Deproteinization and Chemical Modification of Natural Rubber

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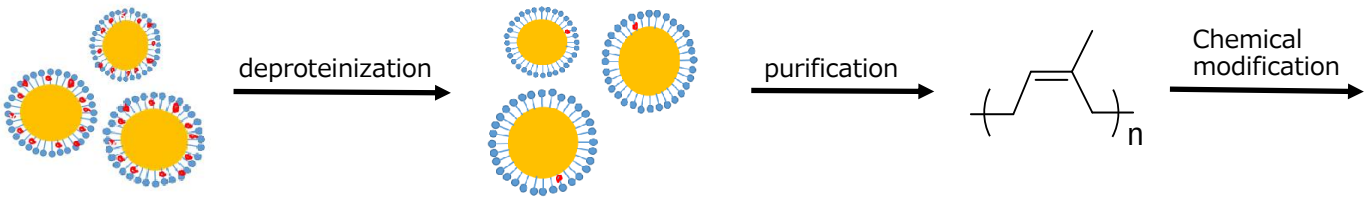
Job Title	Professor	Degree	Ph.D.
Academic Society and Association	American Chemical Society The Chemical Society of Japan The Society of Polymer Science, Japan Japan Research Institute of Material Technology		
Research Keywords	Chemical Modification, Functionalization of Polymeric Materials, Natural Rubber		
Technical Fields and Topics possible for collaboration	・ Deproteinization process of natural rubber ・ Chemical modification of polymers		

Details of the Research Theme

We are focusing on development of deproteinization process of natural rubber (NR) to decrease the allergy concern and chemical modification of NR to obtain the novel functional properties.

Natural rubber (NR) is a highly valuable commercial biopolymer made from *Hevea brasiliensis* latex. It is mostly composed of *cis*-1,4-polyisoprene and trace amounts of non-rubber components, such as proteins, carbohydrates, and lipids. Natural rubber is used and cannot be replaced by synthetic alternatives in various applications including automotive/aircraft tires, medical devices, countless engineering and consumer products. Over the past years, however, concerns over allergic reactions related to some proteins present in natural rubber latex have been publicized.

We collaborate with chemical scientists and engineers in academia and industry to drive these research projects on natural rubber.



(1) **Developing deproteinization process of natural rubber using microfiltration**

Denaturation of natural rubber protein was made by incubation of high ammonium natural rubber latex (HA-NR) with urea in the presence of surfactant. We are interested in microfiltration as a removal process of denatured and water soluble hevein protein from rubber latex other than centrifugal separation.

(2) **Chemical modification of natural rubber**

We are studying the chain end modification of *cis*-1,4-polyisoprene from natural rubber to obtain the unique telechelic polymers.

Synthesis and Characterization of modified Imogolite

Name	OOKAWA Masashi	E-mail	mokawa@numazu-ct.ac.jp
Job Title	Professor	Degree	Doctor of Science
Academic Society and Association	"The Clay Society of Japan", "Society of computer chemistry, JAPAN", The chemical society of JAPAN		
Research Keywords	Imogolite, Nanotubes, Oxidation Catalyst		
Technical Fields and Topics possible for collaboration	▪ analysis using solid state NMR ▪ analysis using FT-IR, XRD and Laser Raman ▪ molecular simulation		

Details of the Research Theme

Application for new oxidation catalyst
Synthesis of new nano-scale materials

Imogolite is a naturally occurring, aluminosilicate clay mineral with typical chemical composition of $(OH)_3Al_2O_3SiOH$. The tubular structure of imogolite proposed by Cradwick et al. is shown in Fig. 1. The tube wall consists of a single continuous gibbsite sheet and orthosilicate anions. The imogolite has an outer diameter of ca. 2 nm and an inner diameter of 1 nm. The FE-SEM image of synthetic imogolite is shown in Fig. 2. The fibrous morphology was observed. Recently we synthesized Fe-containing imogolite using the modified method reported by Suzuki et al.

It was shown that the synthetic material played as catalyst to synthesize phenol from benzene with H_2O_2.

