Low-Carbon Research Network Japan (Lcnet)

Network Building Program of Research Centers for Reduction of Carbon-dioxide Emission

"Research-Network Building Program for Reduction of Carbon-dioxide Emission"

Creation of a low-carbon society is a challenge which not only Japan but the whole world should work on immediately. We consider "Green Nanotechnology" (nanotechnology for environment- and energy-technology) will play very important role to create a low-carbon society.

This program has been started in the scope of "Challenge toward Environment and Energy Technology", which is a part of the "Groundwork for Growth-strategy, through the 2009 supplementary budget of the Ministry of Education, Science and Technology.

From this point of view, we will integrate (gather together) research results and knowledge of "Green Nanotechnology" to accelerate application of environment technology in practical use, through forming a goal-oriented research-network. In order to achieve innovative research through fusion of related research fields, we create two kinds of research centers for the research network. One is hub centers, and others are satellite centers. The both types of centers will be equipped with advanced research system and apparatus. At the same time, we will build up a network participated by all research centers centered by the hub centers.

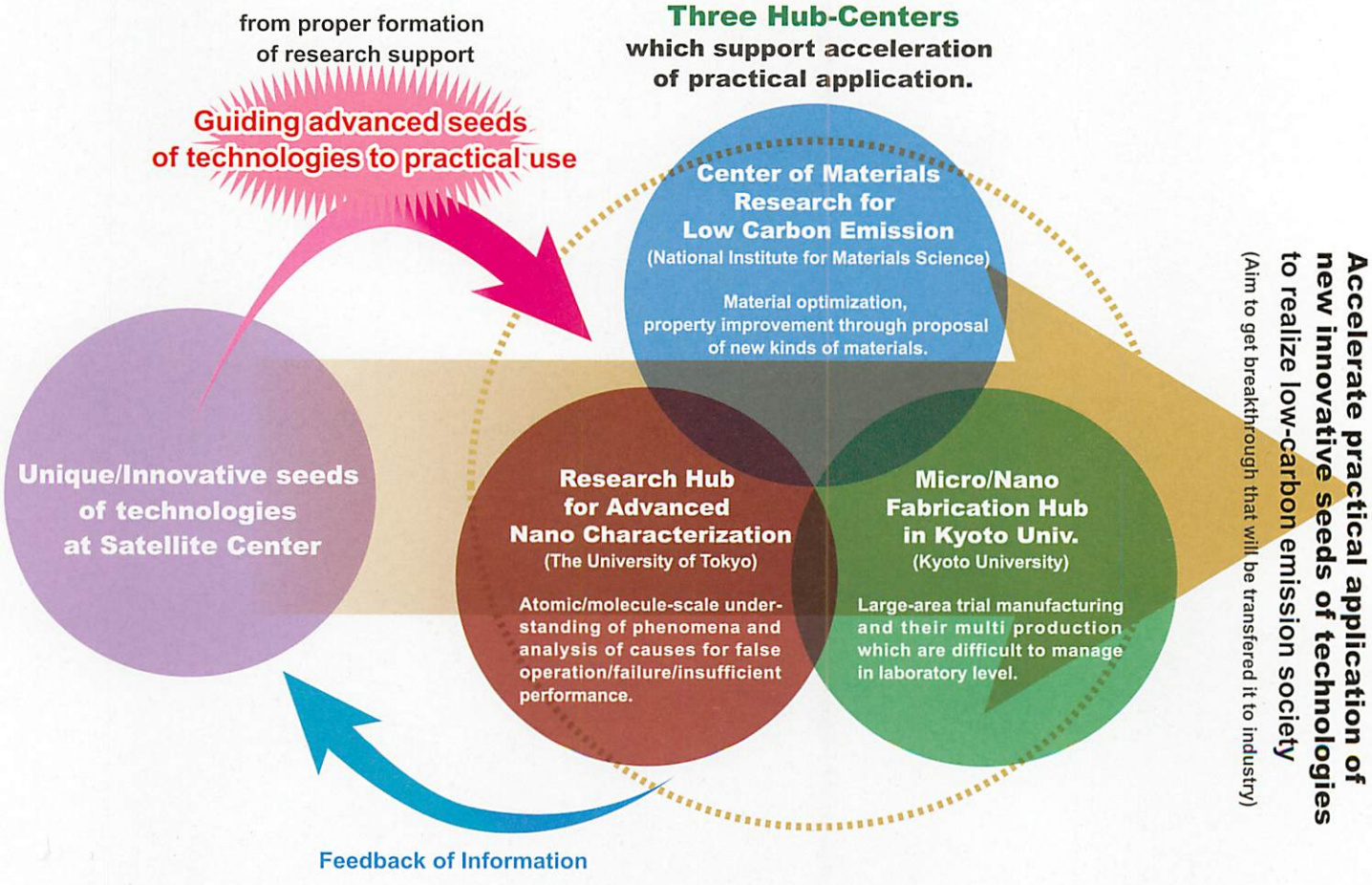
(1) Hub centers

As an institute/organization that has high research potentials for "Green Nanotechnology", such as a number of excellent research results and technology seeds, the hub centers are aiming to create seeds of great technological innovation by intensively tackling the common fundamental topics for the development of environment & energy technologies. Furthermore, the hub centers will provide supports to accelerate commercialization of the research results and technology seeds created by the satellite centers, with the most advanced facilities which are difficult to be implemented by the individual satellite centers. The detailed supporting functions of the hub centers are set as follows: (i) microprocessing and fabrication, (ii) evaluation and measurement, and (iii) materials fabrication.

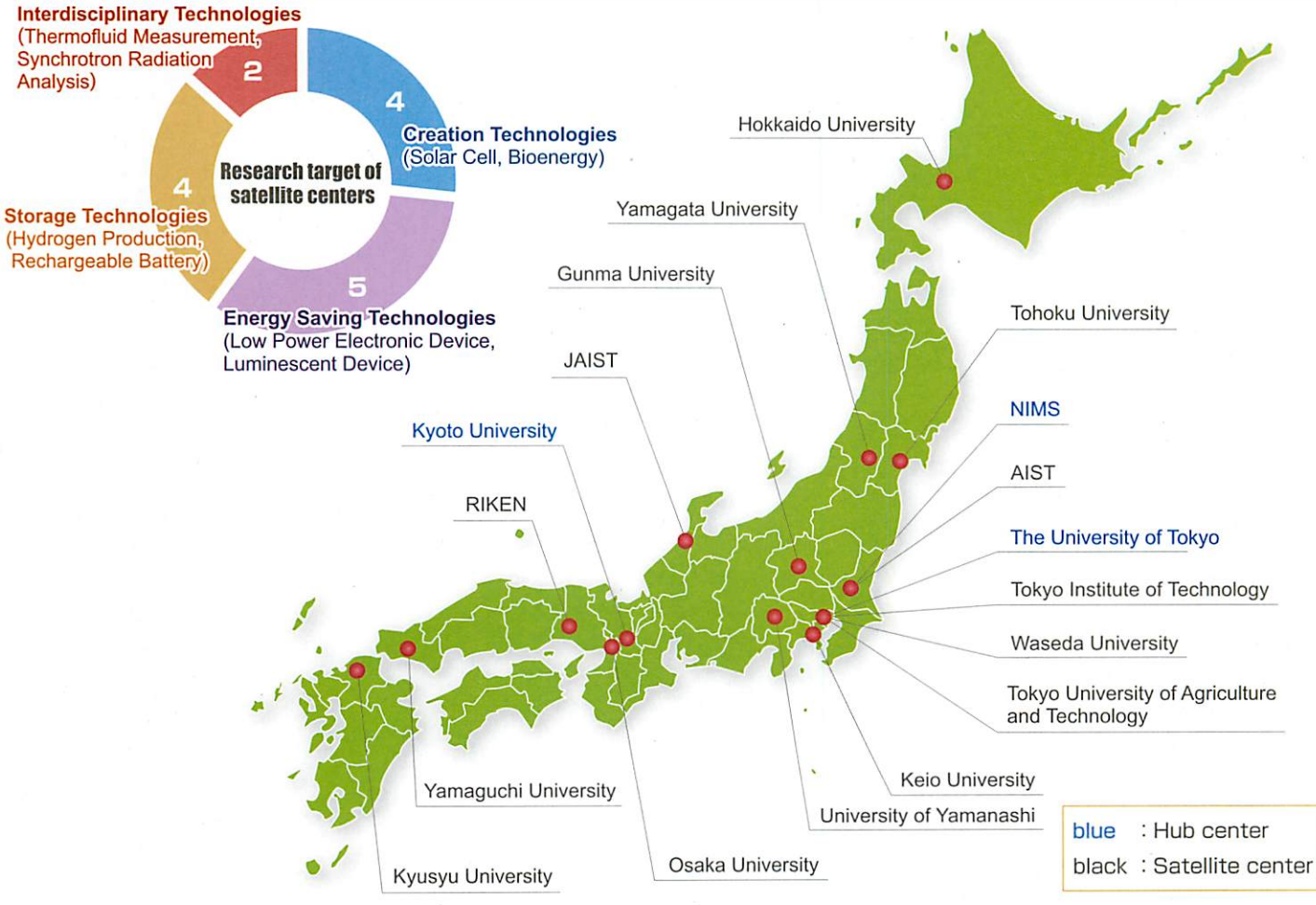
(2) Satellite centers

As an institute/organization that has excellent research results and technology seeds related to "Green Nanotechnology", the satellite centers will accelerate the commercialization of their respective research results by cooperating with the hub centers. Moreover, R&D activities at satellite centers will be accelerated by appropriate cooperation with the hub centers, by utilizing advanced facilities installed at the hub centers, and by tackling the problems that may not be solved by individual research at the satellite centers.

