●Basic Stage

Nanotech Materials

(Fiscal Year 2004-2006)

Central Iwate-Kamaishi Area

Development of "New" Ni-Free Co-Cr-Mo Alloys with Enhanced Functionality and High Biocompatibility to be Applied in Medical Devices

Center for Regional Collaboration in Research and Education, Iwate University
3-18-8 Ueda, Morioka City, Iwate 020-8550 JAPAN
TEL: +81-19-621-6006

Core Research Organization

Iwate University

Major Participating Research Organizations

Industry···Nittetsu Fine Products Co., Ltd., Dowa Forging Co., Ltd., MIKUNI CORP., and others
Academia···Iwate University, Iwate Medical University, Tokyo Medical and Dental University, and others
Government···Iwate Institute Research Center, National Institute for Material Science,
Kamaishi Otsuchi Industrial Research Development and Training Center, and others

Main Results of City Area Program

1) Fabrication of artificial hip joint made of Ni-free Co-Cr-Mo alloys via net-shaped closed-die forging technique

Figure 1 shows a vacuum induction melting furnace capable of producing 30 kg ingots. We established a technique of making Co-Cr-Mo alloy ingots using the melting furnace. We developed fine-grained Co-Cr-Mo alloys by hot-forging processes, and compiled a processing map for Ni-free Co-Cr-Mo alloys. We also investigated the optimization of hot-forging processing. Based on these processes, we established an FEM simulation method to fabricate an artificial hip joint by hot forging (Fig. 2). As a result, we successfully produced a half-size model of an artificial hip joint made of Ni-free Co-Cr-Mo alloy, and established the methodology required to fabricate artificial hip joints using FEM simulations that incorporate the detailed high-temperature deformation behavior of Co-Cr-Mo alloys (Fig. 3).

Figure 1 (a) Vacuum melting furnace in the Kamaishi Area

Figure 1 (b) Co-Cr-Mo alloys produced using the vacuum melting furnace

Figure 2 Results of an FEM simulation of the fabrication of an artificial hip joint via hot forming

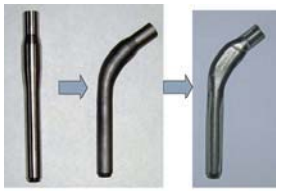


Figure 3 Artificial hip joint made of Ni-free Co-Cr-Mo alloys following the net-shaped closed-die forming technique

2) R&D for Ni-free Co-Cr-Mo alloys with high strength and ductility, and high bio- and MRI-compatibility

We discovered that suppression of the release of Ni ions from the surface of Co-Cr-Mo alloy containing a small amount of Ni occurs via the addition of minor Ti, Nb, and Zr, which shows no toxicity. Furthermore, the addition of a small amount of Zr reduces the cell toxicity of Co-Cr-Mo alloys. The addition of Fe to the alloys acts to increase the compatibility with Osteoblast cells.

The magnetization of Co-Cr-Mo alloys decreases with increasing Cr content to 26 mass%, and changes the magnetic properties from ferromagnetism to paramagnetism. Moreover, we found that the magnetization is further reduced with heat treatment.

Figure 4 shows stress–strain curves for Co-Cr-Mo alloy enriched with Cr and N. The developed alloys show excellent strength and ductility compared with conventional Co-Cr-Mo alloys.

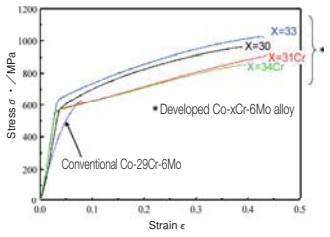


Figure 4 Stress–strain curves for Co-Cr-Mo alloy enriched in Cr and N

Approaches after Completion of Project

In the Advanced Stage, we will continue with the project that aims to establish the business, with the following research topics.

[Research and development of high-value-added Cobalt-based alloy from Iwate, Japan]

We aim to further develop the results obtained in the Basic Stage to enable the industrial application of the alloys, conducting cooperative industry-academia-government research to satisfy the specific needs of industry. The main projects are as follows.

