Academic Year 2024

Graduate School of Engineering, The University of Tokyo

Department of Applied Chemistry

Guide to Entrance Examinations

Master's Program

Doctoral Program

【Contact】

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Objectives of Education/Research at the Department of Applied Chemistry

The objectives of education and research in our Department are to cultivate independent human resources who have both a wide-ranging foundation and advanced expertise in applied chemistry and can take the initiative in conducting research and development in a variety of fields based on them. In addition, our department also aims to promote world-leading cutting-edge research.

General Information for Applicants in AY 2024

It is possible that the contents of the Application Guidelines for the Graduate School of Engineering and the Guide to Entrance Examinations for the Department of Applied Chemistry will be changed. In that case, we will announce the change on the following websites, so you need to check them at any time.

Graduate School of Engineering Website:
https://www.t.u-tokyo.ac.jp/en/soe/admission/general-guideline
Department of Applied Chemistry Website:
https://www.appchem.t.u-tokyo.ac.jp/en/examination/

1. Periods of Acceptance of Application and Examinations (Refer to the Application Guidelines for the Graduate School of Engineering)

Regular Admission

Master's Program (for those who wish to enroll in April or October) *1

Application accepted	From June 29 to July 5 (3 pm), 2023
Examination dates *1, *2	From August 28 to August 29, 2023 *2
Announcement of successful applicants	September 7, 2023

Doctoral Program *1

		Application Schedule A		Application Schedule B
		For those who wish to enroll in April	For those who wish to enroll in October	
Application accepted		From June 29 to July 5 (3 pm), 2023		From November 27 to December 1 (3 pm), 2023
Examination dates	First stage *1	August 29, 2023 *2		Mid-January to early February, 2024 *3
	Second stage	Late January to mid-February 2024 *3, *4	At the same time as the first stage	At the same time as the first stage
Announcement of successful applicants		(September 7, 2023 for the first stage results) February 15, 2024	September 7, 2023	February 15, 2024

*1 For information on eligibility and application procedures, see Application Guidelines for the Graduate School of Engineering.

*2 Refer to the examination dates specified in this Guide (p. 8). It is possible that the examination dates will be changed. Therefore, you need to check the websites of Graduate School of Engineering and Department of Applied Chemistry at any time.

*3 The date will be announced later.

*4 For those who have been conferred, or are expected to be conferred by September 30, 2023, a Master's or a professional degree, the examination will be conducted at the same time as the first stage.

2. Implementation Methods, etc.

1) The examination for the Master's program and the first stage examination of Application Schedule A for the doctoral program will be held on-site. The second stage examination for the doctoral program Application Schedule A and the examination for the doctoral program Application Schedule B will be announced separately.
2) The examination will be held at the examination room of the Graduate School of Engineering, the University of Tokyo (7-3-1 Hongo, Bunkyo-ku, Tokyo). You will be notified of the detailed information about the location when an examination admission card is sent.
3) Applicants must enter the designated examination room at least 20 minutes before the start of the examination.

3. Items to Bring

1) Examination admission card
2) Black pencils (or black mechanical pencils), an eraser, a pencil sharpener (a desktop type is not allowed), a watch (watches with functions other than time measurement are not allowed), and mask (including spares)
3) Use of electronic devices such as cell phones is strictly prohibited throughout the examination, even if you only use it as a watch. Make sure to completely deactivate any sound alerts and/or alarm settings, turn off the phone's power, and put it in your bag before you enter the examination room. Do not take it out in the examination room.
4) Wear a mask (plain, covering both nose and mouth) properly during the examination.

4. Notice during the Written Examinations

1) Follow the instruction from the proctor during the examination.
2) You cannot leave the examination room after the start of the examination.
3) The examination admission card must be kept on your desk at all times during the examination.
4) Applicants cannot take home the answer sheets or the problem booklets after the examination.
5) Do not leave the room until instructed to do so by the proctor.

5. Others

1) If there is a change in your current address or contact information after submitting the application, you must notify us of it promptly.
2) We do not answer any inquiries about acceptance or rejection by telephone calls, fax, e-mail, and other inquiries.
3) If any false statement or forgery is found in the application documents, or if there is clear evidence that there was any fraudulent activity in the examination, the pass may be canceled even after enrolling in or going on to a graduate school.

