CREST '14

Core Research for Evolutionary Science and Technology

Strategic Basic Research Programs

http://www.jst.go.jp/

独立行政法人
科学技術振興機構
Japan Science and Technology Agency

CREST

Network-based (team-based) research giving rise to outstanding results that lead to scientific and technological innovation

Concept

To achieve Strategic objectives established by the Japanese government, the CREST program promotes unique and world-leading directed basic research. The CREST program seeks to produce outstanding results that contribute significantly to scientific and technological innovation.

Outline

1. Management of Research Areas by Research Supervisors

Research Supervisors oversee the activities of Research Directors affiliated with industrial, academic and governmental institutions, and manage Research Areas as virtual research institutes. To maximize the research results in each Research Area, Research Supervisors manage the Research Areas by setting directions of Research Areas, selecting Research Projects, coordinating and approving research plans, sharing views with and advising Research Directors, evaluating Research Projects, etc.

2. Strong Leadership of Research Directors

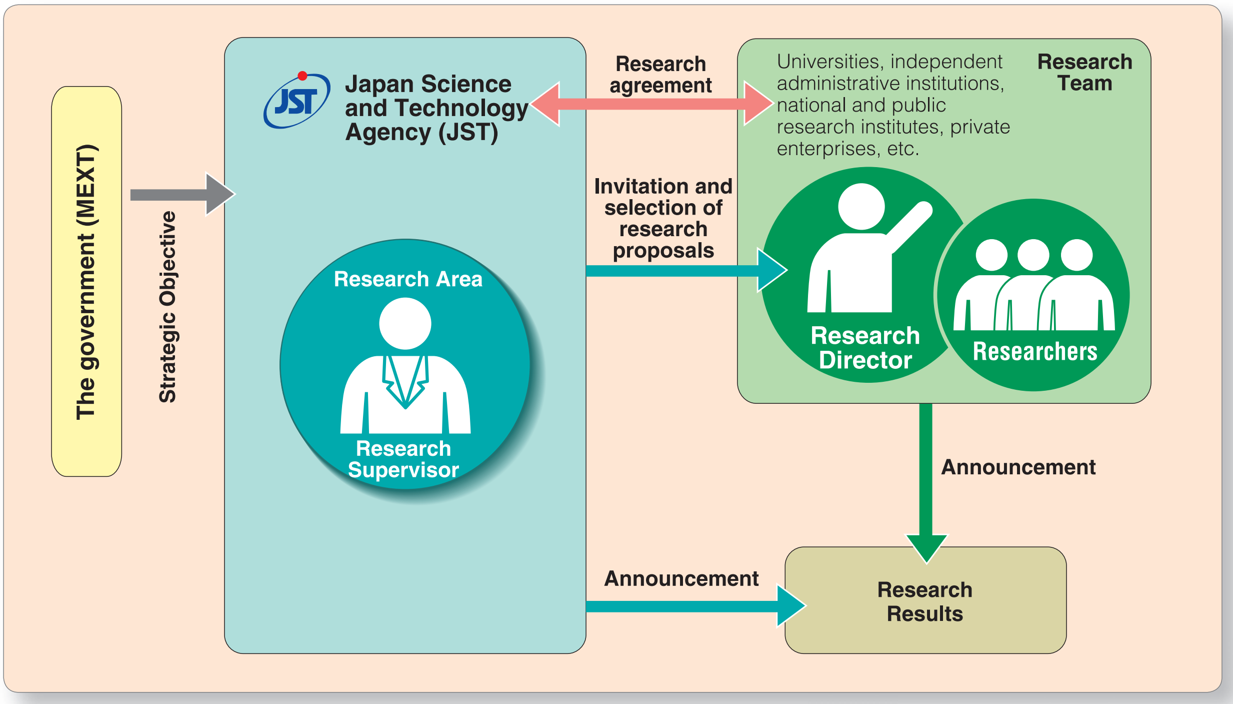
In pursuit of the research concept he or she has proposed, a Research Director will assemble a single optimal research team consisting of multiple researchers. The Research Director bears responsibility for the entire research team and advances research in a way that contributes to achievement of the Research Area's overall objectives.

3. Formation of Networks for Scientific and Technological Innovation

Each Research Director, with the support of the Research Supervisor and Research Area Advisors, will form a network of researchers inside and outside the Research Area and actors from industry and others. Research Directors utilize this network for the effective production of results and development of innovation by sharing information and collaborating with these people.

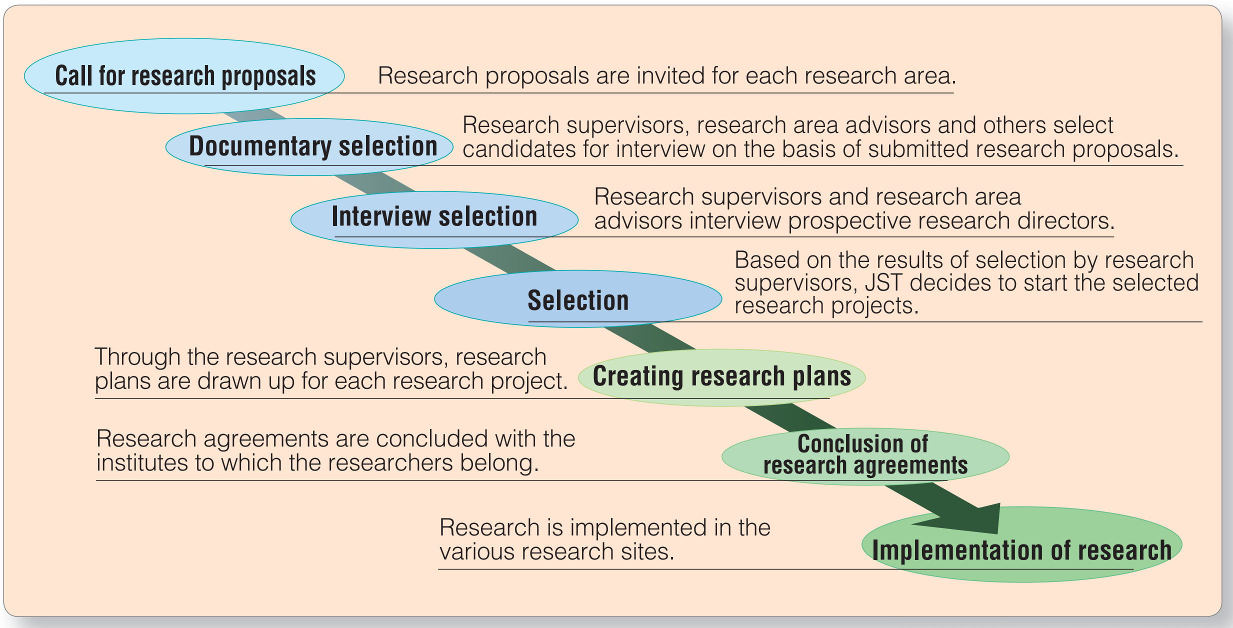
Flow of CREST

Research proposals are invited and selected, research agreements are concluded with the institutes to which the researchers belong, and the research is promoted.



From research proposals to the start of the research

Details of Information about the deadline for proposals, and an outline of the invitation are published on the JST website (http://www.jst.go.jp/EN/index.html).