In addition, broad opportunities for usage of the facilities will be offered not only to researchers inside the network but also to external researchers from the point of view of the efficient utilization of the research infrastructure.



Low-Carbon Research Network (Lcnet) 18 Centers



Hub center	Institute/University	Website	Function
Center of Materials Research for Low Carbon Emission	NIMS	http://www.nims.go.jp/low_carbon/	Materials Fabrication and Design
Research Hub for Advanced Nano Characterization	The University of Tokyo	http://interface.t.u-tokyo.ac.jp/todai-hub.html	Nano Characterization
Micro/Nano Fabrication Hub in Kyoto Univ.	Kyoto University	http://www.ksys.me.kyoto-u.ac.jp/	Micro/Nano fabrication

Satellite research center	Institute/University	Website	Target
Research Center for Highly-Efficient Photoelectric Conversion System Using Optical Nano-Antenna	Hokkaido University	http://lcs.es.hokudai.ac.jp/	Solar Cell
Center for Fusion Research of Nano-Interface Devices	Tohoku University	http://res.tagen.tohoku.ac.jp/~teitanso/	Rechargeable Battery , Low Friction
Center for Research on Smart Organic Electronics Devices Based on Nano-Processing Technology	Yamagata University	http://www.yz.yamagata-u.ac.jp	Luminescent Device
Center for Advanced Carbons for Hydrogen Technologies	Gunma University	http://www.gunma-u.ac.jp/	Hydrogen Production
Platform for Green Functional-Oxide Nanotechnology	AIST	http:// www.open-innovation.jp/GreFON/	Low Power Electron Device
Center for ultra high efficiency photovoltaics by quantum nanostructure	Tokyo Institute of Technology	http://www.pe.titech.ac.jp/LCS_by_nanotech/index.htm	Solar Cell
Center for Ultra-Low-Loss Power Diamond Transistor	Waseda University	http://www.all-nano.waseda.ac.jp/diamond_transistor/index.html	Low Power Electron Device
Center for green nano-bioelectronics	Tokyo University of Agriculture and Technology	http://www.tuat.ac.jp/research/nanobioe/	Nano, Bio
Sensing center for nano/micro thermofluid & thermal properties	Keio University	http://www.tfe.sd.keio.ac.jp/nmtfs	Thermofluid Sensing
Center for Fuel Cell Nanomaterials	University of Yamanashi	http://www.yamanashi.ac.jp/	Fuel Cell, Hydrogen Production
Research Center for Organic/Oxide Green Nano Device	Osaka University	http://www.sanken.osaka-u.ac.jp/labs/nano/	Low Power Electron Device
Center for Nano-Rheological Printing	JAIST	http://www.jaist.ac.jp/index-j2.shtml	Solar Cell
The SR Nano-Beam Analysis Center for Green/Nano-technologies	RIKEN	http://www.spring8.or.jp/	Synchrotron Radiation Analysis
Green Devices Research Center	Yamaguchi University	http://www.eng..yamaguchi-u.ac.jp/	Luminescent Device
Center for Nanomaterials of Future Fuel Cell Electrocatalysts	Kyushu University	http://low-carbon.cstm.kyushu-u.ac.jp	Hydrogen Production, Fuel Cell

Center of Materials Research for Low Carbon Emission

National Institute for Materials Science (NIMS)
Managing Director, Junichi Sone
URL: http://www.nims.go.jp/low_carbon/ TEL: +81-29-851-3354 ex.3822 E-MAIL: nims-hub@nims.go.jp
Contact person : Katsumi Suzuki

Outline of the center

In order to realize a low-carbon society, it is essential to develop innovative materials that can efficiently achieve the goals for "renewable energy" and "conservation of energy". To support the satellite centers of the Low-Carbon Research Network Japan (Lcnet), and moreover to support low-carbon research carried out (by researchers throughout) in Japan, a highly advanced facility-cluster for materials development (fabrication) will be intensively equipped. Also, a hub center for materials design and fabrication will be established at NIMS. We will respond requests for support and cooperation with both inside and outside of the network. Furthermore, we will determine material design guidelines to build up principles improving the properties of materials dramatically.

Research support plan and directions

Design concept and administration guideline of the hub center

Synthesis and processing facilities for the precise control of materials structure and property as well as facility clusters capable of on-site property evaluation and design will be equipped at NIMS. NIMS will collaborate with satellite centers, other hub centers, and with institutions outside of the network. NIMS will also take a leadership in nanotechnology and materials-research to realize a low-carbon society.

Original research potentials and available research support

This hub center will be equipped with advanced facilities for materials synthesis as well as nano-scale processing, observation, measurement and evaluation. Thus, the hub center will have excellent features and strength for promotion of the research related to "Materials design and fabrication". The center will be capable of gathering together a broad range of materials scientists for materials design, theoretical study, etc. For that purpose, the hub center will provide essential human (researcher cluster) and materials (facility cluster) resources for supply, analysis, processing and evaluation of all kinds of fabricated materials.

Measures for the activation of the network

As a hub center, advanced facilities will be equipped, and the common use of them will be promoted. We will also create and operate a portal site to foster cooperation inside this research network and we will also promote cooperation with institutions and universities outside the network.

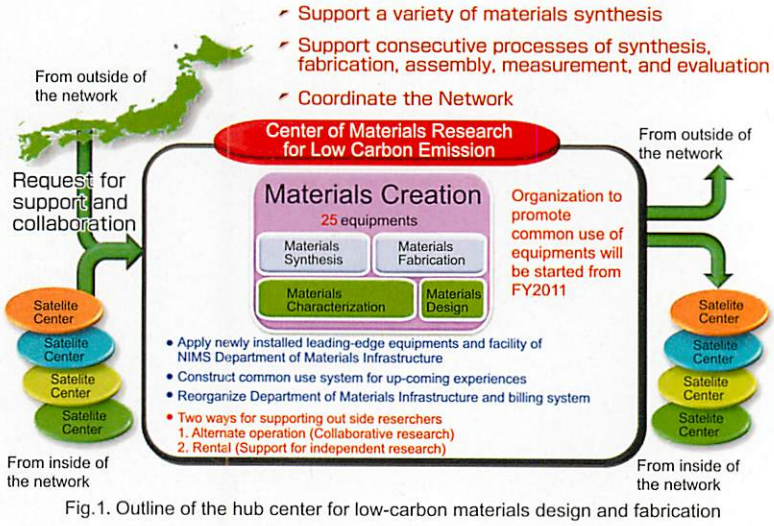


Fig.1. Outline of the hub center for low-carbon materials design and fabrication

Main common-use facilities

Materials Synthesis

Film growth apparatus

Quantum well film growth apparatus (MBE)
Carbon-based materials synthesis apparatus (MPCVD)
Nitrides vapor phase epitaxy apparatus (MOCVD)
Multinary alloy thin film co-sputtering system

Existing apparatus
Diamond film growth apparatus (4) MOCVD (2)
Metals and Oxides sputtering apparatus (2)
Oxides ADL Electron beam deposition apparatus (2)

Bulk and crystal growth apparatus

Spark plasma sintering apparatus (high temperature)

Existing apparatus
Nanoparticle and powder synthesis (2)
High temperature high pressure crystal growth (2)
High temperature bulk crystal growth (2)
• Materials Manufacturing and Engineering Station, common use facilities cluster

On-site processing

High precision electron beam lithography system
Field emission scanning electron microscope for nanomanipulator-based processing
Nano-focused ion beam system

• Nanotechnology Innovation Center, common use facilities cluster

On-site characterization

Ultra-high resolution helium ion microscope
In-situ working environment nanoscale physical characterization instrument
3D multiscale micro-structure analyzer

Common use facilities cluster of
• High Voltage Electron Microscopy Station
• Materials Analysis Station
• High Magnetic Field Station

Research Hub for Advanced Nano Characterization

The University of Tokyo

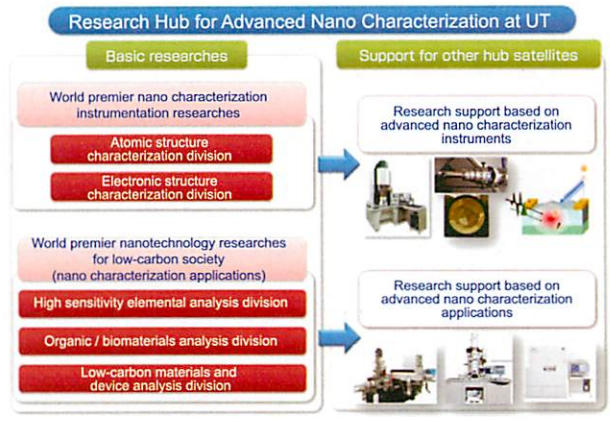
Managing Director, Takehiko Kitamori

URL: http://interface.t.u-tokyo.ac.jp/todai-hub.html TEL: +81-3-5841-7689 E-MAIL: todai-hub@sigma.t.u-tokyo.ac.jp

Contact person : Takahisa Yamamoto

Summary

In this research hub, broader range of advanced nano characterization facilities are gathered in one place to support material developments and device engineering for the realization of low-carbon society. This research hub provides state-of-the-art nano characterization techniques for other research hubs and satellites.



