Shimane University Nanotechnology Project Center

Shimane University had organized S-nanotech project during 2004 to 2007 for the development of nano-materials that are economical, simple, environment-friendly and practical. This project has been handed down by Industry-University Cooperation project in "Shinjiko-Nakaumi" area, "S-Green & Life Nanomaterials Project".

We have established “Shimane University Nanotechnology Project Center” in January 2013 to accelerate the research of Shimane nanotech.

Director : Yasuhisa Fujita (*Interdisciplinary Graduate School of Science & Engineering*)

Members:

Yukikuni Akishige, Tetsuya Takahashi, Katsura Nishiyama, Shinya Tsukada (*Faculty of Education*)

Takeshi Isobe, Joji Sekine, Atsushi Nagai, Haruo Takeshita, Masatoshi Fujii, Junko Fujihara, Akihiro Matsumoto (*Faculty of Medicine*)

Takuya Ohba, Yoko Suyama, Ichiro Hiromitsu, Makoto Handa, Yasuji Yamada, Hiroji Masuda, Yasushi Seike, Kohji Omata, Yutaka Nishigaichi, Hiroshi Usuki, Hiroyuki Kitagawa, Wenchang Yeh, Kazuto Arakawa, Ryo Sasai, Shuting Li, Shigekazu Morito, Takahisa Ikeue, Toshiyuki Yoshida, Kokoro Kitamura, Kazutake Uehara (*Interdisciplinary Graduate School of Science & Engineering*)

Tatsuyuki Yamamoto, Hideo Akiyoshi , Satoka Aoyagi, Keisuke Yoshikiyo (*Faculty of Life and Environmental Science*)

Shijo Nishigori, Takaya Yamada, Kohji Nishimura, Miki Tongu, Taisuke Hayashi (Interdisciplinary Center for Science Research)

Nanotechnology Project Center
Center of the Promotion of Project Research, Organization for Research, Shimane University
1060 Nishikawatsu-cho, Matsue-shi, Shimane 690-8504, Japan
http://www.ecs.shimane-u.ac.jp/~fujita/nanotechprojectcenterhp/toppage_japanese.html

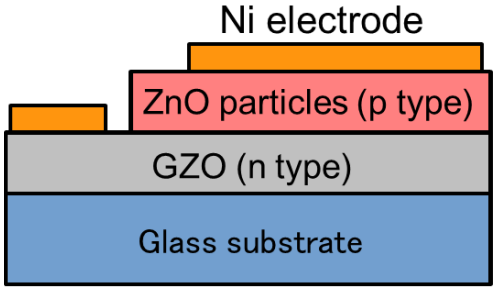
Development of next-generation low-cost solar cells

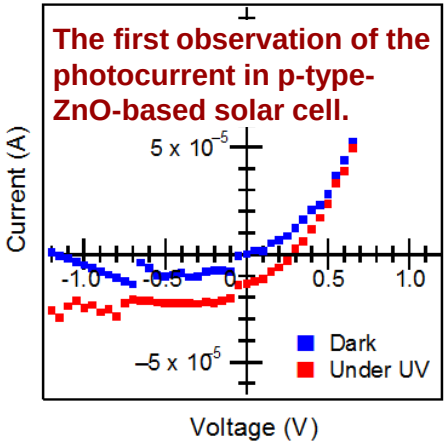
Solar-cell group of S-Green & Life Nanomaterials Project
Shimane University, Japan

Key words: "Low cost", "Easily processible", "Eco-friendly"

Research topics.

1. ZnO-nanoparticle-based solar cells fabricated by wet process (Prof. Yasuhisa Fujita)
2. Band-gap engineering of ZnO (Prof. Yasuhisa Fujita)
3. ZnO-based transparent conducting films (Prof. Yasuji Yamada)
4. Si/Ge hybrid solar cells fabricated by sputter epitaxy (Prof. Wenchang Yeh)
5. Photoinduced electron transfer in semiconductor nanosheet/organic dye hybrid (Prof. Ryo Sasai)
6. Organic solar cells using soluble phthalocyanines (Prof. Ichiro Hiromitsu)
7. Synthesis of new phthalocyanines and porphyrins for solar cells (Prof. Makoto Handa, Prof. Takahisa Ikeue)

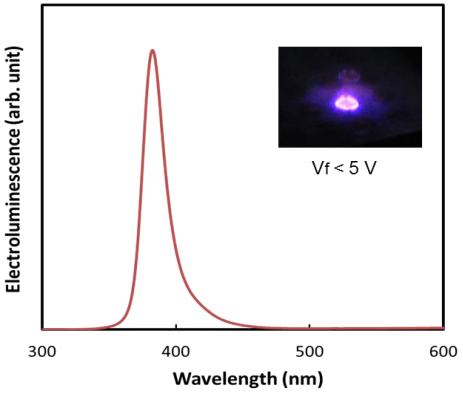




Scheme of the ZnO-nanoparticle-based solar cell, and its current-voltage characteristics.

Development of ZnO films and nanoparticles

Yasuhisa Fujita
Professor, Department of Mechanical, Electrical and Electronic Engineering,
Interdisciplinary Graduate School of Science & Engineering
fujita@ecs.shimane-u.ac.jp
http://ecs.riko.shimane-u.ac.jp/~fujita/Eindex_.html



UV LEDs using ZnO nanoparticles

World's first UV LEDs using nitrogen doped ZnO nanoparticle coated films have been developed. Low cost solid state lighting devices will be realized without single crystal substrates and epitaxial growth techniques, because this LEDs only use nanoparticle films on glass or metal substrates.

