

# Degree Programs in Pure and Applied Sciences

## Graduate School of Science and Technology

### Doctoral Program in Mathematics

| Field of Research          | Faculty             | Detailed Description of Research Field                                                            |
|----------------------------|---------------------|---------------------------------------------------------------------------------------------------|
| A l g e b r a              | AKIYAMA Shigeki     | Number theory, Ergodic theory, Self-similar structure                                             |
|                            | SAGAKI Daisuke      | Representation theory of Lie algebras and quantum groups                                          |
|                            | MASUOKA Akira       | Hopf algebra, Quantum group                                                                       |
|                            | CARNAHAN Scott      | Moonshine, Automorphic forms, Algebraic geometry, Vertex algebras                                 |
|                            | [KIMURA Ken-ichiro] | Algebraic cycles, Motives                                                                         |
|                            | [MIKAWA Hiroshi]    | Prime number theory                                                                               |
| G e o m e t r y            | INOUCHI Jun-ichi    | Integrable systems                                                                                |
|                            | KAWAMURA Kazuhiro   | Geometric topology                                                                                |
|                            | TASAKI Hiroyuki     | Differential geometry, Integral geometry and their applications                                   |
|                            | HIRAYAMA Michihiro  | Dynamical systems, Ergodic theory                                                                 |
|                            | [AIYAMA Reiko]      | Differential geometry, Submanifolds theory                                                        |
|                            | [ISHII Atsushi]     | Low dimensional topology, Knot theory                                                             |
|                            | [NAGANO Koichi]     | Global Riemannian geometry, Geometry of metric spaces                                             |
| A n a l y s i s            | KAKEHI Tomoyuki     | Global analysis, Differential equations on symmetric spaces                                       |
|                            | TAKEUCHI Kiyoshi    | Algebraic analysis and its applications to singularity theory                                     |
|                            | TAKEYAMA Yoshihiro  | Mathematical physics, Solvable models, Special functions                                          |
|                            | KINOSHITA Tamotsu   | Weakly hyperbolic equation, Microlocal analysis                                                   |
| Mathematics of Information | AOSHIMA Makoto      | Statistical science, Large complex data, High-dimensional statistical analysis, Asymptotic theory |
|                            | * (TSUBOI Akito)    | Mathematical logic, Model theory, Stability theory                                                |
|                            | KOIKE Ken-ichi      | Statistical sequential estimation, Bayesian inference                                             |
|                            | SHIOYA Masahiro     | Axiomatic set theory                                                                              |
|                            | TERUI Akira         | Computer algebra, Symbolic-numeric computation                                                    |

| Field of Research | Faculty        | Detailed Description of Research Field                                                                            |
|-------------------|----------------|-------------------------------------------------------------------------------------------------------------------|
|                   | YATA Kazuyoshi | Multivariate analysis, Sequential analysis,<br>High-dimension low-sample-size data analysis,<br>Asymptotic theory |

(Note)

- ◆ Those marked with \* will be retiring by March 31, 2021. Only application of Ph.D. candidates for the Early Completion Program will be accepted to these members. Applicants who wish to conduct research under the supervision of one of these members should consult the faculty member prior to application.
- ◆ Those marked with ※ will be retiring by March 31, 2022. Only application of Ph.D. candidates for the Early Completion Program will be accepted to these members. Applicants who wish to conduct research under the supervision of one of these members should consult the faculty member prior to application.
- ◆ Applicants are advised to choose one of the faculty members above, other than those enclosed by the parentheses “[ ]”, as an academic supervisor. The members enclosed by “[ ]” will also cooperate with their research as academic advisors.
- ◆ Applicants are requested to discuss their research plan, prior to application, with the faculty member by whom they would like to be supervised.

For inquiries about the entrance examination, please contact:

Prof. Shigeki Akiyama, Chair, Doctoral Program in Mathematics

Email: akiyama#math.tsukuba.ac.jp (Remove “#”)

