Special Research Projects

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

(a) Inter-University Network for Common Utilization of Research Equipments
(b) MEXT Program Advanced Research Infrastructure for Materials and Nanotechnology in Japan: Spoke Organization in Advanced Materials Recycling Technologies and Representative Organization in Cross Sectional Technical Domain of Materials Synthesis Process
(c) "Development of Cold-Atom Based Quantum Simulators and Their Applications to Quantum Computing" within the Framework of Japan's Flagship Program on Quantum Sciences and Technologies "Q-LEAP" by MEXT and "PRISM" by the Cabinet Office of Japan (2018–2028)
(d) "Large-Scale and High-Coherence Fault-Tolerant Quantum Computer with Dynamical Atom Arrays" Supported by the Cabinet Office/JST R&D Program "Moonshot Goal 6": Realization of a Fault-Tolerant Universal Quantum Computer That Will Revolutionize Economy, Industry, and Security by 2050
(e) MEXT Promotion of Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence Program (CURE): Frontier of Spin Life Sciences [Spin-L]

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.

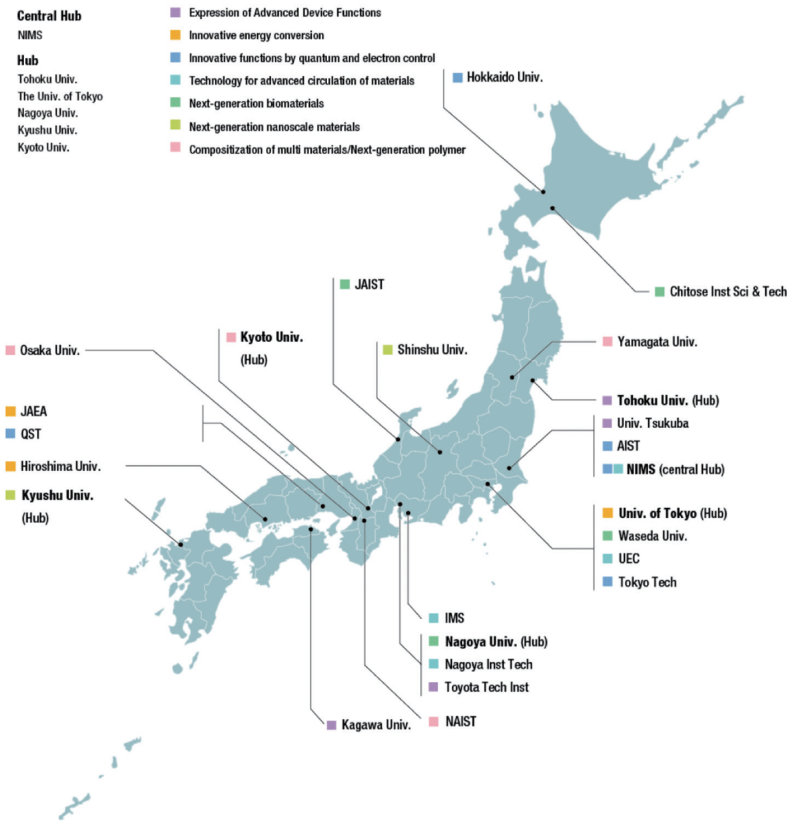
(a) Inter-University Network for Common Utilization of Research Equipments

It is highly important to improve instrumental supporting environments for research and education in the field of science and engineering. Nowadays, advanced research instruments are indispensable for conducting researches and educations with high standard quality. To install such sophisticated instruments, tremendous amount of budgets would be necessary. In 2007, for constructing a national-wide network to provide easy accesses to high-level equipments to researchers and students in universities all over Japan, the five-year project "Functioning of Inter-University Network for Efficient Utilization of Chemical Research Equipments" was launched. The network maintains an internet machine-time reservation and charging system by the help of equipment managers and accounting sections in each university. 72 national universities as well as Institute for Molecular Science (total 73 organizations) all over Japan have been participating in the network. From 2009, the registered equipments are open to the researchers and students of all the public (prefectural *etc.*) and private universities and private companies. Since 2010, the project has been renamed "Inter-University Network for Common Utilization of Research Equipments" still keeping the original strategy and stable functioning. Since 2018, the institutions that provide research facilities are open to public and private universities. Currently, the network is organized by 78 organizations. The number of registered users amounts to 19,500 in 674 universities/institutions/companies (as of July, 2024). Network usage reaches more than 190,000 times a year, in which external usage amounts to 5,400 times, and these numbers continue to grow. Moreover, we have actively provided various opportunities where technical staffs and users can improve their technical skills and frankly communicate with each other.