Information of Examinations for the Applicants for the Department of Applied Chemistry (Master's Program), Graduate School of Engineering, The University of Tokyo

1. Any applications from those who meet the qualifications for a master's program will be accepted, irrespective of the department they graduated from and the year when they were qualified.
2. Applicants are required to fill out the **Questionnaire Sheet 1** (p. 10, p. 11) in this Guide and specify the order of preference on the **Questionnaire Sheet 2** (p. 12). Submit both questionnaires together with the application for admission.
3. Note that those who do not fulfill the required number of subjects will be rejected. In order to qualify for admission, it is necessary to meet both requirements: "the evaluation by the total score of 1) foreign language, 2) general education subjects, and 3) oral examination" and "the evaluation by 3) oral examination alone".
4. Priority to be assigned to the first-choice laboratory will be given to a several number of applicants who wish to proceed to a doctoral program at the same laboratory where they completed their master's program. Applicants wishing to go on to a doctoral program at their first-choice laboratory should check the box in the "☐ **I wish to go on to a doctoral program at the laboratory of my first choice. I have received guidance and an interview before applying, and have received approval from the faculty member.**" row at the bottom of Questionnaire Sheet 2. In addition, the applicants must contact the faculty member of the desired laboratory by June 7, 2023. The applicants must have guidance and an interview before applying, and must obtain the approval of the faculty member before applying.
5. Foreign nationals who have the qualifications listed in the Application Guidelines for the Graduate School of Engineering are eligible to take Special Selection for International Applicants. Applicants who wish to take the Special Selection for International Applicants must contact the faculty member of the desired laboratory by June 7, 2023, and have an interview and guidance before applying. Applicants who have graduated or are expected to graduate from The University of Tokyo or other universities in Japan must take the regular admission examination.
6. If any false statement or forgery is found in the application documents, or if there is clear evidence that there was any fraudulent activity in the examination, the pass may be canceled even after enrolling in or going on to a graduate school.
7. Assignments of successful applicants to laboratories will be posted on the bulletin board of the Department of Applied Chemistry at Building No. 5 of the Faculty of Engineering after the announcement of successful applicants.

Examination subjects (Second stage)	Remarks
1) Foreign language (English) *1 Submission of an official score: TOEFL iBT or TOEFL-iBT Home Edition	There will be no written test at the venue. (200 points)
2) General education subjects Chemistry Physical Chemistry (1 problem) Inorganic Chemistry (1 problem) Organic Chemistry (1 problem)	Answer two of the three problems in physical chemistry, inorganic chemistry, and organic chemistry. Problems related to analytical chemistry, polymer chemistry, and biochemistry may be included. (600 points)

3) Oral examination	In the oral examination, motivation for studying at the Department of Applied Chemistry and communication ability are gauged. In addition, questions on research for the graduation thesis (or the equivalent) and general chemistry are asked. (100 points)

*1【**Notes**】

- Applicants should submit a score from a test administered in September 2021 or later.
- Score submission deadline: August 7, 2023
- In order to be in time for the application period of the graduate school entrance examination, applicants should take the TOEFL test as early as possible, check the score by themselves, and register the Appointment Number of the score to be submitted at the time of application.
- For information on how to submit a score, please refer carefully to the information provided in Application Guidelines for the Graduate School of Engineering carefully.

Information on Examinations for the Applicants for the Department of Applied Chemistry (Doctoral Program), Graduate School of Engineering, The University of Tokyo

I. The First-stage Examination

1. Any application from those who meet the qualifications for a doctoral program will be accepted, irrespective of the field of specialization in the master's program and the year when they were qualified.
2. Applicants must contact in advance the academic supervisor whom they want to be guided by in the program and receive guidance and an interview.
3. All applicants, except those who have completed (or are expected to complete) the Graduate School of Engineering of The University of Tokyo, must submit an Academic Transcript from the Previous University specified in "7. Documents to Submit" in the Application Guidelines for the Graduate School of Engineering.
4. Applicants are required to specify the name of academic advisor whom they want to be guided by in the **Questionnaire Sheet 1** (p. 10, p. 11) in this Guide and submit it together with the application for admission.
5. The examination subjects are as listed below. Note that those who do not fulfill the required number of subjects will be rejected. In order to qualify for admission, it is necessary to meet the requirements in all categories from 1) to 3).
6. If any false statement or forgery is found in the application documents, or if there is clear evidence that there was any fraudulent activity in the examination, the pass may be canceled even after enrolling in or going on to a graduate school.

Application Schedule A

Examination subjects *1	Remarks
1) Foreign languages (English) *2, *3 Submission of an official score: TOEFL iBT or TOEFL-iBT Home Edition	There will be no written test at the venue.
2) Specialized academic subjects	Essay type examination on specialized academic subjects
3) Oral examination	Questions on the research performed in one's master's program or equivalent thereof are asked.

Application Schedule B

Examination subjects [*1]	Remarks
1) Foreign languages (English) [*2, *3] Submission of an official score: TOEFL iBT or TOEFL-iBT Home Edition	There will be no written test at the venue.
2) Specialized academic subjects	Essay type examination on specialized academic subjects
3) Oral examination	Questions on the research conducted for one's master's program or its equivalent are asked.

Note:

*1 Applicants who have completed (or plan to complete) the master's or professional degree program at The University of Tokyo are exempted from "foreign languages".