Research Collaboration Plans and Directions

Design Concepts and Management Policies on the Hub

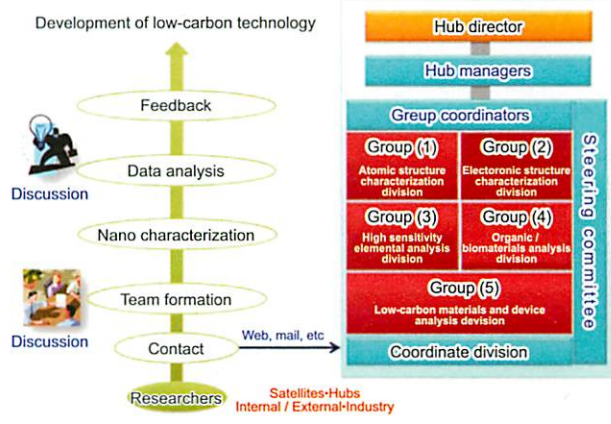
Based on the strong scientific backgrounds on the nano characterization researches in the University of Tokyo, we have organized five divisions of nano characterization areas which can cover wide range of materials science and device engineering fields essential for the low-carbon society.

Research Potentials as a Hub, Research Collaborations/Supports for Satellites

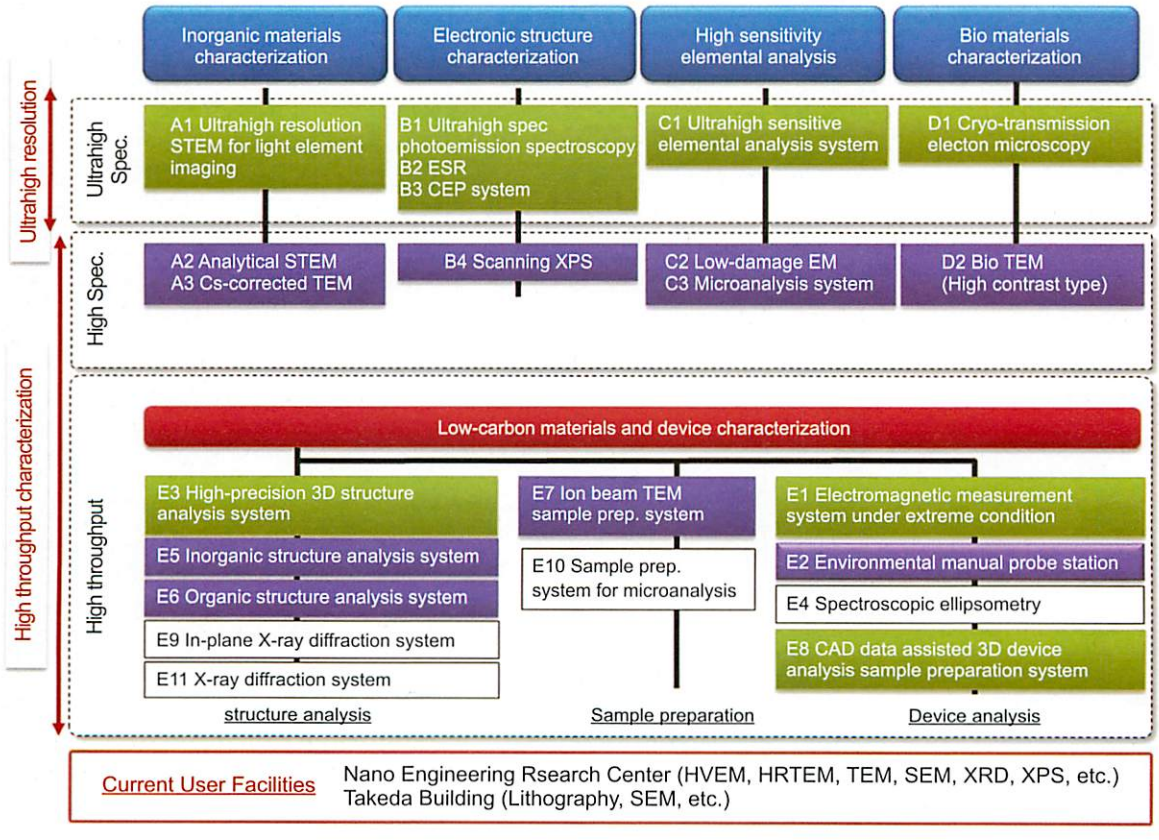
We combine our research potentials for advanced nano characterization such as direct light element imaging, electronic state measurements, high sensitivity elemental analysis, and for green nanomaterials such as hetero-interface materials, organic-inorganic hybrid materials, biomimetic materials, in order to enhance green nanotechnology. Also, we provide advanced nano characterization techniques to other research hubs and satellites.

Plans for Activating the Network

We set up a service division which provide a total support to the outside researchers. This division manages web registration system, open labs and seminars for efficient and fruitful research interactions.



Main Open Facilities

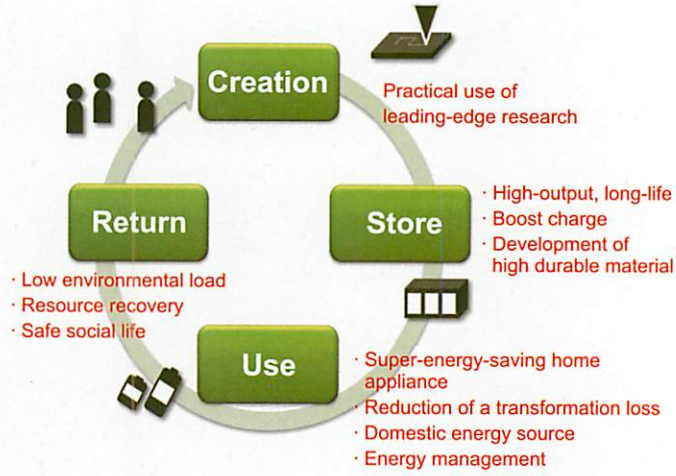


Micro/Nano Fabrication Hub in Kyoto Univ.

Kyoto University
Managing Director, Satoru Komori
URL: http://www.ksys.me.kyoto-u.ac.jp/ TEL: +81-75-753-5231 E-MAIL: kyodai-hub@saci.kyoto-u.ac.jp
Contact person: Masashi Takeuchi

Summary

The role of the micro/nano fabrication hub is to accelerate the research and the development of various innovative materials and nano/micro devices, and to contribute to the technology transfer in the industrial field for the realization of low-carbon future. The research fields are divided into four domains of "Creation", "Store", "Use", and "Return". Various equipment are provided for researchers and students in the hub. That equipment is used for examining and fabricating nano/micro devices of variety materials and the thin film materials on a wafer scale.



