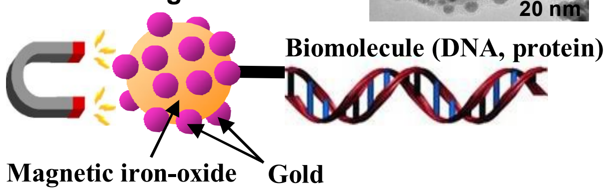
Application in high-density recording media



Nanobio Particle

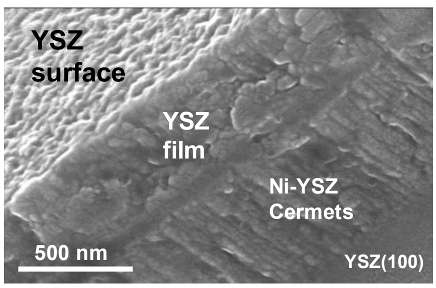
Application in medical care and diagnosis





Fuel Cell Thin Films

Application to compact, lightweight and high-efficiency fuel cells



Resources Engineering Group

Professor : Masashi IWATA

Solid-Liquid Separation (SLS) is a major unit operation that exists in almost every flow scheme related to the chemical process industries, ore beneficiation, pharmaceutics, food or water and waste treatment. It is the most simple and the most energy efficient process among all separation processes. Our research focuses on pretreatment processes for SLS, filtration, mechanical expression, electro-forced separation, and centrifugation.

Pretreatment：flocculation, etc.

Settling or flotation：use of density difference between dispersoid & dispersion medium

Filtration：straining particles through filter media

Dewatering：squeezing solid-liquid mixture by mechanical pressure or electro kinetic force

Centrifugation：separation under centrifugal field

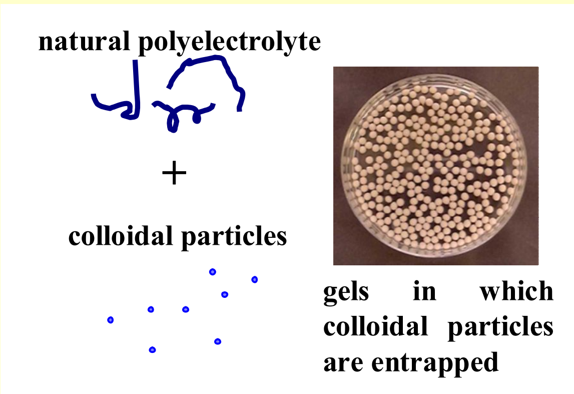
Solid-liquid separation

A novel technique utilizing particle immobilization in gels has been proposed for a pretreatment process of difficult-to-filter colloidal suspensions. A mixture of alginate aqueous solution and colloidal suspension is added dropwise to a calcium chloride aqueous solution, resulting in calcium alginate gels. Colloidal particles are immobilized in the gels. The gel suspension is deliquored gravitationally, followed by mechanical expression of the gel particles. We have investigated fundamental aspects of this technique.

Filtration can be used as a forming method of ceramic green body. We have proposed forming technique of functionally graded material by use of filtration method.

We analyzed mechanical expression under constant pressure, constant rate, and variable pressure-variable rate conditions, for obtaining rational design method of SLS equipment. We have recently reported mechanical expression and centrifugal dewatering of soft material such as hydro gel particles.

We have also elucidated the mechanism of electro-osmotic dewatering (EOD); i.e. EOD is a kind of consolidation process. EOD can be effectively combined with conventional mechanical expression (ME) . EOD-ME combined equipment can be designed well by using our theory. We currently engaged in research for remediation of metal-contaminated soil by use of electro-osmotic flow.



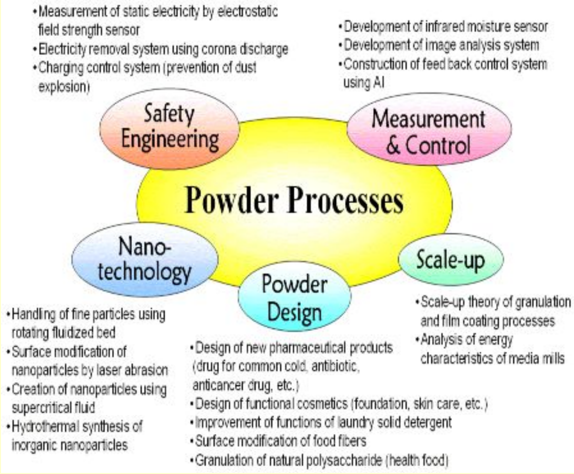
A new technique utilizing particle immobilization in gels , for a solid-liquid separation of difficult-to-filter colloidal suspensions.

Expression-type automatic filter press. (From Kurita Machinery Mfg. Co., Osaka. With permission.)