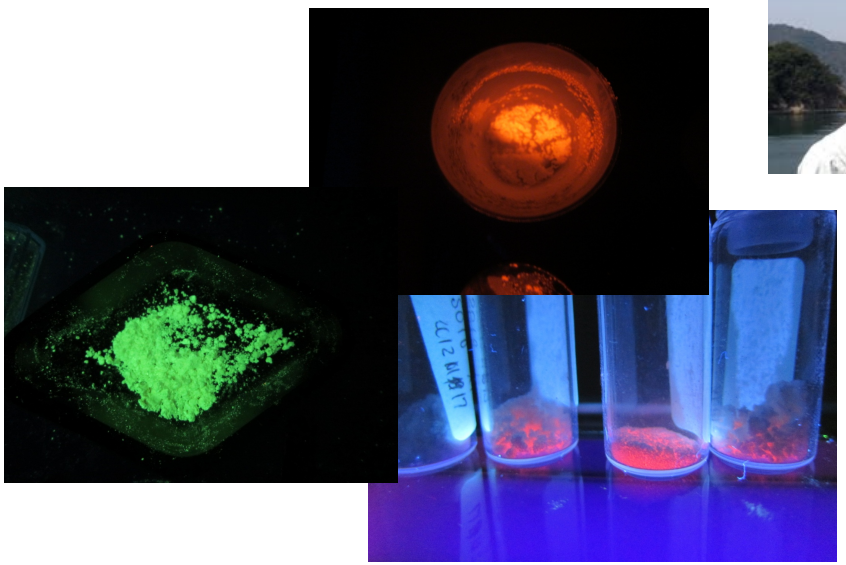
Growth of ZnO films using MOCVD

We have developed MOCVD (Metalorganic Chemical Vapor Deposition) system with a high-speed rotating disk. We are trying to develop high quality ZnO films using MOCVD.

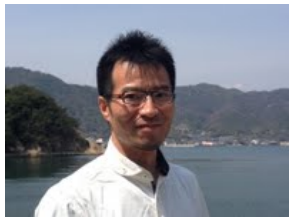
Creation of color-tunable emitting devices by using rare-earth nanoparticles / organogels

Director: Associate Professor, Katsura Nishiyama (Dr. Sci.)

- **Design and fabricate UV-excitation, VIS-emitting, full color-tunable devices. Employ rare-earth nanoparticles, complexes, &/ organogels**
- **Being applicable to nano-crayons, lasing devices, biomarkers, …**
- **Seek enthusiastic scientists with chem, phys, bio, … backgrounds**
- **Experienced Director (KN) as regards international collaborations**



Emission from rare-earth nanoparticles under UV excitation



Director, KN
- ✓ Fluency in English
- ✓ Also speaks some other Asian and European languages

Group photo

Further inquiries

Dr. Katsura Nishiyama

Dept. Chem., Facul. Edu, Shimane University

katsura_nishiyama@edu.shimane-u.ac.jp

Like us on Facebook

http://www.facebook.com/nishiyama.lab

Physics of Dielectrics

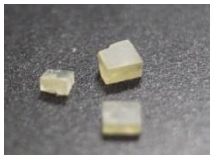
Akishige Laboratory

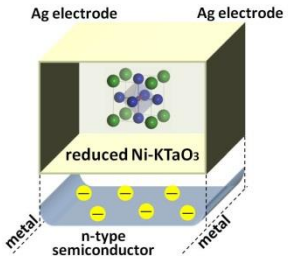
http://physics.edu.shimane-u.ac.jp/English/index_English.html

We design new dielectric materials to understand physics better. In turn, we are curious how the dielectric properties can be controlled by temperature and electric field. We take multidisciplinary approaches integrating various sample preparation technique and measurements to solve pressing problems in physics as well as engineering.

Sciences

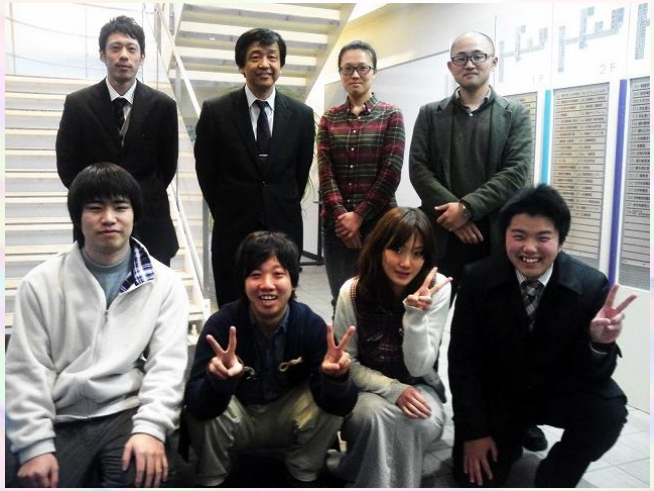
Solid State Physics
Statistical Physics
Inorganic Chemistry





Applications

Materials Design
Dielectrics
Piezoelectrics
Ferroelectrics



Y. Akishige, PhD
Dean of Faculty of Education, Shimane University
akishige@edu.shimane-u.ac.jp

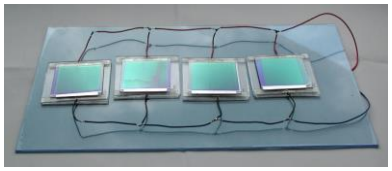
Development of organic thin-film solar cells

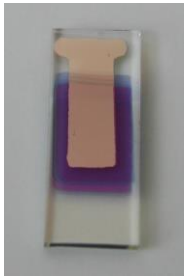
Prof. Ichiro Hiromitsu, Department of Physics and Materials Science
Shimane University, Japan
http://www.phys.shimane-u.ac.jp/hiromitsu_lab/English.html

Organic thin-film solar cell (OTFSC) is one of the candidates for the next-generation solar cells. In the laboratory of Prof. Hiromitsu, the properties and the working mechanism of OTFSC are studied to improve the performance of OTFSC.