On - going Research Areas

37 Research Areas, 431 Research Themes

Research Area	Research Supervisor
Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy	**Koichi Eguchi** Professor, Graduate School of Engineering, Kyoto University
Phase Interface Science for Highly Efficient Energy Utilization	**Nobuhide Kasagi** Professor Emeritus, The University of Tokyo / Principal Fellow, CRDS, JST **Kazuhito Hashimoto** (Assistant Supervisor) Professor, The University of Tokyo
Creation of Essential Technologies to Utilize Carbon Dioxide as a Resource Through the Enhancement of Plant Productivity and the Exploitation of Plant Products	**Akira Isogai** Professor Emeritus, Nara Institute of Science and Technology
Establishment of Core Technology for the Preservation and Regeneration of Marine Biodiversity and Ecosystems	**Isao Koike** Professor Emeritus, The University of Tokyo
Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms	**Tadashi Matsunaga** President, Tokyo University of Agriculture and Technology
Creative Research for Clean Energy Generation Using Solar Energy	**Masafumi Yamaguchi** Dtstinguished Professor, Toyota Technological Institute
Innovative Technology and System for Sustainable Water Use	**Shinichiro Ohgaki** President, Japan Water Research Center **Mikio Yoda** (Deputy Research Supervisor) Senior Chief Engineer, Information & Control Systems Company, Hitachi Limited
Creation of Innovative Technologies to Control Carbon Dioxide Emissions	**Itaru Yasui** President, National Institute of Technology and Evaluation/Vice Rector Emeritus, United Nations University
Innovative Technology Platforms for Integrated Single Cell Analysis	**Sumio Sugano** Professor, Graduate School of Frontier Sciences, The University of Tokyo
Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites	**Takao Shimizu** Director-General, Research Institute, National Center for Global Health and Medicine
Innovation for Ideal Medical Treatment Based on the Understanding of Maintenance, Change and Breakdown Mechanisms of Homeostasis among Interacting Organ Systems	**Ryozo Nagai** President, Jichi Medical University
Structural Life Science and Advanced Core Technologies for Innovative Life Science Research	**Keiji Tanaka** Director, Tokyo Metropolitan Institute of Medical Science
Development of Fundamental Technologies for Diagnosis and Therapy Based upon Epigenome Analysis	**Masayuki Yamamoto** Professor, Tohoku University **Toshikazu Ushijima** (Deputy Research Supervisor) Chief of Division, National Cancer Center Research Institute
Creation of Fundamental Technologies for Understanding and Control of Biosystem Dynamics	**Tadashi Yamamoto** Professor, Okinawa Institute of Science and Technology (OIST)
The Creation of Basic Medical Technologies to Clarify and Control the Mechanisms Underlying Chronic Inflammation	**Masayuki Miyasaka** Professor, Osaka University
Elucidation of the Principles of Formation and Function of the Brain Neural Network and Creation of Control Technologies	**Seiji Ozawa** Professor, Takasaki University of Health and Welfare
Fundamental Technologies for Medicine Concerning the Generation and Regulation of Induced Pluripotent Stem (iPS) Cells	**Toshio Suda** Professor, Keio University
Etiological Basics of and Techniques for Treatment of Allergic and Autoimmune Diseases	**Kazuo Sugamura** President, Miyagi Prefectural Hospital Organization
Creation of a Novel Technology Towards Diagnosis and Treatment Based on Understanding of Molecular Pathogenesis of Psychiatric and Neurological Disorders	**Teruhiko Higuchi** President, National Center of Neurology and Psychiatry
Development of Atomic or Molecular Two-Dimensional Functional Films and Creation of Fundamental Technologies for Their Applications	**Atsushi Kurobe** Senior Fellow, Corporate Research & Development Center, Toshiba Corporation
Innovative Nano-electronics through Interdisciplinary Collaboration among Material, Device and System Layers	**Takayasu Sakurai** Professor, Institute of Industrial Science, The University of Tokyo **Naoki Yokoyama** (Deputy Research Supervisor) Fellow, FUJITSU LABORATORIES LTD.
Creation of Innovative Functional Materials with Advanced Properties by Hyper-nano-space Design	**Tohru Setoyama** Executive Officer Fellow, Mitsubishi Chemical Corporation
Establishment of Molecular Technology towards the Creation of New Functions	**Hisashi Yamamoto** Professor,Chubu University/Emeritus professor,University of Chicago
Creation of Innovative Functions of Intelligent Materials on the Basis of the Element Strategy	**Kohei Tamao** Science Advisor / Director, Global Research Cluster, RIKEN
Enhancing Applications of Innovative Optical Science and Technologies by Making Ultimate Use of Advanced Light Sources	**Tadashi Itoh** Professor / Vice Director, Institute for Nano Science and Design, Osaka University
Creation of Nanosystems with Novel Functions Through Process Integration	**Jun'ichi Sone** Vice President, National Institute for Materials Science
Development of High-Performance Nanostructures for Process Integration	**Masahiro Irie** Professor, Rikkyo University
Research of Innovative Material and Process for Creation of Next-generation Electronics Devices	**Hisatsune Watanabe** President & CEO, Semiconductor Leading Edge Technologies, Inc.
Modeling Methods allied with Modern Mathematics	**Takashi Tsuboi** Dean / Professor, Graduate School of Mathematical Sciences, The University of Tokyo
Intelligent Information Processing Systems Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration	**Norihiro Hagita** Board Director, Director, Social Media Research Laboratory Group, Advanced Telecommunications Research Institute International
Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving	**Yuzuru Tanaka** Professor, Graduate School of Information Science and Technology, Hokkaido University
Advanced Core Technologies for Big Data Integration	**Masaru Kitsuregawa** Director General, National Institute of Informatics **Etsuya Shibayama** (Deputy Research Supervisor) Professor, The University of Tokyo
Creation of Fundamental Theory and Technology to Establish a Cooperative Distributed Energy Management System and Integration of Technologies Across Broad Disciplines Toward Social Application	**Masayuki Fujita** Professor, Tokyo Institute of Technology
Development of System Software Technologies for post-Peta Scale High Performance Computing	**Akinori Yonezawa** Co-director, RIKEN Advanced Institute for Computational Science
Creation of Human-Harmonized Information Technology for Convivial Society	**Toyoaki Nishida** Professor, Graduate School of Informatics, Kyoto University
Alliance for Breakthrough between Mathematics and Sciences (ABMS)	**Yasumasa Nishiura** Professor, Tohoku University
Fundamental Technologies for Dependable VLSI System	**Shojiro Asai** Executive Vice President, Rigaku Corporation

Strategic Objective	First Year	Call for Proposals	Projects	Page
Creation of core technologies for innovative energy carrier utilization aimed at the transport, storage, and use of renewable energy	FY2013	Open	3	P. 4
To realize breakthroughs in phase-interface phenomena and create basic technologies for high-functionality interface that will result in dramatic advancements in highly-efficient energy utilization	FY2011	-	13	P. 4
Creation of basic technologies for utilizing plant photosynthetic functions and biomass that will enable the actualization of efficient carbon dioxide utilization	FY2011	-	13	P. 4
Creation of basic technologies for understanding marine ecology highly efficiently and forecasting marine life changes to conserve and regenerate the marine biodiversity required for sustainable usage of ocean resources	FY2011	-	16	P. 5
Establishment of basic technologies to create bioenergy from algae and other aquatic microorganisms, including growth rate control and metabolic network construction based on genome analysis and function modification	FY2010	-	13	P. 5
Creation of natural light energy conversion material and utilization basic technology through the fusion of different fields	FY2009	-	15	P. 5
Development of innovative technologies for realizing sustainable water management by mitigating water problems intensified by climate change	FY2009	-	17	P. 6
Creation of innovative technologies related to reducing global warming in an effort to realize a sustainable society	FY2008	-	15	P. 6
Creation of integrated single cell analysis fundamental technology contribute to the elucidation of biological functions	FY2014	Open	-	P. 7
Creation of core technologies for early-stage drug discovery through the investigation of disease-specific profiles of biomolecules	FY2013	Open	6	P. 7
Integrated clarification of the maintenance and change mechanisms of dynamic homeostasis in the body and creation of technology to understand and regulate complex dynamic homeostasis to achieve preventive medicine, appropriate diagnosis and treatment	FY2012	Open	10	P. 7
Creation of new technologies for breakthrough in understanding and predicting biological activities and intermolecular interactions by means of “Novel Structural Life Science” that contributes to new medical treatment and prevention of various diseases, food safety enhancement and environmental improvement	FY2012	Open	13	P. 8
Creation of the basic technologies for disease analysis and elucidation of stem cell differentiation mechanisms by using epigenomic comparison toward the realization of treatments and regenerative medicine used to prevent, diagnose, and treat diseases	FY2011	-	19	P. 8
Creation of the technology systems to have absolute control of cells and cell populations by reproducing cell kinetics in silico/in vitro in order to achieve an integrated understanding of life phenomena and realize safe and highly effective treatments among other benefits	FY2011	Open	11	P. 8
Creation of basic medical technologies for the prevention, diagnosis and treatment of cancer, arteriosclerotic diseases, and autoimmune disorders by the elucidation of the mechanisms underlying chronic inflammation	FY2010	-	17	P. 9
Clarification of the control mechanisms of neural circuit operation and its formation	FY2009	-	19	P. 9
Creation of innovative basic medical technologies by stem cell manufacturing and control based on cell reprogramming	FY2008	-	23	P. 9
Development of medical technology using immunoregulation to overcome allergic and autoimmune diseases including pollinosis	FY2008	-	15	P. 10
Creation of innovations toward the development of diagnosis and treatment of psychiatric and neurological disorders based on elucidation of complex and higher brain functions	FY2007	-	14	P. 10
Development of innovative materials and devices based on atomic or molecular two-dimensional functional films, and their applications to practical uses	FY2014	Open	-	P. 11
Creation of innovative core technologies by merging material technology, device technology, and nano-system optimization technology toward the realization of information devices with ultra-low power consumption and multiple functions	FY2013	Open	3	P. 11
Creation of new functional materials by means of technology for controlling spaces and gaps in advanced materials in order to realize selective material storage, transport, chemical separation, and conversion, etc.	FY2013	Open	4	P. 11
Establishment of molecular technology, which is the free control of molecules to bring innovation to environmental and energy materials, electronic materials, and health and medical materials	FY2012	Open	10	P. 12
Creation of innovative function of materials by application of nanoscale material structural control technologies, such as controlling the atomic arrangement, towards the practical use of rare-metal-free materials and new targeted functions, such as ultra-high coercivity and ultra-high fracture toughness	FY2010	-	12	P. 12
Enhancing advanced materials science and life science toward innovations using new light sources, including state-of-the-art laser technology	FY2008	-	16	P. 12
Creation of next-generation nanosystems through process integration	FY2008	-	16	P. 13
Creation of next-generation nanosystems through process integration	FY2008	-	16	P. 13
Exploitation of materials and nanoprocesses for the realization of novel electronic devices with novel concepts, novel functions and novel structures	FY2007	-	18	P. 13
Development of mathematical sciences to describe and analyze social issues in which basic principle is unclear	FY2014	Open	-	P. 14
Development of intelligent information processing technology to realize creative collaboration between human and machines	FY2014	Open	-	P. 14
Creation, advancement, and systematization of innovative information technologies and their underlying mathematical methodologies for obtaining new knowledge and insight from use of big data across different fields	FY2013	Open	2	P. 14
Creation, advancement, and systematization of innovative information technologies and their underlying mathematical methodologies for obtaining new knowledge and insight from use of big data across different fields	FY2013	Open	4	P. 15
Creation of theory, mathematical model, and fundamental technology to establish a cooperative distributed energy management system, which enables the optimization of demand and supply for various energies including renewable energy	FY2012	-	23	P. 15
Creation of basic technologies for system software essential to massive parallel processing (mpp) computation with manycore and other processors	FY2010	-	14	P. 15
Creation of basic technology that enables an information environment that is in harmony with people	FY2009	-	17	P. 16
Search for breakthrough by mathematical / mathematical sciences researches toward the resolution of issues with high social needs (focusing on collaboration with wide research fields in science and technology)	FY2008	-	13	P. 16
Development of fundamental technologies for the large-scale integrated-circuit system that can guarantee high reliability and high security	FY2007	-	11	P. 16