Process Systems Engineering Group

Professor : Satoru WATANO
Associate Professor : Tomohiro IWASAKI
Research Associate : Hideya NAKAMURA

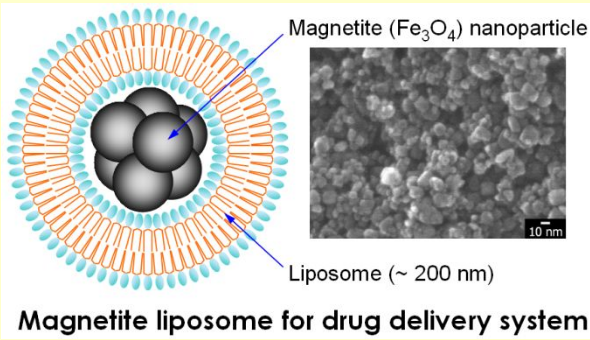
Research Topics



Outline of research objects

Powder is an assembly of small solid particles, which is used in many products such as food, medicine, cosmetics, etc., and is classified as a solid. However, it sometimes behaves more like a gas or liquid, depending on the handling method. Therefore, creation of products using powder is not easy. Recently, in particular, the size of particles used in generation of products have become increasingly smaller, and because of the increased need of products which function and perform at higher levels, it becomes necessary to create new particulate materials by combining different kinds of powders. As a result, the development of powder processing techniques, including the analysis and evaluation, has become very important. Therefore, with the intent of creating functional particulate materials, our research group is engaged in comprehensive research concerning various powder processing ranging from basic to application to practical use taking into perspective various angles and viewpoints. More specifically, one of our principle research objectives is the development of environment-friendly powder processing techniques using nanotechnology. For example, we are conducting the syntheses of nanoparticles using supercritical fluid and hydrothermal reaction field, and the development, scale-up, model analysis and computer simulation of various powder processing for the production of highly functional pharmaceutical products and cosmetics.

Novel nanoparticle fluidization device for granulation and film coating using a centrifugal field



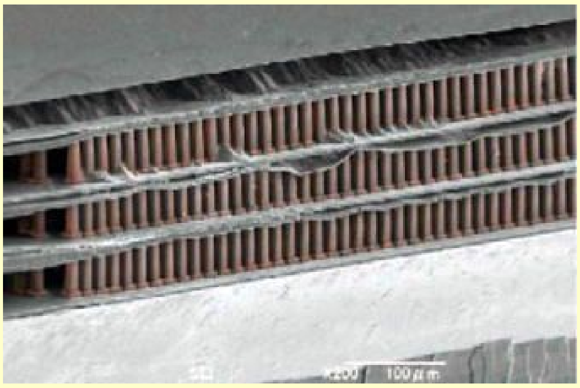
Magnetic nanoparticles-wrapped liposomes (magnetoliposomes) are a promising tool for drug delivery system. Ultrafine magnetite nanoparticles used as the magnetic material can be prepared by a novel low-environmental-impact process we have developed, in which a mechanochemical effect is used.

Materials Process Engineering Group

Professor : Kazuo KONDO
Associate Professor : Takeyasu SAITO
Research Associate : Naoki OKAMOTO

Research Topics

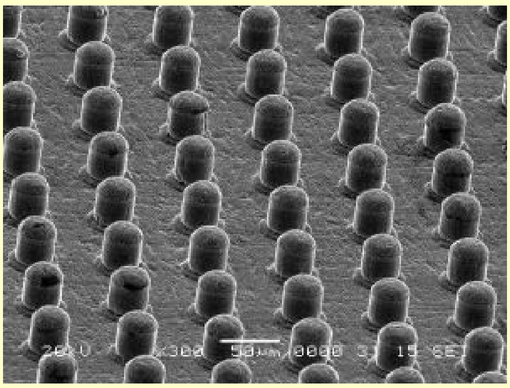
Material processing engineering is a field which specializes in researching manufacturing methods of various useful and functional materials including metals, semiconductors, ceramics. However, in order to use these materials in actual products, it is necessary to effectively manufacture the products so that they have properties suitable for their purposes, such as structure, electric resistance, film thickness, crystal quality. Therefore, of primary importance is considering the most appropriate conditions including temperature, pressure and concentration for each required property.



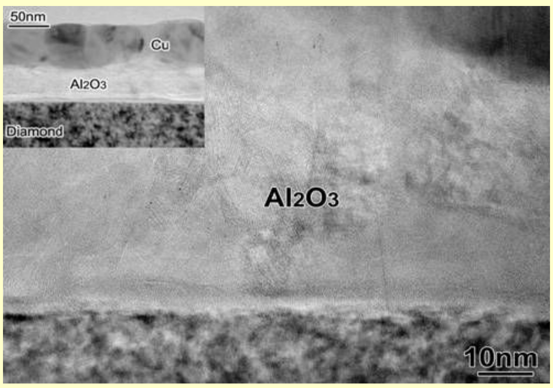
SEM image of through silicon via (TSV) Cu wiring for 3-D package

Many functional materials have been contrived from research based on silicon semiconductors; computer memory and microprocessors are the examples. Furthermore, the size of transistors has become extremely small, and recently the importance of new materials, processes and innovative packing technologies which had never been considered before has been increased. In order for the required function to be realized in extremely precise and complicated shapes, the research of material manufacturing processes based on scientific and engineering knowledge is essential.