(b) MEXT Program Advanced Research Infrastructure for Materials and Nanotechnology in Japan: Spoke Organization in Advanced Materials Recycling Technologies and Representative Organization in Cross Sectional Technical Domain of Materials Synthesis Process

Since 2021, ARIM (Advanced Research Infrastructure for Materials and Nanotechnology in Japan) program supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT) has been conducted, succeeding to MEXT Nanotechnology Platform program that was completed in March, 2022. In this new program, seven "key technology domains" are set. Each key technology domain team consist of one hub organization and several spoke organizations, with the center hub of National Institute of Materials Science (NIMS). The hub & spoke networks for collecting, accumulating, and structuring research data that are created from observation, measurement, synthesis and fabrication equipment and facilities, were launched in order to strengthen AI-driven materials & device R&D using informatics techniques. IMS belongs to one of the key technology domains of "Advanced materials recycling technologies" led by the NIMS hub, together with the spoke organizations of Nagoya Institute of Technology and The University of Electro-Communications. Domestic and international equipment sharing is the most important purpose in this program, as in the Nanotechnology Platform program. Moreover, users and staffs are requested to provide experimentally obtained data to the Data Platform Center (DPC) that are being constructed in NIMS. Accumulated structured data will be shared through the NIMS DPC. In addition, we will contribute to strengthening material innovation force by building a "Material D Platform" in collaboration with the Data creation/utilization type material research and development project. In this program, three areas of shared methodology are set to promote cooperation across the seven key technology domains. IMS also acts as a representative organization for the cross-sectional technological area concerning the material synthesis process to promote technological cooperation among all the participating organizations. Human resource development is also an important aim in this program and IMS regularly conducts training sessions with "EQ-NET" to upskilling of the technical staffs engaged in this program. In IMS, the mission for the ARIM program is mainly organized by Instrument Center, supported by Research Center for Computational Science in data storage and transfer to NIMS DPC. Through this program, a new electron spin resonance (ESR) system and a new superconducting quantum interference device (SQUID) magnetometer, a high-throughput low-temperature single-crystal x-ray diffractometer, and an automatic organic synthesis system were installed in IMS in FY2021–2023. We hope that this program will successfully be performed and equipment sharing and data sharing will be accelerated.

Ministry of Education, Culture, Sports, Science and Technology (MEXT)
Advanced Research Inftrastructure for Materials and Nanotechnology in Japan (ARIM)



List of Equipment Supports in IMS Spoke (FY2024)

Supporting Element		Responsible Persons	Charging Persons
Organization Management in IMS Spoke		T. Yokoyama	T. Nakamura, M. Ehara, K. Iwahashi, T. Suzuki, K. Nakamoto, Y. Ota, M. Kaku, Y. Funaki, Y. Hyodo
Organization Management in Cross-Sectional Technological Area of Material Synthesis		T. Yokoyama	Y. Ota, K. Nakamoto, M. Kaku, Y. Kurita, A. Ishikawa
UVSOR Synchrotron Radiation	X-Ray Magnetic Circular Dichroism	T. Yokoyama	O. Ishiyama
Microstructure Fabrication	Maskless Lithography with Step Gauge	H. Yamamoto	T. Kondo, S. Kimura, N. Takada, A. Ishikawa
	3D Optical Surface Profiler		
	Electron Beam Lithgraphy		
Electron Microscopy	Field Emission Scanning Electron Microscopy	T. Yokoyama	O. Ishiyama
	Low Vacuum Analytical Scanning Electron Microscopy		
	Field Emission Transmission Electron Microscope		S. Iki, T. Ueda, M. Uruichi

