Research Center for Deep Geological Environments

According to the electronic power supply policy of the Government, high-level radioactive waste from the nuclear power plants must be buried deep underground for several decades. To dispose of the waste safely, information about deep geological environments of the Japanese islands is necessary. Required information includes: underground geological characteristics, dynamic geological processes, and the long-term stability of geological environments. To provide technical, neutral, and reliable information, the center, as a core of the national geological survey, will make an extensive investigation of deep geological environments.

Research Center for Developing Fluorinated Greenhouse Gas Alternatives

CFC (chlorofluorocarbon) compounds have been widely used in various industries due to their outstanding properties. However, these compounds cause the depletion of the ozone layer and global warming. The development of alternative technologies is needed.

To protect the ozone layer, a wide variety of CFC alternatives have been proposed and introduced into the market under the Montreal Protocol, but as for the global warming, three fluorinated gases such as HFC (hydrofluorocarbon), PFC (perfluorocarbon) and SF₆ (sulfur hexafluoride), were classified as greenhouse gases to be reduced under the Kyoto Protocol. Since then the development of alternative technologies has become an important issue.

In this research center, we will study and propose new alternatives to fluorinated greenhouse gases. Our approach will include the scientific evaluation of the effect of fluorinated compounds on global warming and an investigation of the necessary properties of possible candidates. The collective search for, recovery, disposal and re-use of fluorinated greenhouse gases will be conducted in parallel with our other research.

Research Center for Life Cycle Assessment

Life Cycle Assessment (LCA) is a method to assess the environmental affects of goods or services. For example, when we assess the life cycle environmental influence of a car, we should take account of not only the pollution by exhaust gas but also environmental affects by manufacturing and scrapping of the car, production of its materials, and so on. LCA considers assessed goods or services from the cradle to the grave. Many manufacturing companies have started to adopt this method to evaluate the environmental performance of industrial products.

Through our research activities, Research Center for Life Cycle Assessment is targeting to promote the construction of environmentally acceptable societies and the life of less environmental impacts.
"Active faults" refer to faults that have a possibility of producing large earthquakes. There are many active faults in Japan.
Active Fault Research Center conducts the following research to reduce seismic hazards.

1. Study of active faults
We survey 98 major active faults in Japan and estimate the probability and magnitude of future earthquakes for each fault. We also study large active faults overseas to advance the evaluation method of earthquakes on domestic large active faults such as the Median Tectonic Line or Itoigawa-Shizuoka T. L.

2. Assessing earthquake hazards
Combining information on geologic structures and active faults, we estimate seismic hazards. We also study tsunami deposits preserved in geologic layers and make computer simulations of tsunamis.

3. Public outreach
We annually publish Interim Reports on active fault studies. We also publish active fault strip maps and 1:500,000-scale seismotectonic maps. We plan to publish maps showing possible hazards from future earthquakes and tsunamis.

Information on these publications will be also available on our web site.

Active faults in the Kinki-Tokai district and their maximum earthquake probabilities in the 21st century
In order to enjoy the advantage of chemical substances as much as possible without losing public acceptance, we must manage those chemicals on the basis of scientifically sound risk assessment. We focus on the following four research topics.

**Research topics**

1. Development of methodology for exposure assessment of chemicals
   We develop the methodology for estimating concentrations of chemical substances in environmental media and the behavior model of chemical substances in human body. We also develop the methodology for assessing ecological risk of persistent chemicals.

2. Searching chemicals with significant risk
   We screen the chemicals with little risk information and find the chemicals with significant risk by integrating the information from monitoring, source identification method and epidemiological studies.

3. Development of methodology for quantification of risk
   We derive dose-response relationships of chemicals based on toxicological and epidemiological information. We also quantify and compare their risk levels by developing appropriate endpoints for both fatal and nonfatal ones.

4. Development of methodology for risk management and risk communication
   We incorporate uncertainty and variability into risk assessment and develop the methodology of socio-economic analysis such as cost benefit analysis and cost effectiveness analysis.
Gene Discovery Research Center

As human, animal and plant genome projects progress, the cutting-edge of life science research in the 21st century will focus on gaining comprehensive understanding of the inter-connected functions of genes, proteins and other biological substances, and their roles in complex biological phenomena and diseases. Newly gained knowledge will propel development of approaches for prevention and cure of severe diseases, and the creation of valuable new industrial, pharmaceutical, and agricultural applications.

The mission of this Center is to discover and explore the new functional genes involved in important biological phenomena from cell regulation to aging; to precisely understand their structure-function relationships and roles in the context of networks of other genes, proteins, and associated biological substances, and by these discoveries contribute to medicine, industry, and society as a whole.

