Special Research Projects

IMS has special research projects supported by national funds. Five projects in progress are:

(a) Next Generation Integrated Nanoscience Simulation Software
Development & Application of Advanced High-Performance Supercomputer Project

(b) Formation of Interdisciplinary and International Bases for Natural Sciences, NINS
"Development of New Computational Methods for Large-Scale Systems and Establishment of Advanced Simulation Center for Molecules and Materials"

(c) Extreme Photonics

(d) MEXT Nanotechnology Network
Nanotechnology Support Project in Central Japan: Synthesis, Nanoprocessing and Advanced Instrumental Analysis

(e) Inter-University Network for Efficient Utilization of Chemical Research Equipments

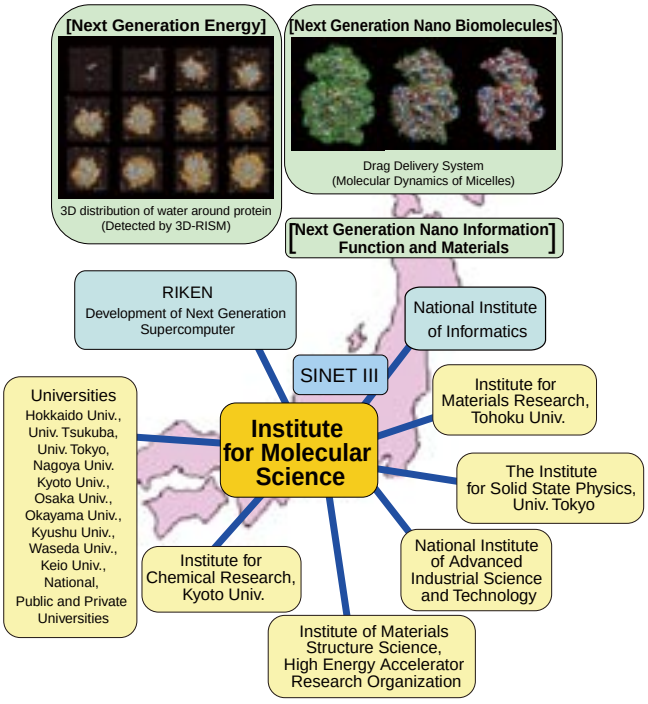
These five projects are being carried out with close collaboration between research divisions and facilities. Collaborations from outside also make important contributions. Research fellows join these projects.

(a) Next Generation Integrated Nanoscience Simulation Software Development & Application of Advanced High-Performance Supercomputer Project

A national project entitled, "Next Generation Integrated Nanoscience Simulation Software" was initiated on April 1, 2006 at Institute for Molecular Science (IMS). The project is a part of the "Development & Application of Advanced High-Performance Supercomputer Project" of MEXT, which aims to develop a next generation supercomputer and application software to meet the need in the computational science nation-wide.

The primary mission of our project is to resolve following three fundamental problems in the field of nanoscience, all of which are crucial to support society's future scientific and technological demands: (1) "Next Generation Energy" (*e.g.*, effective utilization of the solar energy), (2) "Next Generation Nano Biomolecules" (*e.g.*, scientific contributions toward overcoming obstinate diseases), and (3), "Next Generation Nano Information Function and Materials" (*e.g.*, molecular devices). In these fields, new computational methodologies and programs are to be developed to clarify the properties of nanoscale substances such as catalysts (enzymes), bio-materials, molecular devises, and so forth, by making the best use of the next generation supercomputer.

Among many application programs developed in the project, we have selected six programs, three from the molecular science and three from the solid state physics, as "core applications" in the nano-science, and concentrating our effort to tune those programs to the next generation machine. The programs in molecular science are concerned with the MD simulation, the quantum chemistry, and the statistical mechanics of liquids.