Our research group is conducting research concerning "microsize electroplating". This is very important technology in advancing areas of engineering including fine connecting technology for liquid crystal displays, printed circuit boards, high density 3D packaging technology which uses copper through-hole electrodes, low-resistance wiring technology using copper and silver, micro machines. "Electrodeposition" is a method of depositing a solid substance based on electrochemistry, and it can be applied in various ways. Because of its applicability, there is a diversity of potential research surrounding this technology, including materials, manufacturing processes, monitoring methods, reaction engineering, environmental conservation, energy saving. Our research group is also proceeding with research on the processes of manufacturing both wide band gap materials for harsh environment application and ferroelectric materials for nonvolatile memory application.



SEM image of Cu core Pb free solder bump



TEM image of the gate structure of diamond FET

“Science and Engineering for Water-Assisted Evolution of Valuable Resources and Energy from Organic Waste”

The 21st Century COE Program in Osaka Prefecture University

< A World-Class Base for Research and Education >

The 21st Century COE Program in Osaka Prefecture University

The 21st century COE (Center of excellence) Program is a program implemented by the Ministry of Education, Culture, Sports, Science and Technology to “provided focused support for establishing in universities in Japan bases for research and study in various fields of academia, aiming to raise the standards of research to world-class level and to nurture creative human resources that will be able to take the global leads in research. By doing so, the program promotes the creation of universities that are very unique and have the capacity to complete an international level.” In fiscal 2002 (first year of the program), Department of Chemical Engineering in the Graduate School of Engineering of the Osaka Prefecture University submitted an application for a project entitled “Science and Engineering for Water-Assisted Evolution of Valuable Resources and Energy from Organic Wastes”, and this project was adapted by the 21st century COE Program. The project received a grant of ¥610 million in fiscal 2002-2006. The project was headed by Dr. Hiroyuki Yoshida, Professor of the Department of Chemical Engineering, Graduate School of Engineering. 70 to 80 people worked in this immense research team a fiscal year: 24 faculty members in the field of chemical engineering and chemistry, six postdoctoral fellows, five doctoral students, two research assistants and about 40 graduate and fourth-year students.

Sub-Critical Water

We have developed a new research area, “Waste Refinery Engineering”, in which developments of conversion technologies of organic wastes to valuable resources and/or new energy are the most important. We used sub-critical water as the reaction field.

When both the temperature and pressure of water increase, water and steam reach the same density, and a condition is achieved in which it is impossible to differentiate water from steam. The point at which this occurs is the “critical point” (647 K, 22.1 MPa), and if the temperature and pressure exceed this critical point, the water becomes “super critical water”. Super critical water has extremely high oxidizing properties, and much research has been done to find ways to perform oxidation decomposition using super critical water. However, with this method, organic material is broken into carbon dioxide, so it is not possible to convert the waste material into a recyclable material. Prof. Yoshida has focused his attention on sub-critical water, water at a high temperature and pressure that is below the critical point. Prof. Yoshida has found that the use of this type of water makes it possible to perform hydrolysis to easily and quickly break down organic material into peptides, amino acids, organic acids, sugars, etc., converting the wastes into valuable materials. Although sub-critical water is just water, it works as a strong organic solvent. Prof. Yoshida has also clearly demonstrated that sub-critical water can extract 100% of the oil content from organic material almost instantly.

Generating Various Types of Usable Resources and Energy from Organic Wastes by Using Sub-Critical Water Technology

Sub-critical water treatment has generated a variety of new resources. Conversion of fish waste to valuable resources is shown here as an example among our many successful cases. After sub-critical water reaction, fish waste (fish heads, bones, internal organs, scales etc.) was separated into solid (bone) and liquid, and the liquid separated into aqueous solution and oil (Figure 1). The solids included calcium and phosphorous which will be depleted in the near future. Lactic acid is in fierce competition to develop as materials of biodegradable plastics in the world, are extensively produced in the liquid. Other useful organic acids and amino acids were also produced. DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid) can be extracted at a high concentration from the oil, and concurrently, materials which can be used for cooking oil, soap, lubrication oil and biodiesel oil can be obtained.