*2 **Application Schedule A:** Applicants should submit a score from a test administered in September 2021 or later.
Application Schedule B: Applicants should submit a score from a test administered in February 2022 or later.
For information on how to submit a score, please refer carefully to the information provided in Application Guidelines for the Graduate School of Engineering carefully.

*3 **The score must be 61 in iBT or above**.

II. The Second-stage Examination

Application Schedule A

For those who have passed the first-stage examination, questions on research in the master's program or the equivalent are asked.[*1, 2]

Note:

*1 For those who have already acquired a master's or professional degree at the time of application or who are expected to acquire one by September 30, 2023, an oral examination in the first-stage examination will also play the role of the second-stage examination.

*2 For those who live outside Japan, remote examination using Zoom, for example, may be permitted.

Application Schedule B

An oral examination in the first-stage examination will also play the role of the second-stage examination.

List of Laboratories

Number of students to be admitted in academic year 2024
Master's program: 33
Doctoral program: 13

Department	Name of Laboratory
Graduate School of Engineering	Noji Laboratory Yamaguchi Laboratory Yanagida Laboratory Nishibayashi Laboratory Uemura Laboratory Kim Laboratory Fujita-Sato Laboratory
Research Center for Advanced Science and Technology	Ishikita Laboratory
Institute of Industrial Science	Fujioka Laboratory Tatsuma Laboratory Ishii Laboratory, Sunada Laboratory Tsukamoto Laboratory
Graduate School of Frontier Sciences	Takeya Laboratory (also serves as a lab in Graduate School of Engineering)

Note for filling out the Questionnaire Sheet 2

- Assignment of successful applicants to laboratories is conducted in the order of scores of the examination, giving priority to the preference of the applicants with the highest grade. Enter the order of preference in the blank column on the left of each individual laboratory name. Note that you may not be able to pass if you cannot be assigned to any of the laboratory due to an incorrect entry (such as entering the same number in multiple spaces) or an entry in only some of the laboratories. If you wish to change the order of preference after submitting an application, fill out the **Questionnaire Sheet 2: Notification of Change** and submit it according to the instructions given during the general education subject examination.
- Applicants who wish to apply to a laboratory in the Graduate School of Frontier Sciences should contact the faculty member of the laboratory they wish to apply to in advance and receive guidance before applying.
- Priority to be assigned to the first-choice laboratory will be given to a several number of applicants who wish to proceed to a doctoral program at the same laboratory where they completed their master's program. Applicants wishing to go on to a doctoral program at their first laboratory should check the box in the "☐ **I wish to go on to a doctoral program at the laboratory of my first choice. I have received guidance and an interview before applying, and have received approval from the faculty member.**" row at the bottom of Questionnaire Sheet 2. In addition, the applicants must contact the faculty member of the desired laboratory by June 7, 2023. Applicants must have guidance and an interview before applying, and must obtain the approval of the faculty member before applying.

Examination Dates

Program	Examination Subjects		Date and Time	Remarks
Master's Program (Second-stage examination)	Foreign languages English			- Submit your official TOEFL score. - There will be no written test at the venue.
	Regular education subjects Chemistry		August 29, 2023 From 9:00 to 11:00	- Answer two of the three problems in physical chemistry, inorganic chemistry, and organic chemistry. Important instructions regarding the notification of change will be given during this examination.
	Oral examination		August 28, 2023 From 9:00	- Arrive at the venue 15 minutes earlier. - In the oral examination, motivation for studying at the Department of Applied Chemistry and communication ability are gauged. In addition, questions on research for the graduation thesis (or the equivalent) and general chemistry are asked.
Doctoral Program (Application Schedule A)	First-stage examination	Foreign languages English *1		- Submit your official TOEFL® score. - There will be no written test at the venue.
		Specialized academic subjects	August 29, 2023 From 13:00 to 14:30	
		Oral examination *2	August 29, 2023 From 15:00	- Prepare two to three A4-sized sheets of your research summary in the master's program or the equivalent. - Make a presentation using PowerPoint or other software (Twenty-minute presentation and ten-minute question and answer period).
	Second-stage examination *3, *4, *5		Late January to mid-February 2024	- For those who have passed the first-stage examination, questions on research conducted for one's master's program or its equivalent are asked.
Doctoral Program (Application Schedule B)	Foreign languages English *1			- Submit your official TOEFL® score. - There will be no written test at the venue.
	Specialized academic subjects		undecided *6	
	Oral examination *5		undecided *6	- Same as Application Schedule A.

*1 Applicants who have completed (or plan to complete) the master's or professional degree program at The University of Tokyo are exempted from "foreign languages" and "general education subjects".

*2 For those who are enrolled in the master's program of this Department, this is substituted by the interim presentation of a master's thesis.