Research Collaboration Plans and Directions

Design Concepts and Management Policies on the Hub

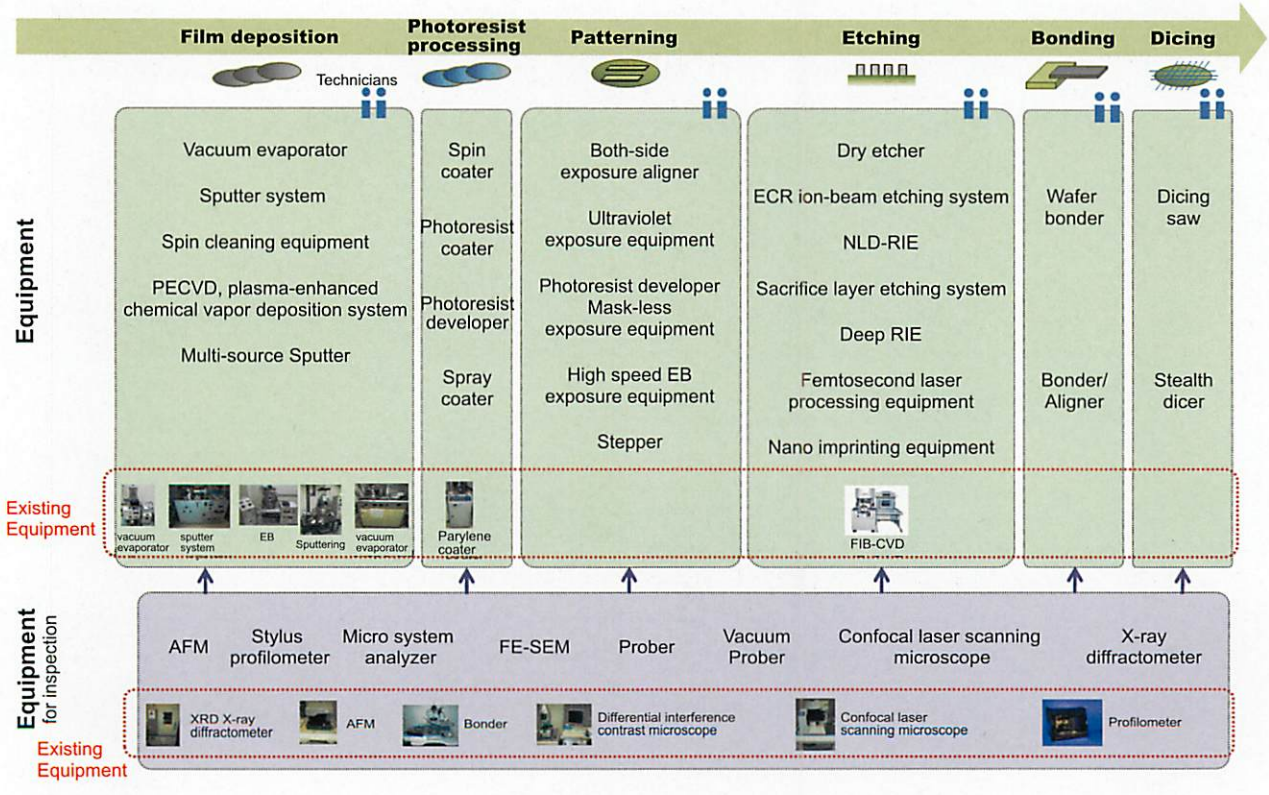
The user can apply various substrates in the size of 4 inches or 6 inches in the hub. The user can also use various fabrication processing machines; thin film deposition, photo lithography, photoresist processing, patterning, wet and dry etching, bonding, dicing and evaluation. The highly established technical engineers who can give education and learning about the processing machines and advanced micro-fabrication technologies support the advanced technology.

Research Potentials as a Hub, Research Collaborations/Supports for Satellites

Kyoto University has an abundant research performance in the field of the materials and devices for realization of low-carbon future, and can offer the advanced fabrication technology based on that research performance. Moreover, the research environment of the hub, which has the ability to apply large wafers for trial production from the stage of basic research through the practical development enables the acceleration and the early commercialization of the research and the development.

Plans for Activating the Network

Teleconferencing systems are served in the hub for seamless communication between the hub and the satellite. The hub also cooperates with other hubs closely.

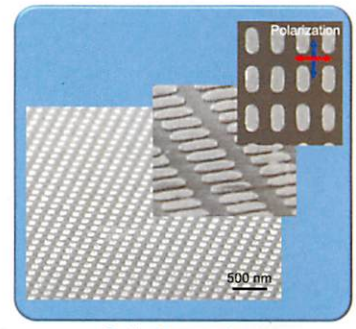


Research Center for Highly-Efficient Photoelectric Conversion System Using Optical Nano-Antenna

Hokkaido University
Managing Leader, Hiroaki Misawa
URL: http://lcs.es.hokudai.ac.jp TEL: +81-11-706-9340 E-MAIL: lcs@es.hokudai.ac.jp
Contact person : Yasutaka Matsuo

Summary

Research center for highly-efficient photoelectric conversion system using optical nano-antenna is to study new photoelectric conversion devices, especially next generation solar cells using optical nano-antenna which can harvest near-infrared light efficiently. Although many types of solar cells have been proposed and constructed before, these energy conversion systems are not sufficient for photoelectric conversion in near-infrared wavelength. This research center promotes research and development of next generation solar cells according to achieve highly-efficient photoelectric conversion of near-infrared light using metallic nanostructures as optical antenna.



Optical nano-antenna

Research Plan and Directions

Strategies and Methods for Solving Problems

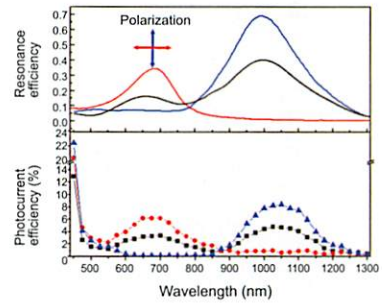
(1) Design and fabrication of optical nano-antenna according to increase enhancement of optical near-field, (2) Design and fabrication of sub-wavelength structures in order to increase interaction between photons and optical nano-antenna, (3) Analysis of photoelectric conversion dynamics

Originality and Unique Techniques

- Design and fabrication of plasmonic nanodevices for new photoelectric conversion system
- Analysis for dynamics and efficiency of photoelectric conversion process

Expected Outcomes

Development of solar cells to achieve highly-efficient photoelectric conversion of near-infrared light as well as visible light and creation of new nanodevices using optical nano-antenna.



Photoelectric conversion efficiency using Au nanorods/TiO_2 device

Main Open Facilities

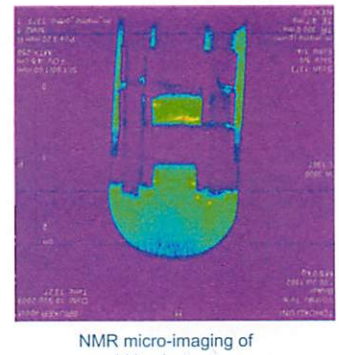
- Analysis system for photoelectric conversion dynamics
- Ultra-High Precision Electron Beam Lithography System
- Atomic Layer Deposition (ALD) system
- Laser Drawing System

Center for Fusion Research of Nano-Interface Devices

Tohoku University
Managing Leader, Kazue Kurihara
URL: http://res.tagen.tohoku.ac.jp/~teitanso/ TEL: +81-22-217-5149 E-MAIL: teitanso@res.tagen.tohoku.ac.jp
Contact person : Toru Miura

Summary

Center for fusion research of nano-interface devices will perform the research and development for rechargeable battery and low friction technique, especially focus on solving the problem concerning the nano-interface design. The nano-interfaces of these devices have not been well elucidated, which results in the energy loss at the interfaces and disturbs the development of such devices. This center performs researches according to the plan and directions described below, and will establish the principles for the optimized design of the nano-interfaces for accelerating the development of a highly efficient rechargeable battery and a low friction technique.


NMR micro-imaging of Li ion battery

Research Plan and Directions

Strategies and Methods for Solving Problems

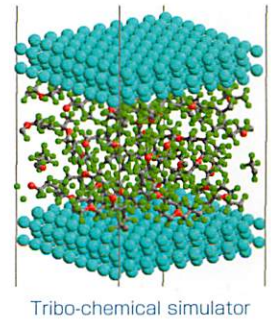
Elucidation of structures as well as the dynamics of ion and molecules at electrodes and tribological interfaces on the atomic to nanometer scales.

Originality and Unique Techniques

NMR and SIMS micro-imaging of chemical reactions in batteries; characterization of interfaces by surface forces and resonance shear measurement; fabrication of low friction interfaces using complex texturing.

Expected Outcomes

Accelerated development of an innovative Li-ion rechargeable battery and an innovative ultra-low friction technique, which are important for energy saving towards low-carbon society.


Tribo-chemical simulator

Main Open Facilities

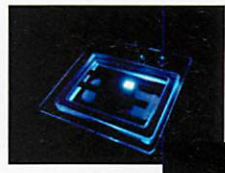
- Secondary ion mass spectroscopy
- Spectroscopic measurement system for nano-interfaces

Center for Research on Smart Organic Electronics Devices Based on Nano-Processing Technology

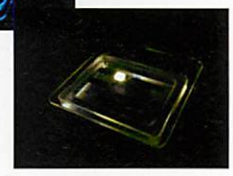
Yamagata University
Managing Leader, Yoshihiro Ohba
URL: http://www.yz.yamagata-u.ac.jp TEL: +81-238-26-3004 E-MAIL: koukenkyu@jm.kj.yamagata-u.ac.jp
Contact person : Shutoku Konsei

Summary

This research center develops smart organic electronics devices, especially, high-efficiency OLEDs, based on nano-processing technology for controlling of behaviors of light.