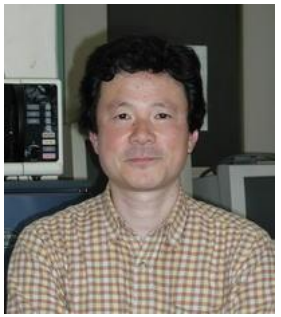
Research subjects of the students

1. **Development of the OTFSC using new transparent electrode GZO**
2. **Study of the role of the internal electric field of OTFSC in the photovoltaic effect**
3. **Optimization of the internal electric field of OTFSC**
4. **Effect of the doping of organic semiconductor on the performance of OTFSC**
5. **Effect of insertion of thin buffer layer between the orgacic thin film and the electrode**





OTFSC's prepared by the students



Prof. I. Hiromitsu

Transparent Conducting Oxides

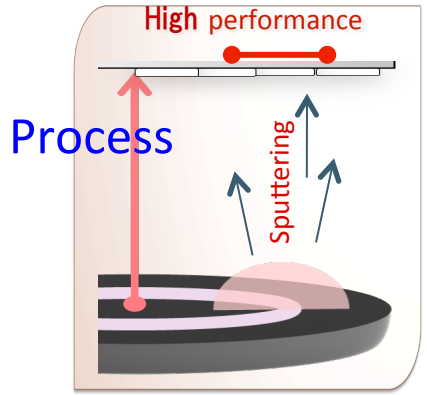
Innovate New Science and Technology

Prof. Yasuji Yamada, Dr. Shuhei Funaki

We are interested in the developments of

- cost efficient processes in TCO film fabrication such as sputtering
- chemically tolerable TCO films for severe circumstance application
- high performance of composite films for electronic engineering

Current Materials : ZnO, TiO_2 and other eco-materials



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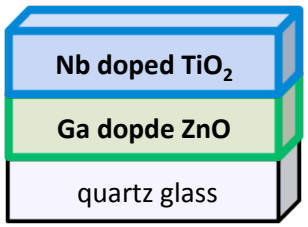

Structure

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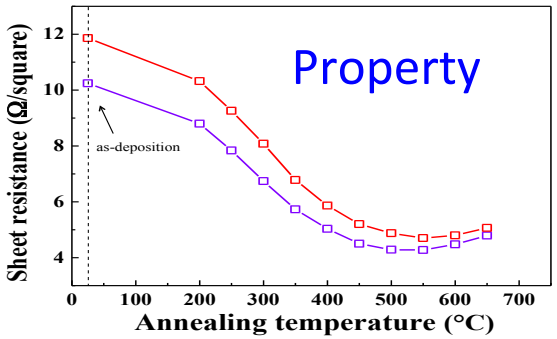

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High Performance

Physics and Materials Science, Interdisciplinary Graduate School of Science and Engineering

URL: http://www.phys.shimane-u.ac.jp/yamada_lab/index.html e-mail: yamadaya@riko.shimane-u.ac.jp, s-funaki@riko.shimane-u.ac.jp

Metal Complexes with Multi-Fuctionality

Makoto Handa, Takahisa Ikeue

Department of Chemistry, Interdisciplinary Graduate School of Science and Engineering, Shimane University

Research activities:

Syntheses and development of new metal complexes with molecule-designed ligands for their applications such as catalysts, photosensitizers, and gas-adsorbing and magnetic materials etc.

Complexes engaged in our lab.:

- Phthalocyanines
- Porphyrins
- Latern-type Dinuclear Complexes

Welcome to Advanced Catalysts and Catalysis Laboratory

Noble materials design by nonlinear regression models (genetic algorithm, artificial neural network, support vector machine, ...) is applied for solid catalyst development in our lab.

- Design of Catalysts for Organic Resources Conversion
  - Organic Resources Conversion
  - Catalyst Development under High Pressure
  - Catalyst Design using Nonlinear Regression Models
- Thesis Title (2012)
  - Development of zeolite catalyst for bio-ethanol to olefin conversion by non-linear regression model
  - Preparation of ceria for three-way cayalyst with high activity by non-linear regression models
  - Preparation of Co catalyst for methane dry reforming by non-linear regression models
  - Active Mo catalyst for hydrocracking of heavy oil by non-linear regression models
- Contact
  - `http://www.crc.shimane-u.ac.jp/res-pr/seeds/omata.pdf`
  - `omata@riko.shimane-u.ac.jp`

Organic Chemistry Laboratory

Yutaka Nishigaichi, Prof. D. Sc. (nishigai@riko.shimane-u.ac.jp)

Department of Chemistry,
Interdisciplinary Graduate School of Science and Engineering,
Shimane University

Research activities:

Selective Reactions with Organometallic Reagents

- Remote Asymmetric Induction with Chiral Allyl-tin/silicon Reagents

  1,4- & 1,5-Asym. induction toward aldehydes and imines

- Photo-assisted Reactions with Organometallic Reagents

  Addition/substitution/coupling reactions with B, Si, Sn reagents via photo-induced electron transfer

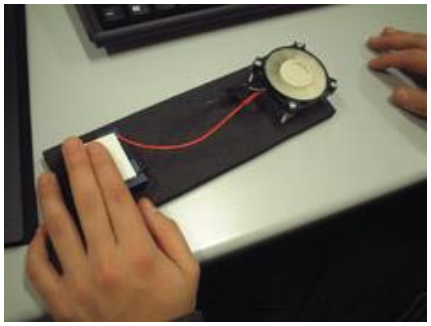
- Application toward Natural Product Synthesis

Design and of Processing of Thermoelectric Materials

Hiroyuki Kitagawa (Materials Science & Engineering)

kitagawa@riko.shimane-u.ac.jp

http://www.phys.shimane-u.ac.jp/kitagawa_lab/index.html (Japanese text)



Thermoelectric generation

directly converts heat energy into electric power by using the large Seebeck effect of semiconductor.