1. R&D for promoting the commercialization of biomedical Co-Cr-Mo alloys

We will undertake R&D into the fabrication technology required to use Co-based alloys as biomaterials. We also aim to develop Ni-free Co alloys and Co alloys with reduced magnetization, suitable in avoiding metal-induced MRI artifacts.

2. Development of Co-Cr-Mo alloys for industrial use

We intend to apply Co-Cr-Mo alloys to other biomaterial applications by considering the various properties of the developed alloys. We will seek to make use of the alloys in cooperation with relevant industries.

3. R&D for recycling techniques of Co-based alloys

In this project, we focus on research and development in three main areas: 1. the supply of scrap Co-based alloys, 2. recycling technology, and 3. the cost of recycling, with the aim of developing recycling techniques for Co-based alloys from used products, as it is necessary to ensure the stable supply of Co, Cr, and Mo as raw materials.

●Basic Stage

Others

(Fiscal Year 2004-2006)

Nagaoka Area

Enhancement of an Advanced Material and Development of Green Processing Technology

Niigata Industrial Creation Organization
Bandaijima Building 10F, 5-1 Bandaijima, Chuo-ku, Niigata City, Niigata 950-0078 JAPAN
TEL: +81-25-246-0068

Core Research Organization
Nagaoka University of Technology

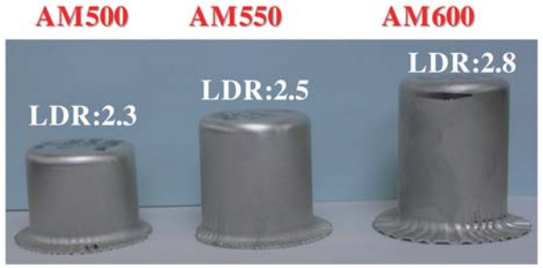
Major Participating Research Organizations
Industry···Tsubamex Co., Ltd., Toyo Rikagaku Kenkyusho Co., Ltd., Nakano&Co. Labs, and others
Academia···Nagaoka University of Technology, Niigata Institute of Technology, Nagaoka National College of Technology, and others
Government···Industrial Research Institute of Niigata Prefecture, National Institute for Material Science

Main Results of City Area Program

1. We succeeded in the development of a high-strength and high-ductility magnesium alloy

Various alloy components were examined in a trial manufacturing process, and a Mg-5.5mass%Al-0.15%Mn additive alloy was developed. Against the target value of tensile strength multiplied by the value of ductility for 7500 MPa, this alloy has achieved the target value as 295 MPa for tensile strength, 26% for extension and 7970Mpa for the value which the tensile strength multiplied by ductility.

Properties of high strength and high ductility were demonstrated, enabling the press-forming of existing aluminum-alloy-and-carbon steel at 200℃or less.



Press-forming Parts Using the Developed Material

2. We succeeded in developing a high-efficiency whetstone for low-fixed-pressure grinding

The use of the new whetstone enabled the efficient lamina processing of a hard material such as ceramic from a soft material such as magnesium. The whetstone can be used to accurately and efficiently process various materials used in IT equipment.


Honeycomb-type Diamond Grinding Whetstone

Approaches after Completion of Project

1. The new processing technology will be important for the precision processing industry

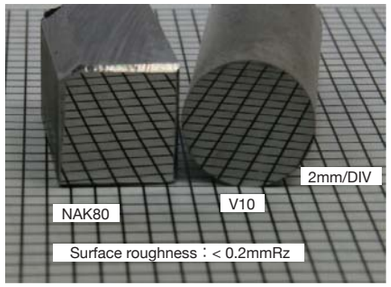
An extremely accurate supersonic wave spindle was jointly developed with a related company. We developed supersonic wave-processing technology as part of the development theme “Development of Monitor-Invoking-Type Highly Accurate Metal-Mold Processing.”

This product greatly improves the processing-side accuracy of supersonic machining due to its rigidity and accuracy. Following a processing evaluation, the product will be commercialized. There exists increasing demand from IT-related companies for highly accurate processing of unworkable metallic materials.

A low-fixed-pressure mechanism grinder demonstrated the performance of the honeycomb-type diamond grinding whetstone developed as part of the development theme “High Speed, Highly Accurate Grinding, and Surface Function of the Magnesium Alloy” in conjunction with a related company.