Ultra highly efficient organic light-emitting diode



White organic light-emitting diode

Research Plan and Directions

Strategies and Methods for Solving Problems

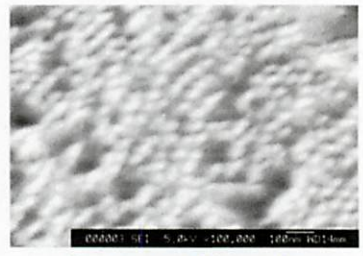
Development of fabrication techniques for high efficiency OLEDs with wide areas via construction of nano-structures to improve efficiencies such as light out-coupling efficiency.

Originality and Unique Techniques

Techniques to fabricate OLEDs with precise nano-structures to control behaviors of light based on the marriage of the advanced researches on OLEDs and the precise nano-fabrication technologies.

Expected Outcomes

Development of high-efficiency OLEDs with wide areas to relieve an industrialization bottleneck of OLEDs.



Nano-structures fabricated by thermal nano-imprinting

Main Open Facilities

- Precise Nano-machining System
- Laser Microscope
- X-ray Diffraction Analyzer
- Atomic Force Microscope
- Roll-to-Roll Imprint System
- Exposure System

Center for Advanced Carbons for Hydrogen Technologies

Gunma University
Managing Leader, Junichi Ozaki
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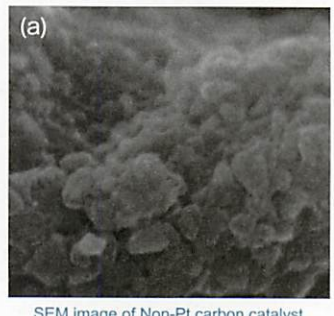
Contact person : Atsushi Machida

Summary

The mission of this center is to develop carbon materials used for formation, storage and utilization of hydrogen resources. These will be accelerated by the close locations of the such as synthesis, evaluation of performances and structural analyses of the carbons.



SEM image of Non-Pt carbon catalyst (Nanoshell)

Research Plan and Directions

Strategies and Methods for Solving Problems

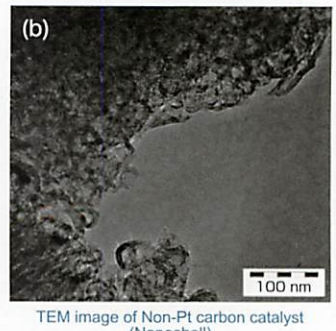
Effective syntheses of the advanced carbons for the abovementioned purposes are explored by understanding the correlation between their structures and functions.

Originality and Unique Techniques

The members of this center have superior ability to develop functional carbon materials, which is evidenced by their accomplishment of non-platinum cathode catalytic carbons in fuel cells.

Expected Outcomes

The development of the carbon materials aimed in this project will accelerate the advent of a social system based on hydrogen energy, which is expected to be 2050.



TEM image of Non-Pt carbon catalyst (Nanoshell)

Main Open Facilities

- Electron spin resonance spectrometer
- Raman scattering spectrometer

Platform for Green Functional-Oxide Nanotechnology

National Institute of Advanced Industrial Science and Technology

Managing Leader, Hiroyuki Akinaga

URL: http:// www.open-innovation.jp/GreFON/ TEL: +81-29-861-3210 E-MAIL: grefon_contact@m.aist.go.jp

Contact person : Hisashi Shima

Summary

Platform for Green Functional-Oxide Nanotechnology (GreFON) is a multi-user facility, promoting an innovation in the field of energy and environmental technologies, by the integration with nanotechnology. The integration enables us to utilize the exceptional functionalities of oxides for various energy-saving and energy-creating applications.

The application of the functional oxide in the whole area of nanoelectronics is our first target, and the research and development is promoted based on the following plan.

Energy-saving Electronic Device consisting of Transparent Oxides

Research Plan and Directions

Strategies and Methods for Solving Problems

The platform offers an open innovation network where the research and development is accelerated both by nano-characterization and nano-fabrication functions. The research bottleneck will be solved by the cutting-edge nano-characterization techniques and the rapid prototyping.

Originality and Unique Techniques

The platform offers a chance to use practical techniques and IP, in terms of the thin-film and the heterostructure growth of various oxide materials and state-of-the-art nano-characterization technologies.

Expected Outcomes

For example, non-volatile logic and memory devices and Solid Oxide Fuel Cell (SOFC).

Main Open Facilities

- Defect Characterization System with Slow Positrons
- X-ray Photoelectron Spectroscopy
- Nano-Fab & Characterization tools

Cooperation with National Institute of Materials Science
Magnetic Materials Center: http://www.nims.go.jp/apfim/
Atomic Electronics Group: http://www.nims.go.jp/atom_ele_gr/

Center for ultra high efficiency photovoltaics by quantum nanostructure

Tokyo Institute of Technology

Managing Leader, Akira Yamada

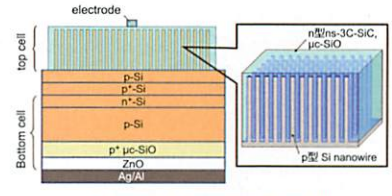
URL: http://www.pe.titech.ac.jp/LCS_by_nanotech/index.htm TEL: +81-3-5734-2572 E-MAIL: miya@pe.titech.ac.jp

Contact person : Yasuyuki Miyamoto

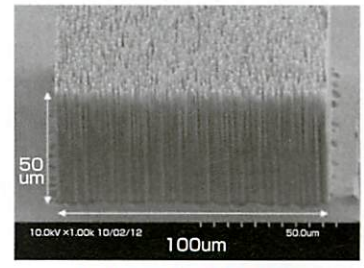
Summary

By combining photovoltaics technologies with nano-fabrcaition techniques in Tokyo Tech, wide-bandgap solar cells using the quantum effect of nano-structures can be achieved.

This center will develop tandem type solar cells incorporated with this wide-bandgap solar cell to realize ultra high efficiency full-spectum solar cells for a great reduction of CO_2.



Schmatic of nanowire solar cell



SEM view of silicon nanowire

Research Plan and Directions

Strategies and Methods for Solving Problems

The bandgap of silicon can widen by using quantum effect of nano-structures. Using this quantum effect, wide-bandgap cells, which can be stacked with conventional solar cells, will be develop.

Originality and Unique Techniques

Tokyo Tech can fabricate photovoltaics with 18.5% efficiency by using silicon heterojunction solar cell. On the other hand, nano-fabrication technologies for optics and electrics devices are also high level in the world. With the combination of these two technologies, high efficiency photovoltaics by quantum nanostructure can be developed.

Expected Outcomes

As renewable energy in low carbon society, photovoltaics are most promising technology. In this project, the efficiency of photovoltaics will be improved.

Main Open Facilities

- Electron beam lithography machine
- Scanning electron microscope

Center for Ultra-Low-Loss Power Diamond Transistor

WASEDA UNIVERSITY

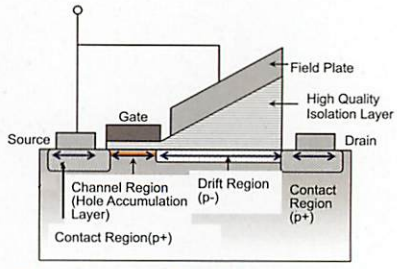
Managing Leader, Hiroshi Kawarada

URL: http://www.all-nano.waseda.ac.jp/diamond_transistor/index.html TEL: +81-3-5286-9068 E-MAIL:kawarada@waseda.jp

Contact person : Hiroshi Kawarada

Summary

Center for ultra-low-loss power transistor of Waseda University is creating high-voltage and low-resistance switch with high insulation and conductivity, which are obtained by uniform electric-field distribution and high current-density on Field Effect Transistor(FET) made from semiconducting diamond. We also construct facilities which allow us to process various advanced materials including diamond that compose the transistor and its peripherals. By these activities we feature our satellite to create various transistor structures for high power, high frequency with high precision; and to evaluate details of the transistor performance.



High voltage power field-effect transistor with planar-drift structure

Research Plan and Directions

Solutions and Methods for Our Target

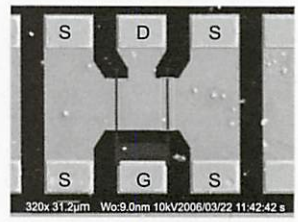
For minimizing loss of power devices, we need to satisfy two trade-off requirements: high voltage resistance at the off-condition and high conductivity at the on-condition. Diamond is a semiconductor with the highest break-down electric field. On the other hand, it is a low resistance material exhibiting superconductivity. In this project we take advantage of such characteristics of diamond to accelerate applied technologies for (FET).

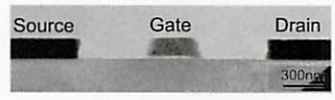
Originality and Unique Technologies

To develop a high-voltage and low-loss power FET, we process a planer type drift-structure for high-voltage resistant part by using three dimensional nanofabrication, which is one of our most advanced technologies.