Creation of Innovative Core Technology for Manufacture and Use of Energy Carriers from Renewable Energy

Research Supervisor
Koichi Eguchi
Professor, Graduate School of Engineering, Kyoto University

2013 – 2020

This research area, looking ahead to a hydrogen energy society making stable and efficient use of renewable energy, aims to create fundamental and core technology for efficient conversion of renewable energy to energy carriers that store and transport chemical energy, and for extraction and use of electrical energy, hydrogen, and motive power, etc., from the energy carriers. The research to be carried out to these ends will fuse different fields such as electrochemistry, catalytic chemistry, materials science, and process engineering, without regard to the walls and fences between fields. Examples of the research topics are electrosynthesis, catalyzed synthesis, and electrode and reaction field materials enabling use of renewable energy such as wind power and sunlight for efficient direct synthesis of energy carriers, and synthesis of energy carriers by thermochemical processes using solar heat or the heat of the earth (geothermal energy). Also included in this research area are direct fuel cells, enabling electrical energy to be extracted by using energy carriers as fuel, and dehydrogenation technology for efficient dehydrogenation of energy carriers at low temperatures.

In this research, it is recommended that pioneering studies be carried out contributing to the synthesis and use of new energy carriers superior in hydrogen content, conversion efficiency, and safety to organic hydrides and ammonium, on which research is already under way. However, research on these existing energy carriers can be taken up in this research area if it covers original technology based on new ideas, with different methods for synthesis, use, storage and transport than those assumed up to now.

Phase Interface Science for Highly Efficient Energy Utilization

Research Supervisor
Nobuhide Kasagi
Professor Emeritus, The University of Tokyo/ Principal Fellow, CRDS, JST

Assistant Supervisor
Kazuhito Hashimoto
Professor, The University of Tokyo

2011 – 2018

The primary goal of this research area is to greatly advance fundamental science and technology, which include exploration of phase-interfacial energy conversion/transport phenomena and creation of high-performance phase interfaces, in order to achieve ever more efficient energy utilization and thus to realize an enriched sustainable society.

Specifically, we take up the challenge of creating phase interfaces with significantly reduced energy losses and/or those for highly efficient energy use by deepening fundamental theory and control/optimization methodology of phase interface phenomena. To accomplish these goals, it is indispensible to establish analytical and design techniques integrating nano-, meso- and macro-scales, as well as theoretical methods for the control and optimization of phase interface structures. Furthermore, it is important that the results of such cutting edge fundamental research should be transferred and effectively applied to the design of real equipment and systems, leading to dramatically improved performance, reduced carbon emissions and lower costs.

The ultimate goal of this research area, therefore, is to elucidate energy conversion and transport mechanisms at phase interfaces in order to enable highly efficient energy use; to develop measurement, modeling and simulation methods for integrative analysis and design of phase interface phenomena at multiple scales; to establish mathematical methods for the control and optimization of phase interface structures; and to realize highly functional phase interfaces that allow for theoretically possible maximal performance in actual devices and equipment. To meet these goals, we encourage integrated challenges that go beyond the bounds of existing scientific disciplines and combine the knowledge gained in different fields.

Creation of Essential Technologies to Utilize Carbon Dioxide as a Resource Through the Enhancement of Plant Productivity and the Exploitation of Plant Products

Research Supervisor
Akira Isogai
Professor Emeritus, Nara Institute of Science and Technology

2011 – 2018

This research area targets the creation of essential technologies for utilizing carbon dioxide, as a resource, through the enhancement of plant photosynthesis and the exploitation of plant products.

In detail, the research topics include 1) developing essential technologies that enhance photosynthetic potential through an integrative and systematic approach to understanding the regulatory mechanisms of photosynthesis, the basis of material productivity in plants, with consideration of the interaction between metabolism and translocation of photosynthetic products and other metabolic pathways such as nitrogen assimilation; 2) developing essential technologies that improve the photosynthetic activity, carbon storage potential, and biomass productivity of plants, through the elucidation of the mechanisms by which plants adapt to various environments; and 3) the study of mechanisms of biomass production and decomposition, and the development of technologies for improved biomass utilization. In parallel with these three research topics, this research area focuses on collaboration and synergy in the fields of plant science and biomass engineering.

Establishment of Core Technology for the Preservation and Regeneration of Marine Biodiversity and Ecosystems

Research Supervisor

Isao Koike

Professor Emeritus, The University of Tokyo

2011 – 2018

In this research area, we will pursue cutting-edge research and development of observation and monitoring techniques and prediction models in order to advance the understanding of marine biodiversity and ecosystems. Toward this end, our goal is to establish the core technology essential to the conservation and restoration of marine biodiversity and ecosystems.

In recognition of the current bottleneck in research on marine biodiversity and ecosystems, emphasis is placed on techniques for acquiring biological data, including environmental factors, as well as on prediction modeling. This research area is focused on (1) developing broad, continuous sensing and monitoring techniques for marine organisms and biological populations as well as related environmental factors, in order to improve the efficiency of species identification and biomass estimation and to develop cutting-edge techniques for accumulation and integration of basic biological and environmental data through analysis of ecological networks; and (2) developing novel models for understanding spatial and temporal changes in marine ecosystems and biodiversity and for making predictions about these biological systems.

To investigate items (1) and (2), researchers participating in each project must identify marine biological populations and/or biological processes which are the target of the proposed technique or model. In other words, field research and monitoring are required for validating the developed techniques and models; furthermore, close collaboration is necessary across a wide range of research disciplines. This research area, however, does not appreciate only observational investigations or monitoring of marine species and biological populations.

To overcome the traditional limitations on marine research, we strongly recommend collaborative research between researchers engaged in marine biological sciences (such as marine ecology and taxonomy) and researchers from a wide array of disciplines in engineering and life sciences. Through collaborative research with clearly defined targets, this research area can make significant contributions to policymaking for the conservation of marine environments, including the establishment of marine protected areas and sustainable use of marine resource that takes into account of negative effect on marine organism.

Creation of Basic Technology for Improved Bioenergy Production through Functional Analysis and Regulation of Algae and Other Aquatic Microorganisms

Research Supervisor

Tadashi Matsunaga

President, Tokyo University of Agriculture and Technology

2010 – 2017

This research area aims to create new basic technologies for bioenergy production using algae and other aquatic microorganisms. Some algae and other microorganisms have high lipid or carbohydrate content, produce various hydrocarbons, and show high growth capability. These properties can be applied to innovative technologies for bioenergy production.

Specifically, research proposals should focus on improvements in the efficiency of energy production through the elucidation of the physiological functions and metabolic pathways of algae and other aquatic microorganisms, which are effective bioenergy producers, using advanced scientific technologies from the fields of genomics, proteomics, metabolomics, and cell analysis. Moreover, the results of proposed research may also benefit various other technologies related to the production of useful chemicals and water treatment using algae and other aquatic microorganisms.

Challenging research themes in broad areas including biology, chemistry, and engineering are welcome for the future realization of innovative technologies leading to bioenergy production.

Creative Research for Clean Energy Generation Using Solar Energy

Research Supervisor

Masafumi Yamaguchi

Distinguished Professor, Toyota Technological Institute

2009 – 2016

This research covers solar photovoltaic technology that converts sunlight directly into electrical energy encompassing; research and development that contributes to the creative clean energy generation for the future, including the creation of chemical fuel technologies for hydrogen generation using solar energy; and technology for the simultaneous production of electrical energy and chemical fuel.