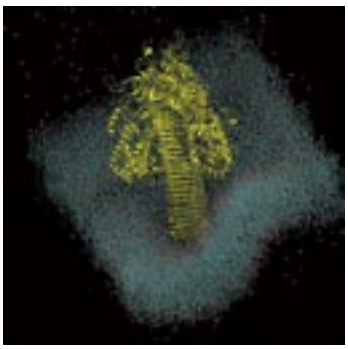


(b) Formation of Interdisciplinary and International Bases for Natural Sciences, NINS "Development of New Computational Methods for Large-Scale Systems and Establishment of Advanced Simulation Center for Molecules and Materials"

This project aims to establish a core computational science center for molecular and material systems and to develop advanced methodologies for large-scale calculations. We are trying to create a new interdisciplinary field by integrating the different views and methodologies in each field that belongs to a different hierarchy of natural sciences. Structures and dynamics of large-scale complex systems, such as nanomaterials and biological systems, are investigated with a variety of sophisticated computational methods based on theories of quantum and statistical mechanics, and so on. Seminars and workshops for the advanced calculations and for the development of human resources are also conducted by this project.

The project is organized by five institutes of the National Institutes of Natural Sciences, *i.e.* Institute for Molecular Science, National Astronomical Observatory of Japan, National Institute for Fusion Science, National Institute for Basic Biology, and National Institute for Physiological Sciences, and other universities and research institutes.

The followings are the research titles of groups participating from IMS:



Massive molecular dynamics to simulate puncture of lipid bilayer by gp5.

EHARA, Masahiro	Theoretical Studies of Molecular Excited States and Chemical Reactions
HIRATA, Fumio	Theoretical Study of Molecular Recognition Based on the 3D-RISM Theory
NAGASE, Shigeru	Quantum Chemistry Calculations of Nanomolecules
NOBUSADA, Katsuyuki	Theoretical Calculations for Electron Dynamics Strongly Coupled to the Electromagnetic Field
SAITO, Shinji	Theoretical Studies of Condensed Phase Dynamics by Using Molecular Simulation
YONEMITSU, Kenji	Theory for Nonequilibrium Control of Collective Dynamics in Quantum-Classical Hybrid Many-Particle Systems
YANAI, Takeshi	Theory Development for Multireference Electronic Structures with ab initio Quantum Chemical Methods

(c) Extreme Photonics

Institute for Molecular Science has a long-standing tradition of promoting spectroscopy and dynamics of molecules and molecular assemblies. Accordingly, photo-molecular science is one of major disciplines in molecular science. This field is not confined in the traditional spectroscopy, but makes solid basis for other disciplines including nanoscience and bioscience, *etc*. Therefore, continuing developments in spectroscopy and microscopy are vital to enhance our abilities to elucidate more complex systems in time and spatial domains. In order to achieve full developments of photo-molecular science, we need to pursue three branches in developing: (1) new light source, (2) new spatio-temporally resolved spectroscopy, and (3) new methods to control atomic and molecular dynamics. Since 2005, we have started the program of "Extreme Photonics" in collaboration with the RIKEN institute. Currently 6 groups in IMS are involved in this program, and the specific research titles are as follows:

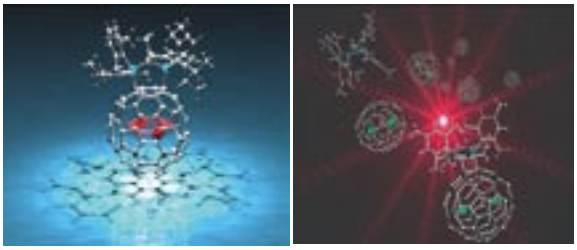
(1) Development of new light sources	
TAIRA, Takunori	Micro Solid-State Photonics
(2) Development of new spatio-temporally resolved spectroscopy	
OKAMOTO, Hiromi	Development of Extreme Time-Resolved Near-Field Spectroscopy
MATSUMOTO, Yoshiyasu	Development of Spatio-Temporally Resolved Spectroscopy for Surfaces and Interfaces
(3) Development of new methods to control atomic and molecular dynamics	
OHMORI, Kenji	Development of Attosecond Coherent Control and Its Applications
HISHIKAWA, Akiyoshi	Reaction Imaging and Control with Extremely Short Laser Pulses
OHSHIMA, Yasuhiro	Quantum-State Manipulation of Molecular Motions by Intense Coherent Laser Pulses

(d) MEXT Nanotechnology Network
Nanotechnology Support Project in Central Japan: Synthesis, Nanoprocessing and Advanced Instrumental Analysis

The Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan started the Nanotechnology Network Project in April 2007 in order to support Japanese nanotechnology researches not only for university and government researchers but also for private company researchers. IMS participates in this project as a core organization (project leader: YOKOYAMA, Toshihiko, Prof. & Director of Research Center for Molecular Scale Nanoscience) with Nagoya University (representative: BABA, Yoshinobu, Prof.), Nagoya Institute of Technology (representative: SUMIYAMA, Kenji, Prof.) and Toyota Technological Institute (representative: SAKAKI, Hiroyuki, Prof. & Vice President of TTI), and establishes a nanotechnology support center in central Japan area for these five years. We will support

1) Public usage of various advanced nanotechnology instruments such as ultrahigh magnetic field NMR (920 MHz), advanced transmission electron microscopes, and so forth
2) Design, synthesis and characterization of organic, inorganic and biological molecules and materials,
3) Semiconductor nanoprocessing using advanced facilities and technologies.

We will promote applications not only to each supporting element, but to combined usage of several supporting elements such as a nanobiotechnology field that is highly efficient in this joint project. In 2007 Oct.–2008 Spt., the number of accepted projects applied to IMS amounted 112 (the total number of days is 674).



Example of the outstanding achievement obtained by the collaboration between the theoretical group (supported by Prof. Nagase) and the experimental user group (Prof. Akasaka *et al*. in University of Tsukuba). These pictures were published as the covers of *Chem. Comm.* of Jul. 24, 2007 and Feb. 7, 2008.

List of Supports in IMS

Person in Charge	Support Element
OKAMOTO, Hiromi	Space- and Time-Resolved Near-Field Microspectroscopy
YOKOYAMA, Toshihiko	Magneto-Optical Characterization of Surface Nanomagnetism
YOKOYAMA, Toshihiko	Electron Spectroscopy for Chemical Analysis
NISHI, Nobuyuki	Tunable Picosecond Raman Spectroscopy
HIRAMOTO, Masahiro	Fabrication and characterization of organic semiconductor devices
NISHI, Nobuyuki	300kV Transmission Analytical Electron Microscopy
YOKOYAMA, Toshihiko	Focus Ion Beam Processing & Field Emission Scanning Electron Microscopy
NAGAYAMA, Kuniaki	Phase Contrast Transmission Electron Microscopy for Nanobiological materials
YOKOYAMA, Toshihiko; KATO, Koichi	920 MHz NMR Spectrometer
OGAWA, Takuji	Preparation of Molecular Electronic Devices and Electric Conductivity Measurements
NAGASE, Shigeru	Quantum Chemical Calculation for Molecular Design
SUZUKI, Toshiyasu; NAGATA, Toshi; SAKURAI, Hidehiro	Synthesis & Design of Functional Organic Nanomaterials

(e) Inter-University Network for Efficient Utilization of Chemical Research Equipments

Academic and industrial activities in Chemistry in Japan have been world-leading over the past 30 years. Needless to say, it is highly important to improve the supporting environment for research and education in science and engineering. In particular, research equipments are advancing all the time to more intelligent and expensive ones, making measurement time shorter with higher reliability. It would be economic and efficient for the researchers and students of all national universities to share such equipments for performing high level research and education.

From 2007, we started the 5 year project "Functioning of Inter-University Network for Efficient Utilization of Chemical Research Equipments." This network is operated through an internet machine-time reservation and charging system by the help of equipment managers and accounting sections in each university. All the universities are grouped into 12 regions and in each region the hub university organizes the regional committee for the operation of regional network system. There is no barrier for every user to access to any universities beyond his/her regional group.

Although the financial condition of the government is now extremely hard, the government decided to start this project in the end of 2006. In 2007, some starting budget was appropriated for preparing the new system and we started a trial network operation with 119 equipments offered by 55 universities and IMS. In 2008, the budget increased more than ten times and has been used for preparing a full-scale operation system of machine reservation/charging, and for repairing/upgrading of 19 instruments. In the end of August, the number of user registrants amounts to 4300 in 72 universities and IMS covering 1161 laboratories in Japan. From the fall of 2008, the registered equipment increases to 200. This may also increase the number of users and laboratories.

We believe that this innovative system can motivate and stimulate researchers and students to carry out new researches, and make chemistry research in Japan far more successful and active.

