Special Research Projects

IMS has special research projects supported by national funds. Three projects in progress are:
(a) MEXT Nanotechnology Platform Program
Platform of Molecule and Material Synthesis
(b) Inter-University Network for Efficient Utilization of Research Equipments

These two 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.

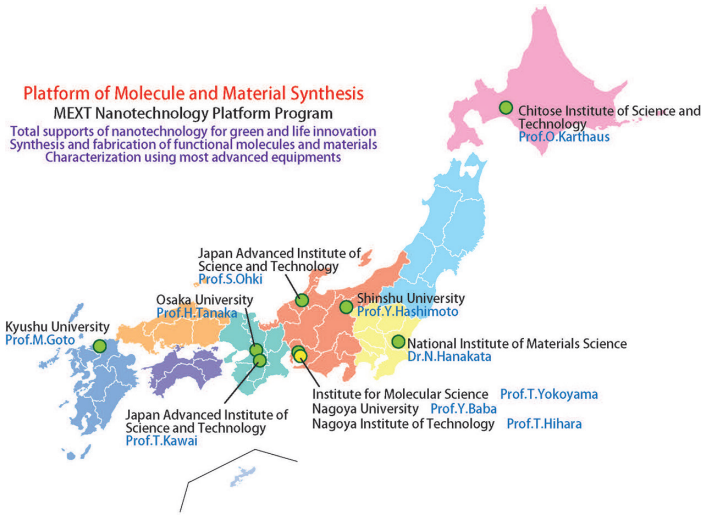
(a) MEXT Nanotechnology Platform Program Platform of Molecule and Material Synthesis

Since July 2012, Nanotechnology Platform Program supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT) has been conducted in order to promote public usage of various nanotechnology facilities. This program will continue until March 2022 and consists of three platforms of nanostructure analysis, nanoprocessing, and molecule and material synthesis, together with the management center of the platforms. Each platform consists of about ten organizations all over Japan. IMS conducts a representative core organization of the Molecule and Material Synthesis Platform. All the organizations in this platform are shown in Figure. In this platform, to promote green and life innovation researches using nanotechnology related techniques not only for universities and government institutes but also for private companies, we will open various kinds of our facilities with total supports including molecular synthesis, materials fabrications, characterization, data analysis and scientific discussion. We will encourage applications not only to each element, but to combined usage of several supporting elements for biotechnology and green chemistry. In IMS, the number of accepted proposals in FY2019 amounted 155 (141 non-proprietary and 12 proprietary proposals, excluding inhouse applications from IMS) and the total number of days used for the supports is 2949 (2834 days for non-proprietary proposals and 116 days for proprietary ones).

List of Supports in IMS (FY2019)

Supporting Element		Responsible Persons	Charging Persons
Platform Management		T. Yokoyama	M. Ohara, Y. Toyama, Y. Shibata
Organization Management in IMS			Y. Hyodo, Y. Funaki
UVSOR Synchrotron Radiation	X-Ray Magnetic Circular Dichroism	T. Yokoyama	T. Koitaya, K. Yamamoto, O. Ishiyama
Microstructure Fabrication	Maskless Lithography with Step Gauge	H. Yamamoto	M. Aoyama, N. Takada, T. Kondo, S. Kimura, T. Kikuchi
	3D Optical Surface Profiler		
Equipment Development	Machine Shop		M. Aoyama, T. Kondo, T. Toyota, F. Mizutani, J. Mathuo
Electron Microscopy	Field Emission Scanning Electron Microscopy	T. Yokoyama	O. Ishiyama, A. Toyama
	Low Vacuum Analytical Scanning Electron Microscopy		
	Field Emission Transmission Electron Microscope		S. Iki, T. Ueda, M. Uruichi
X-rays	Single Crystal X-Ray Diffractometer		M. Fujiwara
	Low Temperature Single Crystal X-Ray Diffractometer for Microcrystals		Y. Okano
	Molecular Structure Analysis using Crystalline Sponge Method		M. Fujita, T. Mitsuhashi
	Powder X-Ray Diffractometer		M. Fujiwara
	X-Ray Fluorescence Analysis		T. Ueda
	Small Angle X-Ray Scattering for Solutions	S. Akiyama	A. Mukaiyama