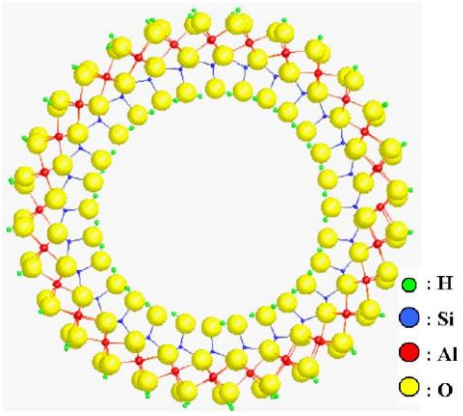


Fig.1 Structure model of Imogolite

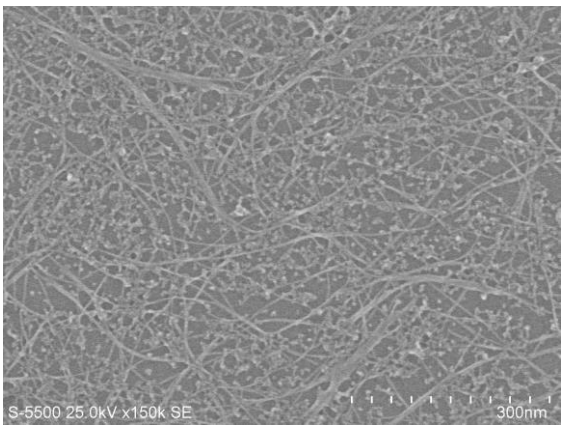


Fig.2 FE-SEM image of synthetic imogolite

Heterogeneous Catalysis for Environmental Conscious Applications

Name	INAZU Koji	**E-mail**	kinazu@numazu-ct.ac.jp
Job Title	Professor	**Degree**	Doctor of Engineering
Academic Society and Association	Chemical Society of Japan, American Chemical Society, Catalysis Society of Japan, the Japan Petroleum Institute, Japan Zeolite Association		
Research Keywords	Heterogeneous catalysis, Supported metal catalyst, Ammonia, Renewable energy, Hydrogen, Abatement of environmental pollutants.		
Technical Fields and Topics possible for collaboration	▪ Chemical conversion of variety of compounds for utilization of energy and for environmental protection.		

Outline of the Research

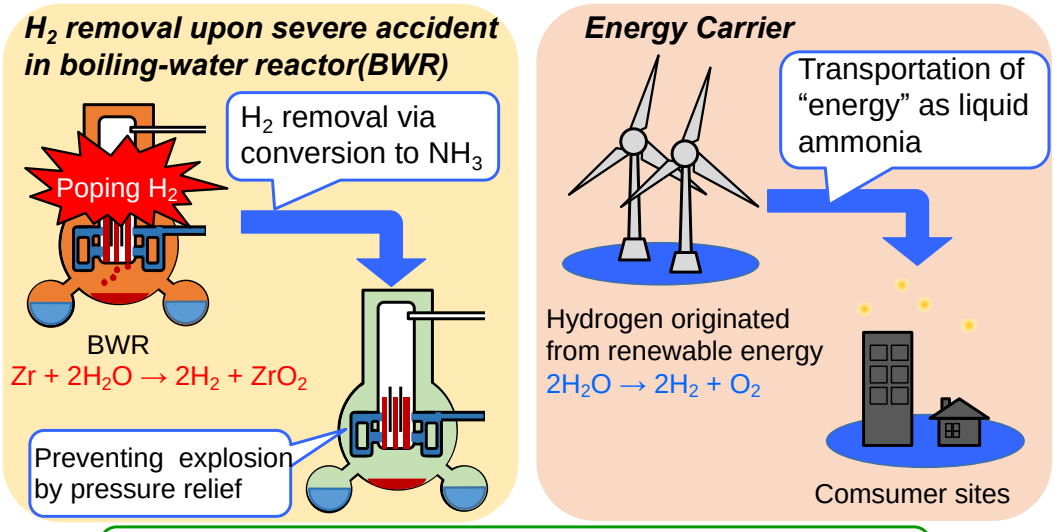
Toward novel heterogeneous reactions at solid-gas and/or solid-liquid interfaces, unique and original solid catalysts have been developed in our research group.

In development of environmental benign processes both in energy utilization and in production/abatement of artificial chemicals, catalysts play a crucial role by serving new reaction pathways with lower activation energy.

In our research group, variety of solid catalysts especially supported metal catalysts are prepared and examined for such processes. Recent activities are of great relation to so-called energy carrier for utilizing renewable energy.

Our current specific target is ammonia, which is well-known fundamental chemicals with huge production mass worldwide, as an energy carrier for renewable energy. Hydrogen can be produced by electrolysis of water powered by solar voltaic or wind power generation. Nitrogen is also able to be obtained by various separation techniques such as cryogenic or membrane ones. Although feeding pressure and rate of such reactants, i.e. H2 and N2, are fluctuating upon a change in the weather, our original ruthenium, iron, and cobalt based catalysts can work even under the conditions drastically different from conventional industrial ammonia synthesis conditions. Moreover, taking such advantages of our catalysts, we have been trying to adopt the catalyst as a key device to prevent the boiling-water nuclear reactors from tragic hydrogen explosion upon such a severe accident caused by hectic earthquake.

$$3H_2 + N_2 \xrightarrow{\text{Catalyst}} 2NH_3$$



Sufficiently Active Catalyst under the conditions drastically different from conventional processes.

Sulfur amino acid metabolism in fish

Name	GOTO Takanobu	E-mail	goto@numazu-ct.ac.jp
Job Title	Professor	Degree	Ph.D in Biochemistry
Academic Society and Association	The Japanese Society of Fisheries Science		
Research Keywords	Fish, Metabolism, Sulfur amino acids, Taurine,		
Technical Fields and Topics possible for collaboration	▪ Enzyme assay ▪ Amino acid analysis ▪ High performance liquid chromatography		

Details of the Research Theme

As demonstrated in previous many reports, some fish, especially marine fish require taurine for its maintenance of normal physiological condition such as prevention of green liver syndrome and best growth performance. However, it is still uncertain that why and how fish produce taurine in its body although the biosynthetic capacities and ways of this amino acid are different among the fish species. Until now, it seems that fresh water fish has higher capacity to produce taurine compared to marine fish and common carp has a peculiar way to biosynthesize this amino acid. Many unsolved questions concerning taurine biosynthesis still have been existed in fish.