X-rays	Single Crystal X-Ray Diffractometer	T. Yokoyama	Y. Okano
	Low Temperature Single Crystal X-Ray Diffractometer for Microcrystals		
	Powder X-Ray Diffractometer		M. Fujiwara, M. Miyajima
	Operando Multi-Purpose X-Ray Diffraction		M. Fujiwara, M. Miyajima
	Small Angle X-Ray Scattering for Solutions	S. Akiyama	Y. Furuike
	Molecular Structure Analysis using Crystalline Sponge Method	M. Fujita	T. Mitsuhashi, T. Yokoyama
Electron Spectroscopy	X-Ray Photoelectron Spectroscopy	T. Yokoyama	S. Iki, O. Ishiyama
	Angle Resolved Ultraviolet Photoelectron Spectroscopy for Functional Band Structures	S. Kera, K. Tanaka	K. Fukutani
Electron Spin Resonance	Pulsed High Field ESR	T. Yokoyama, T. Nakamura	M. Asada, M. Fujiwara, M. Miyajima, S. Iki, T. Ueda
	X-Band CW ESR		
	X, Q-Band CW ESR		
	Pulsed ESR		
SQUID	Superconducting Quantum Interference Device		M. Asada, M. Fujiwara, M. Miyajima, S. Iki
Thermal Analysis	Differential Scanning Calorimeter (Solutions)	T. Yokoyama	H. Nagao, M. Uruichi
	Isothermal Titration Calorimeter (Solutions)		
	Calorimeter for solids		M. Fujiwara, M. Miyajima
Mass Spectrometer	Matrix Assisted Laser Desorption/Ionization Time of Flight Mass Spectrometer		M. Uruichi, K. Fujikawa
Spectroscopy	Microscopic Raman Spectroscopy		M. Uruichi, K. Fujikawa
	Fourier Transform Far Infrared Spectroscopy		
	Fluorescence Spectroscopy		T. Ueda
	Ultraviolet & Visible Absorption Spectroscopy		
	Absolute Photoluminescence Quantum Yield Spectrometer		
	Circular Dichroism		T. Mizukawa, M. Uruichi, K. Fujikawa
Lasers	Picosecond Laser		T. Ueda
High Field NMR	600 MHz Solids	K. Nishimura	
	600 MHz Solutions	T. Yokoyama	T. Mizukawa, M. Uruichi, H. Nagao
Functional Molecular Synthesis and Molecular Device Fabrication	Organic Field Effect Transistors	H. Yamamoto	T. Sato
	Organic Synthesis DX	T. Suzuki	N. Momiyama, N. Ohtsuka
	Large Scale Quantum Mechanical Calculations	M. Ehara	
	Magnetic Thin Films	T. Yokoyama	
	Supplementary Apparatus in Instrument Center	T. Yokoyama	

(c) "Development of Cold-Atom Based Quantum Simulators and Their Applications to Quantum Computing" within the Framework of Japan's Flagship Program on Quantum Sciences and Technologies "Q-LEAP" by MEXT and "PRISM" by the Cabinet Office of Japan (2018–2028)

Quantum science and technology, such as quantum computers, quantum simulators, and quantum sensors, are qualitatively new technologies that take advantages of the "wave nature" of microscopic particles including electrons and atoms. Since quantum science and technology can revolutionize functional materials, drug design, information security, artificial intelligence, etc., huge investments are being made in the science and technology policies of various countries around the world. In Japan, the "Committee on Quantum Science and Technology" was established in June 2015 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) to discuss policy issues related to quantum science and technology, and a new national project, the "MEXT-Quantum Leap Flagship Program (MEXT Q-LEAP)" was launched in 2018 based on the discussions by the committee. This research and development program that aims for discontinuous solutions (Quantum leap) to important economic and social issues by making full use of quantum science and technology (https://www.jst.go.jp/stpp/q-leap/en/index.html). The program consists of three technological areas: (1) Quantum information technology (Quantum simulator, Quantum computer), (2) Quantum metrology & sensing, and (3) Next generation laser.

The ongoing research project led by Prof. Kenji Ohmori at IMS and named "Development of cold-atom based quantum simulators by optical control with precisions on the attosecond temporal and nanometer spatial scales and their applications to quantum computing," which has been adopted as a Large-Scale Basic Foundation Research project in the Q-LEAP

"Quantum information technology" area, aims to develop a completely new quantum simulator /quantum computer with core competences, which will cut deeply and sharply into fundamental problems of quantum mechanics, in close collaboration with Kyoto University, Okayama University, and Kindai University.

(d) "Large-Scale and High-Coherence Fault-Tolerant Quantum Computer with Dynamical Atom Arrays" Supported by the Cabinet Office / JST R&D Program "Moonshot Goal 6": Realization of a Fault-Tolerant Universal Quantum Computer That Will Revolutionize Economy, Industry, and Security by 2050

The "Moonshot R&D Program" is a large-scale national program led by the Cabinet Office, aiming to create disruptive innovations originating in Japan to address important social issues such as the super-aging society and global warming, and to promote the realization of ambitious goals "Moon Shots" (Cabinet Office/JST Moonshot R&D Program: https://www.jst.go.jp/moonshot/en/).

Goal 6, "Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050," aims to develop a quantum computer that can meet the exploding demand for information processing, while conventional computers are reaching their limits in terms of progress. The key to solving diverse, complex, and large-scale real-world problems with quantum computers is the realization of a fault-tolerant universal quantum computer that can correct quantum errors during computations.

The R&D project "Large-scale and high-coherence fault-tolerant quantum computer with dynamical atom arrays" led by Prof. Kenji Ohmori at IMS under Goal 6 develops dynamical qubit arrays in which each of the cold-atom qubits arranged in a large array of optical tweezers is freely and rapidly moved during computation including gate operations and error detection / correction, or before computation for algorithm dependent optimization of the spatial configuration of atomic qubits. The goal is to realize a practical fault-tolerant quantum computer with high stability and usability through integration and packaging of the key components under the collaboration with industries.