Research foci include, (1) development of novel nucleic acid-based tools for gene discovery, (2) exploration of biological networks and the structure-function relationship of their components, genes, proteins and associated biological substances, (3) delineation of cellular regulatory mechanisms, (4) determination of genetic and molecular mechanisms responsible for age-regulation of the blood coagulation system, (5) development of novel gene delivery systems and gene therapy methods.

Correlated Electron Research Center

Correlated Electron Research Center (CERC) aims at exploring new quantum-functional materials and developing new quantum-devices on the basis of emerging physical science on correlated electron system. The term “correlated electrons” represents the state of matter where many electrons are strongly interacting with each other, forming the liquid-, solid-, and liquid-crystal-like state of electrons. Those electronic phases can be switched by external stimuli, which causes drastic changes in magnetic, electrical, and optical properties. Such a phase switching can be as fast as one picosecond or less. Correlated electron (CE) technology will utilize this gigantic phase-response of electrons as the out-put functionality.
**Human Stress Signal Research Center**

It is said that this is the age of stress. We are exposed to various chemical, biological, physical, and social stressors, such as toxic chemicals (including dioxin and endocrine disrupting chemicals) air pollutants (diesel exhaust gas and particles) viruses, radiation, ultraviolet light, noise, overwork, anxiety, insomnia, depression and technostress. There is now increasing evidence that shows the involvement of such stress in a variety of disorders, diseases, and aging. It is a matter of the utmost importance to study the biological effects of such stress and develop means to cope with them.

This Research Center aims to uncover the biological response to such stress by molecular, cellular and tissue levels and develop a sensitive and specific lab-chip to detect stress-markers and also devices to measure, in situ, the extent of stress to humans. It is hoped that this Research Center will take the initiative for promoting stress-bioscience interdisciplinarily and internationally.

---

**Digital Manufacturing Research Center**

One of the main features of the Japanese manufacturing industry is the strong production ability, the combination of manufacturing skill and manufacturing technology development, especially those of small and medium enterprises (SMEs). Based on the recognition that Japan is losing this core competence, technological research and development programs are recommended by which manufacturing skills owned by skilled engineers are strengthened by information technology, to create additional values. The research center focuses on the material processing technology, the standing business activity for the SMEs. The objectives are to enhance the competitiveness and to create new industrial business models by analyzing, modeling the skills and digitalizing them. A common software platform for the digitalized skills is being developed concurrently so user SMEs can customize and develop them freely in their own way. The research is being done in close connection with tri-sectors and all of the research results are open to the public via the Internet as manufacturing information infrastructure.
Goal

Cyber Assist Research Center is a forum for collaboration of industry and academia to embody a future information technology integrating device, infrastructure, software, and services.

Our final goal is to develop a mobile terminal called My-Button, the infrastructure communicating with it, and prototype services based on them. Those services will provide you with appropriate information in accordance with your situation while protecting your privacy. This is essential for everybody to enjoy the merits of information technology.

Cyber

“Cyber” is often used to mean the virtual logical space created by the Internet and the computers plugged therein, but we use this term in its original sense of cybernetics (the field of study on control and communication). Namely, cyber space stands for a sensor-actuator network plus control systems plugged to it. “Cyber assist” is to assist you with a communication network involving intelligent sensors built into the town.

Situated Assist

We consider semantic annotation of information content with anchors to physical locations. Interactive information services based on meaning and context are realized by referring to rich contextual information containing your location and needs, and using semantically annotated information content including the user model.

Privacy Protection

The present Internet and telephones communicate based on addresses and phone numbers, which identify individuals. Services are provided along the same line and paid via credit-card numbers. Who got which service cannot be concealed. Legal protection cannot be perfect.

Location-based communication is an entirely new communication method we are developing. Your physical location will be the target of services without identifying you. You pay for it by digital cash, which also avoids your identification. This is to reintroduce in the cyber space the real cash, the great anonymous medium of transaction.
Research Center for Advanced Manufacturing on Nanoscale Science and Engineering

- Advanced nanoscale manufacturing and its applications for optical devices and energy conversion engineering -

Advanced nanoscale manufacturing as a novel ultra-fine processing technology will be established for engineering applications utilizing microscopic structure, size and surface effects and quantum effects. Nanoscale manufacturing ("nano-manufacturing") aims at the technical innovation in manufacturing as followed. 1) The investigation and analysis of nanoscale effects, that is, control the function of devices that are based on nanoparticles and molecular engineering. 2) The realization of nanoscale effects for the advanced devices by means of nanoscale manufacturing.

The definite research themes are the development of advanced tool and machine, and ultra-fine manufacturing technique for nanoscale processing. As results of this research, advanced optical devices and energy conversion devices will be developed.

This research center will attempt to realize the "engineering application of the microscopic effects" through the development of the advanced processing methods including the analysis of nanoscale effects.