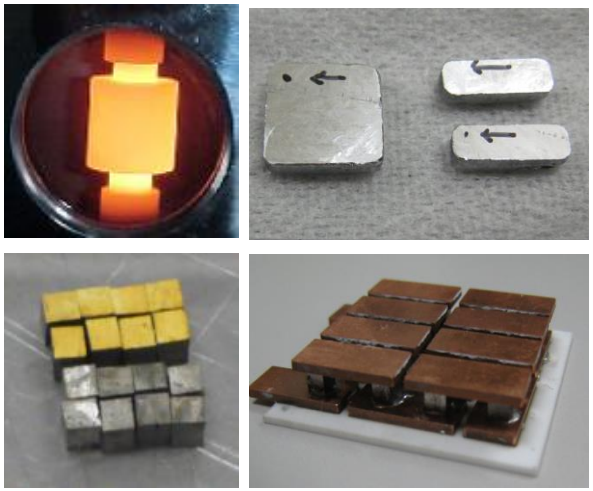
The **excellent TE materials** lead the thermoelectric systems to **"green" technologies** !

Material: Pnictides, Calcogenides, etc

Process: Sintering, Liquid-phase growth

Evaluation: Texture, Crystal structure,

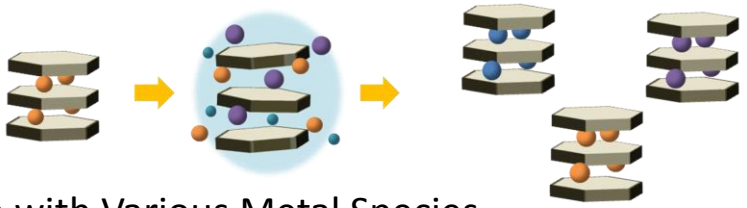
Thermoelectric and Carrier transport properties



R & D of Innovative Materials & Technology for Issues related to Environment, Resources Depletion, and Energy

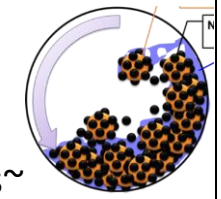
Prof. R. SASAI
Division of Physics and Materials Science, Interdisciplinary Graduate School of Science and Engineering
(URL of Ryo's laboratory: http://www.phys.shimane-u.ac.jp/ryo_lab/index.html)
Contact e-mail address: rsasai@riko.shimane-u.ac.jp

< Present Research Projects as below >



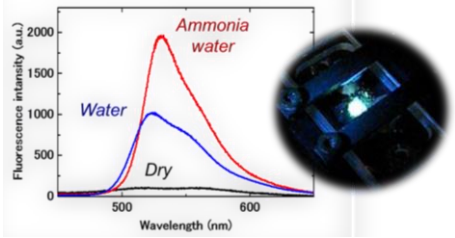
【Water environmental conservation】

1. R & D of Layered Double Hydroxide
   with Specific Anion Selectivity
2. Fundamental Research of Layered Double Hydroxide with Various Metal Species



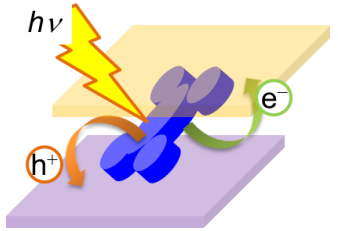
【Resource recovery】

1. R & D of 'Eco-friendly' Resource Recovery Techniquefrom Spent Industry Materials
   ~ Hydrothermal and/or Mechanochemical Techniques~



【Environmental monitoring】

1. R & D of Layered Inorganic/Luminous Dyes Hybrids
   with Molecular/Ion Detection Abilities



【Artificial photosynthetic system】

1. R & D of Novel Artificial Photosynthetic System
   by Hybridizing Photosensitizers with Semiconductor Nanosheets

Welcome to contact me anytime !

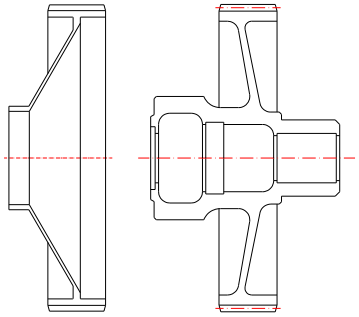
Machine Design Laboratory

Department of Mechanical, Electrical and Electronic Engineering, Shimane University, Japan

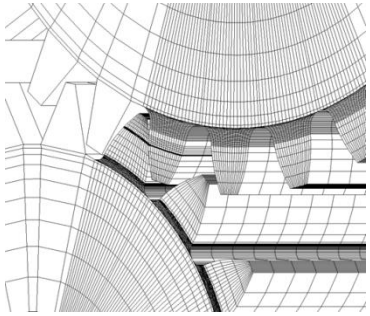
Shuting LI, Ph.D. & Associate Professor; E-mail: shutingli@ecs.shimane-u.ac.jp; http://www.ecs.shimane-u.ac.jp/~shutingli/

Research Interests:

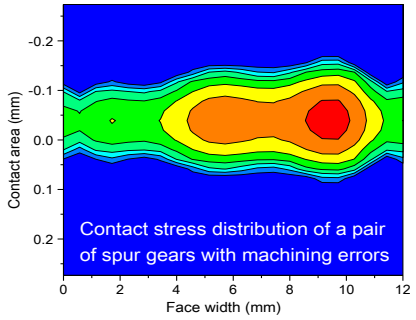
(1) Mechanical design and machine elements
(2) Static and dynamic behavior analyses of various kinds of gears and geared mechanical systems
(3) Design of the strain wave gearing, pin gear reducers and planetary gear devices
(4) Power transmission system of cars, robots, helicopters, aircrafts, aerospace and wind turbines
(5) Dynamics and safety problems of high speed trains
(6) Applications of finite element method in engineering design and strength evaluation