Specifically, the target of the research and development are solar cells and materials composed of silicon crystals and thin films, compound semiconductors, dye-sensitized and organic materials, and new super high-efficiency solar cells, in addition to the creation of useful fuels, such as hydrogen, and the simultaneous creation of valuable material and clean energy using solar energy. In this research area, we will focus on the basics of material search, fundamental physical analysis (light absorption, charge separation, material deterioration, and so on), and on new principles for realizing higher efficiency and longer lifetime. We will perform creative research and development that establishes the breakthrough technologies in the future. To this end, the research will be a fusion of material sciences and device physics; consequently to create breakthrough technologies in this area, we will combine the expertise of researchers from the different fields of physics, chemistry, and electronic engineering and utilize cutting edge nanotechnology to promote research and development by combining the strengths of different disciplines.

Innovative Technology and System for Sustainable Water Use

Research Supervisor
Shinichiro Ohgaki
President, Japan Water Research Center

Deputy Research Supervisor
Mikio Yoda
Senior Chief Engineer, Information & Control Systems Company, Hitachi Limited

2009 – 2016

This research area is focused on the creation of physical and/or social water management systems that would be adaptive measures for a variety of water issues of concern to Japan or other countries and caused by climate change or other factors. Using innovative water treatment technologies and water resources management systems, optimal water use, as measured by qualitative and quantitative criteria, is sought in the respective stages of water supply, discharge, reclamation, and resource recovery. Proposed researches should contribute to sustainable water use from the most rational of many perspectives, including energy consumption, socioeconomic impact, environmental load, public health, and/or site-specific circumstances of targeted areas.

Examples of research topics to be considered in this research area are: 1) basic R&D in materials science for advanced water treatment and seawater desalination using ozone or membranes and ceramic materials; 2) water quality assessment; and 3) comprehensive water resources (surface and subsurface water) and environmental management systems at the watershed scale. Comprehensive management systems should consider water treatment, reclamation, and resource recovery in different water uses including drinking water, sewage, industry, and agriculture.

Creation of Innovative Technologies to Control Carbon Dioxide Emissions

Research Supervisor
Itaru Yasui
President, National Institute of Technology and Evaluation/Vice Rector Emeritus, United Nations University

2008 – 2015

This research area was chosen for the purpose of developing innovative technologies to be used chiefly to reduce CO2 emissions, with roughly twice the efficiency of existing technologies. The resulting technologies are to contribute to halve global greenhouse gas emissions by 2050, which is in line with the proposals of the Japanese Government at Heilingendamn Summit, 2007. The research projects in this Area shall aim to create a low-carbon society, using new concepts and principles to achieve direct or indirect means of CO2 emission reduction, for example, technologies to realize dramatic performance improvements in renewable energy and technologies to dispose CO2 in an innovative manner.

In specific terms, the research area covers all new energy technologies with the exception of nuclear power. Such technologies include: energy production and storage technologies that can fundamentally improve the efficiency of conventional products, technologies that bring innovative reductions in energy consumption - such as those utilizing new-concept solar cells, CO2 processing technologies, ocean energy and bio-energy technologies. Included also are carbon capture and sequestration technologies on the assumption that fossil fuels will continue to be used. Though the research area concentrates on the supply side of the energy chain, demand-side technologies are also considered to enable enhancement of energy efficiency. Therefore, projects in this area will be accepted if they are innovative and promise high social impact.

We expect to receive research proposals of fundamental research with definite targets that would bring innovation to the industrial structure and energy infrastructure of future society. When making the proposal, the applicant must provide a quantitative scenario in terms of the expected emission reduction in million tons if the technology concerned is to be commercialized in about 2020 to 2030 or so.

Innovative Technology Platforms for Integrated Single Cell Analysis

Research Supervisor
Sumio Sugano
Professor, Graduate School of Frontier Sciences, The University of Tokyo

2014 – 2021

This Research Area will provide methodological and technological platforms for the quantitative and comprehensive description of biomolecules within individual cells, especially in a population in situ, including their changes in time courses and their interactions.

These platforms will consist of core and peripheral technologies that realize simultaneous and comprehensive acquisition of information of genome, epigenome, transcriptome, proteome and metabolome at the single cell level. We recognize that some technologies are matured and be ready for use, while others are still in their infancy and need to prove their concepts. However, we believe that any technologies and methodologies developed in this Research Area should be applied to real challenges for the better understanding of biological processes in relations to cellular heterogeneity or transition of cellular states.

In order to develop these single cell analyses as platforms, we will encourage interdisciplinary teams to participate in this Research Area for facilitating the technology development, system integration, system usability and standardization. In addition, to accelerate these developments with the maximal impact, projects are subject to reshuffles and re-organization, as well as possible collaboration among projects in the corresponding PRESTO Research Area, in related funding programs or in other activities.

Creation of Innovative Technology for Medical Applications Based on the Global Analyses and Regulation of Disease-Related Metabolites

Research Supervisor
Takao Shimizu
Director-General, Research Institute, National Center for Global Health and Medicine

2013 – 2020

The aim of this Research Area is to create breakthrough technology platforms based on biomolecular dynamics analysis, the outcomes of which will contribute to medical applications such as drug discovery, disease diagnosis, and prevention. The technology platforms should increase the capacity of current systems to find, identify, and quantify disease-related metabolites and their associated factors as potential target molecules for disease control and broader medical applications.

In particular, metabolomics and other "omics" approaches are in great demand for the identification of disease-associated factors; therefore, these need to be developed. Further, we need the technology to identify proteins and other biomolecules related to these factors so they are within the scope. By combining biomedical research projects with the newly developing technology platforms, this Research Area aims to deliver proofs of concept for human disease control by taking full advantage of information obtained about core biomolecules as potential targets for medical applications.

The technical goals specified by the Research Area should be shared among individual research projects. Therefore, the management strongly encourages them to collaborate with others within this so-called virtual-network-type institute as well as with projects in the corresponding Precursory Research for Embryonic Science and Technology (PRESTO) Research Area, both aiming for the establishment and sophistication of technologies in a team-oriented manner. The management also prioritizes smooth translations to clinical applications; therefore, it considers further efforts allied with other drug discovery programs.

Innovation for Ideal Medical Treatment Based on the Understanding of Maintenance, Change and Breakdown Mechanisms of Homeostasis among Interacting Organ Systems

Research Supervisor
Ryozo Nagai
President, Jichi Medical University

2012 – 2019

The objective of this research area is to comprehend the process from birth to demise, which takes place in the individual, from the view of a dynamic homeostatic mechanism and to elucidate the mechanisms as to how the individual adapts and changes in reaction to internal and external stresses in a spatio-temporal and cross-sectional manner. The dynamic homeostatic mechanism is operated via a high-order network consisting of the nervous, immune, endocrine, circulatory, and other systems.

Furthermore, we aim to understand various diseases, including lifestyle diseases, as deviations from or breakdown of a "homeodynamic" state, constituting a ground for the development of preventive technologies that predict and control such deviation.

Particularly in recent years, technologies such as development of cell-specific genetically modified animals and cell separation technologies have made great progress and they have triggered major changes in life science and medicine. Expectations are to gain a better understanding of mechanisms of homeostasis and adaptations to various stressors, which function through interactions between different cells, systems, and organs. Furthermore, advances in life science and clinical medicine that control these mechanisms are needed. Specifically:

1. How complex functional networks behave interdependently in order to maintain homeostasis in response to external and internal stresses will be elucidated. These networks correlate among multiple organs, such as between parenchyma cells and interstitial cells, among organs as well as among the systems like the nervous, immune, endocrine, circulatory and others. In particular, humoral factors, neurotransmission, immunocytes, and interstitial cells that are involved in the maintenance and dysfunction of homeostasis need to be identified. These findings are needed to develop technologies that can be used to control homeostasis.
2. Researchers are expected to elucidate the phases of sequential and dynamic changes that take place in an individual's homeostatic mechanism during the life stages through birth, growth, development, and aging. Technologies that enable early detection of the subtle symptoms of these phases, as well as those to control them, are to be developed.
3. This research area involves research aiming at elucidation of the mechanisms in onset and progression of organ dysfunction resulting from internal and external factors, the biological defense mechanisms against stresses and injuries and healing mechanisms. Furthermore, we aim to develop technologies that will assist in the diagnosis and treatment of human patients. We will apply results of basic research for examination in clinical cases as much as possible, and investigate the potential of medical care where multiple medical departments cooperate based on new concepts of pathology.
4. We aim at the establishment of highly reliable methods to control these networks, based on multilateral understanding of the dynamic interactions between these complex networks. To achieve this goal, we will work to promote simulation technologies and theoretical computational science research that would make these technologies possible.

Through this research, we will elucidate previously unknown molecular, cellular, and networking mechanisms and develop new medical technologies based on these understandings.