*3 For those who have already acquired a master's or professional degree at the time of application or who are expected to acquire one by September 30, 2023, an oral examination in the first-stage examination will also play the role of the second-stage examination.

*4 For those who live outside Japan, remote examination using Zoom, for example, may be permitted.

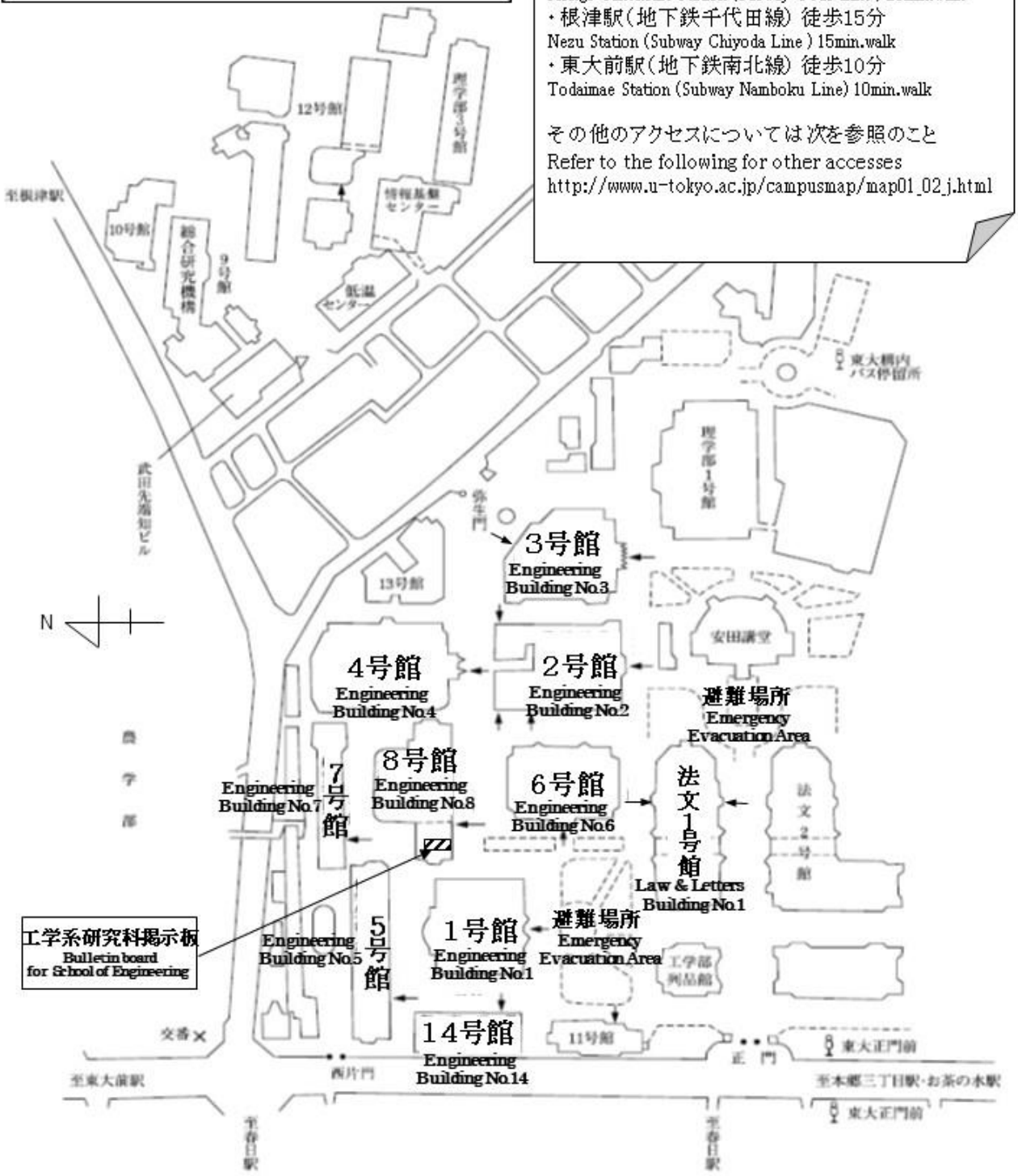
*5 For those who are enrolled in the master's program of this Department, this is substituted by the final presentation of a master's thesis.

*6 The date will be announced later.