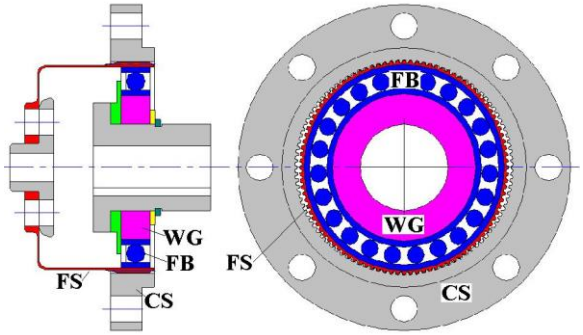
Gears for helicopters



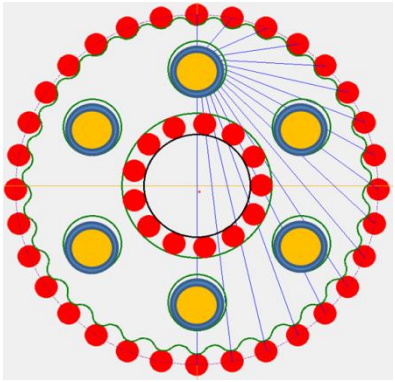
FEA model of gears



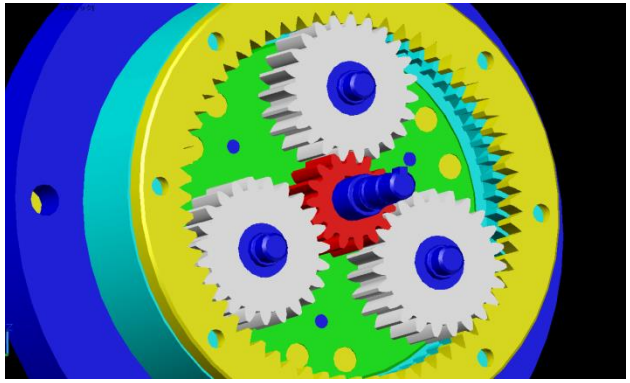
Gear contact stresses



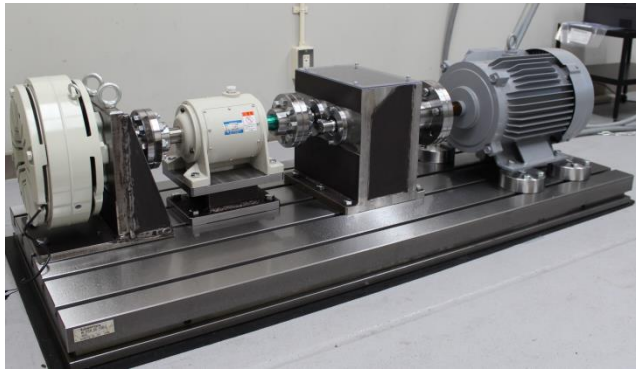
Gear device for aerospace



Pin gear device for robots



Planetary gear for wind turbines



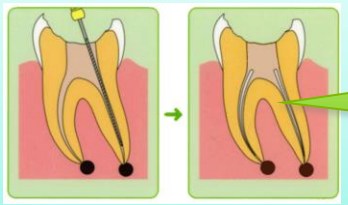
Experimental device of gears

Application of bacterial cellulose “Nata de coco” to medical use

Application to dental root canal treatment

Deep dental caries

Dental root canal treatment



Application of ”Nata de coco” as a novel root filling materal !

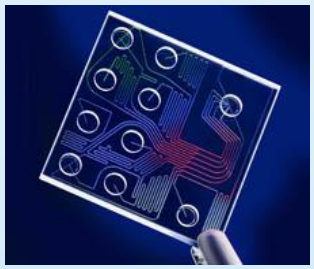
“Nata de coco” = Bacterial cellulose (BC)

Paper point is made of same cellulose

This study is designed to prove the applicability of BC from the viewpoints of absorbability, drug release, mechanical strength and the reaction of a living cell.

Aya Yoshino, Joji Sekine
Department of Oral and maxillofacial Surgery Shimane University Faculty of Medicine
http://www.med.shimane-u.ac.jp/oral/index.htlm

Application to microchip electrophoresis



Microchip electrophoresis

”Nata de coco” gel is used for sensitive microchip electrophoresis.

We are trying to enhance the emission intensity of SYBR Gold which used to DNA detection by using ZnO nanoparticles.

Applied to sensitive and rapid Medical diagnosis.

Junko Fujihara, Haruo Takeshita
Department of Legal Medicine Shimane University Faculty of Medicine
http://www.med.shimane-u.ac.jp/legal_med/Legal%20Med%20index.html

Raman spectroscopic analysis of living cells

Tatsuyuki Yamamoto[1] , Hideo Akiyoshi[1], and Yasuhisa Fujita[2]
[1]Faculty of Life and Environmental Science, Shimane University,
[2]Interdisciplinary Graduate School of Sci. & Eng., Shimane University,

Members of Nanotech center of Shimane University

Our study: We study on a technique to visualize the behavior of molecules functioning in living cells by Raman spectroscopy. Raman spectroscopy is a technique which let us know the structures and conditions of molecules by analyzing the vibrations of molecules. The technique has been recently more widely used in the frontier of clinical applications.

An example of our study: We have found a fission yeast mutant strain, which cannot grow well due to the lack of coenzymeQ10 (CoQ10, a coenzyme essential for respiration) synthesis, grows fairly by the addition of CoQ10 inclusion complex (Figure 1). By Raman mapping and other studies, we have found that the recovery in the growth was not brought about by the recovery of respiration activity but by the anti-oxidative function of CoQ10 (Figure 2). We await for your interest in our study!!

Figure 1.