Preventing the cut powder from clogging and efficient cooling were achieved by supplying cooling water, making use of the porous structure of the developed whetstone. As a result, vastly improved grinding was achieved at low fixed pressure.

We will first develop a hard, fragile material, followed by a soft material and a hybrid material of the two. This machine demonstrates high performance in the processing of these exotic materials.



Surface grinding by extremely accurate supersonic wave spindle


Low-fixed-pressure mechanism grinder

●Basic Stage

Life Sciences

(Fiscal Year 2004-2006)

Foot of Mt. Fuji Area

Development of equipment and agents for cancer diagnosis by genomics and proteomics

Shizuoka Organization for Creation of Industries - Pharma Valley Center
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TEL: +81-55-980-6333

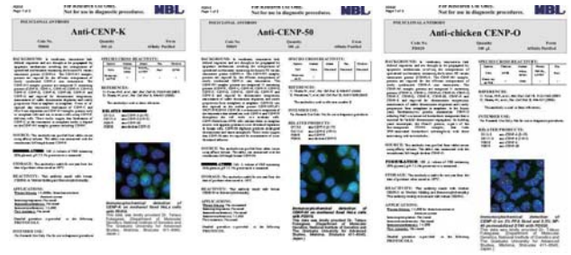
Core Research Organizations
National Institute of Genetics, Shizuoka Cancer Center,
Numazu National College of Technology, Tokai University

Major Participating Research Organizations
Industry···KYOWA MEDEX Co., Ltd., BL Co., Ltd., Yanaihara Institute Inc., ABLE Corporation, Effector Cell Institute, Inc., International Bio-Informatics Co., Ltd
Academia···National Institute of Genetics, Numazu National College of Technology, Tokai University School of High-Technology for Human Welfare
Government···Shizuoka Cancer Center, Numazu Technical Support Center of Industrial Research Institute of Shizuoka Prefecture,
Fuji Technical Support Center of Industrial Research Institute of Shizuoka Prefecture

Main Results of City Area Program

1. Development of three types of antibodies

Cancer has negative effects on chromosomal division.
We are investigating the development of drugs for diagnosis and treatment by targeting the proteins localized in the centromers region of chromosomes. Based on the release (in fiscal year 2007, by MBL Co., Ltd.) of three types of antibodies (“anti-centromers proteins”), there are high expectations to develop a diagnosis-enabling drug.



Antibodies: CENP-K, CENP-50, CENP-O

2. Product launch: Adenovirus Diagnosis Kit

The City Area Program saw the development of a prototype of a highly sensitive immunochromatography method based on nanoparticles of platinum and gold colloids. The Adenovirus Diagnosis Kit was launched in June of fiscal year 2008. The high sensitivity enables the rapid diagnosis of pharyngoconjunctival fever caused by viruses (Tauns Inc., Ltd., Head Office: Numazuru City, Shizuoka Prefecture).

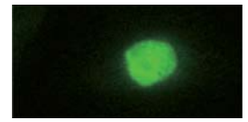

Adenovirus Diagnosis Kit

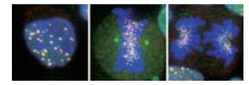
Approaches after Completion of Project

1. Development of a basic technology for cancer diagnosis by genomics

Progress has been made in the early diagnosis of cancer and medical treatment. Ongoing research is focusing on the development of products based on the prototype made from three antibodies based on anti-chromosomal centromer proteins.

Clinical tests are underway to assess the stability and utility of the visualization reagent Psoralen, used for the first time as a photoactive probe of DNA structure.

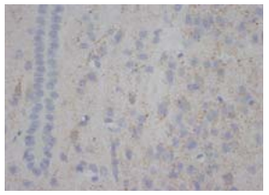

Psoralen signal


New intracellular protein structure of centromers

2. Research into tumor markers based on proteomics and development of a cancer-diagnosis system

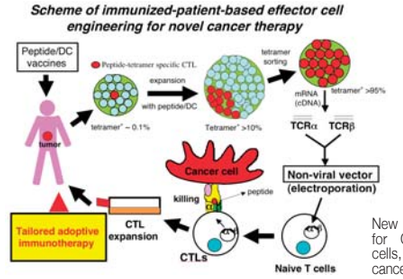
Development and production of new tumor-diagnosis systems and medical treatment

Development of specific antibodies of lung-cancer proteins: validation by clinical tests is currenty underway. We are also currently investigating the possible detection of colon cancer markers in excrement.