試験場案内(東京大学本郷キャンパス)
Campus Map for the Examination
(Hongo campus, the University of Tokyo)

地下鉄利用　Subway
・本郷三丁目駅(地下鉄丸の内線) 徒歩20分
Hongo-sanchome Station (Subway Marunouchi Line) 20min.walk
・本郷三丁目駅(地下鉄大江戸線) 徒歩20分
Hongo-sanchome Station (Subway Oedo Line) 20min.walk
・根津駅(地下鉄千代田線) 徒歩15分
Nezu Station (Subway Chiyoda Line) 15min.walk
・東大前駅(地下鉄南北線) 徒歩10分
Todaimae Station (Subway Namboku Line) 10min.walk

その他のアクセスについては次を参照のこと
Refer to the following for other accesses
http://www.u-tokyo.ac.jp/campusmap/map01_02_j.html



【Applicants must submit this sheet together with the application for admission. Applicants for the master's program must also submit the **Questionnaire Sheet 2** on p. 12.】

Questionnaire Sheet 1

Department of Applied Chemistry
(For both master's and doctoral programs) Graduate School of Engineering, The University of Tokyo

Name of Applicant		＊ Examinee Number	
Former University (Department/Faculty)			
Contact information after examination: (Address, telephone number and email address of home, lodging, current university, etc.)	Telephone: Email address:		

Please describe in detail about (1) your motivation to enroll in or go on to the Department of Applied Chemistry, (2) what you want to study and research in the Department of Applied Chemistry, and (3) your future outlook and course plan.

【**To master's program applicants**】The information contained herein will be used as a reference for the oral examination.

<Questionnaire Sheet 1 continued>

Name of an academic supervisor you want to be guided by **(for applicants to the doctoral program only)**	

* Do not enter the examinee number.

Questionnaire Sheet 2

(For applicants to the master's program only. Submit this sheet together with the application for admission.)

- Listed below are the names of all laboratories of the Department of Applied Chemistry.
- Enter the order of preference (1, 2, 3…) in the blank column on the left of each individual laboratory name.
- Note that you may not be able to pass if you cannot be assigned to any of the laboratory due to an incorrect entry (such as entering the same number in multiple spaces) or an entry in only some of the laboratories. It is highly recommended to keep a copy of this sheet.
- Priority to be assigned to the first-choice laboratory will be given to a several number of applicants who wish to proceed to a doctoral program at the same laboratory where they completed their master's program. Applicants wishing to go on to a doctoral program at their first laboratory should check the box in the "☐ **I wish to go on to a doctoral program at the laboratory of my first choice. I have received guidance and an interview before applying, and have received approval from the faculty member.**" row at the bottom of Questionnaire Sheet 2. In addition, the applicants must contact the faculty member of the desired laboratory by June 7, 2023. Applicants must have guidance and an interview before applying, and must obtain the approval of the faculty member before applying.
- This form must be submitted at the time of application. If you wish to change the order of preference, fill out the **Questionnaire Sheet 2: Notification of Change** on the following page and submit it according to the instructions given during the general education subject examination.

Order of Preference	Name of Laboratory	Order of Preference	Name of Laboratory	Order of Preference	Name of Laboratory
	Noji Laboratory		Yamaguchi Laboratory		Yanagida Laboratory
	Nishibayashi Laboratory		Uemura Laboratory		Kim Laboratory
	Fujita-Sato Laboratory		Ishikita Laboratory		Fujioka Laboratory
	Tatsuma Laboratory		Ishii Laboratory		Sunada Laboratory
	Tsukamoto Laboratory		Takeya Laboratory		

☐ **I wish to go on to a doctoral program at the laboratory of my first choice. I have received guidance and an interview before applying, and have received approval from the faculty member.**

I declare that my order of preference is as above.

Name of Applicant

Questionnaire Sheet 2: Notification of Change

This form must be filled out only when the applicant for the master's program wishes to change the order of preference of laboratories and must be submitted according to the instructions given during the general education subject examination.

- Listed below are the names of all laboratories of the Department of Applied Chemistry.
- Enter the order of preference (1, 2, 3…) in the blank column on the left of each individual laboratory name.
- Note that you may not be able to pass if you cannot be assigned to any of the laboratory due to an incorrect entry (such as entering the same number in multiple spaces) or an entry in only some of the laboratories. It is highly recommended to keep a copy of this sheet.

Order of Preference	Name of Laboratory	Order of Preference	Name of Laboratory	Order of Preference	Name of Laboratory
	Noji Laboratory		Yamaguchi Laboratory		Yanagida Laboratory
	Nishibayashi Laboratory		Uemura Laboratory		Kim Laboratory
	Fujita-Sato Laboratory		Ishikita Laboratory		Fujioka Laboratory
	Tatsuma Laboratory		Ishii Laboratory		Sunada Laboratory
	Tsukamoto Laboratory		Takeya Laboratory		

I declare that my order of preference is as above.