Structural Life Science and Advanced Core Technologies for Innovative Life Science Research

Research Supervisor
Keiji Tanaka
Director, Tokyo Metropolitan Institute of Medical Science

2012 – 2019

This Research Area aims to integrate cutting-edge life science areas with structural biology for creating "structural life science" and advanced core technologies that will lead to innovation in life science. It will address fundamental problems in life science by integrating advanced methods of structural analysis seamlessly and establishing general principles for elucidating and predicting dynamics of hierarchical structures ranging from the atomic to the cellular and/or tissue levels.

The recent large-scale research projects in structural biology in Japan have achieved major advances in determination of protein structures with biological significance. Proteins play key roles in biological events; however, they do not function alone. Therefore, the next important step is to determine the dynamics of such proteins and to study the functional mechanisms underlying the interactions among proteins and various other biological macromolecules. For example, many diseases of animals and plants are caused by protein abnormalities. Thus, structural life science, a new branch of science proposed for understanding biological phenomena of fundamental importance based on structural methods, should play an essential role in elucidating molecular mechanisms and developing new therapeutic methods and means of disease prevention. The structural life science approach is also required for promoting a healthy and long-lived society, establishing safe food production systems, and solving environmental problems. Structural life science addresses these issues by establishing general principles underlying temporal and spatial changes of biological systems at the atomic or molecular level and by predicting dynamics of biological phenomena from these principles.

Utilizing the structural life science approaches, this CREST Research Area seeks to analyze dynamics of important functional machineries involved in biological phenomena, for example, large protein complexes and organelles; to identify pathogens and determine their structures in complex with cognate interaction molecules; to search efficiently lead compounds for structure-based drug discovery processes; and to create advanced technologies required for such studies.

Development of Fundamental Technologies for Diagnosis and Therapy Based upon Epigenome Analysis

Research Supervisor
Masayuki Yamamoto
Professor, Tohoku University

Deputy Research Supervisor
Toshikazu Ushijima
Chief of Division, National Cancer Center Research Institute

2011 – 2018

For healthy life and development of novel strategies for disease prevention, diagnosis, and therapy, this research area focuses on discovery of new principles and establishment of fundamental medical technologies based on epigenome analyses accompanied by biological analyses.

Specifically, this research area invites proposals that identify epigenome alterations useful for identification of etiologies or those critically involved in development and progression of cancers or other chronic disorders, such as arteriosclerosis, diabetes, neurological diseases, and autoimmune diseases. The findings should lead to identification of novel mechanisms for induction of epigenome alteration or maintenance of epigenomes or to innovative strategies for disease prevention, diagnosis, and therapy. This area also invites proposals that, by comparing epigenome profiles during stem cell differentiation, reveal mechanisms of cellular differentiation and establish technologies for robust directed differentiation of various cells to specific lineages. Furthermore, this area invites proposals that develop key technologies for more efficient analysis of methylomes and histone modifications, and for control of epigenomes.

In this research area, JST cooperates with the International Human Epigenome Consortium (IHEC) through some proposals.

Creation of Fundamental Technologies for Understanding and Control of Biosystem Dynamics

Research Supervisor
Tadashi Yamamoto
Professor, Okinawa Institute of Science and Technology (OIST)

2011 – 2019

Living organisms are in dynamical balance between their responses to environmental stimuli and their ability of maintaining homeostasis. Through observation, experimentation and measurement of biological phenomena conducted by macromolecules including chromosomes, proteins, and lipids at levels of cell-free system, cells and cell populations, the researches of this research area is expected to gain an integrated understanding of dynamical balance of the living organisms in both spatial and temporal dimensions. At the same time, the research of this research area should aim to create technologies that can control biological phenomena.

The research should elucidate an operating principle of dynamic and complex biological phenomena that has been hard to address by traditional approaches. To do so, the research needs to utilize rapidly growing high-speed/super-resolution technologies for measurement/analysis, and to integrate life sciences with cutting edge fields of mathematics, physics, chemistry, engineering, information science and computer sciences. We promote leading researches with interdisciplinary views for comprehensive understanding of dynamic systems of the living organisms using modeling and simulation based on mathematical science.

The Creation of Basic Medical Technologies to Clarify and Control the Mechanisms Underlying Chronic Inflammation

Research Supervisor
Masayuki Miyasaka
Professor, Osaka University

2010 – 2017

The purpose of this research is to elucidate the mechanisms through which inflammation becomes chronic, and the creation of basic technologies for the early detection, control, resolution, and reparation of chronic inflammation.

More specifically, this involves research aimed at

1) identifying factors that induce and maintain the chronicity of inflammation by determining failure mechanisms of inflammation control;
2) clarifying the mechanisms through which specific diseases (including cancer, degenerative neurological disorders, and arteriosclerotic diseases) develop as a result of chronic inflammation, and to create basic technologies to control them; and
3) creating basic technologies that allow the early detection and quantitative assessment of chronic inflammation. This not only involves established basic or clinical research, but also emphasizes on research that sufficiently sublimes evidence-based findings for understanding high-dimensional inflammation control mechanisms, and leads to the development of new preemptive basic medical technologies.

Elucidation of the Principles of Formation and Function of the Brain Neural Network and Creation of Control Technologies

Research Supervisor
Seiji Ozawa
Professor, Takasaki University of Health and Welfare

2009 – 2016

This research area aims to elucidate the molecular and cellular mechanisms of the generation, development, and regeneration of the brain neural network; to investigate how neural networks composed of a variety of elements in individual brain areas work and express their specific functions; and to clarify how the brain works as a coherent system by integrating the activities of these local networks. On the basis of such research, it also aims to create technologies for controlling the process of formation and activities of the brain neural network.

Specific approaches may include elucidation of the molecular mechanisms of development, differentiation, regeneration, target recognition, and migration of neurons (components of neural networks) and glial cells that significantly influence neural network formation and functions; elucidation of the mode of neural network activities by combining new technologies, such as visualization of specific neurons with the use of specific expression molecules and fluorescent proteins, simultaneous recording of activities of many neurons, and local stimulation with a caged compound; research to clarify the relationship of higher order brain functions with synaptic events through the combination of research at the network and system levels in model animals and research on the regulatory mechanism of synaptic transmission at the molecular and cellular levels; elucidation of the mechanism of neural network reorganization at the critical period or after brain damage; and creation of technologies for intervention in its process.

Fundamental Technologies for Medicine Concerning the Generation and Regulation of Induced Pluripotent Stem (iPS) Cells

Research Supervisor
Toshio Suda
Professor, Keio University

2008 – 2015

The objective of this research area is to establish fundamental technologies contributing to advanced medicine through the development of cellular reprogramming technology. Remarkable progress has been made in this field recently, especially the generation of iPS cells. The research objectives include the advancement and simplification of this technology, the elucidation of pathological mechanisms through the development of model cells, the formulation of new therapy strategies, and novel methods for the early discovery of diseases.

Specifically, included is research on cellular reprogramming and differentiation mechanisms using genomics, chromosome structure and epigenetic analysis; research on gene transfer regulation; high-throughput screening of reprogramming-inducing compounds; and research using iPS cells generated from patients with congenital diseases for the elucidation of pathological mechanisms. Moreover, the research also covers an area that may lead to the pioneering of new therapy methods and preventive medicine through the integration of stem cell research and pathological studies.

Etiological Basics of and Techniques for Treatment of Allergic and Autoimmune Diseases

Research Supervisor
Kazuo Sugamura
President, Miyagi Prefectural Hospital Organization

2008 – 2015

This research area aims to improve prevention, diagnosis, and treatment of human immunological diseases, centered on allergic and autoimmune diseases, and includes research for development of basic technologies for improvement of appropriate functioning of the immune system. Diseases centered on allergic responses and autoimmune systems vary from those that may lower the quality of life (QOL) of patients to those leading to death in serious cases. Deepened understanding of the immune mechanism and control of such diseases at levels of molecules, cells, organs, and tissues will be evolved into understanding of a higher-level control immune network system at individual levels, leading to clinical application. Specific examples of research projects include immunoregulatory mechanisms by regulatory cells, construction mechanisms of the mucous membrane immune system, autoimmune system, acquired immune system, and natural immune system and their control, etiological mechanisms of autoimmune and allergic diseases, immune and infection control mechanisms, development of drugs and vaccines against diseases and measurement of their effects, establishment of methods for diagnosis and treatment of diseases, and so forth.

Creation of a Novel Technology Towards Diagnosis and Treatment Based on Understanding of Molecular Pathogenesis of Psychiatric and Neurological Disorders

Research Supervisor
Teruhiko Higuchi
President, National Center of Neurology and Psychiatry

2007 – 2014

Psychiatric and neurological disorders attributable to disorders of higher brain functions, such as cognition and emotion, are an issue of high social demand in Japan, which is increasingly affected by a declining birthrate, aging, and social tension. This Research Area aims at the creation of a novel technology for prevention, diagnosis, and therapy for psychiatric and neurological disorders.More specifically, it targets research towards evidence-based objective diagnosis and curative therapy based on the understanding of molecular pathogenesis of psychiatric and neurological disorders that engender higher brain function disorders. Exemplary research objects include: development of diagnostic methods using, for example, biological markers, which are available as an objective index from biochemical or molecular genetic points of view, or functional markers such as non invasive brain imaging technology; analysis of animals used in disease modeling reproducing gene mutation or environmental change;and search for and identification of target molecules towards innovative drug development for implementing basic treatment. This Research Area also deems important those studies that aim at organic fusion of different research areas or study methods, including clinical study for disorders vs. fundamental study like brain science, psychiatric disorder study vs. neurological disorder study, and intermediate phenotype analysis studies like brain imaging vs. gene analysis study, to advance these studies.