(e) MEXT Promotion of Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence Program (CURE): Frontier of Spin Life Sciences [Spin-L]

Frontier of Spin Life Sciences

The MEXT CURE project, "Frontier of Spin Life Sciences (Spin-L)," launched in September 2023, aims to pioneer a new interdisciplinary field by integrating molecular, life, and physiological sciences. This initiative establishes a hub for magnetic resonance (MR) technology and research, leveraging existing joint usage/research systems.

The core of Spin-L is formed by the three Okazaki institutions: NIPS, IMS, and ExCELLS. They focus on developing new MR molecular probes and conducting MR imaging on model animals to explore novel measurement principles and methods for living organisms. To accelerate this cutting-edge research, Spin-L fosters strong collaboration among Japanese researchers, promoting industry–academia partnerships through various mechanisms. These include project research by specially appointed faculty, cross-appointments, human exchange programs, joint usage/research, and human resource development, all operating under a unified framework on the Okazaki Campus.

Beyond the core institutions, the project involves several participating institutions, including Institute for Chemical Research (Kyoto University), Institute for Protein Research (The University of Osaka), Brain Research Institute (Niigata University), and Institute for Quantum Life Science (QST). These collaborations address specialized technologies and compound synthesis. The project not only facilitates joint research and usage across diverse universities, companies, and platforms but also emphasizes training cross-disciplinary researchers and technical staff.

Main achievements in FY2024

The Hub Director General is Dr. Nabekura, Director General of NIPS (to be succeeded by Dr. Isa, Director General of NIPS, in FY2025). An administrative office has been established to manage the Hub, with Dr. Nakamura, Team Leader at IMS, serving as the Head of the Administrative Office. The following committees and meetings are also held:

Steering Committee: Composed of two members from each core institution and one from each node institution. Held approximately once a year.

Core Meeting: Held as needed, approximately four times a year.

Hub Meeting: Held approximately once a year.

Joint Research Committee: Held approximately once a year (Starting from FY2025, email reviews are conducted approximately once a month for project evaluations).

External Evaluation Committee: Composed of four members, including one international member. In FY2024, External Evaluation Committee members participated as observers in an interdisciplinary research meeting and the Steering Committee, providing an overall assessment of activities.

Project Implementation Details:

Joint Usage Research: A Joint Usage Committee has been established to decide on the adoption of projects and assign project numbers for “Spin-Life Research Projects (each core institution),” “Problem-Setting Type (Open research conducted in collaboration with the Visiting Research Group and other institutions),” and “Collaborative Research by the Visiting PIs and Project Research Staff (within the Hub).” In FY2024, 78 “Spin-Life Research Projects” and 2 “Collaborative Research by Visiting PIs and Specially Appointed Faculty” projects were adopted.

Young Researcher Development Program/Overseas Dispatch Grant: This program supports dispatches to overseas laboratories for several weeks. In FY2024, two applications were received, and overseas dispatches were conducted.

Young Researchers’ Retreat: Young researchers from different institutions across the Hub played a central role in planning the overnight retreat. In FY2024, it was held at NIPS from September 11–12, with 32 participants from core and node institutions.

Interdisciplinary Training Course: On the afternoon of September 12, 2024, following the Young Researchers’ Retreat, lectures were given at NIPS, IMS, and ExCELLS to 12 researchers and engineers from across Japan.

Okazaki Conference

(a) The 82nd Okazaki Conference
Recent Advances and Perspectives of Interfacial Materials and Molecular Sciences Lead by Next-Generation Laser Techniques and Computational Science

(July 28–31, 2025)

Organizers: T. Sugimoto (*IMS*), A. Morita (*Tohoku Univ.*)

Invited Overseas Speaker: Yuen-Ron Shen (*Univ. of California Berkeley, USA*), Hai-Lung Dai (*Temple Univ., USA*), Eric Borguet (*Temple Univ., USA*), Elsa Yan (*Yale Univ., USA*), Chuanshan Tian (*Fudan Univ., China*), Martin Thämer (*Fritz-Haber-Inst., Germany*), Hongfei Wang (*Westlake Univ., China*), Sean Roberts (*Univ. of Texas at Austin, USA*), Ali Hassanali (*International Cent. for Theoretical Physics, Italy*), Franz Geiger (*Northwestern Univ., USA*), Juli Gibbs (*Univ. of Alberta, Canada*), Dennis Hore (*Univ. of Victoria, Canada*), Zefeng Ren (*Dalian Inst., China*), Craig Schwartz (*Univ. of Nevada, USA*), Eric Tyrode (*KTH Royal Inst., Sweden*), Doseok Kim (*Sogang Univ., Korea*)

Interfacial molecular science plays a central role in elucidating the origins of critical material functions such as heterogeneous catalysis, molecular devices, batteries, and sensors, and has long been one of the major frontiers of molecular science. In recent years, remarkable advances supported by state-of-the-art laser techniques and computational science have positioned Japan as an internationally recognized contributor to this field. To further promote its development and global visibility, we organized this international conference.