Expected Goals

Steady loss and switching loss of inverter operated at 1000V will be reduced to 1/10 or less. The inverter loss is expected to be 1% or less, which is currently not obtained even in other wide bandgap materials such as SiC and GaN.





High-frequency and high-output diamond MOSFET

Main Open Facilities

- Precisely Controlled Semiconductor Substrate Alignment, Surface processing, and Bonding System
- Focus Ion / Electron Beam Nanofabrication and Observation System
- High Voltage Device Performance Tester

Center for Green nano-bioelectronics

Tokyo University of Agriculture and Technology

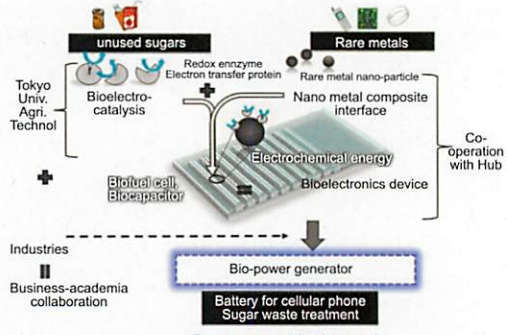
Managing Leader, Koji Sode

URL: http://www.tuat.ac.jp/research/nanobioe/ TEL: +81-42-388-7027 E-MAIL: nanobioe@cc.tuat.ac.jp

Contact person : Koji Sode / Kazunori Ikebukuro

Summary

We focus on the development of "Bioelectro-catalysis" which is a key technology for "Green nano-bioelectronics". Green nano-bioelectronics is a novel engineering to proceed Nano-bioelectronics in view of Green technology. To develop Bio-power-generator, we are planning to use unused sugars in various kinds of biomass for its energy source according to the following research plans and directions.



Green nano-bioelectronics

Research Plan and Directions

Strategies and Methods for Solving Problems

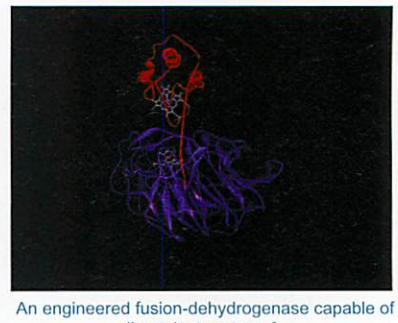
We develop the enzyme which can oxidize various kinds of unused sugar to construct Bioelectro-catalysis.

Originality and Unique Techniques

There are few reports on the enzymes which can efficiently oxidize unused sugars and those development is our originality and unique techniques.

Expected Outcomes

We will develop a novel green technology such as Bio-power-generator, using Bioelectro-catalysis.



An engineered fusion-dehydrogenase capable of directelectron transfer

Main Open Facilities

- Bioelecto-catalysis design/evaluation instrument

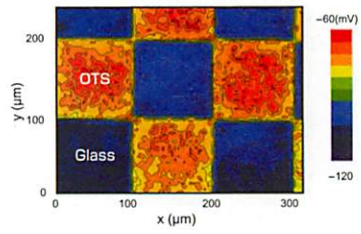
(Mass spectroscopy, SPR, Fluorescence correlation spectroscopy, micro calorie meter)

Sensing Center for Nano/Micro Thermofluid & Thermal Properties

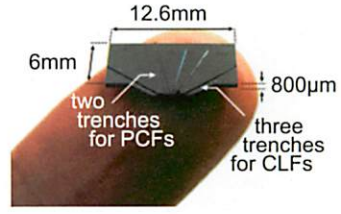
Keio University
Managing Leader, Koichi Hishida
URL: http://www.tfe.sd.keio.ac.jp/nmtfs TEL: +81-45-566-1739 E-MAIL: nmtfs_info@tfe.sd.keio.ac.jp
Contact person : Norihisa Miki

Summary

Keio University constructs Sensing Center to help Japanese researchers measure thermofluid quantities and thermal properties in nano/microscale, which will contribute to develop novel Green devices that will become one of the key elements of the Low Carbon Society.



Wall zeta-potential mapping



Micro viscosity sensor

Research Plan and Directions

Strategies and Methods for Solving Problems

This Center has advanced sensing facilities with the high spatial and temporal resolution, which enables researchers to obtain the spatial distribution in time series of thermofluid quantities and thermal properties in micro/nano device, and contributes to expand activities between the Hubs, Satellites and others.

Originality and Unique Techniques

In this Sensing Center, all potential users can measure fluid velocity, temperature and pH, and zeta-potential of nano/microchannel, thermal conductivity and permittivity of device materials under ultrahigh vacuum condition, etc. with the high spatial and temporal resolution. Moreover, novel sensing facilities based on stimulated Raman scattering and near-field optics will be developed.

Expected Outcomes

This Sensing Center enhances collaborating between the Hubs, Satellites and others by providing leading-edge facilities for integrating nano/micro devices.

Main Open Facilities

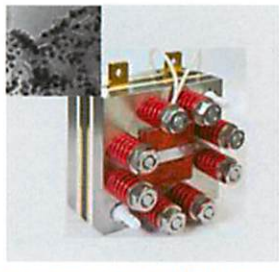
- Spatial and temporal sensing system for multivariable of thermofluid in microscale
- Ultra high-speed sensing system for thermofluid velocity in microscale
- Nano-PIV/LIF system using wide-area evanescent wave illumination
- Atomic-resolved Kelvin probe force microscope
- Nanoscale thermal imaging system with environmental control unit

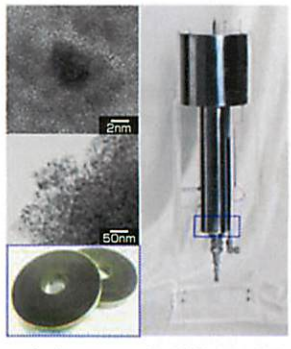
Center for Fuel Cell Nanomaterials

University of Yamanashi
Managing Leader, Masahiro Watanabe
URL: http://www.yamanashi.ac.jp/ TEL: +81-55-254-7092 E-MAIL: harasina@yamanashi.ac.jp
Contact person : Mitsumoto Harashina

Summary

Our Center is developing and evaluating materials for fuel cells and fuel reformers with the full use of nanotechnology to establish the basic technology for high performance fuel cells. At present, the key aspects of the research are new fuel cell materials such as catalysts, electrolyte membranes, membrane-electrode assemblies (MEAs) and fuel reforming catalysts.


Polymer electrolyte fuel cell and electrocatalyst synthesized by the nanocapsule method



Compact fuel processor for 1kW-class PEFC and metal-monolithic catalyst for selective CO methanation

Research Plan and Directions

Strategies and Methods for Solving Problems

In order to contribute to the actual widespread utilization of fuel cells, we will develop and evaluate hydrocarbon membranes with high protonic conductivity and dimensional stability, Pt alloy catalysts, and fuel reforming catalysts with high activity and high durability, based on nanotechnology.

Originality and Unique Techniques

We have invented high-activity Pt catalysts alloyed with non-precious metals for CO-toerant H_2 oxidation and O_2 reduction. We also developed the "nanocapsule method," for the synthesis of nano-sized Pt and Pt-alloy particles based on nanotechnology, and the 1 kW-class metal monolith-equipped reformer with a selective CO methanation catalyst.

Expected Outcomes

With the establishment of the above, a basic technology for high performance fuel cells will realize such performance with high reliability and low cost at the same time, and will contribute to the widespread use of fuel cells.

Main Open Facilities

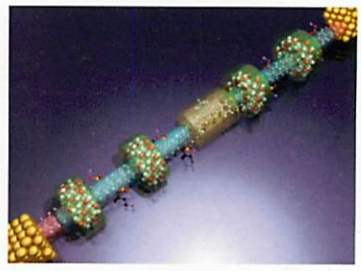
- Evaluation system for hydrogen reformer
- Micro-differential scanning calorimetry
- X-ray diffractometer
- X-ray fluorescence analysis

Research Center for Organic/Oxide Green Nano Device

Osaka University
Managing Leader, Tomoji Kawai
URL: http://www.sanken.osaka-u.ac.jp/labs/nano/ TEL: +81-6-6879-4309 E-MAIL: lw-device@sanken.osaka-u.ac.jp
Contact person : Akihiro Oshima

Summary

At this center, low power-consumption type organic and oxide nano-scale devices are investigated with focusing on the nano-scaling of devices and the optimization of nano-fabrications. In order to attain our object, the 10-nm level accuracy of fabrication as well as the closer cooperation of the three functions of nanofabrication/electrode-fabrication/observation is highly important.