Development of Atomic or Molecular Two-Dimensional Functional Films and Creation of Fundamental Technologies for Their Applications

Research Supervisor
Atsushi Kurobe
Senior Fellow, Corporate Research & Development Center, Toshiba Corporation

2014 – 2021

The focus of this research area is on atomic or molecular two-dimensional functional films (two-dimensional thin film structure consisting of atoms or molecules, or functional thin film materials with two-dimensional electronic states equivalently made at some surfaces or interfaces) as the building blocks of next-generation energy-efficient materials and devices. The objective of this research area is to establish a direction for creating new values and new markets that will be achieved through a basic foundational approach toward R&D on the development of two-dimensional atomic or molecular thin-film structures or of finite thin-film edge structures, the clarification of phenomena related to new functional expressions, and the creation of scientific base for devices taking advantage of those new functions, principles, and structures.

The research targets such tangible fields as physical sciences, synthetic chemistry, and device engineering as they relate to the development and application of atomic or molecular thin two-dimensional functional films. By promoting cooperation among these disciplines, we can endeavor to create foundations for crystal growth technologies contributing to the realization of innovative materials and devices; measuring, analyzing, and processing technologies aimed at clarifying and controlling structures and physical properties; and material and device design technologies, and to formulate basic theories.

Innovative Nano-electronics through Interdisciplinary Collaboration among Material, Device and System Layers

Research Supervisor
Takayasu Sakurai
Professor, Institute of Industrial Science, The University of Tokyo

Deputy Research Supervisor
Naoki Yokoyama
Fellow, FUJITSU LABORATORIES LTD.

2013 – 2020

This research area aims to implement research and development to drastically improve the energy efficiency of information processing, enable the production of new functions, and present paths to truly commercialize the outcomes of such research and development and lead them to innovations by coordinating and integrating researches on materials, electronic devices, and system optimization.

Production of innovative basic technologies is necessary for achieving drastically better energy efficiency of information processing and providing new functions which are the goals of this research area rather than solely relying on the advancement of microfabrication. Such technologies are essential for improving performances and enhancing the Internet and information devices and useful for producing new applications and services, which are more closely related to the physical world by heavily using sensors and actuators.

The following nano-electronics materials and devices are considered specific research fields: devices made from new functional materials,new semiconductors and new insulators, such as carbons, composite materials, and single monoatomic layer materials; quantum effect devices; low-leakage devices; new structural logic devices; new memory devices; devices for power management; new electronic devices for physical world interfaces; and non-Boolean Algebra processing devices. Yet, this research area pursues new functional materials and devices based on new materials, new principles, and new structures rather than being limited to materials and devices listed above. Meanwhile, applications, systems, architectures, and circuits technologies must be coordinated or integrated based on synergy to lead them to true innovations. Thus, this research area actively promotes the optimization of selection and directions of materialtechnologies and device technologies by aiming for practical applications. This research area aims to produce fundamental technologies for innovative information devices through reinforcement and acceleration of such interdisciplinary scientific technologies.

Creation of Innovative Functional Materials with Advanced Properties by Hyper-nano-space Design

Research Supervisor
Tohru Setoyama
Executive Officer Fellow, Mitsubishi Chemical Corporation

2013 – 2020

This research area focuses on finding solutions to some of the most important challenges facing human civilization in the 21st century, such as those related to the environment, resources (feed-stocks), energy, medicine, and health, through the development of the technology of hyper-nano-space design to create innovative materials with cutting-edge functions that are not realizable with conventional existing technology.

In particular, the objective of our research is to realize the expression of highly desirable and advanced functions and properties in materials used for the storage, transportation, and separation of energy and chemical resources, catalytic conversion, highly efficient energy conversion, mitigation and removal of environmental contaminants, procurement of potable water, as well as in materials used for medical care and health purposes. Hyper-nano-space design is the sophisticated design and control of the space-and-gap architecture that is formed from the positioning and linking of atoms and molecules; in other words, it is the design and control of the dimension, shape, size, composition, regularity, crystallinity, and interface of materials to create sufficiently differentiated revolutionary functional materials.

Our research subjects include not only widely recognized space-and-gap-controlled materials such as nano-porous materials, meso-porous materials, materials with layered or cage structures, nano-tubes, macro-molecules, supermolecules, biomolecules, and structural materials, but also materials in which the space-and-gap architecture has the potential to be the venue for functional expression. With a team that brings together knowledge across diverse disciplines such as chemistry, physics, biology, engineering, computational science, and measurement technology, we encourage going beyond just fundamental research and setting our sights on realizing functions and properties that can lead to the most advanced materials and products in the world, with possibilities for industrial applications for use in Japan. That is, we want to contribute to Japan's Renaissance in the 21st century by means of our scientific aspect—hyper-nano-space design.

Establishment of Molecular Technology towards the Creation of New Functions

Research Supervisor
Hisashi Yamamoto
Professor,Chubu University
/Emeritus professor,University of Chicago

2012 – 2019

"Molecular Technology" is a series of technologies that enable us to qualitatively change existing science and technology through purposefully designing and synthesizing molecules and creating the physical, chemical, and biological functions of materials at a molecular level. The creation of new physical properties at the molecular level is the ultimate form of material synthesis in which the best and most suitable molecules selected from an infinite number are freely designed and synthesized by controlling molecular shape/structure, electronic state, aggregate/composite, and transport/migration with the collaborative use of precision synthesis techniques and theoretical and calculation sciences. With this, we can expect the creation of ultimate new intelligent materials that truly are competitive industrially.

In this research area, we shall set as our final goal the establishment of molecular technology that can lead to the creation of unique new intelligent materials, devices, and processes that are innovative as well as precise and unachievable with a mere extension of existing science and technology, which remains at a conventional molecular library, by deepening our exploration of various problems needing to be addressed down to a molecular level and by designing / synthesizing / manipulating / controlling / aggregating those molecules that have desirable functions.

To bring more universality into our research and development in this molecular technology, we shall consider those bottleneck application problems that have not been solved by knowledge of such individual disciples as chemistry, physics, and biology as common and shared ones, and make an effort to build a unique technology system by overcoming those problems through an interdisciplinary approach.

Based on the common base of "Molecular Technology," those researchers, who have been actively engaging in their respective projects of wide-ranging application and in special fields with little contact with other fields, shall come together to review each other's research and technology and bring in new perspectives. Ambitious and challenging research topics shall be pursued by those cross-sectional team members who are strongly aware of their mission of making a breakthrough in the development of new intelligent materials to meet wider social needs.

Creation of Innovative Functions of Intelligent Materials on the Basis of the Element Strategy

Research Supervisor
Kohei Tamao
Science Advisor / Director, Global Research Cluster, RIKEN

2010 – 2017

This research area addresses resource, energy, and environmental problems, which should be solved to build a sustainable society from the viewpoint of materials science and solid-state science based on the Element Strategy and aims to create innovative functions of intelligent materials that are quite different from conventional functions.

Specifically, under the concept of the Element Strategy "understanding and effective use of the roles of key elements that determine the properties and functions of intelligent materials," we conduct research and development to create innovative properties and functions of intelligent materials by multilaterally and systematically elucidating and understanding problems common in the expression of a variety of functions, such as structure, interface, and electron correlation, and controlling the functions. With a variety of element properties in mind, we investigate ways of expressing the intended functions from a microscopic viewpoint, such as electronic state, atomic arrangement, and molecular structure, and aim to create innovative functions of intelligent materials to solve a variety of problems by using various methods, such as measurement technology and computational science, and designing structures, functions, and reactions. We promote ambitious and challenging research with a multidisciplinary integration beyond the boundaries of the academic fields of physics, chemistry, engineering, and materials science.

Enhancing Applications of Innovative Optical Science and Technologies by Making Ultimate Use of Advanced Light Sources

Research Supervisor
Tadashi Itoh
Professor / Vice Director, Institute for Nano Science and Design, Osaka University

2008 – 2015

The present research area aims at accelerating collaboration and fusion of potential research and development (R&D) capacities related to light utilization science and optical technologies that currently are individually investigated in different fields such as substances and materials; processing and measurement; information and communication; environment and energy; and life sciences, so as to build up foundations for creation of a innovative new stream for "relation of materials to photons" in the field of optical science and technology.

At present, various types of advanced light sources represented by high performance, state-of-the-art lasers are widely available, leading to rapidly increasing numbers and extent of research projects performed for investigation of their usage. However, since the advanced light sources are placed into black boxes, these light sources are not always utilized to the extent of their maximum potential. Taking these circumstances into account, the present research area promotes distinguished research regarding "relation of materials to photons" in which characteristics of light sources are extremely utilized.