Nonlinear optical spectroscopy with intrinsic interfacial selectivity, particularly vibrational sum-frequency generation (SFG), has proven to be a uniquely powerful approach for studying soft surfaces and buried interfaces, extending the scope of conventional surface science. Japan has historically provided fundamental international leadership in this field, through both the theoretical formulation and computational realization of SFG, and the development of broadband phase-sensitive detection methods. More recently, IMS achieved the world's first success in tip-enhanced near-field SFG nano-spectroscopy, breaking the diffraction limit by several orders of magnitude. Building on this foundation, new approaches are rapidly emerging, including ultrabroadband IR–terahertz techniques and theoretical models capable of reproducing the full complexity of interfacial SFG spectra.

The conference program reflected the breadth of this expanding field. Presentations covered the development of new spectroscopic methods such as near-field tip-enhanced SFG, synchrotron-radiation-based second harmonic generation and theoretical advances that capture both interfacial and bulk contributions. Additional highlights included the development of SFG scattering spectroscopy and its application to nanoparticle surfaces, studies of solid–liquid mineral interfaces in environmental chemistry, selective probing of proteins at biological interfaces, solvent structures at electrochemical interfaces, and interfacial properties of organic molecular devices. By uniting these diverse topics under the common framework of interfacial spectroscopy, the meeting successfully created an international platform for scientific exchange and discussion. This outcome is expected to have a significant impact in shaping a shared vision for the future of interfacial molecular science.

Joint Studies Programs

As one of the important functions of an inter-university research institute, IMS facilitates joint studies 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) Enhancing the Durability of Metal Complex–Carbon Electrodes in Electrochemical CO_2 Reduction in Water

SAITO, Susumu (*Nagoya Univ.*)
JUNG, Jieun (*Nagoya Univ.*)
SUGIMOTO, Toshiki (*IMS*)

Carbon dioxide (CO_2) is an attractive carbon resource. Two-electron reduction of CO_2 yields industrially valuable products such as carbon monoxide (CO) and formic acid (HCO_2H). Among various approaches, electrochemical CO_2 reduction using water as the electron and proton source has gained increasing attention, with both solid metal electrodes and metal complex–based electrocatalysts being actively studied. Compared with solid metal electrodes, which typically require higher overpotentials and show lower product selectivity, metal complex–supported electrodes offer distinct advantages, including lower energy consumption, rational molecular-level design through the choice of metal centers and organic ligands, efficient electron transfer, and reduced catalyst loading.

A key challenge, however, lies in the stable immobilization of metal complexes on electrode surfaces. Structural degradation of complexes under applied potential or their detachment from the electrode surface leads to significant loss of CO_2 reduction activity. Enhancing the durability of such catalysts is therefore an urgent issue. In this study, we developed a robust metal complex–based electrode catalyst with high durability by anchoring a (PNNP)Ir complex onto a carbon paper (CP) support, yielding [(PNNP)Ir]/CP electrodes, as reported below.

We developed an iridium complex catalyst, Mes-IrPCY$_2$, bearing a tetradentate PNNP ligand, as a highly efficient photocatalyst for CO_2 reduction. This complex exhibits an exceptional turnover number (TON > 10,400), far exceeding conventional mononuclear self-sensitized systems. The PNNP ligand, composed of a bipyridine unit and two phosphine donors, allows systematic tuning of electronic and steric properties through ligand modification. In this study, we first advanced toward next-generation electrodes by immobilizing (PNNP)Ir complexes on carbon paper (CP). The electrodes, [(PNNP)Ir]/CP, were fabricated by coating the complexes with pyrrole polymer and carbon powder. Structural characterization of [Mes-IrPPh$_2$]/CP using SEM and EDS confirmed a homogeneous distribution of N, P, and Ir, with the complex concentrated on the CP surface. Electrochemical tests revealed that [Mes-IrPPh$_2$]/CP exhibited catalytic current at a low onset potential (E_{on} = −0.24 V vs. RHE), marking the first demonstration of such low-voltage activity for this class of molecularly engineered electrodes. These findings underscore the promise of PNNP–Ir complexes as durable, tunable platforms for efficient CO_2 electroreduction and artificial photosynthesis.