Organic nanowire device

Research Plan and Directions

Strategies and Methods for Solving Problems

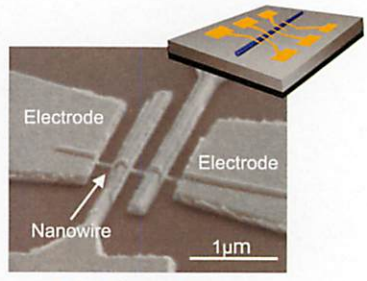
From the breakthrough of the limit of current device processing accuracy (about 100 nm) and nano-observation of devices under operating conditions, the super energy-saving devices with 10-nm level accuracy are developed.

Originality and Unique Techniques

Development of organic and oxide nano-scale devices. Establishment of the in-situ observation of operating devices and fabrication process.

Expected Outcomes

By the acceleration of R&D for low power-consumption organic and oxide nano-scale devices, the project is aiming for a 2.64 million tons reduction in CO_2.



Oxide nanowire device

Main Open Facilities

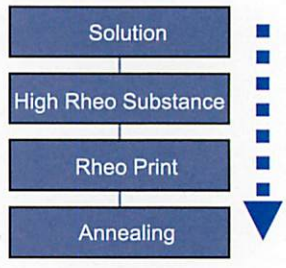
- Nanofabrication System for Nano-device
- Electrode Fabrication System for Nano-device
- Observation & Analysis System for Nano-device

Center for Nano-Rheological Printing

Japan Advanced Institute of Science and Technology
Managing Leader, Tatsuya Shimoda
URL: http://www.jaist.ac.jp/index-j2.shtml TEL: +81-761-51-1910 E-MAIL: sinkou@jaist.ac.jp
Contact person : Kenya Nomura

Summary

Our regional center conducts research and development of Nano-Rheological Printing (N-RP) technology for its industrialization. The N-RP method enables direct imprinting of nano-scale devices less than 100nm by using substances with high rheological properties from solution. If this method can be industrialized, nano-sized devices such as transistors could be manufactured with far lower material and energy consumption compared with current conventional methods. This new method would also contribute to lower CO_2 emissions in high-tech industries. The outline of the activities of our project is provided below.



Process of Nano-Rheological Printing

Research Plan and Directions

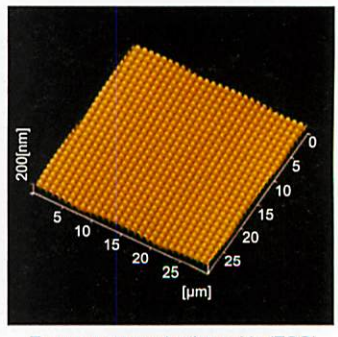
Research Purpose and Content

industrialization of Nano-Rheological Printing and prototyping of devices described below.

1. Establishment of the technology for high-accuracy large-area printing
2. Prototyping of transparent conductive oxide substrate using N-RP for a high- efficiency solar cell
3. Trial manufacture of a transistor array for flat panel displays using N-RP

Originality and Unique Techniques

The N-RP technique is unique in the world because of its high-accuracy printing. Accuracy one or two order higher than with conventional printing is possible, through the combination of careful material preparation with the best tuning of process and equipment.



Transparent conductive oxide (TCO) substrate by N-RP

Expected Outcomes

Industrialization of N-RP is expected to greatly enhance both material yield and energy efficiency in manufacturing high-tech devices. These improvements will also, in turn, reduce CO_2 emission actually.

Main Open Facilities

- Nano-pattern Printing System
- Atmosphere-controlled Coater

The SR Nano-Beam Analysis Center for Green/Nano-technologies

RIKEN
Managing Leader, Tetsuya Ishikawa
URL: http://www.spring8.or.jp/ TEL: +81-791-58-0900 E-MAIL: riken-kikaku@spring8.or.jp
Contact person : Yuri Mazuka

Outline

The SR Nano-Beam Analysis Center for Green/Nano-technologies establishes a satellite of the advanced nano-scale analysis platform that provides SR analysis technology for nano-materials at the atomic, molecular, and electron levels. The Center promotes the use of a high brilliance X-ray nano-beam related to Green/Nano-technologies by applying the most advanced analytical methods.

Research Plans and Directions

Strategies and Methods for solving problems

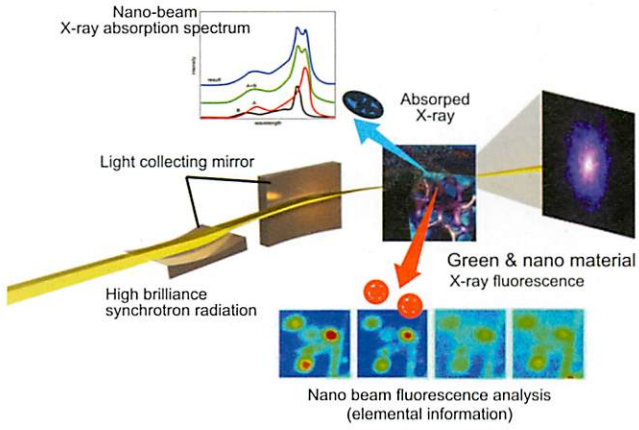
Atomic and molecular structural/electronic/compositional analysis and control at the nano-scale level are essential to the advancement of Green/Nano-technologies. Advanced analytical tools using SR, combined with the nano-scale downsized probe beam, offer excellent solutions for analysis and control.

Original and Unique Technologies

The world brightest synchrotron radiation facility, SPring-8, offers unique capabilities of advanced measurement technologies by fully utilizing stable nano-scale x-ray beams.

Expected Outcomes

1. Contributions to the development of new energy sources: materials research and functional analysis for Lithium batteries, fuel cells, solar devices, etc.
2. Contributions to the development of energy saving materials: R&D on light weight structural materials such as frontier polymers
3. Contributions to the reduction of greenhouse gases: search for animals, plants, and new materials for future greenhouse technologies.



Main Public Facilities

- Nano-beam x-ray absorbing spectrum analyzer
- Nano-beam x-ray fluorescence analyzer

Green Devices Research Center

Yamaguchi University
Managing Leader, Kazuyuki Tadatomo
URL: http://greendev.eng.yamaguchi-u.ac.jp/ TEL: +81-836-85-9915 E-MAIL: moriknt@yamaguchi-u.ac.jp
Contact person : Kentarou Mori

Summary

This Green Devices Research Center is aimed to carry out R&D for high-efficiency green devices, inter alia, technology development of GaN epitaxial growth on patterned sapphire substrates (PSS). PSS has been proved and widely accepted as the most suitable substrates to improve the LED luminous efficiency. Followings are the proposed plan/aim of R&D to accelerate utilization of high-efficiency LED in various applications.

Research Plan and Directions

Strategies and Methods for Solving Problems

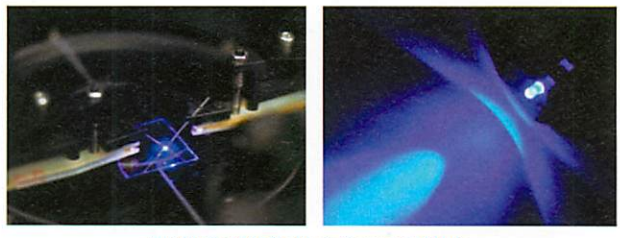
Establishment of high quality GaN crystal growth technology on nano-trench patterned sapphire substrates

Originality and Unique Techniques

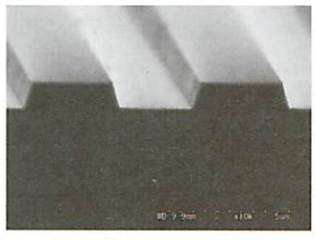
1. Application of nano imprint & photonic crystal technology to PSS
2. Manufacturing of non-polar GaN templates by crystal growth on side-wall of patterned trenches
3. Utilization of various LED chip manufacturing/evaluation facilities

Expected Outcomes

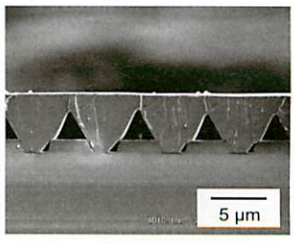
1. Application of PSS to high-efficiency LED
2. High efficiency green LED/LD & power control devices originated with non-polar GaN substrates



First InGaN-LED chip in Yamaguchi Univ.



High-efficiency-proved PSS



Non-polar GaN template grown on PSS

Main Open Facilities

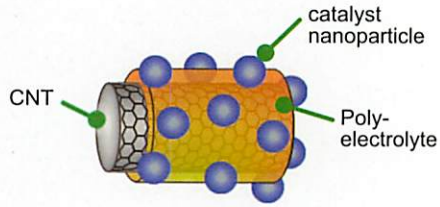
- HVPE (Hydride Vapor Phase Epitaxy)
- Nano Imprint Lithography

Center for Nanomaterials of Future Fuel Cell Electrocatalysts

Kyushu University
Managing Leader, Naotoshi Nakashima
URL: http://low-carbon.cstm.kyushu-u.ac.jp TEL: +81-92-802-2840 E-MAIL: low-carbon@cstm.kyushu-u.ac.jp / nakashima-tcm@mail.cstm.kyushu-u.ac.jp
Contact person : Naotoshi Nakashima

Summary

The mission of the "Center for Nanomaterials of Future Fuel Cell Electrocatalysts" is to design and develop high temperature operative, durable, highly active, platinum-free electocatalysts, for which there is a strong social demand to realize a global low-carbon society. Our technologies for future fuel cell electrocatalysts provide promising solutions to fulfill the above mission.