Electron Spectroscopy	Electron Spectroscopy for Chemical Analysis	T. Yokoyama	S. Iki
	Angle Resolved Ultraviolet Photoelectron Spectroscopy for Functional Band Structures	S. Kera, K. Tanaka	S. Ideta
Electron Spin Resonance	Pulsed High Field ESR	T. Yokoyama, T. Nakamura	M. Asada, M. Fujiwara, S. Iki, T. Ueda
	X-Band CW ESR		
	X, Q-Band CW ESR		
SQUID	Superconducting Quantum Interference Device		M. Asada, M. Fujiwara, S. Iki
Thermal Analysis	Differential Scanning Calorimeter (Solutions)	T. Yokoyama	T. Mizukawa, M. Uruichi, H. Nagao
	Isothermal Titration Calorimeter (Solutions)		
	Calorimeter for solids		M. Fujiwara
Mass Spectrometer	Matrix Assisted Laser Desorption/Ionization Time of Flight Mass Spectrometer		T. Mizukawa, M. Uruichi, K. Fujikawa
Spectroscopy	Microscopic Raman Spectroscopy		M. Uruichi
	Fourier Transform Far Infrared Spectroscopy		
	Fluorescence Spectroscopy		T. Ueda
	Ultraviolet & Visible Absorption Spectroscopy		
	Circular Dichroism		T. Mizukawa, M. Uruichi, K. Fujikawa
Lasers	Picosecond Laser		T. Ueda
High Field NMR	800 MHz Solutions, Cryostat Probe	K. Kato	M. Yagi, S. Yanaka, Y. Isono
	600 MHz Solids	K. Nishimura	
	600 MHz Solutions	T. Yokoyama	T. Mizukawa, M. Uruichi, H. Nagao
Functional Molecular Synthesis and Molecular Device Fabrication	Organic Thin Film Solar Cells	M. Hiramoto	S. Izawa
	Organic Field Effect Transistors	H. Yamamoto	M. Suda, D. Hirobe
	Functional Organic Synthesis	N. Momiyama, T. Suzuki	A. Izumiseki, N. Ohtsuka
	Large Scale Quantum Mechanical Calculations	M. Ehara	
	Magnetic Thin Films	T. Yokoyama	T. Koitaya, K.Yamamoto
	Metal Complexes	T. Kusamoto	
	Inorganic Materials	G. Kobayashi	F. Takeiri
	Biomolecule System	S. Akiyama	A. Mukaiyama, Y. Furuike
	Supplementary Apparatus in Instrument Center	T. Yokoyama	



(b) 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. They are grouped into 12 local regions and in each region the regional committee discusses and determines the operation of regional network systems with the hub university chairing. There is no barrier for every user to access to any universities beyond his/her regional group. From 2009, the registered equipments are open to the researchers and students of all the public (prefectural *etc.*) and private universities. 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 14,000 in 431 universities/institutions/companies covering over 3,800 laboratories in Japan (June, 2020). Network usage reaches about 170,000 times a year, and the number continues 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.

Okazaki Conference

(a) The 81st Okazaki Conference
Forefront of Measurement Technologies for Surface Chemistry and Physics in Real-Space, *k*-Space, and Real-Time

(December 2–4, 2019)

Organizers: T. Sugimoto (*IMS*), T. Kumagai (*Fritz-Haber Institute*)