Okazaki Conference

The 67th Okazaki Conference
Molecular Science and Chemical Biology of Biomolecular Function

Organizers: Y. Mizutani (*Osaka Univ.*), S. Aono (*IMS, Okazaki Inst. Integ. Biosci.*), M. Fujii (*Tokyo Tech.*), K. Ishimori (*Hokkaido Univ.*), M. Saito (*Tohoku Univ.*), H. Sekiya (*Kyushu Univ.*), T. Tahara (*RIKEN*)

Invited Overseas Speakers: P. M. Champion (*Northeastern Univ.*), D. P. Giedroc (*Indiana Univ.*), M. T. Green (*Penn State Univ.*), B. H. Huynh (*Emory Univ.*), M. Lim (*Pusan National Univ.*), R. Walker (*Univ. Maryland*), R. Weinkauf (*Heinrich-Heine Univ. Düsseldorf*)

The 67th Okazaki Conference was held on Nov. 10–12, 2007 in Okazaki Conference Center, in which we had about 120 of attendees including 31 invited speakers and 53 poster presenters. The following five sessions were arranged for the invited talks in the conference: (1) Hydrogen bonding network and proton transfer, (2) Properties and dynamics of soft interface, (3) Protein structure and dynamics: spectroscopy and crystallography, (4) Design of active sites of proteins and model complexes, and (5) Biomolecular function: from molecules to cells.

Molecular science is an interdisciplinary research field between chemistry and physics, and a frontier of which is the research on the elucidation and regulation of molecular system in biological function. Chemical biology is also an interdisciplinary research field between chemistry and biology. Both research fields have the same goal to understand the biological function in molecular level. In this conference, the researchers in the field of molecular science and chemical biology discussed their recent results and exchanged views with one another.

Joint Study Programs

As one of the important functions of an inter-university research institute, IMS facilitates joint study programs for which funds are available to cover the costs of research expenses as well as the travel and accommodation expenses of individuals. Proposals from domestic scientists are reviewed and selected by an interuniversity committee.

(1) Special Projects

A. New Developments in Spin Science Using Pulsed and High-Frequency ESR

KATO, Tatsuhisa *(Josai Univ.)*
MIZOGUCHI, Kenji *(Tokyo Metropolitan Univ.)*
SAKAMOTO, Hirokazu *(Tokyo Metropolitan Univ.)*
NAKAMURA, Toshikazu *(IMS)*
FURUKAWA, Ko *(IMS)*

In order to develop advanced ESR (electron spin resonance) spectroscopy for materials science, we performed functional materials studies, both on isolated molecules and on molecular assemblies. The following two topics were investigated: 1) We determined the molecular structure of novel systems such as N@C_{60}/C_{60} nano-whisker and their spin interaction using ESR spectroscopy, and explored the functionality of the complicated molecule system. 2) We carried out an analysis of spin dynamics for functional molecular assemblies, including molecular conductors and magnetic materials. We searched for cooperative phenomena involved in intra-molecule freedom, and new functional physical-properties originating in molecular assemblies.

A-1 Characterization of N@C_{60}/C_{60} Nano-Whisker by ESR

Endohedral N@C_{60} exhibits the spin ground state ($^4S_{3/2}$) due to the atomic nitrogen, which is located in the center of the fullerene cage. Because of the high symmetry, the guest nitrogen is subjected to isotropic environment and keeps the spherical symmetry of the free atom. The conventional spin relaxation processes are missing for the highly symmetric N@C_{60}, so even small deviation from the ideal structure like modification by crystal field can apparently be detected via interaction with the quartet spin.

C_{60} nano-whisker (NW) containing N@C_{60} was prepared by the crystal growth at the interface between toluene and isopropyl alcohol solutions. Comparing the spectrum of powder N@C_{60}/C_{60}, NW exhibited more enhanced broadening of ESR lines. The enhanced broadening reflects that the local symmetry at the nitrogen site in NW becomes lower than in C_{60} powder. ESR spectrum of N@C_{60}/C_{60} NW would give a good indicator of the solvation in the crystal growth process.

A-2 Spin and Lattice Dynamics near the Spin-Peierls Transition in Alkali-TCNQ

The dynamical nature of the spin-Peierls transition in K-TCNQ and Rb-TCNQ has been unveiled with the frequency and the temperature dependences of ESR line width and resonance positions. The spin-Peierls transition is governed by the competition of the thermal excitation and the exchange energy gain of singlet dimer formation in the half-filled Mott insulators, such as K-TCNQ.