The effect of CoQ10 inclusion complex to *Δdps1*

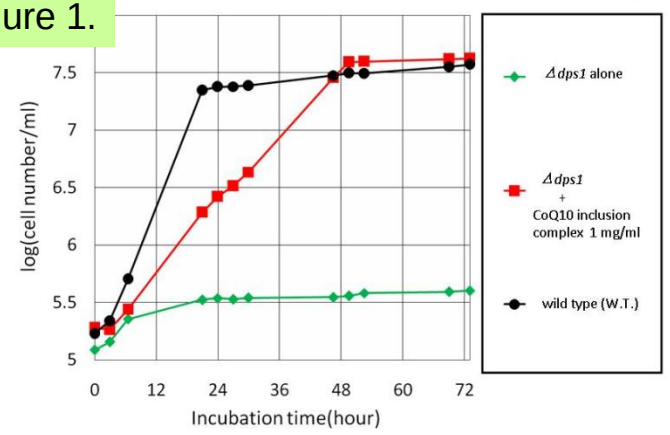
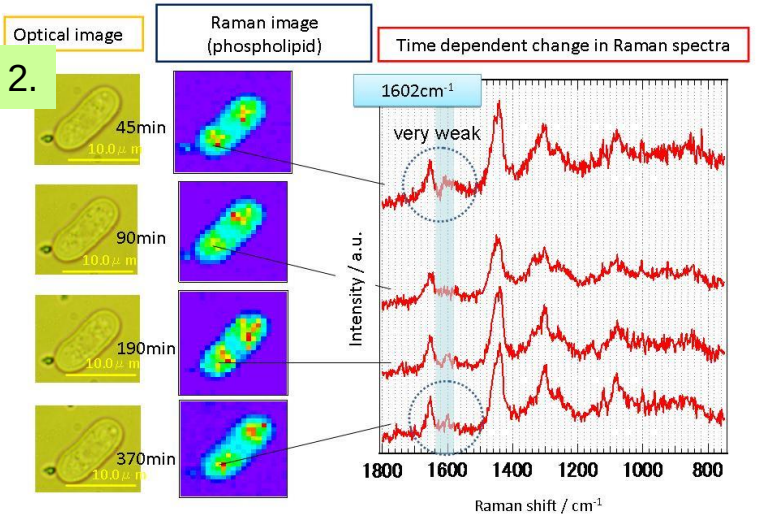


Figure 2.

Raman spectra for *Δdps1*+CoQ10 inclusion complex

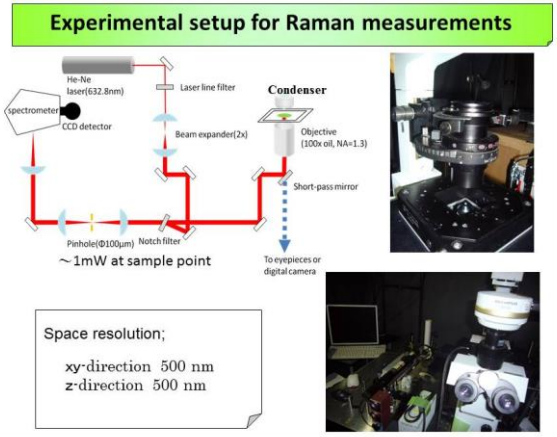


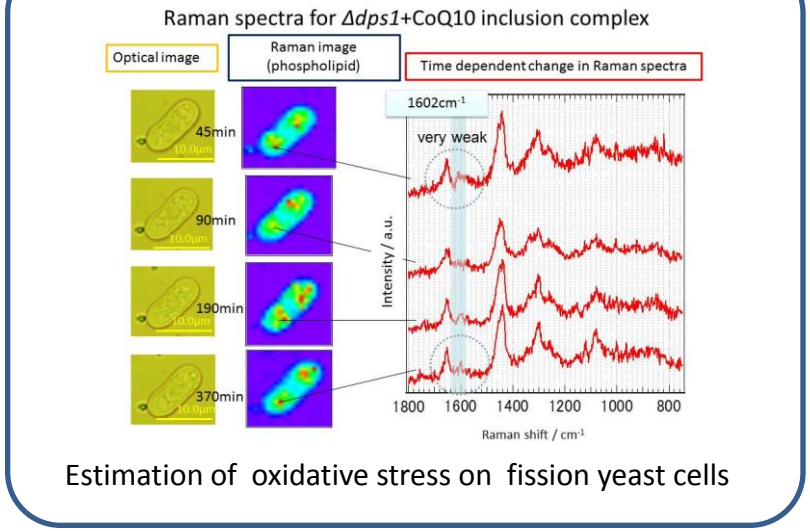
Medical and biological applications of Raman spectroscopy

Tatsuyuki Yamamoto[1,2]

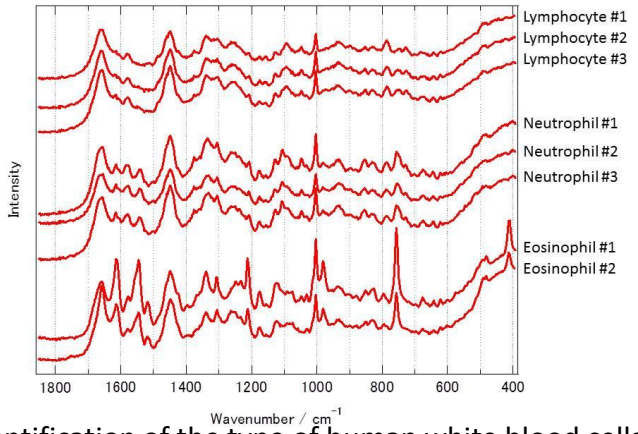
[1]Faculty of Life and Environmental Science, Shimane University
[2]Nanotech Project Center, Shimane University

Objective: Our group is working on medical and biological applications of Raman spectroscopy.
Raman spectroscopy is a technique to give us structural and environmental information on molecules by their vibrational spectra, which are frequently called as "molecular fingerprints".
We utilize this technique to elucidate, e.f. the metabolic activity of living cells, diagnosis of various diseases.