A schematic drawing of our electrocatalyst.

Research Plan and Directions

Strategies and Methods for Solving Problems

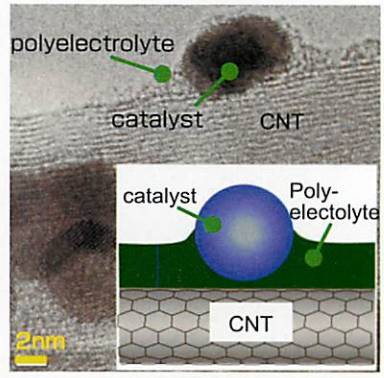
1. Replacement of conventional materials with frontier nanomaterials, such as carbon nanotubes (CNT).
2. A strategic approach to the construction of catalyst interfaces using our bottom-up assembling technology.

Originality and Unique Techniques

The design and creation of an ideal triple-phase boundary structure using a CNT nanocoating technique based on bottom-up assembling technology.

Expected Outcomes

The development of high temperature operative, highly durable, highly active platinum-free electocatalysts.



Our electrocatalyst forming an ideal triple-phase boundary structure.

Main Open Facilities

- Nanocarbon fuel cell measurement system
- Electronic state measurement system
- TEM system for microstructure measurements
- Mid-IR& Far-IR absorption spectrophotometer measurement system

Coordination office

National Institute for Materials Science (NIMS)
University of Tokyo
Kyoto University

Outline

Three Hub-Centers for Materials Design and Fabrication for Low-Carbon Research takes the role as the coordination office of "Low-Carbon Research Network Japan (Lcnet). The coordination offices support the entire activity of the Lcnet.

Activity

- We provide coordination of the entire project, consultation service as well as promotion of international exchange, collection and transmission of information, networking and human resource development.
- New operating system and website for common use based on up-coming experiences will be constructed.
- Organization to promote common use of equipments will be started from FY2011.
- The coordination office opens the worldwide researchers.

Follow-up System / Steering Committee

Since this project is treated as "an emergency-economic measure for tomorrow's ease and growth" announced by Prime minister of Japan and his cabinet, progress of green technology by this project is thought and judged from a view point of plan-do-check-act (PDCA) cycle by the National Policy Unit; Cabinet Secretariat and the Cabinet Office; Government of Japan, and if necessary, revisions and/or modifications of the project is claimed. Thus, under the MEXT administration, a steering committee as shown below is organized for following-up activities, achievements and outcomes of each research-center or whole of the network.

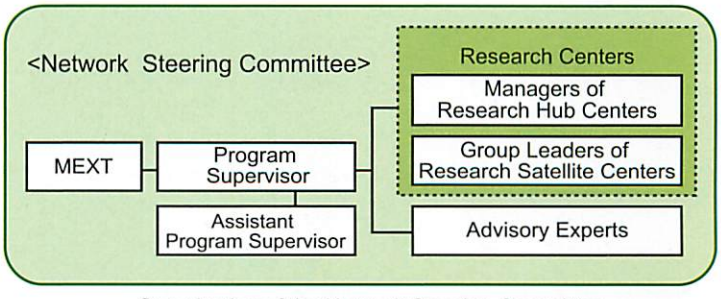
Follow-up System

Network Steering Committee

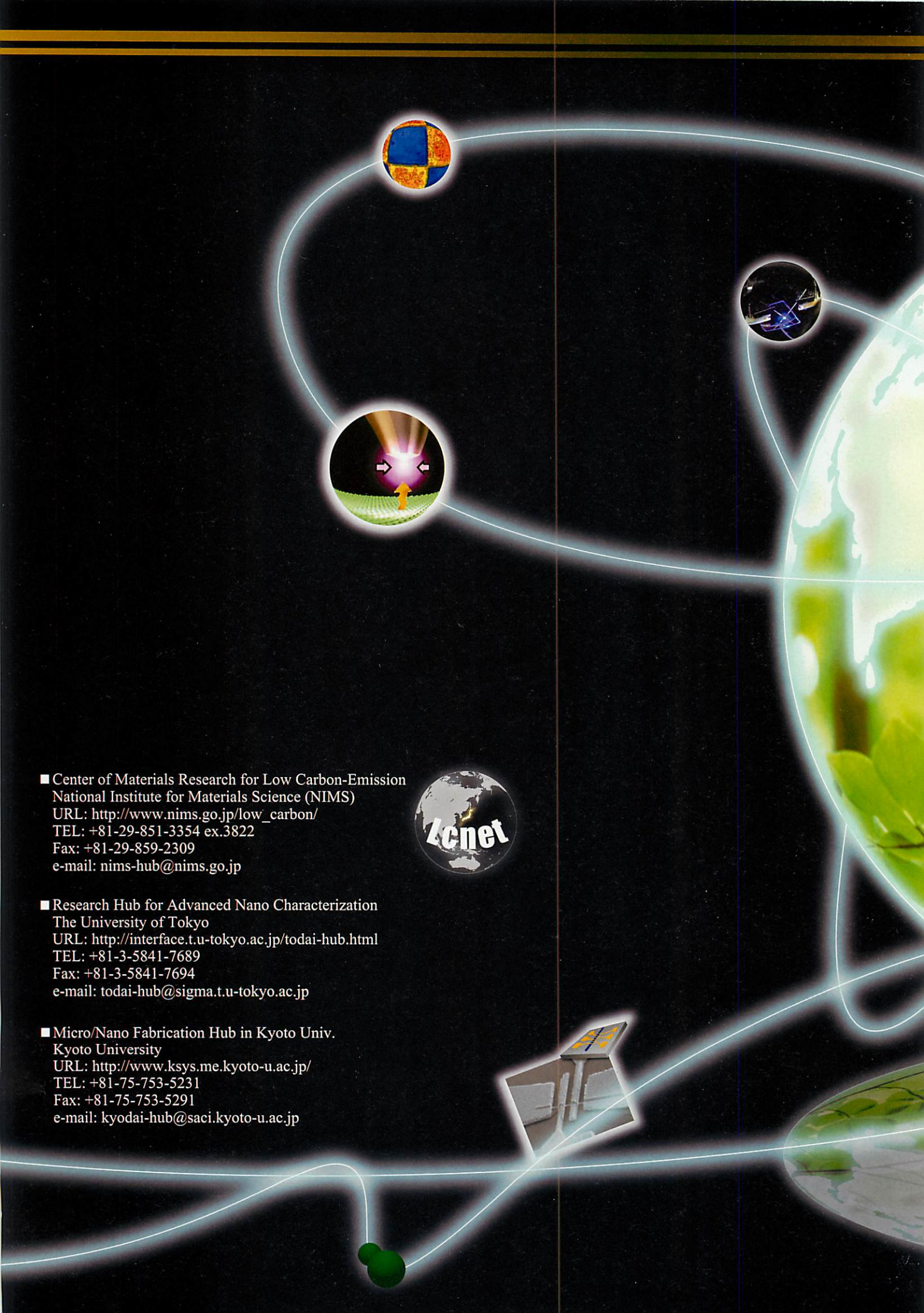
A network steering committee, composed of the managers of the research hub centers and the group leaders of the research satellite centers and advisory experts, must be regularly called for the sake of grasping progress of whole the project and reconsidering project scheme. The status of this project are summarized and reported to MEXT.

Branch Subcommittee

A branch subcommittee for each research center, composed of representatives of the centers and the designated advisory experts, must be established. The advisory experts are in charge with inspecting the research outcomes and accompanying activities of the center, and giving specific advices for accelerating research.



Organization of the Network Steering Committee



■ Center of Materials Research for Low Carbon-Emission
National Institute for Materials Science (NIMS)
URL: http://www.nims.go.jp/low_carbon/
TEL: +81-29-851-3354 ex.3822
Fax: +81-29-859-2309
e-mail: nims-hub@nims.go.jp

■ Research Hub for Advanced Nano Characterization
The University of Tokyo
URL: http://interface.t.u-tokyo.ac.jp/todai-hub.html
TEL: +81-3-5841-7689
Fax: +81-3-5841-7694
e-mail: todai-hub@sigma.t.u-tokyo.ac.jp

■ Micro/Nano Fabrication Hub in Kyoto Univ.
Kyoto University
URL: http://www.ksys.me.kyoto-u.ac.jp/
TEL: +81-75-753-5231
Fax: +81-75-753-5291
e-mail: kyodai-hub@saci.kyoto-u.ac.jp