With approaching temperature to the spin-Peierls transition T_{SP}, the singlet dimer of TCNQ molecules could be thermally excited to the triplet dimer in the singlet ground state. ESR observes the so-called “Pake-doublet” signals caused by the dipolar interaction between two electrons in an excited triplet dimer. With further approach to T_{SP}, the triplet dimer dissociates to the two isolated spin solitons with spin 1/2, resulting in the doublet ESR signals with the reduced peak separation due to the increased spin-spin distances on the dynamical average.

Thus, the separation of the doublet signals rapidly decreases near T_{SP}, accompanied with the maximum of the ESR line width which is dominated by the spin-lattice relaxation rate due to quasi-1D diffusion of the spin solitons. Therefore, these analyses of the frequency and the temperature dependences could provide ample information on the spin and lattice dynamics, important for the understanding of the phase transitions.

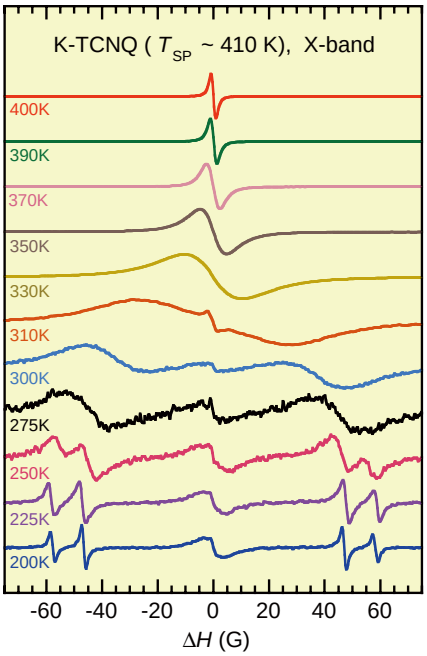


Figure 1. The temperature dependence of ESR spectra of K-TCNQ taken at X-band (~9.5 GHz). The center signals at ΔH = 0 below 310 K might be originated by defects. Doublets correspond to the signal pairs around ±50 G or ±60 G.

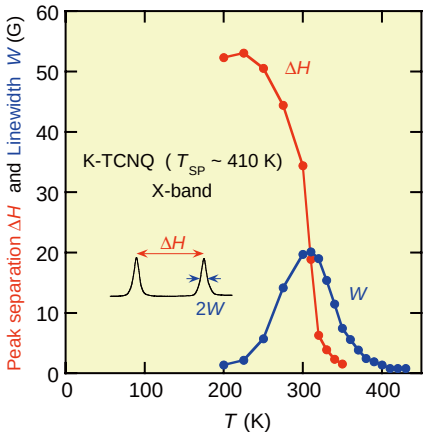


Figure 2. The temperature dependence of the peak separation for the outer doublet at ±60 G and the ESR linewidth. Note the steep disappearance of ΔH and the peak of ESR linewidth.

A-3 Spin-Dynamics Investigation by Pulsed-ESR for Phase Boundary between Spin-Peierls and Antiferromagnetic States in $(TMTTF)_2X$

$(TMTTF)_2SbF_6$ is considered to be located at the most negative pressure side in the generalized phase diagram of $(TMTCF)_2X$ at present. Observation of superconductivity in $(TMTTF)_2AsF_6$ (at 4.5 GPa) and $(TMTTF)_2SbF_6$ (6 GPa) under high pressure is also supporting this scenario. However, this model has produced a new unsolved problem: Another antiferromagnetic phase can be expected on the negative pressure side of the spin-Peierls phase according to ^{13}C NMR measurements for $(TMTTF)_2SbF_6$ under physical pressures. However, this phase diagram is based on the preconceived idea that a quantum one-dimensional spin-Peierls phase is sandwiched by two antiferromagnetic phases. In our knowledge, antiferromagnetic phases are stabilized with finite inter-chain interaction by applying pressure. It is also an open question whether the two antiferromagnetic phases (AF-I and AF-II) are of the same origin or not. To understand the *P*-*T* phase diagram of $(TMTCF)_2X$, we carried out pulsed-ESR measurements on $(TMTTF)_2[(AsF_6)_x(SbF_6)_{1-x}]$.