Invited Overseas Speaker: A. Paarmann (*Fritz-Haber Inst.*), A. Mazheika (*Technical Univ. Berlin*), A. Urakawa (*Delft Univ. of Tech.*), C. Kley (*Fritz-Haber Inst.*), H. Freund (*Fritz-Haber Inst.*), H. Ogasawara (*Stanford Linear Accelerator Cent.*), J. Stähler (*Fritz-Haber Inst.*), L. Grill (*Univ. of Graz*), M. Rossi (*Fritz-Haber Inst.*), N. Lin (*Hong Kong Univ. of Sci. and Tech.*), R. Ernstopher (*Fritz-Haber Inst.*), S. Wu (*Fudan Univ.*), T. Kumagai (*Fritz-Haber Inst.*), Y.-P. Chiu (*Natl. Taiwan Univ.*), Y. Tong (*Fritz-Haber Inst.*)

Surface/Interface science has contributed to a wide range of disciplines in heterogeneous catalysis,electrochemistry, and semiconductor science/technology. The development of surface characterization techniques and sophisticated experiments under atomically well-defined conditions played a central role, which have also been one of the driving forces for nanoscience and nanotechnology during the last few decades. The rapid advances of various laser sources, synchrotron facility, high-frequency electronic devices, scanning probe methods, nanoscale fabrication techniques, and computational science bring a new dimension to measurement science and technology, and a combination of different state-of-the-art techniques creates unprecedented measurement techniques for surface physics and chemistry in real-space, *k*-space, and real-time. In addition to the study of model systems, operand measurements have gained increasing attention to elucidate working principles of catalysts and electrochemistry. Low-dimensional materials, hybrid organic/inorganic interfaces, and molecular devices/machines are the scope of emerging measurement techniques. Theory and computational science provide indispensable tools to interpret elementary processes at the atomistic level and also pave the way for highly-efficient data analysis and material design. In the conference, we discuss the latest development of surface characterization techniques and how they can contribute to the innovation in material and energy conversion using heterogeneous catalysts and novel optoelectronic and electrochemical devices.

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) Construction of Synthetic Microdomains to Artificially Assemble Biological Polymers on Lipid Membranes Using Metal Complex Lipids

OHTANI, Ryo (*Kyushu Univ.*)
KAWANO, Kenichi (*Kyoto Univ.*)
KINOSHITA, Masanao (*Kyushu Univ.*)
YANAKA, Saeko (*IMS*)
KATO, Koichi (*IMS*)

Cell membranes are nonuniform entities characterized by heterogeneous molecular assemblies that mediate biological processes exemplified by signal transduction. Accumulating evidence has indicated that these microdomains comprise various lipid molecules including glycosphingolipids and cholesterol and serve as molecular platforms where specific biomolecules accumulate to perform sophisticated functions. To gain a deeper understanding of these complex membrane functions, we employed a multilateral approach in an attempt to artificially control membrane properties and their molecular assembly.

In this project, we created and applied *metal complex lipids* for (1) manipulating lipid membrane properties such as curvature and viscosity to construct synthetic domain architectures and (2) controlling assemblies of biological polymers thereon. The metal complex lipid consists of a metal complex moiety as its hydrophilic head and an alkyl chain as its hydrophobic tail. It exhibits different physical properties from those of natural lipid species, which further impacts lipid membrane properties. Through investigation of the influence of the metal complex lipids on phase-transition and molecular-assembling behaviors of both artificial and cell membranes, we successfully constructed an artificial phase separation system with micro-sized rigid domains consisting of metal complexes in living cell membranes. Furthermore, we succeeded in synthesizing a new metal complex lipid which could provide unique fluid–fluid phase separation in lipid membranes. The metal complex lipid not only exhibits such domain formation property but also offers a possibility to hybridize with biomolecules via the click chemistry approach due the head part incorporating an ethynyl substituent. We expect that this metal complex lipid will be applicable to assembling and accumulating biomolecules in lipid membranes, which is now underway.

We held three collaboration meetings in the 2019 to extensively discuss our research progress and future planning. All meetings were held at Yamate 3rd Bilding 2F small meeting room on June 10, September 11, and November 11, 2019. Moreover, collaborating experiments to synthesize the hybrid metal complex lipid with sugar chains were carried out at December 18th to 23rd, 2019 in the Kato lab.