Telephone: 81-29-853-4009

- ◆ Website of Doctoral Program in Mathematics: <https://nc.math.tsukuba.ac.jp>

## Doctoral Program in Physics

| Field of Research |             | Faculty                                                                                                                                                                     | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Particle physics  | Theory      | ISHIBASHI Nobuyuki<br>KURAMASHI Yoshinobu<br>ISHIKI Goro<br>ISHIZUKA Naruhito<br>TANIGUCHI Yusuke<br>YAMAZAKI Takeshi<br>YOSHIE Tomoteru<br>[MOHRI Kenji]<br>[OHNO Hiroshi] | (1) Research on nonperturbative aspects of elementary particle physics by numerical analyses based on lattice field theory (QCD, physics beyond the standard model including string theory, tensor renormalization group)<br>(2) Research on mathematical aspects of quantum field theory and string theory (nonperturbative formulation of string theory, quantum gravity, gauge/gravity correspondence)                                                                                                                                                        |
|                   | Experiment  | UKEGAWA Fumihiko<br>HARA Kazuhiko<br>TAKEUCHI Yuji<br>[SATO Koji]<br>[IIDA Takashi]                                                                                         | (1) Studies of elementary particles at hadron-hadron colliding beam experiments (Higgs particle physics, top quark properties, electroweak interactions, bottom quark physics, quantum chromodynamics and strong interactions, and searches for new particles such as supersymmetry).<br>(2) Searches for neutrino decays and the determination of their masses using the cosmic neutrino background.<br>(3) Development of new particle detectors for the LHC accelerator luminosity upgrade, linear electron-positron colliders, and other future experiments. |
| Astrophysics      | Theory      | UMEMURA Masayuki<br>OHSUGA Ken<br>MORI Masao<br>YAJIMA Hidenobu<br>[YOSHIKAWA Kohji]<br>[WAGNER Alexander]                                                                  | (1) Formation of Cosmic Structure and Observational Cosmology<br>(2) Formation of the First Generation Objects<br>(3) Formation and Evolution of Galaxies<br>(4) Formation of Black Holes<br>(5) Evolution of Planetary Systems and Astrobiology<br>Theoretical researches on these issues by using simulations with supercomputers and by analytic methodology.                                                                                                                                                                                                 |
|                   | Observation | KUNO Nario<br>[NITTA Tom]                                                                                                                                                   | Observational study of our Galaxy, galaxies, active galactic nuclei, distant universe, et al., and development of radio telescopes and detectors. Projects of submillimeter and terahertz telescopes which will be installed in the Antarctic plateau are advancing, in addition to observing with existing telescopes such as the Nobeyama 45-m telescope and ALMA.                                                                                                                                                                                             |
| Nuclear physics   | Theory      | NAKATSUKASA Takashi<br>YABANA Kazuhiro                                                                                                                                      | (1) Theoretical researches on quantum many-body systems with the strong interaction, such as                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Field of Research        |            | Faculty                                                                                                                                                     | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|                          |            | ※[HASHIMOTO Yukio]<br>[HINOHARA Nobuo]                                                                                                                      | microscopic structure of unstable nuclei and neutron stars, nuclear reaction for element synthesis in the universe, etc.<br>(2) Computational approaches to interaction between ultra-short laser pulse and material.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                          | Experiment | OZAWA Akira<br>ESUMI Shinichi<br>SASA Kimikazu<br>[CHUJO Tatsuya]<br>[MORIGUCHI Tetsuaki]                                                                   | (1) Experimental Study of Nuclear physics using relativistic heavy ion collider (Quark Gluon Plasma, Big Bang Cosmology, Reaction mechanism of high energy nuclear collision)<br>(2) Evolution of Nucleosynthesis using RI beam (Nucleosynthesis, Unstable nuclei, Precise mass spectroscopy of rare nuclei)<br>(3) Accelerator Mass Spectrometry (AMS) of cosmogenic nuclides(Global environmental changes, Age dating, Cosmic-ray intensity variation and Ultrasensitive detection method for radionuclides), Environmental radiation and Radiation physics<br>(4) R&D of new experimental devices (Accelerator, detector, new application of accelerator beam)                                                                                                                                                                                                                                                                                                                                                                                             |
| Condensed matter physics | Theory     | OKADA Susumu<br>TOKURA Yasuhiro<br>HATSUGAI Yasuhiro<br>TANIGUCHI Nobuhiko<br>[YOSHIDA Kyo]<br>[YOSHIDA Tsuneya]<br>[MIZOGUCHI Tomonari]<br>[MARUYAMA Mina] | (1) Condensed matter physics and computational material sciences(Okada,Maruyama):<br>Using the first-principles techniques based on the quantum mechanics, we study physical and chemical properties of nanoscale materials, ranging from the semiconductor to biomaterials.<br>(2) Quantum transport (Tokura,K. Yoshida):<br>Theory of quantum transport in nano-structures made of various semiconductors. Non-equilibrium dynamics and quantum coherence in compound quantum system and possible application to quantum computations.<br>(3) Quantum theory of matter( Y. Hatsugai, T. Yoshida,T.Mizoguchi):<br>Theoretical/numerical studies of quantum phases of matter (theory of bulk-edge correspondence, graphene, quantum (spin) Hall systems, strongly correlated systems, exotic superconductors, quantum spins, Berry phases, topological insulators, etc.)<br>(4) Nano Quantum Physics (Taniguchi): Quantum properties and quantum transport phenomena in semiconductor nanostructures; Quantum field theories of nonequilibrium steady states; |