In order to answer the questions, we are going to establish suitable methods to measure enzyme activities about sulfur amino acid metabolism including taurine biosynthesis in fish. In mammals, taurine is thought to be produced from cysteine in various ways and organs. Our research data will give an additional information about the metabolic and physiological difference of sulfur amino acids between mammals and fish and these information will be useful in developing new fish feed in future.

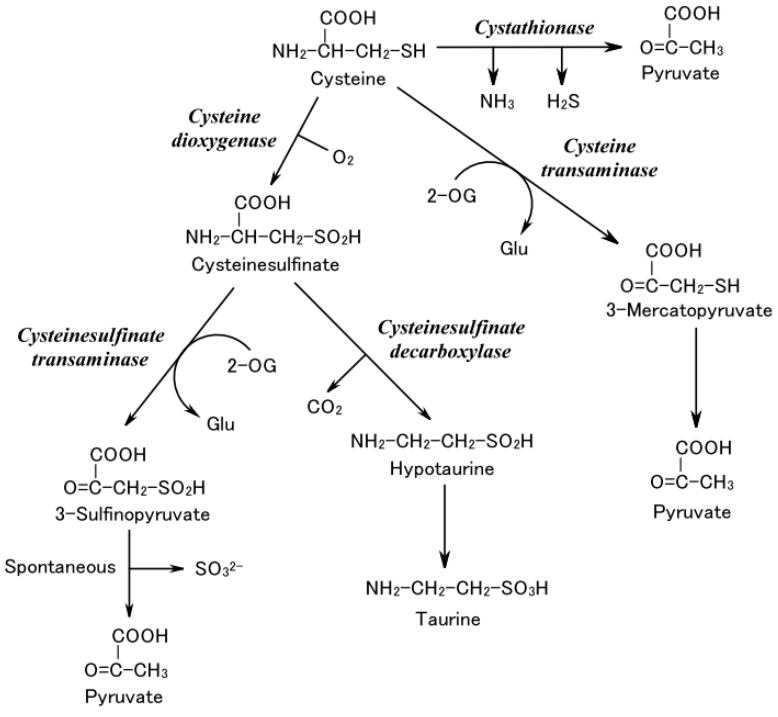


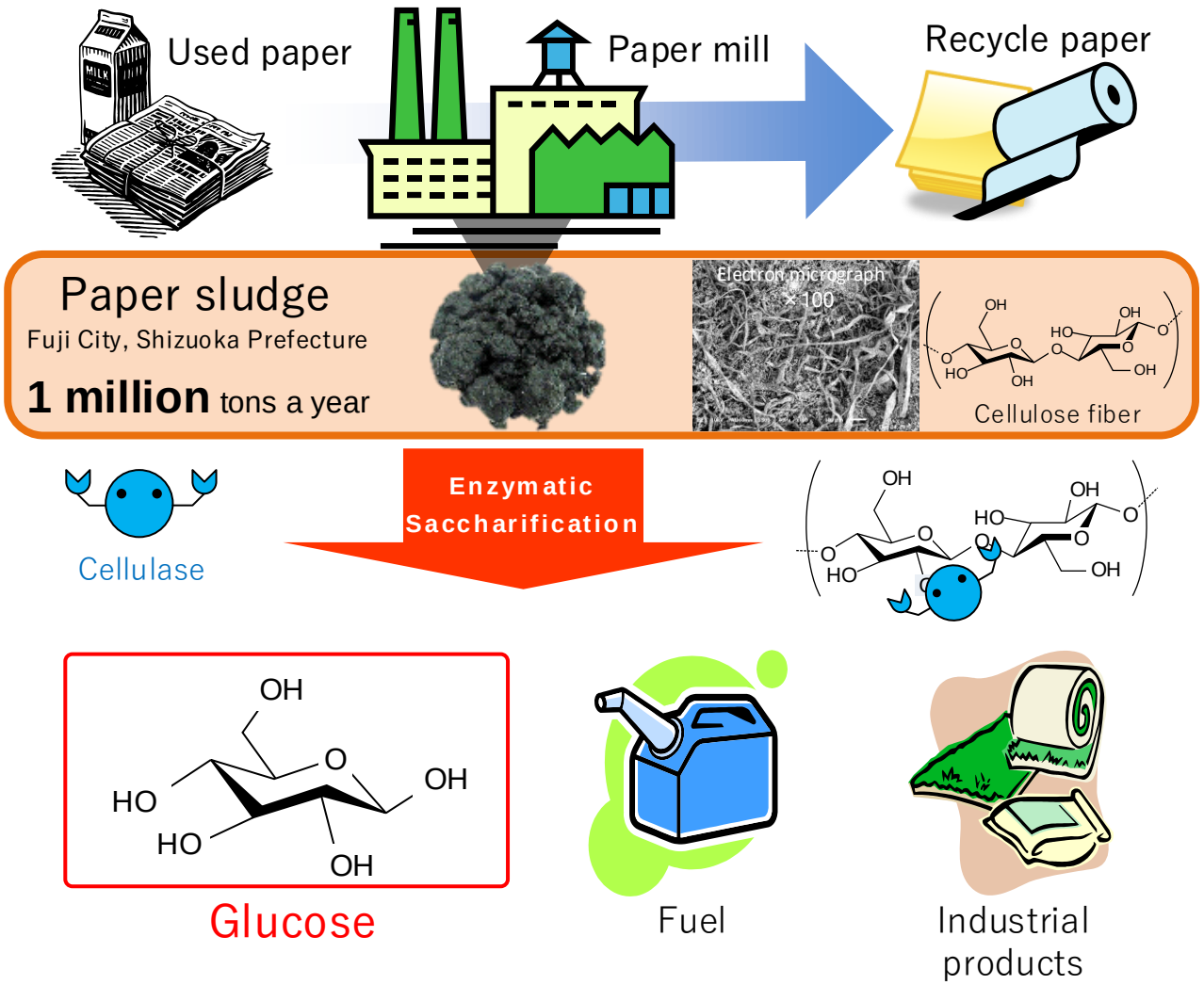
Fig. The pathway of cysteine metabolism in mammals.