New antibody candidates for immunostaining of lung cancer cells (coloration in the culture of lung cancer cells: light brown)

Development of immunized-patient-based technologies and expansion to clinical applications

Genetic technologies related to the amplification of melanoma cytotoxic T lymphocytes (CTL) are being developed with the aim of obtaining an immunotherapeutic treatment.



New amplification method for CTL-specific cancer cells, and application to cancer treatment

●Basic Stage

Nanotech Materials

(Fiscal Year 2004-2006)

Mie/Ise Bay Shore Area

Development of New Functional Materials for Next-Generation Displays and Application to Devices

Advanced Materials Innovation Center, Mie Industry and Enterprise Support Center
1-30 Shiohamacho, Yokkaichi City, Mie 510-0851 JAPAN
TEL: +81-59-349-2205

Core Research Organization
Mie University

Major Participating Research Organizations
Industry…NORITAKE ITRON CORP., Hamamatsu Photonics K.K., Kureha Elastomer Co., Ltd., and others
Academia…Mie University, Nagoya University
Government…Mie Prefecture Industrial Research Institute

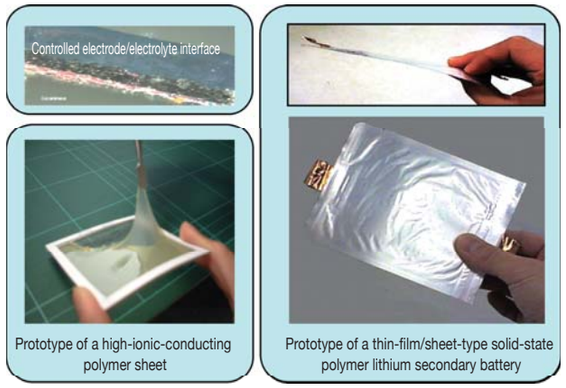
Main Results of City Area Program

【We attained success in the trial manufacturing of a prototype solid-state thin-film polymer-lithium secondary battery!!】

- Lithium secondary batteries are expected to yield the highest performance in terms of the battery power source of intelligent electric devices, storage of electric energy generated from renewable energy sources, and as the power source of hybrid cars. At present, the electrolytes in most lithium batteries used in cellular phones are “liquid electrolytes” that consist of “liquid-state organic electrolytes” and minor “gel polymer type.” In the future, it will be desirable that lithium batteries are “completely solid state” and occur in a “sheet state” to enable progress in terms of safety, free design, and size.

- To achieve an ideal solid-state battery, it is necessary to develop a “high-ionic-conducting solid-state polymer electrolyte” using a dry polymer system without liquid organic electrolytes. High-ionic-conducting polymer electrolyte can be produced by developing a special polyethylene oxide, PEO, a complex polymer. We synthesized composite materials of $LiFePO_4$-carbon complex cathode particles and metal (Li, Si)-carbon complex anode particles with enhanced electrode properties in a special PEO complex polymer. We developed the technology required to produce thin sheets of polymer electrolyte and to control the interface between layers of cathode material and electrolytes, resulting in greatly reduced interface resistivity.

Trial prototype manufacture of a sheet-type solid-state polymer lithium secondary battery



Prototype of a high-ionic-conducting polymer sheet

Prototype of a thin-film/sheet-type solid-state polymer lithium secondary battery

- We manufactured a completely solid-state lithium polymer sheet battery of A7 size (74–105 mm), which was used to power a miniature-type DC motor and LED lamp at 20°C, under which conditions solid-state lithium polymer batteries do not usually function.

Approaches after Completion of Project

1. Continued development of a solid-state polymer lithium battery for practical use
   Joint research has been undertaken to ensure vertical cooperation among upstream and downstream industries as a core component of the research plan during the Basic Stage, with the aim of developing a completely solid-state lithium polymer battery. Joint research into practical applications of the technology have begun as part of an industry–academia–government cooperation, with the aim of regional innovation as a theme of the Development Stage in 2008.