Furthermore, this research area covers leading research that will enable achievement of breakthroughs in the field of light utilization science and technology, and also includes objective-oriented basic research in a wide range of fields such as life sciences and environmental and energy. It should be noted that this research area puts special importance on seeds that will create research aimed at fusion of advanced optical science and optical technology as well as at creation of a novel stream, e.g. by showing truly effective methods of making extreme use of state-of-the-art light sources such as lasers. In these research projects, analyses of events or identification of principles do not mean the end of the research, but instead how these technologies can be put to practical use will always be taken into account. The present research area does not aim at the world record of the light source performance itself but includes research that identifies any relevant and advanced need regarding the light source required for research processes and provides feedback on such needs to the light source development research, contributing to practical advancement of optical utilization science and optical technology fields.

Creation of Nanosystems with Novel Functions Through Process Integration

Research Supervisor
Jun'ichi Sone
Vice President, National Institute for Materials Science

2008 – 2015

This Research Area aims at creation of next-generation nanosystems that produce novel functions by promoting evolution and integration of top-down processes such as photolithography and bottom-up processes based on self-organization. Specifically, this aims at development to build up technologies such as sensors, actuators, biochips, electronic and optical devices, and energy devices that bring breakthrough in the functions and performance, focusing on studies on novel functions produced by fusion of nanostructured devices, such as nanoelectronic circuits, Micro Electro Mechanical Systems (MEMS) and Nano Electro Mechanical Systems (NEMS) manufactured using top-down processes, and materials such as biological, organic, and self-organized materials, or studies on construction of functional bottom-up nanostructures as systems applicable to engineering. In addition, development of next-generation nanosystems based on the integration and optimization of these technologies is also taken into consideration in the promotion of research.

Development of High-Performance Nanostructures for Process Integration

Research Supervisor
Masahiro Irie
Professor, Rikkyo University

2008 – 2015

For efficient, flexible development of next-generation nanosystems, the effective linkage of top-down and bottom-up processes is essential. This research area aims at exploring how to connect molecular nano-structures and functions to structures and functions of macroscopic materials and creating self-sustained and high-performance nano-structural materials with unique structures and functions that can be achieved only by the bottom-up processes.

At the molecular and supra-molecular levels, minute molecular machines, molecular motors and artificial muscles have been reported, and their specific functions have been discussed. However, we have not yet succeeded in linking these nano-structural materials to the structures and functions of useful macroscopic materials through self-organization and self-assembly processes.

What is most desired for the development of molecular or solid catalysts is that the catalysts should not only be prepared by elaborated molecular and structure design but also be systematically constructed by self-organization and self-assembly processes to realize sophisticated functions not existing before, such as one-pot synthesis of multi-step reactions.

Molecular materials have the potential transforming themselves into any required figure in different ways due to their diversity. With a focus on this potential, the objective of this research area is to pave the way for linking the sophisticated structures and functions already realized at the molecular level (e.g. chemical or physical stimulus responsive properties, catalytic properties, electrical conductivity and magnetism) by using the bottom-up processes to useful materials in a real world and to create self-sustaining and high-performance nano-structural materials having unique functions.

Research of Innovative Material and Process for Creation of Next-generation Electronics Devices

Research Supervisor
Hisatsune Watanabe
Councelor, Semiconductor Leading Edge Technologies, Inc.

2007 – 2014

This Research Area aims at transcending saturation of technology evolution based on a semiconductor Roadmap strategy. It covers research on material, structure, and process development for creating innovative and viable electronics devices that have novel function and high performance that can not be realized merely by the scaling paradigm. Specifically, candidate subjects include: research for highly integrated information processing devices with a novel principle that can solve practical issues, such as increased power consumption and inflation of manufacturing cost; research for devices demonstrating novel function and high performance by the fusion of various technologies or materials including organic substances; process research that enables the above; or research exploiting a novel application thereof. This Research Area promotes research that is expected to engender practical technologies, rather than investigation of properties and mechanisms of materials and processes.

Modeling Methods allied with Modern Mathematics

Research Supervisor
Takashi Tsuboi
Dean / Professor, Graduate School of Mathematical Sciences, The University of Tokyo

2014 – 2021

In this research area, mathematicians and researchers applying mathematics form research teams to attack social issues which have been difficult to be solved. Through the problem-attacking process, we expect also the development of mathematics itself. More specifically, targeting the phenomena for which the governing principles and rules have been unclear, by using the abstractness and universality of mathematics as well as knowledge obtained through application, we advance research to derive innovative models based on mathematical ideas to find the hidden essence of them and to develop new mathematical methods to approach them. We include research for proving the validity of the description on the essence of phenomena by old and new mathematical models, as well as building mathematical theories and techniques for evaluating these models. The targets may be found in social, natural, or life phenomena. This may include others if the research aims to create new fields and give solutions to social issues.

In deriving mathematical models and solving issues, we attach importance on interactive communication not just among researchers in different fields of mathematics but also among researchers in applied fields, the experimental sciences, and information sciences. Furthermore, it is expected that derived mathematical models have universality and develop into modeling techniques that can be applied to solve issues in much wider fields.

Intelligent Information Processing Systems Creating Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration

Research Supervisor
Norihiro Hagita
Board Director, Director, Social Media Research Laboratory Group, Advanced Telecommunications Research Institute International

2014 – 2021

This research area will advance research and development targeting intelligent information processing systems that create co-experience knowledge and wisdom through “balanced or harmonious collaboration” of humans and machines and bring about an improvement in the quality of the intellectual activities of individuals and groups. The balanced or harmonious collaboration means that not only users but also human society may feel the services of machines (or systems) acceptable in the human-machine collaboration.

This research area will target the following research issues:

i The system allows salient feature extraction of the human behaviors, and the ongoing cyber-physical information, and provision of services seamlessly optimized for a specific time, place, and individual, or group

ii The system allows comprehensive explanation of service details, and visualization and/or representation of anticipated benefits and risks through interaction and operation in an excellent manner to facilitate individual or group decision making regarding services provided by machines

iii The system allows sharing of co-experience knowledge and wisdom which are created through harmonious collaboration of human(s), and machines

iv Analysis of intelligent information processing mechanisms for human-human collaboration which are related to the creation of co-experience knowledge and wisdom and/or the research issues mentioned above.

Proposals are expected to include the state-of-the-art technologies in appropriate areas such as information processing, cognitive sciences, social sciences, natural language, computer science, computational science, and robotics, needed for building the systems. Resultant systems may bring about an ambient information society harmonizing humans and machines.

Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving

Research Supervisor
Yuzuru Tanaka
Professor, Graduate School of Information Science and Technology, Hokkaido University

2013 – 2020

Along with the penetration of ICT in society and the advance and spread of sensors, measurement instruments and observation equipment for gathering information in the real world, the amount of data obtained from various fields has grown exponentially and continues to become more diverse. Advanced integration and use of big data are expected to bring about science and technology innovation and the creation of intellectual value through new scientific discoveries, with development of the resulting knowledge leading to creation of social and economic value as well as improvement and optimization of services.

In this research area, studies will be carried out in cooperation with information science and mathematical science field, and various research fields (application fields) in which the use of big data can bring about a great social impact. In order to make scientific discoveries, solve challenging social and economic problems and achieve innovative value creation, large-scale and diverse relevant data which could not be accumulated by individual researchers or organizations will be mutually related and subjected to a high level of integrated analysis. In this way empirical research and development will be carried out on extraction and creation of the innovative knowledge and value that are hidden in big data. To this end the research area will aim for the empirical creation and sophistication of the necessary next-generation application technologies.

Specifically, by means of innovative technologies for high-level integration and use of big data, the research will empirically realize innovative value creation, solutions to challenging social and economic problems, and/or various scientific discoveries in areas such as life science, materials science, health and medical care, society and economy, urban infrastructure systems, disaster prevention and mitigation, agriculture, forestry and fisheries industry, outer space, and the earth’s environment. The purpose is not simply creating knowledge and value by applying existing core technologies. Rather, the aims are new empirical creation and sophistication of next-generation application technologies necessary for achieving the objectives, and establishment of comprehensive and integrated big data analytics system technology adapted to the characteristics of application fields.

Moreover, in this research area collaboration will be encouraged with the related research area, Advanced Core Technology for Big Data Integration, including the sharing and use of next-generation core technologies developed in that area.

Advanced Core Technologies for Big Data Integration

Research Supervisor
Masaru Kitsuregawa
Director General, National Institute of Informatics

Deputy Research Supervisor
Etsuya Shibayama
Professor, The University of Tokyo

2013 – 2020

Along with the penetration of ICT in society and the advance and spread of sensors, measurement instruments and observation equipment for gathering information in the real world, the amount of data obtained from various fields has grown exponentially and continues to become more diverse and more frequent in occurrence. Advanced integration and use of big data are expected to bring about science and technology innovation and the creation of intellectual value through new scientific discoveries, with development of the resulting knowledge leading to creation of social and economic value as well as improvement and optimization of services.