We further evaluated the electrochemical CO_2 reduction performance of the fabricated [(PNNP)Ir]/CP electrodes in aqueous media using a two-compartment electrolysis cell separated by a Nafion membrane, with a Pt anode and the CO_2 reduction cathode. In CO_2-saturated 0.5 M $KHCO_3$ electrolyte, application of −0.37 V vs. RHE for 3 h revealed that [Mes-IrPPh$_2$]/CP exhibited the highest activity. A total of 0.765 mmol of products (formate + CO) was generated from 2.86 μmol of catalyst, achieving a Faradaic efficiency of 86.4% for formate with a current density of 5.49 mA cm^{-2}. Remarkably, even at a lower applied potential of −0.27 V vs. RHE, the electrode maintained high efficiency, with Faradaic yields exceeding 95%. Long-term electrolysis at −0.37 V vs. RHE for 168 h produced 12.5 mmol of formate in a linear growth trend, demonstrating that the [Mes-IrPPh$_2$]/CP electrode catalyst possesses excellent durability under these conditions.

Then, we have also developed an interfacial measurement technique based on nonlinear spectroscopy, in which multiple femtosecond pulses are temporally and spatially overlapped to coherently excite interfacial responses. A key challenge at the outset was that interfacial signals were buried under overwhelming bulk contributions from the aqueous solution and electrode. Through systematic optimization of the measurement scheme, we successfully suppressed bulk-derived background signals by more than four orders of magnitude, thereby establishing a methodology that enables effective detection of signals originating exclusively from the electrode interface. Using this approach, we examined [Mes-IrPPh$_2$]/CP and CP electrode. The results revealed that the molecular response of interfacial water in the electric double layer was strongly modulated compared with bare CP electrodes, and that this modulation depended sensitively on the solution conditions (acidic, neutral, or basic).

In summary, this study established a novel class of CO_2 reduction electrode catalysts based on PNNP–Ir complexes, demonstrating their outstanding durability under both photo- and electrochemical conditions. The integration of in situ nonlinear spectroscopic feedback with catalyst design has enabled deeper understanding of interfacial processes and guided the development of electrodes with enhanced stability and performance. Building on these advances, the research has further evolved into a CREST co-creation project on catalytic upcycling of oxidized carbon resources, underscoring the broader significance of our work in paving the way toward sustainable carbon utilization technologies.

(b) Fabrication of Plasmon-Quantum Dots Hybrid Structures and Elucidation of Their Photoexcited State Dynamics by Ultrafast Nanoscale Microspectroscopy

SHIBUTA, Masahiro (*Osaka Metropolitan Univ.*)
KUMAGAI, Takashi (*IMS*)
IWASA, Takeshi (*Hokkaido Univ.*)
NISHIDA, Jun (*IMS*)
KAMADA, Kazuki (*Osaka Metropolitan Univ.*)

When semiconductor quantum dots (QDs) form a well-packed and highly ordered aggregates, new optoelectric functionalities (*e.g.* carrier transport property) appear due to the quantum chemical interactions between the QDs. These functionalities are promising to be applied for future QD-based solar cells. Furthermore, by integrating metal nanostructures exhibiting plasmonic responses as a substrate to support the QD assembly, the photofunctionalities drastically enhances through a strong interaction with the plasmonic field.

The aim of research is to understand the unique opto-electronic properties resulting from inter-QD and plasmon-QD interactions to achieve precise control of the photofuctionalities in the hybrid system. A research group at Osaka Metropolitan Univ. (Shibuta and Kamada) has precisely synthesized water-soluble QDs (e.g. CdTe and CdSe) with high optical absorption/luminescent properties at visible wavelength range. Short-chain ligands are chosen to stabilize the QDs while promoting stronger inter-QD coupling, enabling a well-packed QD layer to be assembled on a plasmonic substrate by solution-based layer-by-layer deposition (left in the Figure). The plasmonic properties of the plasmon-QD hybrid structure can be characterized by an upconversion fluorescence microscopy excited with a femtosecend laser (Kamada *et. al.*, submitted, bottom right of Figure 1.).

The plasmonically excited carrier/exciton dynamics in the system are then probed by ultrafast and ultrabroadband scanning near-field optical microscopy. This cutting-edge nano-spectroscopy performed in IMS by Kumagai and Nishida begins to reveal the spatiotemporal dynamics of photo-excited carriers (upper right in Figure). The ultrafast phenomena in the plasmon-QD hybrid system will be theoretically addressed approach to understanding light-matter interaction in collaboration with Iwasa's group at Hokkaido Univ.).

This joint research will elucidate the physical mechanisms governing the distinctive optoelectronic properties of QD–plasmonic structures and establish rational design principles for high-efficiency optoelectronic devices and light-to-electricity conversion processes.