2. Initiation of a new joint-research program based on the research results of the Basic Stage
   As part of a collaboration between related companies, academia, and government, progress has been made in research into a high-brightness luminescent material of nitride semiconductor and the development of a nano-focus mini X-ray tube using a carbon nano-tube electron emitter.

3. Feasibility study of the application of General Stage research results to different fields
   A luminescent-material molecular dispersed luminescent polymer and SiO_2 was developed during the Basic Stage. The feasibility of the application of a highly efficient dye-sensitized solar cell has been assessed in collaboration with the Mie Prefecture Industrial Research Institute.

●Basic Stage

Life Sciences

(Fiscal Year 2004-2006)

Southern Area of Lake Biwa

Development of an In Vivo Micro-Diagnosis and Treatment Robot Cluster Formation for Micro-Medical Engineering Industries

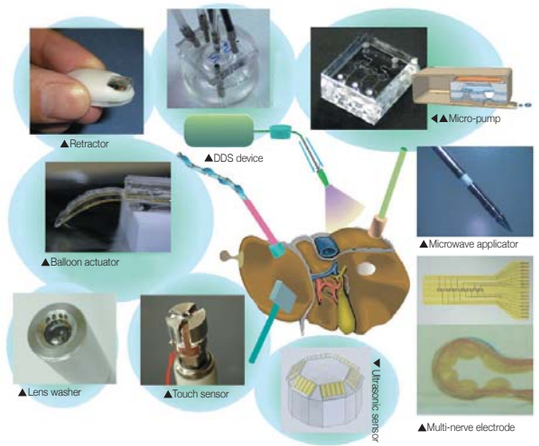
Shiga Prefecture Industrial Support Center
2-1 Uchidehama, Otsu City, Shiga 520-0806 JAPAN
TEL: +81-77-511-1414

Core Research Organizations
Shiga University of Medical Science, Ritsumeikan University, Ryukoku University, Industrial Research Center of Shiga Prefecture

Major Participating Research Organizations
Industry…NIPRO CORPORATION, FUJIFILM Corporation, YAMASHINASEIKI CO., LTD., and others
Academia…Shiga University of Medical Science, Ritsumeikan University, Ryukoku University
Government…Industrial Research Center of Shiga Prefecture

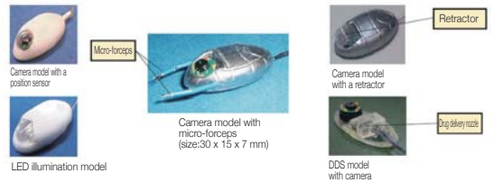
Main Results of City Area Program

1. 「Development of various devices for diagnosis and treatment」
   Various devices were developed using micro- and nano-fabrication technologies for a micro-robot that enables less invasive and long-term diagnosis and treatment.



Developed various devices

2. 「Trial production of End Bionics Robot」
   Many technology “seeds” that contribute to an in vivo micro End Bionics Robot (EBR) have been prepared. For example, the trial prototypes of five different EBR models have been developed using technologies such as an illumination system, a camera system, and a retractor set; we have also verified the movement of these robots in the body.

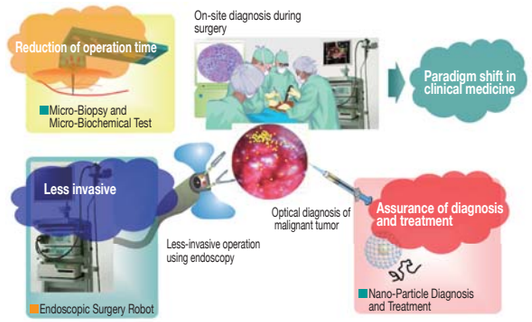


End Bionics Robots with five different usages

Approaches after Completion of Project

1. Development of a manufacturing cluster in cooperation with clinicians and engineers
   With the aim of forming a manufacturing cluster via cooperative medical research and engineering, Shiga Prefecture started a medical engineering project in the Southern Area of Lake Biwa to realize industrial promotion according the prefecture’s strategy. The research and development undertaken as part of an Industry–Academia–Government collaboration has succeeded in strengthening the local innovation system. In addition, the project has benefited from ongoing research in terms of incubating new businesses.