While the ESR spin-lattice relaxation rate, ESR-T_1^{-1}, of $(TMTTF)_2AsF_6$ shows an anomalous but spin-gap behavior below the spin-Peierls phase transition temperature, T_{SP}, the ESR-T_1^{-1} behavior of $(TMTTF)_2[(AsF_6)_x(SbF_6)_{1-x}]$ ($x \sim 0.5$) does not follows a conventional gap behavior suggesting that this salt is situated in the vicinity of the phase boundary between the spin-Peierls and antiferromagnetic phases.

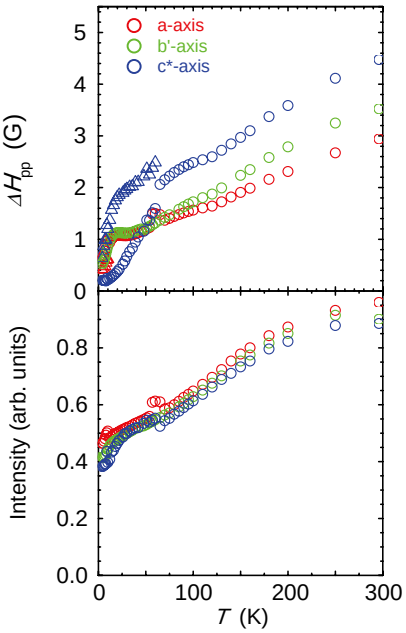


Figure 3. (left) Temperature dependence of the ESR linewidth, ΔH_{pp}, and integrated intensity (relative spin susceptibility) for $(TMTTF)_2[(AsF_6)_x(SbF_6)_{1-x}]$ ($x \sim 0.5$) determined by CW-ESR measurements.

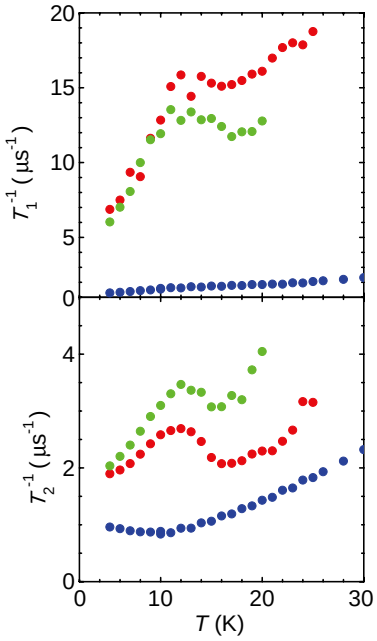


Figure 4. (right) Temperature dependence of the ESR spin-lattice relaxation rate, T_1^{-1}, and spin-spin relaxation rate, T_2^{-1}, for $(TMTTF)_2[(AsF_6)_x(SbF_6)_{1-x}]$ ($x \sim 0.5$) determined by pulsed-ESR measurements.

B. Construction of the Research Methodology for Biomolecular Sensing System

URISU, Tsuneo *(IMS)*
TERO, Ryugo *(IMS)*
TOMINAGA, Makoto *(OIIB)*
SHIGEMOTO, Ryuichi *(OIIB)*
MORIGAKI, Kennichi *(AIST)*
ISODA, Hiroko *(Univ. Tsukuba)*
YAWO, Hiromu *(Tohoku Univ.)*

Although more than 50% of genome drag discovery targets are the membrane proteins, there is no efficient biosensors necessary for screening. Patch clamp using a pipette is a well known and established technique for ion channel current measurements. However, it is not suitable for the screenings due to that it requires a high level of skills and the system scale down is difficult. In this work we are developing a new incubation type planer ion channel biosensor using Si substrates suitable for neural cell function analysis.

B-1 Development of Incubation Type Si-Based Planar Ion Channel Biosensor[1)]

A new planar-type ion channel biosensor with the function of cell culture has been fabricated using silicon on an insulator substrate as the sensor chip material. Coating of the sensor chip with fibronectin was essentially important for cell incubation on the chip (Figure 1a and 1b). Although the seal resistance (R_s) was quite low (~7 MΩ) compared with the pipette patch-clamp gigaohm seal, the whole-cell channel current of the transient receptor potential vanilloid type 1 (TRPV1) channel expressing HEK293 cells was successfully observed (Figure 1c), with a good signal-to-noise ratio, using capsaicin as a ligand molecule. The good agreement between calculated and measured values of R_s indicates that the model of the gap between cell and substrate surface and the assumed value of the cleft thickness, 75 nm, are good approximations.