Estimation of oxidative stress on fission yeast cells



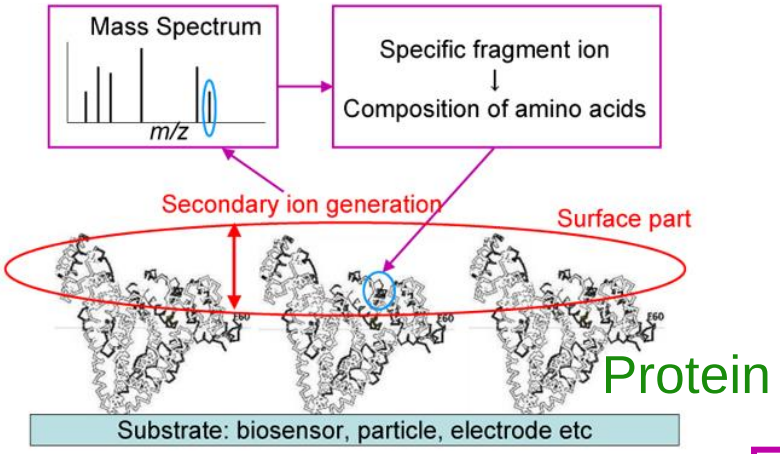
Identification of the type of human white blood cells

BioPhysics Laboratory
~ Surface Analysis for Life Science~

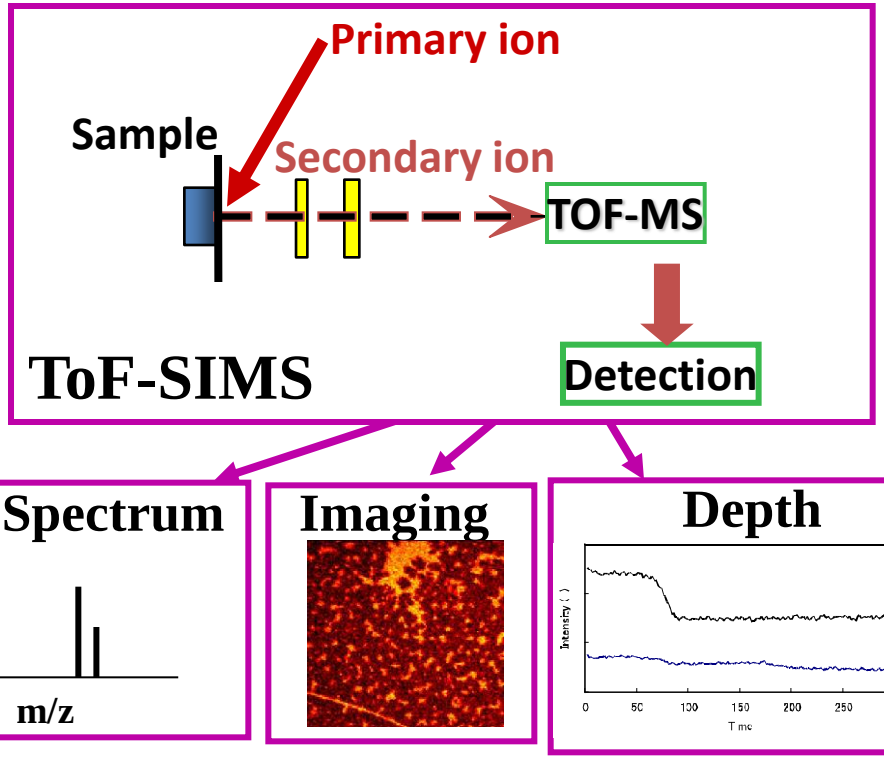
Satoka Aoyagi, Associate Professor, Department of Regional Environmental Sciences
aoyagi@life.shimane-u.ac.jp http://bioinfoenv.shimane-u.ac.jp/aoyagi/

Chemical mapping (submicron scale) & chemical structural evaluation

- Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS)
- Near-Field Infrared Microscope (NFIR)



Evaluating the orientation of an immobilized macromolecules such as proteins.