Recovery of unused resources from biomass waste and production of useful substances

Name	TAKEGUCHI Masayuki	E-mail	takeguch@numazu-ct.ac.jp
Job Title	Professor	Degree	Doctor (Engineering)
Academic Society and Association	The Society of Chemical Engineers, Japan, The Chemical Society of Japan, The Society for Biotechnology, Japan		
Research Keywords	Biomass, Social circulating system, Environmentally conscious technology, Wastewater treatment technology		
Technical Fields and Topics possible for collaboration	▪ Technology to recover unused resources from biomass waste ▪ Production of useful substances from biomass waste using microorganisms ▪ Zero-emission technologies for establishment of recycling-oriented society ▪ Substance production using microorganisms from biogas (methane)		

Details of the Research Theme

Our laboratory is developing technology to recover unused resources from biomass waste (such as proteins, sugars, methane, etc.) discharged from the industrial and agricultural fields, and to convert them into useful substances. As an example, technology for recovering glucose resources from paper waste which is shown below.



Development of Health Beneficial Foods

Name	YOSHINO Kyoji	E-mail	k-yoshino@numazu-ct.ac.jp
Job Title	Professor	Degree	Doctor of Pharmacy
Academic Society and Association	Society for free radical research JAPAN, The Pharmaceutical Society of Japan, etc.		
Research Keywords	Food, Nutrition, Antioxidant, Lifestyle disease, Immunology		
Technical Fields and Topics possible for collaboration	・Evaluation of health beneficial effects, such as antioxidant activity and prevention activity on Lifestyle diseases, of foods by in vitro and in vivo experimental methods ・Analysis of active components including polyphenols in health beneficial foods.		

Details of the Research Theme

Mainly, we evaluate the health beneficial functions of food ingredients. We also receive requests for surveys on specific ingredients or functions.

Recently, increases in the incidence of lifestyle diseases such as diabetes and allergies are social problems. To prevent these diseases by using the foods we ordinary ingest, we have evaluated the health beneficial effects of some food ingredients by in vitro and in vivo experimental methods. Currently, we are investigating some food materials that could suppress oxidative stress, inflammations, and excessive intakes of sugar and lipids. Unlike the development of pharmaceuticals, in the case of functional foods, it is thought to be desirable for us that many foods showing the same health beneficial effects are found, because our dietary life will be enriched by the variation of available foods. Therefore, we are conducting research with the goal of finding more food ingredients with similar health beneficial effects.

The image of health beneficial foods and the active components

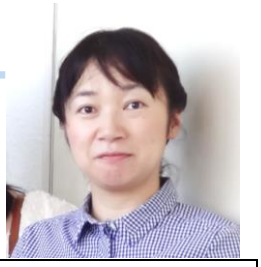
Functions of foods (more functional foods, more desirable)

1st function : Nutrition for life support
2nd function : Senses such as taste and fragrance
3rd function : Regulation of physiological functions

⇩ Functional foods

- Physical rhythm adjustment : nerves, digestive tract, etc.
- Biological defense : immunity, allergies, etc.
- Disease prevention : diabetes, hypertension, tumor, etc.
- Disease recovery
- Aging prevention : oxidative stress, inflammation, etc.
- ・
- ・

Plant breeding science and cytogenetics



Name	Furukawa Kazumi	E-mail	furukawa@numazu-ct.ac.jp
Job Title	Associate professor	Degree	Ph.D. Arg.
Academic Society and Association	Society of plant breeding,, Chromosome science		
Research Keywords	Plant cell、tissue and organ culture, Chromosome analysis, Transformation		
Technical Fields and Topics possible for collaboration	・ Somatic embryogenesis induction in tea plant ・ Chromosome analysis by Fluorescent in situ hybridization ・ Transformation by Agrobacterium-mediated transformation or bombardment transformation		

Details of the Research Theme

Tea plant breeding for sustainable agriculture and human life

The tea plant (*Camellia sinensis*) has unique functional components such as caffeine, catechin, theanine and so on in the leaves. Green tea is an important part of the Japanese cuisine. Japanese cuisine has been listed to the world intangible cultural heritage. And then our aim of research is to produce new tea cultivar.