Fabrication Technology of Uniform Nanoscale Particles for Novel Electronic Devices.
As the 21st century is called “Photon-age”, a highly controlled photoreaction technology is expected to contribute to the solution of the serious global problems of energy shortage and environmental destruction. The center is aiming at the establishment of new technologies, such as highly efficient utilization of solar light energy, which is inexhaustible and clean energy source, and laser chemical processing, which provides the desired product without environmental pollution, by systematic researches from fundamental to practical steps. Our center is also aiming to become the Center of Excellence (COE) in this research field by contributing to our industries as well as disseminating our research results to the world.
Because of the variety of chemical bonds formed by carbon atoms, carbon based materials can form different structures with various properties, ranging from the diamond to the electron emitters that are carbon nanotubes (CNT). Compared to materials with similar proprieties, carbon materials are superior in many cases.

The aim of the Research Center for Advanced Carbon Materials is to investigate the application possibilities of carbon materials; to obtain a new knowledge concerned with the structure and the function of nano-scale materials as, for example, the nano-spaces that are seen in CNT; to develop new carbon materials whose properties surpass those of current materials; to reveal new applications in various fields of applications like UV light emitters and super-tribomaterials.

Macromolecular Technology Research Center

- Environmentally benign frontier polymeric materials -

The Macromolecular Technology Research Center (MTRC) aims to develop basic concepts and generic technology for manufacturing high performance and environmentally benign novel polymeric materials with tailor-made properties by controlling their structure precisely at molecular and supermolecular level.

Outline of Research

MTRC’s main targets are as follows;

1. High-performance Polymers.

Precisely structure controlled polymers
Serious environmental problems press for the establishment of environment-friendly technologies with low consumption of energy and resources. Industrial application of these technologies, on the other hand, calls for new developments in the materials science field, as materials will be used under increasingly severe operating conditions. It is imperative, then, to create novel materials with outstanding combinations of thermal, electrical, chemical and mechanical properties, exhibiting totally new and/or markedly improved functions, as well as with a high degree of reliability and stability.

Synergy is the word commonly used to describe the positive outcome from a mutually beneficial relationship between diverse agents. However, in the case of materials, a good function or property is usually achieved at the expense of another function or property. In general, a material consists of many kinds of structural elements, such as crystalline grains, pores and grain boundaries whose different morphologies and distribution determine the structure. Therefore, simultaneous control of different structural elements at diverse scale levels enables us to attain compatibility of antagonistic properties and a synergistic effect of functions for a given material. This concept will be referred hereinafter as “Hyper-Organized Structure Control”.

The Synergy Materials Research Center aims to create a new family of novel materials, through the application of this concept, to contribute to the solution of environmental problems. The Research Center focuses on the development of four types of materials: permeable materials, tribological materials, environment purifying materials and environmental sensors. Standardization of processing and evaluation of materials is essential to enhance industrial application for those materials. The research center is also involved with standardization-related research. An outline of each research topic will be introduced in the following section.
Supercritical Fluid Research Center

The purpose of Supercritical Fluid Research Center is to develop new super-critical fluid (SCF) technologies for “green chemical processes” or environmentally benign processes. This achievement is based on the elucidation of micro- and/or macroscopic properties of SCFs. Generally, physical properties of SCFs, such as density and viscosity, lie between those of liquid and gas states. Because of these unique features, there has been enormous interest in the use of SCFs as solvents for chemical reactions. The physicochemical characteristics change greatly with variations in temperature and pressure, and the control of these properties may lead to a significant improvement in reaction rate and/or selectivity.

It is expected that the behavior of solute-solvent clustering on a chemical reaction in SCFs would be elucidated effectively by the development of a spectroscopic system at this research center. Results on SCF technology generated at the research center, will further contribute to the industrial companies who take part in the New Sun Shine SCF Project, in terms of developing new industrial technologies.

Nanoarchitectonics Research Center

The exploitation of nanotechnology in the fabrication of nanostructured materials and devices is expected to enable developments such as micro-robot therapy, a complete circulated society and even artificial life in the distant future.

The Nanoarchitectonics Research Center, in close collaboration with the Graduate School of Frontier Sciences, the University of Tokyo, aims to establish “bottom-up” nanoscale technologies based on molecular self-assembly, hierarchical atomic nanostructure construction and atomic level measurement techniques. Typical nanostructured parts and materials would include lipid nanotubes, molecular wires, cluster solids, nano-particles, molecular switches and molecular motors. Bringing together the disciplines of chemistry, physics, biology, materials science and analytical chemistry, this research center takes an interdisciplinary approach to the creation of integrated small objects, such as nano-sensors or nano-chips, on the 1 to 100 nanometer scale. In addition, measurement techniques with extremely high sensitivity and spatial resolution are being developed for the detection and analysis of single molecules that this requires.