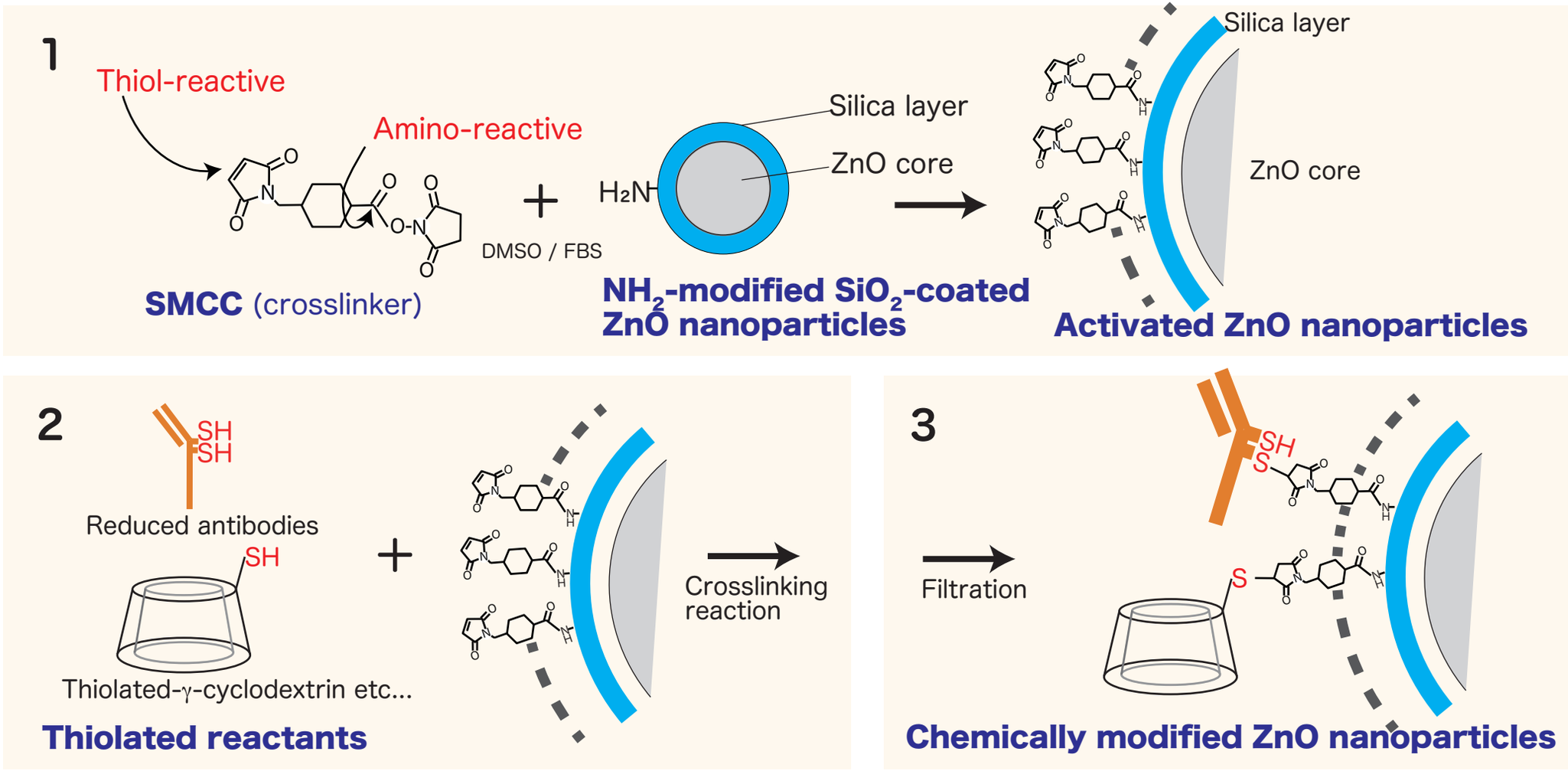


Chemical modifications on ZnO nanoparticles

Keisuke Yoshikiyo[1,2] and Tatsuyuki Yamamoto[1,2]
[1]*Faculty of Life and Environmental Science, Shimane Univ.*
[2]*Nanotechnology Project Center, Center of the Promotion of Project Research, Organization for Research, Shimane Univ.*

Outline of the reaction

1. Activation of ZnO nanoparticles surface or reactants with SMCC, crosslinker.
2. Crosslinking reaction between ZnO nanoparticles and reactants.
3. Purification by microfiltration and/or ultrafiltration.



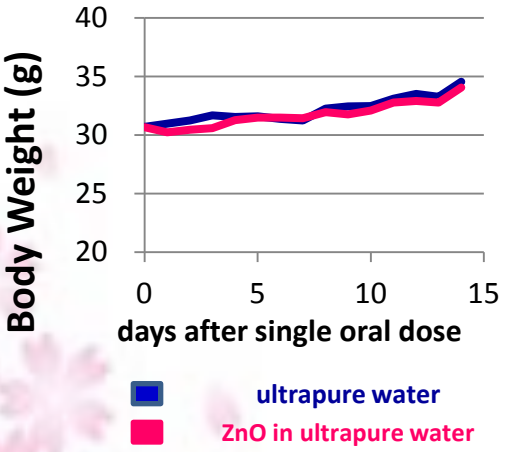
Department of Experimental Animals,

Center for Integrated Research in Science, Shimane University

in vivo evaluation of toxicity and effect

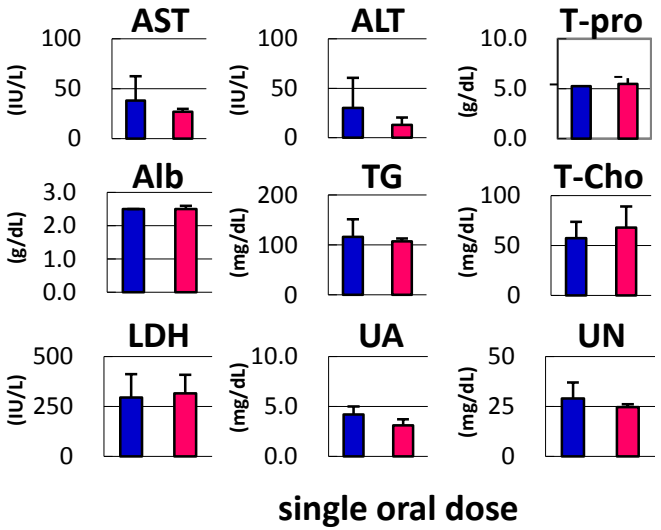
Growth Monitoring

- mouse -



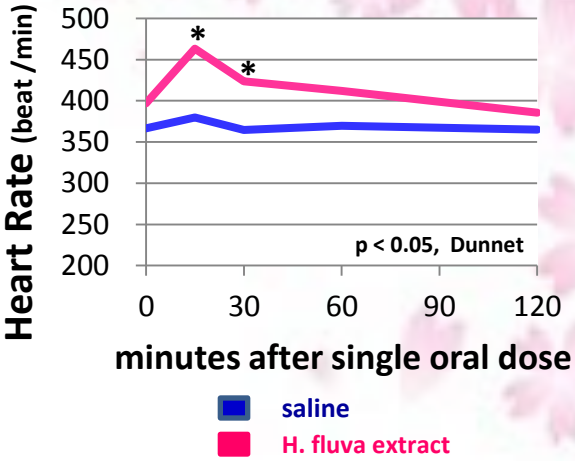
Blood test

- mouse -



Others

- rat -



other activities

tumor immunology

Cancer Immunol Immunother (2013)62:383-391

Cancer Immunol Immunother (2010) 59:769–777

allergy immunotherapy

Journal of Allergy Volume (2012), Article ID 490905

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