B-2 Development of Light Gated Ion channel Biosensor

The network function between neuronal cells has been investigated using an artificial signal input and output detection. In the investigation of the electrically excitable cells, photostimulation provides a versatile alternative to electrode stimulation. Channel of the excitable cell by the photo stimulation is especially useful in constructing the neural network analysis device. In the present work, we have expressed Chlamydomonas reinhardii channelrhodopsin 2 (ChR2) on the cell membrane of a kind of excitable cell C2C12, and measured the basic characteristics of the photo-response. ChR2 has a light absorbance peak at 460 nm and forms a non-selective cation channel, the gating of which is triggered by the photo-isomerization of the all-trans retinal to 13-cis configuration. To investigate the photo-response characteristics of ChR2-expressed C2C12 cell, we have constructed the incubation type planer ion channel biosensor by putting a single C2C12 cell on the micropore of the Si substrate and successfully observed the light-gated whole cell channel current.

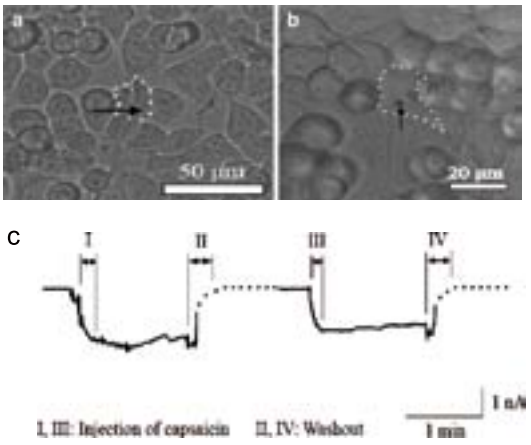


Figure 1. (a, b) Optical microscope images of HEK293 cells spreading on the pores of the planar-type ion channel biosensor. The seal resistance were (a) 6.3 MΩ, and (b) 8.4 MΩ (confluent cells). The arrows show the positions of the pores. The white dotted lines show the cells spreading on the pores. Round cells are sitting on the spreading cells. (c)Whole-cell current of TRPV1-transfected HEK-293 cell measured for the sample of (b) activated by repeated capsaicin (0.5 μmol l^{-1}) applications. Desensitization in the extracellular solution containing Ca^{2+} is observed. Holding voltage is −30 mV. Data are not shown for the dotted line region, where the signal is significantly disturbed by the noise induced by washout operations.

Reference

1) T. Urisu, T. Asano, Z. Zhang, H. Uno, R. Tero, H. Junkyu, I. Hiroko, Y. Arima, H. Iwata, K. Shibasaki and M. Tominaga, *Anal. Bioanal. Chem.*, published online, 2008.

(2) Research Symposia

(From Oct. 2007 to Sep. 2008)

Dates	Theme	Chair
Aug. 29–31, 2007	Self-Organization in the Material and Biological Systems: New Frontiers in Intergrated Research	**TOMINAGA, Masahide** **SAITO, Shinji**
Dec. 4– 5, 2007	New Development of Coordination Photochemistry by Fusing of Photofunctionality and High Reaction Selectivity	**SUZUKI, Takayoshi** **KAWAGUCHI, Hiroyuki**
Dec. 17–19, 2007	Advanced ESR Investigations for Noble Functionalities of Molecular Materials	**MIZOGUCHI, Kenji** **NAKAMURA, Toshikazu**
Mar. 10–11, 2008	Photosynthesis from Molecular Perspectives	**SUGIURA, Miwa** **NAGATA, Toshi**
Jun. 23, 2008	Preparatory Meeting for Molecular Science Summer School	**TAKEDA, Akihiro** **HISHIKAWA, Akiyoshi**
Jul. 18–19, 2008	Creation and Application of Functional Metal Complexes Based on Rational Design of Supporting Ligands —From Biological Systems to Catalysts and Devises—	**ITO, Shinobu** **AONO, Shigetoshi**