(2) Research Symposia

(From Oct. 2018 to Sep. 2019)

Dates	Theme	Chair
Jul. 10, 2019	Design of Molecular Structure Change and Its Function Control Based on Coordination Chemistry	**KOSHIYAMA, Tomomi** **KUSAMOTO, Tetsuro**
Dec. 29, 2019	Joint Workshop on Molecular Science for Young Researcher: Exploring the Unexplored Field of Molecular Science	**KOMATSUBARA, Wataru** **SUGIMOTO, Toshiki**
Dec. 2– 4, 2019	Forefront of Measurement Technologies for Surface Chemistry and Physics in Real-Space, *k*-Space, and Real-Time	**KUMAGAI, Takashi** **SUGIMOTO, Toshiki**

(3) Numbers of Joint Studies Programs

Categories		Oct. 2019–Mar. 2020		Apr. 2020–Sep. 2020		Total		
		Regular	NanoPlat	Regular	NanoPlat	Regular	NanoPlat	Sum
Special Projects		1		1		2		2
Research Symposia		0		1		1		1
Research Symposia for Young Researchers		1		1		2		2
Cooperative Research		22	39	21	18	43	57	100
Use of Facility	Instrument Center		83		58		141	141
	Equipment Development Center	1	4	0	4	1	8	9
Use of UVSOR Facility		94	2	89	1	183	3	186
Use of Facility Program of the Computer Center						268*		268*

* from April 2019 to March 2020

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]	2006.12–2022.10	0	0
Institute of Atomic and Molecular Sciences (IAMS) [Taiwan]	2005. 1–2023. 1	8	0
Korea Advanced Institute of Science and Technology (KAIST) [Korea]	2008. 9–2020. 9	0	0
École Nationale Supérieure de Chimie de Paris (ENSCP) [France]	2009.10–2024.10	1	1
Freie Universität Berlin (FUB) [Germany]	2013. 6–2022. 6	3	0
Indian Institute of Science Education and Research Kolkata (IISER Kolkata) [India]	2015.10–2019.10	0	1
Indian Institute of Science (IISc) [India]	2015.10–2019.10	0	1
National Nanotechnology Center, National Science and Technology Development Agency (NANOTEC/NSTDA) [Thailand]	2017.10–2022.10	1	1
Sungkyunkwan University, Department of Chemistry (SKKU) [Korea]	2018. 4–2022. 3	0	0
University of Oulu [Finland]	2018. 5–2021. 5	5	0
National Chiao Tung University [Taiwan]	2018. 6–2023. 5	3	2
Peter Grünberg Institute, Forschungszentrum Jülich GmbH (FZJ) [Germany]	2018.10–2023. 9	0	3
State Key Laboratory of Physical Chemistry of Solid Surfaces (Xiamen University) [China]	2019.12–2024.12	0	10
Indian Institute of Technology Kanpur [India]	2020. 4–2024. 3	0	0

* No. of researchers during the period from Sep. 2019 to Aug. 2020

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

Institution	Period	Accept*	Send*
Chulalongkorn University, Faculty of Science [Thailand]	2010. 4–2020. 3	1	2
Kasetsart University, Faculty of Science [Thailand]	2011. 3–2021. 4	3	5
University of Malaya, Faculty of Science [Malaysia]	2014. 3–2024.11	2	0
Vidyasirimedhi Institute of Science and Technology [Thailand]	2018. 9–2023. 9	3	0
Friedrich Schiller University Jena [Germany]	2020. 7–2023. 7	0	0

* No. of researchers during the period from Sep. 2019 to Aug. 2020

(2) International and Inter-Institutional Collaboration Symposia

Several international symposia and workshops in molecular science are held in IMS and in Japan. Some workshops are organized with our MOU partners for international collaboration in the MOU partner's country as well as in Japan:

Program	Coordinator	Date	Place
IMS-IAMS Joint Meeting	AKIYAMA, Shuji (IMS) TAKAHASHI, Kaito (IAMS)	2019.9.21	IAMS, Taiwan
IMS-PCOSS Bilateral Symposium	YAMAMOTO, Hiroshi (IMS) REN, Bin (PCOSS)	2019.12.21–24	PCOSS, China
SOKENDAI Asian Winter School "Challenges for New Frontiers in Molecular Science: From Basics to Advanced Researches"	NISHIMURA, Katsuyuki (IMS) MINAMITANI, Emi (IMS)	2020.1.16	IMS
The 2nd International Conference on Materials Research and Innovation (ICMARI)	YAMAMOTO, Hiroshi (IMS) PHONGPHANPHANEE, Saree (KU)	2019.12.16–18	Centara Grand Central Plaza Ladprao, Kasetsart University (KU), Thailand

(3) IMS International Internship Program and SOKENDAI International Lecture & Training Courses

Category	Number of People	
	Overseas	Domestic
IMS International Internship Program (IMS-IIP)	32*	–
SOKENDAI Asian Winter School (2020.1.16)	9†	1

* from Sep. 2019 to Aug. 2020, † include the IMS-IIP students

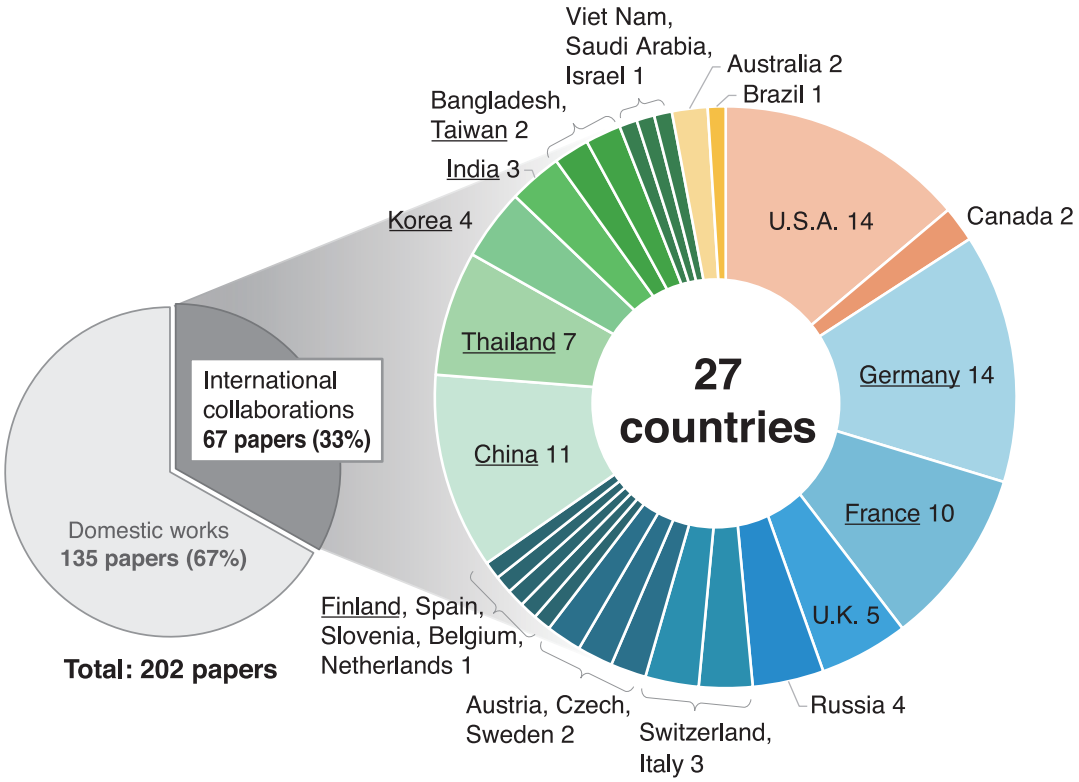
(4) IMS International Collaboration

Category	Number of People
International Joint Research Programs	50
International Use of Facilities Programs	24

from Sep. 2019 to Aug. 2020

Internationally Collaborated Publications

Articles and reviews published in 2019



Underlined countries include MOU Partnership Institutions
Scopus dataset, Nov. 2020