Name of Applicant
Examinee Number

Supervisors	NOJI LAB.
Hiroyuki NOJI, Professor Kazuhito TABATA, Associate professor Hiroshi UENO, Lecturer	The main fields of our research are nanobioscience and nanobiotechnology; single-molecule biophysics, single-molecule digital bioassays, and artificial cell reactor project. ● Single-molecule biophysics We have been pursuing the elucidation of chemo-mechanical coupling mechanism of a rotary molecular motor, ATP synthase by use of single-molecule techniques. ● Single-molecule digital bioassay We developed femto-liter reactor technology that enables single-molecule enzymatic assays, termed 'digital bioassay'. This technology is currently utilized for single-molecule immunoassay digital ELSA that allows ultrasensitive and highly quantitative analysis. This novel analysis strategy attracts large attentions not only from academia but also from industry with expectation for the next-generation platform of diagnostic. ● Artificial cell reactor technology By implementing cell-free gene expression system into femto-reactors, we developed 'digital gene expression' system that allows analysis of gene expression activity from single DNA molecules. This system enables in vitro enzyme screening with unprecedently high accuracy. ● Autonomous artificial cell We have just launched this project with the aim to build artificial cells from purified biomolecules and/or synthetic molecules. Currently, we developed autonomously growing artificial cell reactor system.
Supervisors	YAMAGUCHI LAB.
Kazuya YAMAGUCHI, Professor Kosuke SUZUKI, Associate professor Yoshinobu NAKAMURA, Lecturer	Our laboratory mainly focuses on research topic related to catalysis: 1) development of high-performance solid catalysts for environmentally friendly high-efficiency reactions, 2) precise design of multinuclear metal oxide catalysts using polyoxometalates as molecular templates, 3) conversion of natural carbon resources such as methane As for topic 1, we engage in research on the development of high-performance heterogeneous catalysts for highly efficient liquid-phase organic reactions, especially for catalytic oxidation reactions. Our targets are highly difficult new oxidation reactions such as dehydrogenation, oxygenation, and dehydrogenation cross-coupling by direct activation of C–H and X–H (X is a heteroatom) bonds, and tandem oxidation reactions by using O_2 or without using any oxidants. To realize these reactions, we are designing and developing polyoxometalate molecular catalysts, crystalline nano-oxide catalysts, and metal nanoparticle catalysts. As for topic 2, we engage in research on the design of the inorganic materials that can precisely and freely control the number, composition, and arrangement of metal atoms in the mononuclear to multinuclear metal clusters. We are also studying the application of the designed polyoxometalates having multinuclear metal clusters to catalysis (organic synthesis), photocatalysis, and molecular magnetism. As for topic 3, we engage in research on the developing chemical conversion (oxidation reaction) of abundant natural carbon resources (mainly C1-C4 alkanes). For example, we aim to convert methane to methanol in one step with high yield and high selectivity using O_2 as the oxidant.

Supervisors	YANAGIDA LAB.
Takeshi YANAGIDA, Professor Tsunaki TAKAHASHI, Associate Professor	In nature, there is a highly sophisticated mechanism that creates overwhelming functions by assembling various types of atoms and molecules by themselves while interacting with the surrounding environment in a complicated manner. Our laboratory, based on the physical chemistry of inorganic materials, device chemistry, and molecule chemistry, aim to understand and utilize such nanoscale “spatial material design principle”. These inorganic and organic materials can be spatially designed via the “interface events”. Furthermore, we aim to monitor spatially the multi-component molecules around us by integrating those new material properties (robust molecular recognition functions, etc.) with integrated devices and information science. We also are challenging to develop new research fields and industries that chemistry complex interacting systems. Specific ongoing research themes are listed below. 1. Development of inorganic / organic nanomaterial design method based on spatially selective crystal growth 2. Creation of robust molecular recognition interface 3. Development of single nanostructure property measurements 4. Creation of integrated molecular recognition electronics 5. Approaches of complex systems science via spatiotemporal measurements of multi-component molecules
Supervisors	NISHIBAYASHI LAB.
Yoshiaki NISHIBAYASHI, Professor Yoshiaki TANABE, Project lecturer	Our laboratory is working on the development of molecular transformations mediated by bio-inspired molecular catalysts to yield useful molecules efficiently, which are capable of solving global challenges in energy and environment facing humanity on a global scale. Based on organometallic chemistry, our aim is design and development of nitrogen fixation, ammonia decomposition, reduction of carbon dioxide, and novel reactions including asymmetric synthesis. We are challenging the generation of new energy resources and an innovative social system based on these molecules. 1. Innovation of New Energy Resources and Foundation of New Social Systems 2. Development of New Catalysis Technology to Convert Dinitrogen and Carbon Dioxide into Resources 3. Development of New Catalysts as Solutions to Shortage of Energy Resources Keywords: organic chemistry, catalysts, molecular complexes, organometallic chemistry, organic synthesis, nitrogen fixation, ammonia, energy and environment