Thus it is necessary the transformation technique as tools for understanding metabolic pathway. And in vitro culture technique is essential for transformation.

Our research themes are like below.

(1) Genetic transformation technique of tea plant

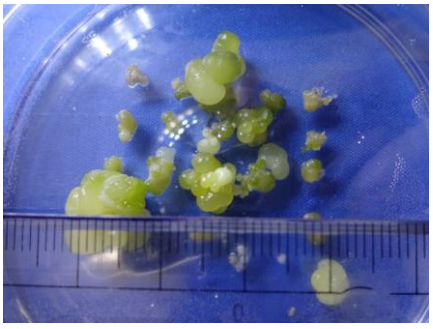
We have been experimenting with which of the two experimental systems is suitable for tea.

・Agrobacterium-mediated transformation system

・Particle bombardment system

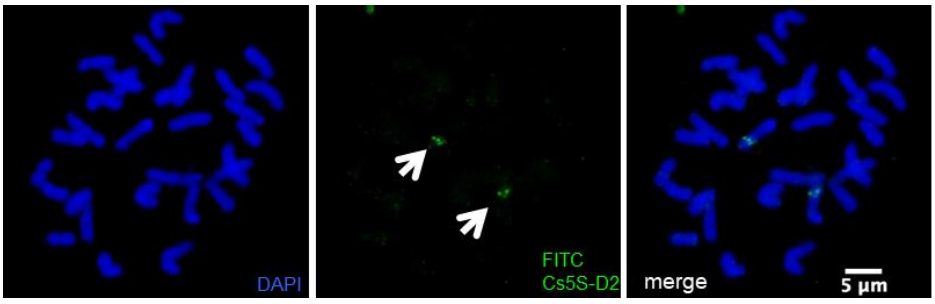
(2) in vitro tissue or organ culture

As the transformation materials, somatic embryos have been induced via cotyledon culture.



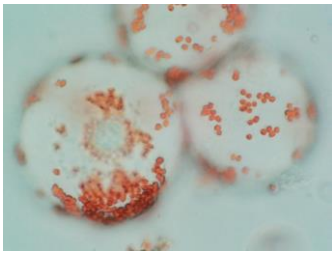
(3) Chromosome analysis using fluorescence in situ hybridization

After transformation, foreign gene locus should be detected on the chromosome. Thus each chromosome identification has been examined using fluorescence probes.



(Optional) Produce science education material

Plant material is good for education. We have been produced science education materials and programs. For example, program of protoplasts isolation from vegetables and observation for junior high school students.



Study on shaft rotation and ion transport of ATP synthase

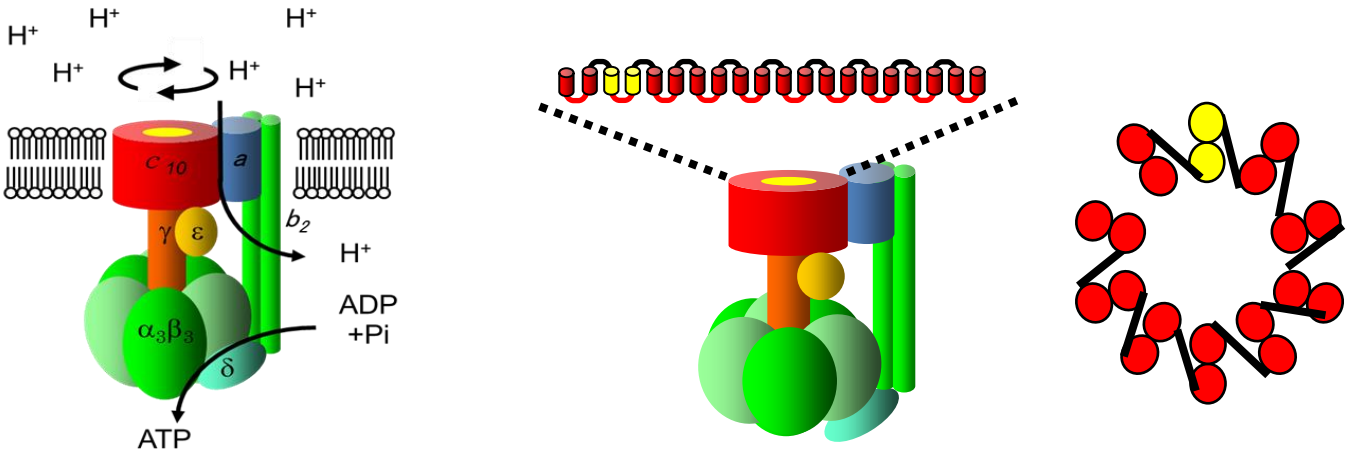
Name	MITOME Noriyo	E-mail	mitome@numazu-ct.ac.jp
Job Title	Associate Professor	Degree	Ph.D., Science, P.E. Jp
Academic Society and Association	Japanese Biochemical Society, The biophysical society of Japan, The Institution of Professional Engineers, Japan		
Research Keywords	ATP synthase, fish vaccine, Volvox		
Technical Fields and Topics possible for collaboration	▪ Purification and analysis of membrane protein ▪ Biochemical analysis of protein ▪ Genetic engineering		

Details of the Research Theme

Purification and analysis of membrane protein, such as ATP synthase using biochemical technique and genetic engineering.