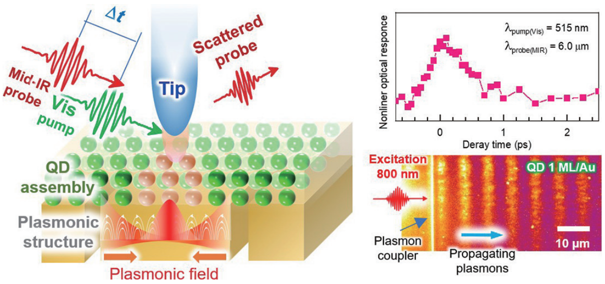


Figure 1. (left) Plasmon-QD hybrid structure and ultrafast and ultrabroadband scanning near-field optical microscopy. (bottom right) Optical imaging of plasmonic excitation. (upper right) Ultrafast response of the corresponding sample.

(2) Research Symposia

(From Oct. 2024 to Sep. 2025)

Dates	Theme	Chair
Oct. 30–31, 2024	Chemical Synthesis 2.0: Toward a New Paradigm in Chemical Synthesis through the Integration of Research Methods	**MOMIYAMA, Norie**
Dec. 17–18, 2024	Approaching Complex Systems ~To What Extent Can We Predict Materials Complexity?	**KITADA, Atsushi** **KERA, Satoshi**
Jan. 20, 2025	Recent Advancements and Functionalities in Electronic Ferroelectrics	**OKIMOTO, Yoichi** **KUMAGAI, Takashi**
Feb. 27–28, 2025	Spin Life Science Using Spin as a Probe: Aiming to Accelerate Interdisciplinary Research	**NAKAMURA, Toshikazu**
Mar. 10–12, 2025	Chirality-Related Dynamic Phenomena	**TOGAWA, Yoshihiko** **YAMAMOTO, Hiroshi**
Apr. 7– 8, 2025	Molecular Science in Tribology	**HIRAYAMA, Tomoko** **ONISHI, Hiroshi**
May 12–13, 2025	Symposium on Optical Materials and its Measurements in UVSOR (SOMU2025)	**KUSOSAWA, Shunsuke** **MATSUI, Fumihiko**

May 31–Jun. 1, 2025	Hierarchical Molecular Dynamics: Advanced Experiments and Theories	**KURAMOCHI, Hikaru**
Sep. 1, 2025	Morino Discussion	**MUNAKATA, Toshiaki** **KUMAGAI, Takashi**
Jun. 15, 2025	Advanced Workshop on Interdisciplinary Exchange in Molecular Science	**KURODA, Runa** **SUGIMOTO, Toshiki**
Aug. 18–20, 2025	The 23rd ESR Summer School —Interdisciplinary Approach for Electron Spin Science—	**IIZUKA, Naoko** **NAKAMURA, Toshikazu**
Jul. 27–31, 2025	Recent Advances and Perspectives of Interfacial Materials and Molecular Sciences lead by Next-Generation Laser Techniques and Computational Science	**MORITA, Akihiro** **SUGIMOTO, Toshiki**

(3) Numbers of Joint Studies Programs

Categories		Oct. 2024–Mar. 2025		Apr. 2025–Sep. 2025		Total		
		Regular	ARIM	Regular	ARIM	Regular	ARIM	Sum
Special Projects		1		1		2		2
Research Symposia		5		4		9		9
Research Symposia for Young Researchers		0		2		2		2
Okazaki Conference		0		1		1		1
Cooperative Research		21	42	19	27	40	69	109
Use of Facility	Instrument Center		103		70		173	173
	Equipment Development Center	0	6	0	9	0	15	15
	UVSOR	102	1	106	1	208	2	210
Use of Facility Program of the Computer Center						429*		429*

* from April 2024 to March 2025

Collaboration Programs

(1) MOU Partnership Institutions

IMS has concluded academic exchange agreements with overseas institutions.

The agreements encourage

- Exchange of researchers
- Internship of students and postdoctoral fellows
- Joint research workshops
- Joint research laboratories

Institution	Period	Accept*	Send*
The Korean Chemical Society, Physical Chemistry Division [Korea]	2006.12–2026. 9	0	0
Institute of Atomic and Molecular Sciences (IAMS) [Taiwan]	2005. 1–2026. 1	0	0
École Nationale Supérieure de Chimie de Paris (ENSCP) [France]	2009.10–2029.11	4	2
National Nanotechnology Center, National Science and Technology Development Agency (NANOTEC/NSTDA) [Thailand]	2017.10–2027.10	0	0
Sungkyunkwan University, Department of Chemistry (SKKU) [Korea]	2018. 4–2026. 3	0	0
University of Oulu [Finland]	2021. 5–2027. 5	0	0
National Yang Ming Chiao Tung University [Taiwan]	2018. 6–2028. 5	3	0
Peter Grünberg Institute, Forschungszentrum Jülich GmbH (FZJ) [Germany]	2018.10–2028. 8	1	0
Indian Institute of Technology Kanpur [India]	2020. 4–2028. 3	0	0
Fritz-Haber-Institut der Max-Planck-Gesellschaft [Germany]	2021. 4–2026. 3	2	1
China Scholarship Council [China]	2023. 1–2028. 1	2	0