Supervisors	UEMURA LAB.
Takashi UEMURA, Professor Nobuhiko HOSONO, Associate professor	All naturally occurring polymers are produced through enzymatic catalysis, where stereo-, regio-, and chemoselective reactions proceed effectively within regulated and well-organized molecular-scale spaces. Inspired by these elegant operations in biological systems, our research group has been developing new methodologies to control the structures of polymers and nanomaterials using microporous compounds, such as MOF, COF, and organic cages. The use of their designable nanopores for materials synthesis can facilitate multi-level structural control over the products. In addition, construction of the host-guest nanocomposites provides unprecedented material platforms to accomplish many nanoscale functions.
Supervisors	KIM LAB.
Yousoo KIM, Professor Emiko KAZUMA, Associate professor	The excitation of molecules on solid surfaces leads to various energetic processes, such as transfer, conversion, and dissipation. Thus, a detailed understanding of the excited quantum states of the molecules is crucial to improving and developing organic energy conversion devices/systems based on (opto)electronic and/or (photo)chemical processes. Our research focuses on (1) real-space observation of surface reaction processes at the single-molecule level, (2) single-molecule measurement of quantum states involved in the processes, and (3) exploration of the selective control of reaction pathways and physicochemical properties of molecular interfaces. The main research topics are as follows. 1. Real-space observation of surface reaction processes at the single-molecule level 2. Development of novel single-molecule spectroscopy and measurement of physicochemical properties 3. Development of novel catalytic surfaces 4. Real-space measurement of energy conversion at electrochemical interfaces 5. Design of reaction systems based on computational science

Supervisors	FUJITA AND SATO LAB.
Makoto FUJITA, Distinguished professor Sota SATO, Project professor	Weak interactions induce the spontaneous organization of various biological structures such as DNA duplexes and protein nanostructures. We are translating such an elegant nature's mechanism into design principle for artificial molecular assemblies by showing the self-assembly of well-designed molecules into functional molecular systems. 1. Self-Assembling Molecular Systems Utilizing Transition Metals: Discrete coordination frameworks are self-assembled from metal ions and well-designed organic compounds. We have successfully constructed unique frameworks in nanoscale such as macrocycles, cages, capsules, nanotubes, and giant spheres. 2. Chemistry of the Confinement Effects: Chemically and physically new phenomena have been developed within the nano-sized cavity of the self-assembled hollow compounds. 3. Innovative Molecular Structure Analysis Utilizing Crystalline Nano Cavities: Through the studies on molecular recognition in solid state by analogy with solution chemistry, we have developed a new, crystallization-free, single crystal X-ray analysis method that is applicable for trace amount of and/or non-crystallizing compounds
Supervisors	ISHIKITA LAB.
Hiroshi ISHIKITA, Professor Keisuke SAITO, Associate professor Hiroyuki TAMURA, Project Associate professor	The energy of life activity is ultimately generated by chemical reactions at active sites in biomolecules. For the active site, transition metal complexes (Mn, Fe, Co, Mo, Zn, etc.) and large π-conjugated molecules are used. By arranging these molecules appropriately in the protein electrostatic environment, which have been optimized during the course of evolution, extremely high-efficiency reactions can be achieved under mild conditions. Using theoretical approaches, we 1) clarify reaction mechanisms based on molecular chemistry and 2) facilitate molecular design such as drug discovery and new high-performance device design. The more complex and experimentally difficult molecules (eg, ~100,000 atoms in the water-splitting enzymes) are, the more the theory has an opportunity to play an active part in research. 1. photosynthetic reaction center proteins and metal proteins ・ Water splitting and oxygen evolution in the Mn_4CaO_5 complex, artificial photosynthesis ・ Electron transfer reaction, proton (H^+) transfer reaction ・ Photoexcitation, photoprotection 2. Drug discovery (target protein, molecular design) ・ Drug design for cancer factors, blood pressure adjustment, etc. 3. Fiberless optogenetics ・ Development of optical sensor protein and demonstration on mouse 4. Simulation for new material development