2. Development stage of City Area Program
   A new project has been initiated to integrate the micro bio-sensing/operation technology developed at the Basic Stage with the technological capabilities of universities and companies in the area, who possess technology in the fields of micro-system integration, biochemical analysis, and the synthesis of nano-particles, among others. The 2007 fiscal year saw the initiation (at the Development Stage) of an on-site diagnosis and treatment system to provide patients with low-stress cancer diagnosis and tumor-removal operations.



On-site diagnosis and treatment system for reducing the physical burden on patients

●Basic Stage

Others

(Fiscal Year 2004-2006)

Osaka East Area

Development of Next-Generation High-Quality Welding Technology (FSW)

Osaka Foundation for Trade and Industry（OsakaTLO）
Business Innovation Center Osaka 14 F
1-4-5 Honmachi, Chuoku, Osaka City, Osaka 541-0053 JAPAN
TEL: +81-6-4964-6688

Core Research Organizations
Osaka Prefecture University，Osaka Sangyo University，Technology Research Institute of Osaka Prefecture

Major Participating Research Organizations
Industry…Isel Co., Ltd./Matsumoto Kikai Co., Ltd./Shimonishi Seisakusho, etc.
Academia…Osaka Prefecture University/Osaka Sangyo University/Kinki University,
Government…Technology Research Institute of Osaka Prefecture

Main Results of City Area Program

1. High-performance modification of microstructure and optimization of welding conditions for high-quality welds in light metal materials

The friction stir welding (FSW) process is implemented in the solid phase, below the melting point of the materials to be joined. Therefore, the microstructure of the base material in the weld zone is largely unchanged after FSW. However, the optimum conditions in terms of reliability must be clarified before applying this technology. In this context, we investigated the relationship between mechanical properties, the reliability of the weld joint, and FSW conditions in aluminum and magnesium alloys. We also investigated the use of FSW in titanium alloys.

＜Fig. ①/Relationship between the reliability of weld joints and FSW conditions＞

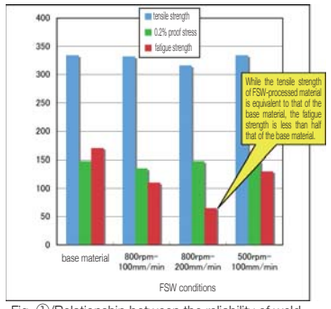


Fig. ①/Relationship between the reliability of weld joints and FSW conditions

Results of a tensile test and cycle fatigue test of the weld joint of the base material and FSW joints under three FSW conditions. (The tensile strengths of the FSW joints under the three FSW conditions are similar to that of the joint on the base material; however, the fatigue strengths of FSW joints vary markedly with FSW conditions.)

＜Fig. ②/FSW applied to titanium＞


Fig. ②/FSW applied to titanium

Appearance of FSW in titanium, which is a light metal with a high melting point and high strength. (In the welding of high-melting-point materials, it is necessary to develop a tool that endures high temperatures in the stir zone. The aim of this project is to develop a high-quality welding method and durable tools using appropriate materials.)

2. Automation of a high-quality welding system for three-dimensionally curved surfaces

We addressed questions such as “What shape were you able to join with FSW?” and “What problems do you encounter with FSW on three-dimensionally curved surfaces?” by investigating the use of a head with five degrees of freedom for welding curved surfaces. We also developed support software for FSW, “FSW Master,” which automatically makes an NC program for curved surfaces based on direct measurements of the shape of the object.