* No. of researchers during the period from Oct. 2024 to Sep. 2025

Academic Exchange Agreement with Overseas Universities/Institutes (SOKENDAI) as follows ;

Institution	Period	Accept*	Send*
Kasetsart University, Faculty of Science [Thailand]	2011. 3–2026. 3	1	5
University of Malaya, Faculty of Science [Malaysia]	2014. 3–2030. 3	2	5
Vidyasirimedhi Institute of Science and Technology [Thailand]	2018. 9–2028.10	0	0
Friedrich Schiller University Jena [Germany]	2020. 7–2028. 7	1	0
Chulalongkon University [Thailand]	2010. 4–2027.10	5	4
Chiang Mai University [Thailand]	2025. 2–2030. 2	5	2

* No. of researchers during the period from Oct. 2024 to Sep. 2025

(2) IMS International Internship Program

Category	Number of People	
	Overseas	Domestic
IMS International Internship Program (IMS-IIP)	26*	–

* from Oct. 2024 to Sep. 2025

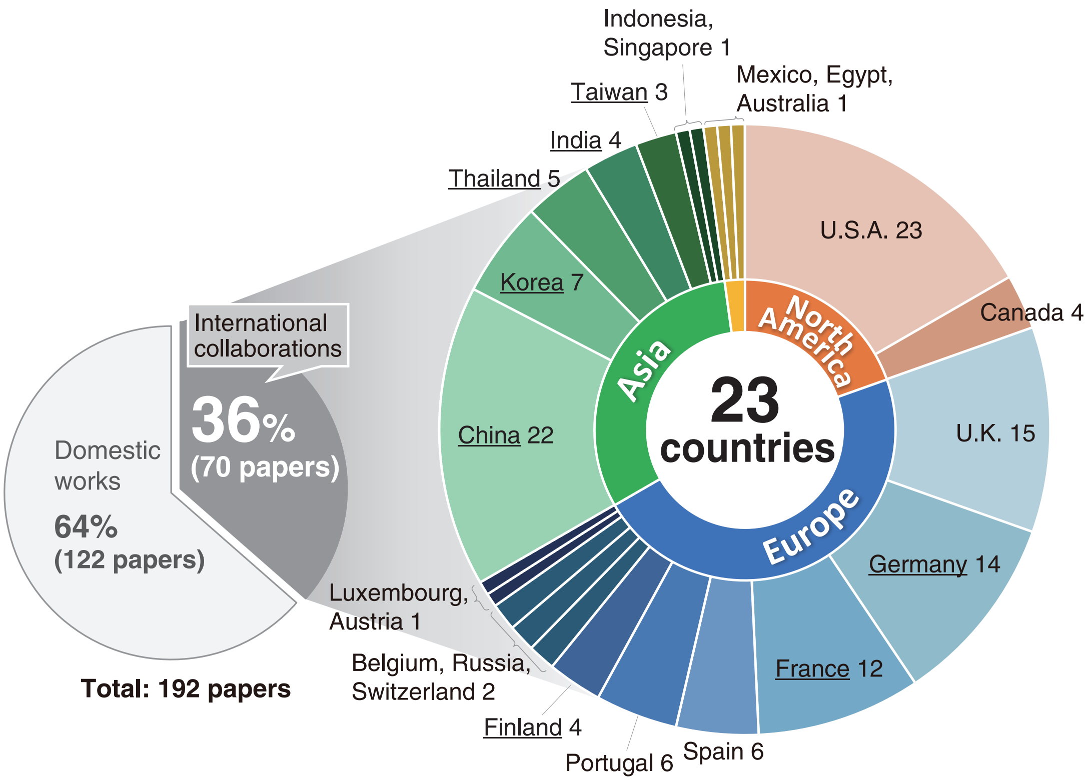
(3) IMS International Collaboration (Including online meetings)

Category	Number of People
International Joint Research Programs	84
International Use of Facilities Programs	69

from Oct. 2024 to Sep. 2025

Internationally Collaborated Publications

Articles and reviews published in 2024



Underlined countries include MOU Partnership Institutions
Scopus dataset, May 2025