Supervisors	FUJIOKA LAB.
Hiroshi FUJIOKA, Professor	We are developing next-generation devices for a sustainable energy and information society based on GaN technologies for blue LEDs, power electronics, and quantum information devices. Until now, electronic devices have been made from single crystals of hard and brittle semiconductors such as Si, and their applications have been limited to personal computers and mobile phones. On the other hand, we are developing a new technique to synthesize high-quality GaN thin films on substrates with completely different chemical properties. This technology will enable structural materials such as organic polymers, glass, and metal foils, which have not previously been used as materials for electronics, to be given intelligent functions such as arithmetic, luminescence, power generation, and communication. Our goal is to contribute to the realization of a low environmental impact information society by developing new functional elements that are light and flexible using chemical methods. The research themes for next year are as follows. 1. Development of organic/inorganic micro LED display as a substitute for organic EL 2. Development of high-efficiency full-color LEDs and UV LEDs for medical use 3. Fabrication of high-efficiency nitride solar cells 4. Development of power electronics for car electronics 5. Development of organic polymer-based electronics 6. Development of materials for quantum devices of artificial intelligence (AI)
Supervisors	TATSUMA LAB.
Tetsu TATSUMA, Professor	Our research interests include photofabrication of metal and semiconductor nanostructures and development of novel photofunctional materials and devices, on the basis of new photonic and electrochemical phenomena. 1. Fundamental studies on plasmon-induced charge separation (PICS) Mechanistic studies on PICS, which we reported for the first time, for improvement of efficiency and development of new applications. 2. Photovoltaic applications PICS is applied to photovoltaic cells, photodetectors, and image sensors. It is also applied to infrared photovoltaics. 3. Photocatalysis Plasmonic photocatalysis and semiconductor photocatalysis are developed for hydrogen generation, deactivation of bacteria and viruses, and so on. 4. Nanophotonic fabrication Nanoscale photo-processing beyond the diffraction limit is developed and applied to fabrication of chiral nanostructures for novel photocatalysts and metamaterials. 5. Light emitting materials and devices Colloidal quantum dots are synthesized and applied to light emitting diodes (QLED) and displays. 6. Other optical materials Nanomaterials for control of light absorption are developed for application to color displays, data storage, and smart windows.

Supervisors	ISHII LAB.
Kazuyuki ISHII, Professor	Discovery and clarification of novel electronic structures are important not only for pioneering new scientific field but also in terms of developing new functions. Metal complexes are promising for designing electronic structures because it can show various electronic states. In our laboratory, we are pioneering new scientific fields by fusing coordination chemistry, photochemistry, and spin chemistry, and are also creating novel functions of organic–inorganic hybrid materials. Our targets are porphyrin and phthalocyanine complexes: the former is the basic skeleton of heme of hemoglobin and chlorophyll in photosynthesis, and the latter is practically used as blue/green dyes or pigments, photoconductors in photocopiers, and optical memory materials. We are investigating them by synthesizing functional complexes, spectroscopically measuring them (e.g. electronic absorption, luminescence, circular dichroism, magnetic circular dichroism, electron spin resonance, various time-resolved measurement, etc.) and analyzing them in detail based on quantum chemical calculations. Our research themes are as follows: 1. Development of functional porphyrin and phthalocyanine complexes 2. Development of photofunctional metal complexes 3. Development of biofunctional molecules for treating cancer 4. Development of new photofunctional materials based on molecular magnetism 5. Development of materials for adsorbing radioactive species
Supervisors	SUNADA LAB.
Yusuke SUNADA, Professor	Subnano or Nanosized metal compounds (Metal clusters) have attracted much interests owing to their own unique properties attributed to the nanosized effect. Our research interests focus on the design and synthesis of a series of well-defined nanosized transition metal clusters, and their application as functional materials. 1. Synthesis of subnano- or nanosized metal clusters based on the template synthesis 2. Elucidation of the detailed chemical as well as physical properties of the metal clusters 3. Application of the metal clusters in a variety of catalysis 4. Synthesis of new functional metal clusters consisting of both transition metal and the main group elements

Supervisors	TSUKAMOTO　LAB.
Takamasa TSUKAMOTO Lecturer	The nature of 'quantum-sized materials', which are ultrasmall nanoparticles with 1 nm diameter exhibiting the quantum size effect, have not been clarified sufficiently yet because of the technical difficulty of their synthesis. In this laboratory, we investigate the development of synthetic methods and properties of such materials by utilizing the knowledge of both organic and inorganic chemistry. 1. Development of synthetic method for quantum-sized materials 2. Evaluation of physical and chemical properties of quantum-sized materials 3. Development of atomic-level chemical reactions 4. Construction of concept of atom-analogy
Supervisors	TAKEYA　LAB.
Junichi TAKEYA, Professor Shunichiro WATANABE, Associate professor	In the development of next-generation electronic devices, it is needed to consider their compatibility to the environment and demands for their diverse functions because of the rapid structural change in human society. Recently, organic semiconductor devices are attracting much attention as a practical candidate to meet such requirements because of their simple and low-cost production processes, low environmental burden, as well as for their unique function of flexibility. The scope of our research group ranges from basic scientific studies on materials chemistry and charge transport physics in organic semiconductor interfaces to the device functionalization and engineering of organic semiconductors. 1. Starting from developing new organic semiconductor materials, we study fundamental charge transport properties to eventually develop high-speed organic transistors utilizing organic single-crystal semiconductors developed in our group. Combining specialties in condensed matter physics, and device engineering, we create innovative electronics through synergistic effects. 2. We promote industrialization of the novel high-performance organic electronics in collaboration with various private companies. Our own start-up companies develop markets of integrated circuits for flexible display panels and IoT sensor tags in collaboration with various industries from chemistry to services.