This research area will aim for the creation, advancement, and systematization of next-generation core technology solving of essential issues common among a number of data domains, and integrated analysis of big data in a variety of fields.

Specific development targets include technology for stable operation of large-scale data management systems that compress, transfer, and store big data, technology for efficiently retrieving truly necessary knowledge by means of search, comparison, and visualization across diverse information, and the mathematical methods and algorithms enabling such services. In pursuing these studies, with a view to overall system design up to the creation of value for society from big data, the creation, advancement, and systematization of next-generation common core technology highly acceptable to the public will be undertaken, through active efforts at fusion with fields outside of information and communication technology.

Moreover, in this research area collaboration will be encouraged with the related area, “Advanced Application Technologies to Boost Big Data Utilization for Multiple-Field Scientific Discovery and Social Problem Solving,” such as by sharing and use of the next-generation core application technology and data obtained in that research.

Creation of Fundamental Theory and Technology to Establish a Cooperative Distributed Energy Management System and Integration of Technologies Across Broad Disciplines Toward Social Application

Research Supervisor
Masayuki Fujita
Professor, Tokyo Institute of Technology

2012 – 2019

The goal of this research area is to create theory, mathematical models and fundamental technology for optimal control of energy demand and supply in energy management systems linking customers and a variety of energy sources including renewable energy.

Specifically, this research area invites proposals on theory and basic technologies to realize cooperative control and situation awareness of spatially distributed energy demand and supply through mutual and real-time interactions of both energies and information.

It is also promoted to create theory and basic technologies integrating human behavior and social rationality in order to lead the selfish decision making of consumers and suppliers to social advantages in overall energy management system.

Moreover, it is also encouraged to create theory and basic technologies to grasp the status of, estimate, and forecast demand and supply of renewable energy by learning from satellite data, regional meteorological observations, geographical information, and past supply-demand records.

This research area also aims at combining different research fields such as system science, control, information, communication, energy and social science in view of the exit of establishing a cooperative distributed energy management system.

Development of System Software Technologies for post-Peta Scale High Performance Computing

Research Supervisor
Akinori Yonezawa
Co-director, RIKEN Advanced Institute for Computational Science

2010 – 2017

The research area aims at developing system software technologies as well as related systems to be used for high performance computing in the post generations of the Japanese national supercomputer K.

More concretely, research and development will be conducted for system software enabling us to exploit maximum efficiency and reliability from supercomputers which will be composed of general purpose many-core processors as well as special purpose processors (so called GPGPU) in the second half of (and/or after) 2010’s. In addition to the system software such as programming languages, compilers, runtime systems, operation systems, communication middleware, and file systems, application development support systems and ultra-large data processing systems are the targets for research and development. Also, the targets include system software in the overlapping layers of software stack, which encourages real usages of developed system software.

Creation of Human-Harmonized Information Technology for Convivial Society

Research Supervisor (2014-2016)
Toyoaki Nishida
Professor, Graduate School of Informatics, Kyoto University

Ex-Research Supervisor (2009-2013)
Yoh'ichi Tohkura
Professor / Deputy Director General, National Institute of Informatics

2009 – 2016

This research area aims for the establishment of fundamental technologies to achieve harmony between human beings and the information environment by integrating element technologies such as real-space communication, human interfaces, and media processing.
Specifically, this research area promotes trans-disciplinary approach among following research scopes to establish Human-Harmonized Information Technology.
Recognition and comprehension of human behavior and real-space context by utilizing sensor networks and ubiquitous computing Technologies for facilitating man-machine communication by utilizing robots and ubiquitous networks Contents technologies related analysis, mining, integrating and structuring of a variety of different types of media, including text, voice, music, and picture images Furthermore, this research area also promotes researches that create the breakthrough technologies for the harmonious interaction of human and information environments, and trans-disciplinary researches on cognition processes in the perspective of creating human harmonized information technologies.

Alliance for Breakthrough between Mathematics and Sciences (ABMS)

Research Supervisor
Yasumasa Nishiura
Professor, Tohoku University

2008 – 2015

Alliance for Breakthrough between Mathematics and Sciences (ABMS) is a grant program established for supporting research activities in mathematical science. It is in particular designed for such a research activity by mathematical scientists that is motivated by social needs, conducted in cooperation with scientists in non-mathematical fields, and is expected to make a scientific breakthrough. It may be viewed as attempting to integrate the rationalism of Descartes and the empiricism of Bacon in the 21st century.

The program will cover studies of the mathematical problems in diverse fields of science: materials science, life science, environmental science, information science, telecommunication science, financial engineering, etc. Research activities in other fields will also be within the scope of the program if those activities propose new research topics arising from social needs, and explore mathematical approaches to those topics.

Priority will be given to such a research activity that develops new mathematical ideas through the study of natural or social phenomena in a field of science while applying existing mathematical methods to that study. The program therefore emphasizes research activity which contributes to the integration of mathematical and experimental sciences.

Fundamental Technologies for Dependable VLSI System

Research Supervisor
Shojiro Asai
Executive Vice President, Rigaku Corporation

2007 – 2014

This Research Area covers the R & D of fundamental technologies for the VLSI system that can guarantee high reliability and high security. It is a societal requirement today to guarantee the reliability and security of information systems, on which human activities depend to an ever increasing extent. The VLSI, its engine, is also a gigantic system itself containing a huge number of circuit elements, and its reliability and security is at the core of those of any information system. This Research Area addresses problems that have to be solved to realize VLSI systems with advanced levels of integration, while ensuring required reliability and security. To be concrete, the scope of this Research Area includes subjects as follows. Some of the major physical problems are fluctuation associated with ultimate miniaturization of integrated-circuit elements, single-event data failure, and deterioration brought by long time use. These degrading factors not only cause malfunctions, but also might prevent a VLSI from large-scale integration. An extensive search for novel technologies to alleviate those factors is required at the device level, circuit level, and system level. On the other hand, because large-scale integration by miniaturization will soon reach its limit, technologies for packaging many chips in three dimensions while ensuring reliability and security are also important subjects. Another R & D subjects are design techniques that prevent mistakes in design that accompanies increase in the scale of integration and complexity of system. Software that facilitates design, verification, manufacturing, and testing is sought for. Also required is R & D of architecture and circuits that detect, confine, and relieve threats to reliability and security from inside and outside of the VLSI system during operation. Requirements for a VLSI system come from the quality and performance requirements of the information system it is used in. How to specify and evaluate reliability and security requirements for the VLSI system is also a subject of this Research Area.

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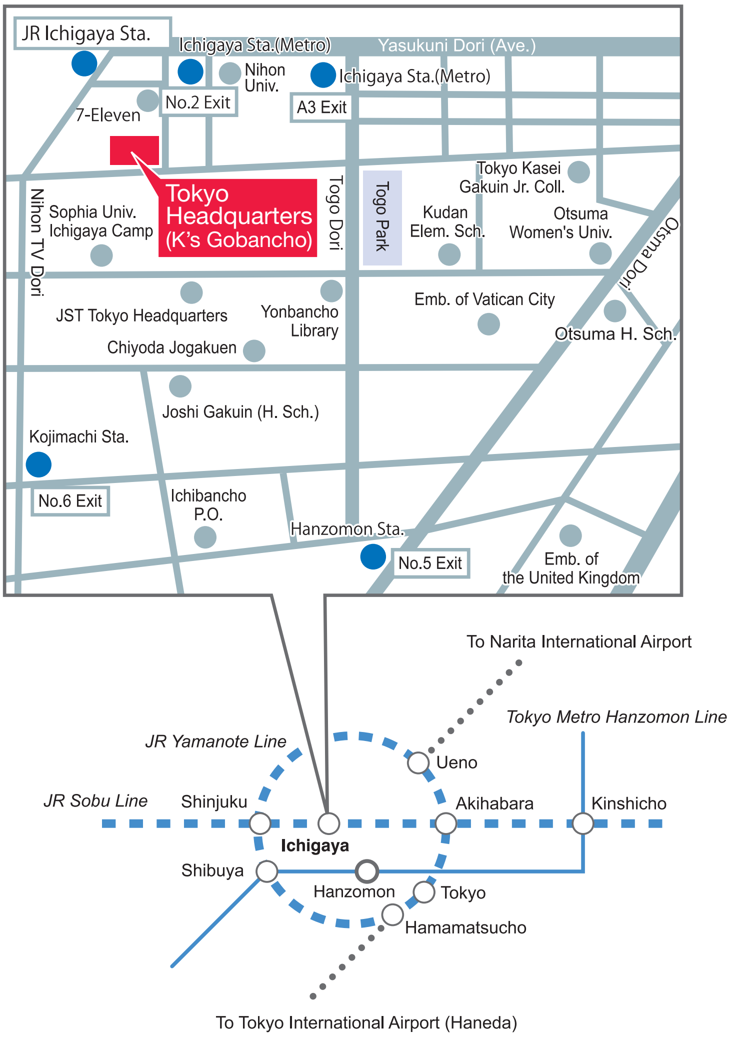

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