＜Fig. ③/Operation of FSW on three-dimensionally curved surfaces＞

＜Fig. ④/Example of a tilted elliptic path followed by FSW inside a quarter-cylindrical plate＞

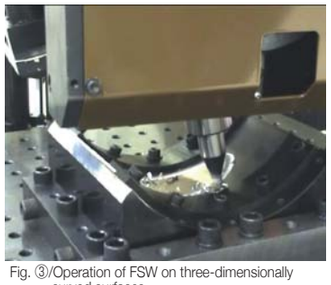


Fig. ③/Operation of FSW on three-dimensionally curved surfaces


Fig. ④/Example of a tilted elliptic path followed by FSW inside a quarter-cylindrical plate

Approaches after Completion of Project

- Foundation of the “Society for the study of the practical use of the friction stir technique”(Osaka Foundation for Trade and Industry)

A society was founded in FY2007 with the aims of developing technical innovations, enhancing competitiveness in the international market, and developing sustainable industry in Osaka, all facilitated by the application of Friction Stir Welding (FSW) technology in the local area and the further promotion of research and development based on the FSW research results achieved as part of this project. The society will also make use of a network for research and development in an industry-academia-government cooperation platform developed in the Osaka East Area.

●Basic Stage

Environment

(Fiscal Year 2004-2006)

Miyakonojyou Basin Area

Creation of an Environmentally Friendly Industry via the Advanced Utilization of Biomass

Miyazaki Prefectural Industrial Support Foundation
16500-2 Higashikaminaka, Sadowaracho, Miyazaki City, Miyazaki 880-0303 JAPAN
TEL: +81-985-74-3850

Core Research Organizations
Miyazaki Prefectural Wood Utilization Research Center, University of Miyazaki, Miyakonojo National College of Technology

Major Participating Research Organizations
Industry…Miyakonojyo Forest Association, JA Miyakonojyo, Tomoku Wood Works, and others
Academia…University of Miyazaki, Miyakonojo National College of Technology
Government…Miyazaki Prefectural Wood Utilization Research Center, Miyazaki Prefecture Industrial Technology Center, Miyazaki Livestock Research Institute

Main Results of City Area Program

1. Product development using obisugi essential oil obtained from the timber-drying process

More than 90% of the Japanese cedar timber in Miyazaki Prefecture is obisugi timber. To ensure high-quality lumber, artificial drying machines are currently under development. We developed a technology for collecting exhaust steam emitted from timber-drying machines and collecting the essential oil in obisugi timber. Various types of effective actions have been confirmed for essential oil collected from obisugi timber, including an insect-repellent effect and antibacterial and antiviral actions; applications have been made for multiple patents. Use of the oil in aroma-based products is also possible; test products have been developed with favorable results.

Obisugi refinement of oil for aromatherapy (prototype)

2. Development of a technology for the recovery of phosphorus from the incinerated ash of livestock waste and utilization as a resource

Alkali neutralization after dissolution with phosphoric acid from the incinerated ash of livestock waste, which contains more impurities than phosphate rock, enables the easy recovery of phosphorus as hydroxyapatite and calcium hydrogen phosphate.

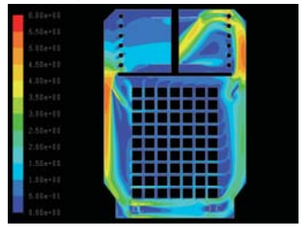
Recovered Hydroxyapatite

Approaches after Completion of Project

1. Cost reduction via a new timber-drying system

Current timber-drying machines involve great energy losses, such as the release of large quantities of high-temperature air (sensible heat) or water vapor (latent heat) into the atmosphere. Accordingly, we aim to greatly reduce electricity and fuel costs by recovering both sensible and latent heat. This will be achieved by developing a high-efficiency timber-drying machine that uses minimal electricity by virtue of analyzing the flow rate within the drying room, and developing a timber-drying schedule based on the use of a drying and curing chamber. Research as part of a project for utilizing advanced technologies in agriculture, forestry, and fisheries (Ministry of Agriculture, Forestry and Fisheries) has been in progress since 2007.


Timber-drying Kiln


Analytical chart of flow velocity in the kiln

2. Efficient alcohol production using recombinant microorganisms

The production of fuel ethanol from foodstuffs has become a topic of controversy; consequently, ethanol production via lignocellulose, a non-foodstuff material, will become of increasing importance. However, fermentation efficiency is poor because lignocellulose contains pentose. Using genetic recombination, we seek to construct a fermentation system with colon bacillus that shows enhanced pentose-utilization ability and efficient use of lignocellulose. Research that makes use of the Development of Preparatory Basic Bioenergy Technologies project (NEDO) has been in progress since 2007.


Culturing E. coli