I am studying protein functions using biochemical and genetic engineering techniques. We have been studying the functions of ATP synthase, using genetic recombination technology and biochemical techniques. I am a Professional Engineer in Japan (biological engineering) and can cooperate in fields such as expression of various proteins using genetic engineering, development of purification methods, measurement of enzyme activity, and chemical modification of proteins.

ATP synthase, which is the main research target, is an important enzyme that exists widely from bacteria to mitochondria of eukaryotic cells and chloroplasts of plants and is widely involved in the synthesis of ATP. This enzyme is known to be a rotating molecular motor that synthesizes ATP by rotating the shaft by the energy of the flow of proton. The rotating shaft of ATP synthase is formed from several proton-binding proteins. I succeeded in producing an active ATP synthase which has 10 proton-binding proteins as a rotating shaft.



ATP synthesis

Synthesis of Particles and Organic–Inorganic Hybrids based on Natural Polysaccharide

Name	YAMANE Setsuko	E-mail	syamane@numazu-ct.ac.jp
Job Title	Associate Professor	Degree	Ph.D
Academic Society and Association	The Society of Polymer Science, The Chemical Society of Japan, Japanese Society for Biomaterials		
Research Keywords	Organic–Inorganic Hybrid, Hyaluronic Acid, Calcium Phosphate		
Technical Fields and Topics possible for collaboration	▪ Chemical modification of natural polysaccharide ▪ Measurement of submicron size colloid particles ▪ Measurement of molecular weight of natural polysaccharide		

Details of the Research Theme

Chemical modification of hyaluronic acid with small amounts of hydrophobic groups such as cholesteryl groups and alkyl groups forms colloidally stable particles in water.

The hydrophobized hyaluronic acid particles can trap proteins and release them easily, therefore the hydrophobic hyaluronic acid particles would be used to protein carrier.

Cholesterol-bearing hyaluronic acid (CHA) is an hydrophobized polysaccharide forms hydrogel particles 100-200 nm in diameter in water. CHA particles can trap proteins through hydrophobic interactions and release them in an active state by the exchange reaction with other proteins. In this research, we approach the functionalization of CHA particles for application of protein carrier.

(1) We synthesize protein carrier by organic-inorganic hybrid method using CHA particle as organic material and calcium phosphate (CaP) as inorganic material. Mineralization of CaP as hard material against CHA particles would be prevents the burst release of proteins.

(2) We control the size of CHA particles according to molecular weight of hyaluronic acid or degree of substitution of cholesteryl groups.

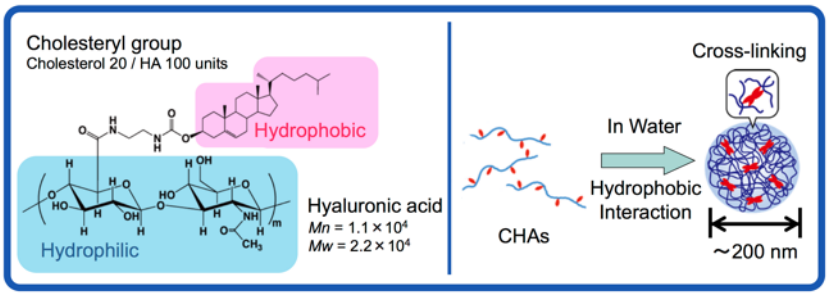


Figure1. Schematic diagram of CHA particle

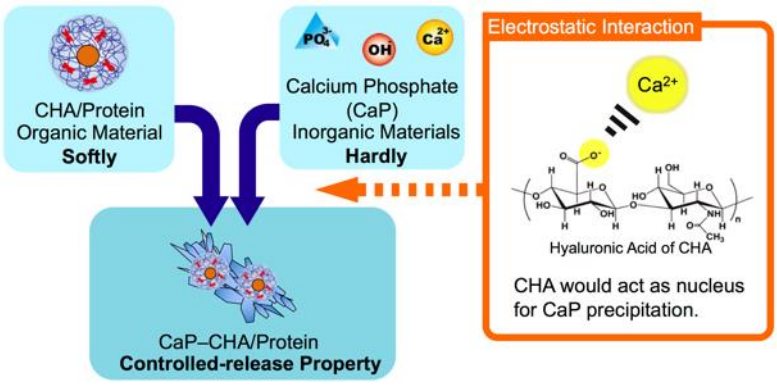


Figure2. CHA-Calcium phosphate hybrid particle for protein carrier

Analytical Application of Near-IR Absorbing Metal Complexes

Name	WARASHINA, Tomoyuki	E-mail	wara@numazu-ct.ac.jp
Job Title	Associate Professor	Degree	Doctor of Engineering
Academic Society and Association	The Chemical Society of Japan, The Japan Society for Analytical Chemistry		
Research Keywords	Metal Complex・Ligand, Near-IR Absorption, Spectroscopy		
Technical Fields and Topics possible for collaboration	・ Investigation of absorption and luminescence of materials (in solutions) ・ Analysis with TOF-MS		