It has also been possible to obtain methane gas much faster and higher yield than normal methane fermentation, if organic wastes are pretreated with sub-critical water before fermentation. Furthermore, applying this process to the treatment of activated sludge from sewage processed and electric power generation using high yield methane gas will be able to provide 0.45% of the total electric power generation in Japan. The research team is also putting a vast amount of effort into the research of procedures for converting meat and bone meal as well as dead cattle, including material containing abnormal prion, into harmless material and useful resources.

Strengthening Advanced Scientific Research

We established the 21st Century COE analytical center and COE cooperative laboratory, and equipped it with 15 different large analytical instruments. In order to develop practical applications for the results of the fundamental experiments described above, the Osaka Prefecture University constructed a 200 m^2 plant building on the campus. We also constructed a series of plants consisting of a continuous sub-critical water hydrolysis plant (maximum throughput: 4 t/d) based on a completely new idea for the continuous separation and recovery of valuable materials, high-speed and efficient methane fermentation using sub-critical water hydrolysis as a pretreatment, an adsorption storage tank for generated biogas, a gas electric power generator, a Vacuum Swing Adsorption for methane gas purification, a methane gas station for motorcycles, and a motorcycle running system based on bio-methane gas (Figure 2).

With the biogas thus produced, electricity is generated, and after being concentrated and refined, the biogas is used as a fuel for powering a "bio-methane gas motorcycle". This bike runs for 50 km on approximately 2 kg of pomace which is waste generated from the process of bean curd.

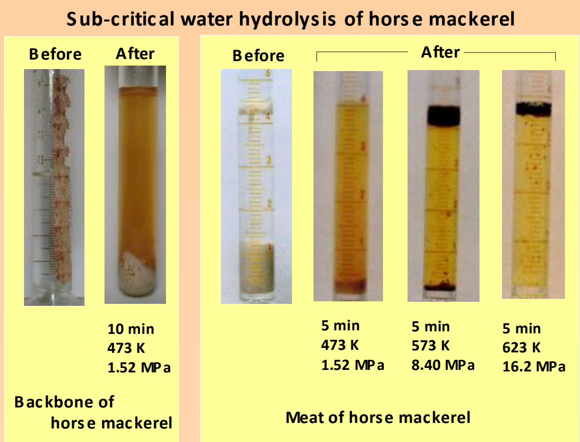


Figure 1

Field-Oriented Education and Research

The practical application of these processes has the inherent features of a new field of science and engineering research. Since the adoption of the 21st Century COE Program in 2002, we have implemented our education and research policy emphasizing the practical applications. We find a germ of science from the field, enhance this germ by engineering, and polish it through a strong partnership among industry, government, and academia. Finally, industry, government, and academia make a collective effort to spread the germ as a practical application worldwide. We believe that the policy will generate next generation of engineering scientists who will develop a new sustainable material and energy system in the world. In order to grow this research and education system more strongly and settle the strongest point in the world, Institute for Material Cycling Engineering was established by the president of our university on December 1, 2006 (Director: Prof. Yoshida).

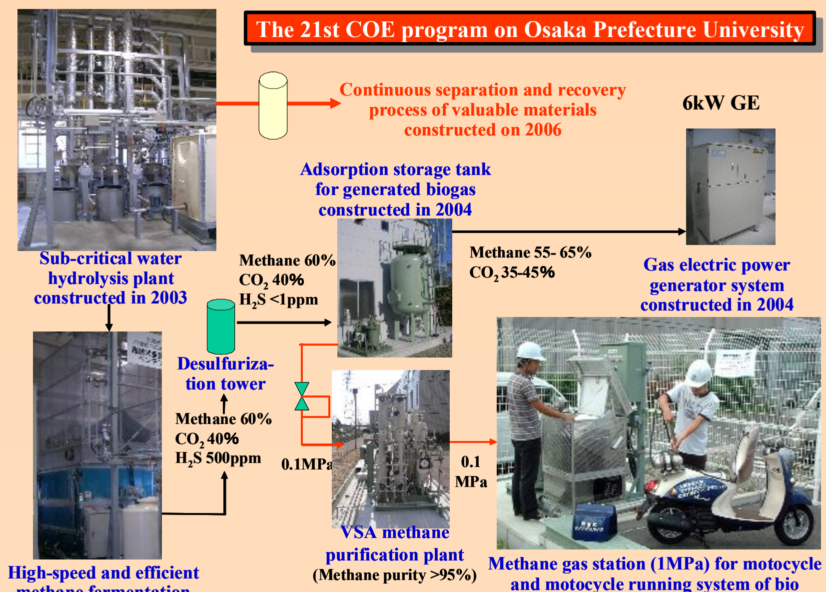


Figure 2

Research Activity

Publication

	2005	2006	2007
Book	10	12	16
Original Paper	31	26	47
Proceedings	67	127	127

Fund

	2005	2006	2007
Fund	¥231,061,000	¥243,969,000	￥82,845,848