(3) Numbers of Joint Study Programs

Categories		Oct. 2007–Mar. 2008	Apr. 2008–Sep. 2008	Total
Special Projects		0	2	2
Research Symposia		3	2	5
Research Symposia for Young Researchers		–	1	1
Cooperative Research		47	46	93
Use of Facility	Instrument Center	28	25	53
	Equipment Development Center	6	4	10
Use of UVSOR Facility		77	70	147
Use of Facility Program of the Computer Center				146*

* from Apr. 2007 to Mar. 2008

Collaboration Programs

(a) IMS International Program

IMS has accepted many foreign scientists and hosted numerous international conferences since its establishment and is now universally recognized as an institute that is open to foreign countries. In 2004, IMS initiated a new program to further promote international collaborations. As a part of this new program, IMS faculty members can (1) nominate senior foreign scientists for short-term visits, (2) invite young scientists for long-term stays, and (3) undertake visits overseas to conduct international collaborations.

Leader	Title	Partner
OHMORI, Kenji	Quantum Control of Atoms and Molecules with Amplitude- and Phase-Shaped Optical Pulses	France: Prof. GIRARD, Bertrand and group members U.S.A.: Prof. LEVIS, Robert J. and group members
JIANG, Donglin	Studies on Molecular Design and Self-Assembly of Light-Harvesting Antennae	China: Prof. WANG, Changchun and group members
URISU, Tsuneo	Construction of Neural Cell Molecular Signal Transmission System and Development of Molecular Science New Field	China: Prof. WANG, Chang-Shun Mr. HE
KIMURA, Shin-ichi	Optical and Photoelectrical Studies on the Local to Itinerant Electronic Structure of Strongly Correlated Electron Systems	Korea: Prof. KWON, Yong-Seung Dr. IM, Hojun Dr. KIM, Hyeong-do and their group members
KOSUGI, Nobuhiro	Resonant Soft X-Ray Spectroscopic Study at UVSOR BL3U	Germany: Prof. RUEHL, Eckart Dr. WINTER, Bernd and their group members Sweden: Prof. PETTERSSON, Lars G. M. Prof. GEL'MUKANOV, Faris and their group members France: Dr. MIRON, Catalin and group members U.S.A.: Dr. GUO, Jinghua and group members
TANAKA, Koji	Photochemical Water Oxidation and Multi-Electron Reduction of Carbon Dioxide	U.S.A.: Dr. MUCKERMAN, James T. Dr. FUJITA, Etsuko and their group members
KATOH, Masahiro	Beam Dynamics in Free Electron Laser	France: Dr. COUPRIE, Marie Emmanuelle Dr. BIELAWSKI, Serge and their group members
TAIRA, Takunori	Q-Switched Nd-Microchip Lasers with COB Doubler	France: Prof. AKA, Gerard Philippe Dr. MORTIER, Michel and their group members

SHIGEMASA, Eiji	Deexcitation Dynamics of Core Excited Molecules Studied by Electron Spectroscopy	France: Dr. SIMON, Marc and group members U.K.: Prof. ELAND, John H. D.
OKAMOTO, Hiromi	Near-Field Spectroscopy of Plasmon-Induced Enhanced Electric Fields in Metal Nanoparticle Systems	Korea: Prof. JEONG, Dea Hong and group members

(b) Asian Core Program "Frontiers of Material, Photo- and Theoretical Molecular Sciences"

Asian Core Program is a multilateral international collaboration program carried our by JSPS (Japan Society for the Promotion of Science). It is designed to create world-class research hubs in selected fields within the Asian region, while fostering the next generation of leading researchers. The program is based on a principle of equal partnership among core institutions in Japan and other Asian countries, so that each institution is expected to secure its own matching fund. Institute for Molecular Science has launched a collaboration project "material, photo- and theoretical molecular sciences" (2006–2011) within the framework of this Asian Core Program with three key institutes in east Asian countries: Institute of Chemistry, Chinese Academy of Science (China); The College of Natural Science, Korea Advanced Institute of Science and Technology (Korea); and Institute of Atomic and Molecular Sciences, Academia Sinica (Taiwan). At present, eight joint researches are in progress, and seven joint seminars are planned within JFY 2008.