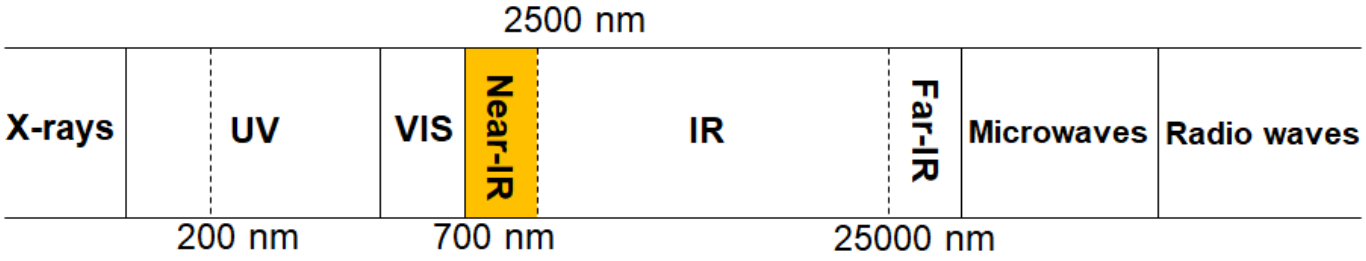
Details of the Research Theme

Synthesis of Near-IR Absorbing Metal Complexes and Study for Analytical Application

Selling Point: Synthesis of Near-IR Absorbing Metal Complexes (λ_{max} 700～900 nm, ε 10^4～10^5)

In near-infrared (Near-IR) region (700～1200 nm), there are only weak overtone and combination bands arising from stretching and bending vibrations of the chemical bondings, such as -OH, -NH, and -CH. In view of analytical chemistry, this very low background absorption level thus with the excellently transparent nature is significantly fascinating, so that Near-IR spectroscopy in biological imaging makes possible nondestructive and noninvasive analyses *in situ*, *in vivo*, and on-line.

We have investigated spectroscopic properties of Near-IR absorbing d^8-transition metal complexes with aromatic *o*-diamines. We aim for the application of these metal complexes to industrial and medical fields, e.g., labeling reagent for target materials and photosensitizer of photodynamic therapy for tumor cells.



Available Equipment and Apparatus

V-670 UV-Visible/NIR Spectrophotometer (Jasco. Co,), F-4010 Fluorescence Spectrophotometer (Hitachi Co.),

MM-60R Multi-Function Water Quality Meter (DKK-TOA Co.), HM-25G pH Meter (DKK-TOA Co.),

JMS-T100LP Accu TOF LC-Plus Atmospheric Pressure Ionization High Resolution Time-of-Flight Mass Spectrometer (JEOL Ltd.)

HAB-151 Potentiostat Galvanostat (KOKUTO DENKO Co.)

Fabrication and Evaluation of Solution-Derived Ceramic Materials and Thin Films

Name	ARAI Takashi	E-mail	arai.takashi@numazu-ct.ac.jp
Job Title	Assistant Professor	Degree	Ph.D. in Engineering
Academic Society and Association	The Ceramic Society of Japan		
Research Keywords	Ceramics, Thin film, Chemical solution deposition,		
Technical Fields and Topics possible for collaboration	▪ Synthesis of ceramic materials and thin films by solution technique ▪ Evaluation of crystal structure, surface morphology and elemental analysis		

Details of the Research Theme

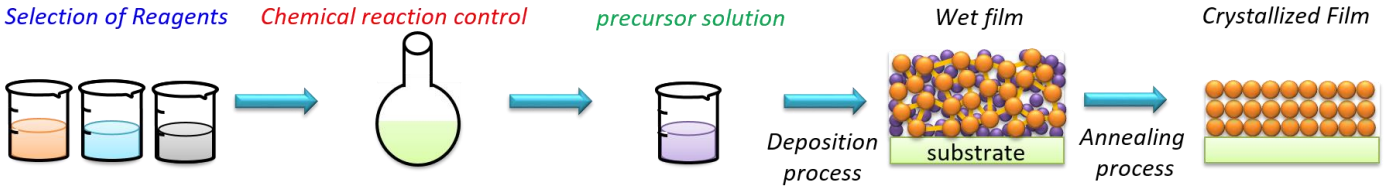
In the solution method, which is a relatively inexpensive ceramics synthesis method, the synthesis process affects the properties of fabricated materials. It is possible to propose a synthesis process and an evaluation method that matches the characteristics of products.

The advantages and preparation flow of the chemical solution deposition method, which is actively used for the synthesis of ceramics and thin films.

Advantages of chemical solution deposition

- Low temperature synthesis compared to solid phase method
- Design of chemical bonding at the molecular/atomic level in solution
- No need for large equipment = cost effective method for the industrial application
- Morphology control suitable for the devices

Flow in the chemical solution deposition



In our study, by using chemical solution deposition technique, morphology, structure, composition and stress are controlled for a fabrication of ceramics or thin films with desired characteristics. The main aim in our laboratory is the fabrication of piezoelectric ceramics thin films with high properties.

Our laboratory has also analysis technology to evaluate crystal structure, surface morphology and elemental mapping by using X-ray diffraction, atomic force microscopy and scanning electron microscopy.

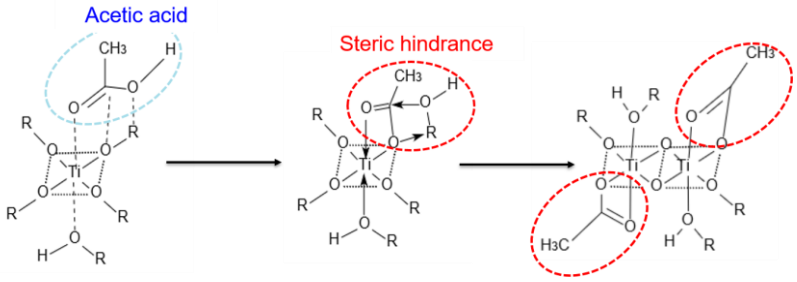


Fig.1. Chemical reaction control

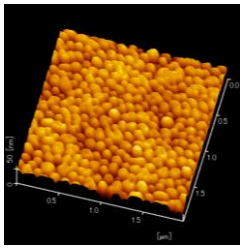


Fig.2 Surface morphology of a film prepared by chemical reaction control

Energy Conversion from Organic Waste and Unused Hydrocarbon Resources by Thermochemical Processing

Name	ITO Takuya	E-mail	t.ito@numazu-ct.ac.jp
Job Title	Assistant Professor	Degree	Ph. D. in Engineering
Academic Society and Association	The Japan Institute of Energy. The Society of Chemical Engineers, Japan. The Chemical society of Japan. Japan Society of Material Cycles and Waste Management		
Research Keywords	Renewable energy, Biomass, BDF, Waste plastic, Liquefaction, Gasification		

Details of the Research Theme

Conversion of various wastes and unused resources to various types of energy (liquid and gas fuels, hydrogen, electricity, etc.)

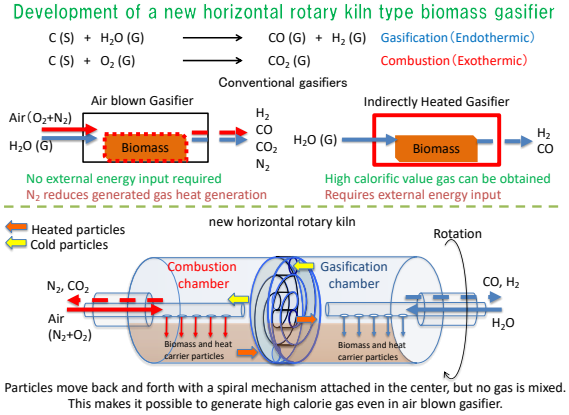
We establish local energy production system for local consumption by designing a small but efficient energy conversion process.

Wastes are inevitably generated in any industry, greater or lesser. It is necessary to use these wastes effectively from the viewpoint of energy security, especially in our country whit poor energy resources. Among them, biogenous wastes such as waste wood, waste cooking oil, agricultural residues, sewage sludge are called biomass and they do not increase atmospheric CO_2 concentration by their combustion because CO2 emitted originally came from present atmosphere (called carbon neutral). On the other hand, waste plastics have a problem of securing landfill sites, and their effective use is required.

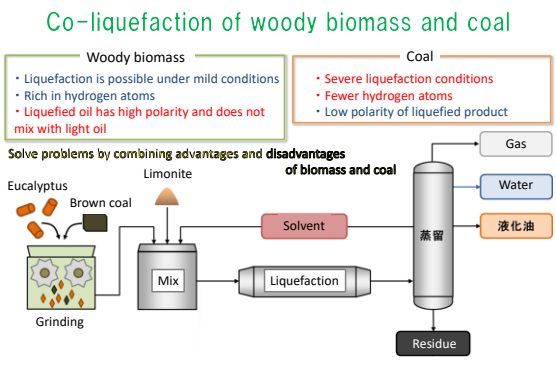
If these wastes are to be used effectively, the collection cost will be a major issue because they are widely dispersed and discharged. Therefore, our laboratory aims to develop a small-scale and efficient energy conversion process which makes it possible to produce necessary energy at the place where waste is discharged with reduced collection cost. So far, we have conducted the following research through actual industry-government-academia collaboration.

- Production of light oil alternative from woody biomass and plastics in municipal waste (NEDO, contracted with companies)
- Development of biodiesel production process from animal oil-and-fats with ill low-temperature properties (joint research with companies)
- Development of highly-efficient hydrogen production process from sewage sludge (Ministry of Land, Infrastructure, Transport and Tourism, contracted with companies)
- Development of fluidized bed materials for fluidized bed combustion/ gasification of biomass containing high potassium (Joint research with companies)

The following are some of the ongoing research themes.



Particles move back and forth with a spiral mechanism attached in the center, but no gas is mixed. This makes it possible to generate high calorie gas even in air blown gasifier.



Produce alternative fuel to petroleum by co-liquefying eucalyptus planted in Australia and Cheap brown coal from Australia