| Field of Research |            | Faculty                                                                                                                                                                                                                                                         | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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|                   |            |                                                                                                                                                                                                                                                                 | Quantum field theories of low dimensional systems, random systems or chaotic systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                   | Experiment | KANDA Akinobu<br>NISHIBORI Eiji<br>MORITOMO Yutaka<br>IKEZAWA Michio<br>ONODA Masashige<br>NOMURA Shintaro<br>MORISHITA Masashi<br>[HIGASHIYAMA Kazuyuki]<br>[KUBO Atsushi]<br>[TOMIMOTO Shinichi]<br>[KASAI Hidetaka]<br>[KOBAYASHI Wataru]<br>[NIWA Hideharu] | <p>(1) Magnetism and Materials Science (Onoda): Multilateral and comprehensive study for correlated electron system (novel superconductivity, metal-insulator transition), quantum spin-fluctuation system, and functional system (novel ion battery, thermoelectric conversion) with NMR, ESR, structure analysis, and conventional measurements of electrical, magnetic or thermal properties.</p> <p>(2) Low temperature physics (Kanda, Morishita): Mesoscopic electron transport in nanoscale systems: quantum transport in graphene and other 2D materials, low dimensional superconductivity and vortices in layered superconductors. Low dimensional quantum properties in quantum fluids and quantum solids (helium) which appear with structural control.</p> <p>(3) Energy materials science (Y. Moritomo, W. Kobayashi, H. Niwa, and H. Higashiyama) Research of the energy materials and devices, such as, sodium-ion secondary battery, perovskite solar cell . thermoelectrics, catalyst, superconductor, and so on with use of Synchrotron-radiation X-ray (SPring-8, PF) and nano probes (NIMS), and so on.</p> <p>(4) Structural Materials Science ( Nishibori, Kasai): Structural materials science using advanced x-ray region photon sources. Ultra-high resolution charge density study; In-situ observation of nano-particle synthesis; structural studies of thermoelectrics, battery materials, molecular functional materials. International research collaboration using research unit project. Advanced Structural research using X-ray free electron laser.</p> <p>(5) Nanophotonics (Ikezawa, Kubo, Tomimoto): [Semiconductor Optics] We investigate optical properties, spin characteristics and quantum optics in low dimensional semiconductor</p> |

| Field of Research |            | Faculty                                                                                                                                  | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |            |                                                                                                                                          | <p>nanostructures such as quantum wells, quantum dots and defects using various spectroscopy, including femto/pico-second laser spectroscopy. [Surface Dynamics] Studies on dynamics of charge carriers, collective excitations such as surface plasmons, and wave packets excited on solid surfaces, hetero-interfaces, and nanostructures. Developments of novel ultrafast time-resolved microscopy methods.</p>                                                                                                                                                                                                                                                                                                                                                                     |
| Biophysics        | Theory     | SHIGETA Yasuteru<br>[SHOJI Mitsuo]<br>[HORI Yuta]                                                                                        | <p>We theoretically investigate the biological macromolecules (proteins, nucleic acids, sugars), which are important in life, and the biological system ranging from a protein to aggregates of proteins by using computational methods to reveal structure-function relationship of biomolecules and elucidate the mechanism of life.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| P l a s m a       | Experiment | SAKAMOTO Mizuki<br>KARIYA Tsuyoshi<br>MINAMI Ryutaro<br>YOSHIKAWA Masayuki<br>[KOHAGURA Junko]<br>[HIRATA Mafumi]<br>[NUMAKURA Tomoharu] | <p>(1) Study on plasma transport and confinement by magnetic and electric fields, and divertor simulation study using a tandem mirror device.<br/>           (2) Study on plasma heating and electric field formation by using microwave, radio frequency wave and neutral beam, and control of heat and particle transport in core and boundary plasmas.<br/>           (3) Plasma diagnostics with X ray, infrared, microwave, particle beam, visible light, laser, etc. Using these diagnostics, especially, study on relation between plasma transport and instability and fluctuation.<br/>           (4) Theoretical analysis and computer simulation related to above experiments and its application to astrophysics.<br/>           (5) Study on plasma-wall interaction.</p> |

【Cooperative Graduate School System】

| Field of Research                  | Faculty                                                                                   | Detailed Description of Research Field                                                                                                                                                                                                                                                                  |
|------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advanced Interdisciplinary Physics | MARUYAMA Toshiki<br>(JAEA)<br>MIYAMOTO Yoshiyuki<br>(AIST)<br>NISHIMURA Shunji<br>(RIKEN) | Simulation researches on dynamics of quark and hadrons (Maruyama)<br>Condensed matter physics: Ultra-fast phenomena by electron excitation(Miyamoto)<br>Study of nuclear astrophysics using new accelerator and new experimental techniques (Nuclear Structure, Nuclear Cosmology, Neutron-Rich Nuclei) |
| Nuclear Fusion and Plasma Physics  | IDE Shunsuke<br><br>※[SAKAMOTO Keishi]<br><br>NAKANO Tomohide<br>( Q S T )                | (1) Study on plasma heating system for a large nuclear fusion device.<br>(2) Study on core-boundary plasma physics for a large nuclear fusion device.<br>(3) Simulation study of a large nuclear fusion device.                                                                                         |
| Frontier Materials Science         | KAWAI Takazumi<br>(N E C)                                                                 | Theoretical research to clarify the dynamics of chemical reaction and electronic states in atomic scale using first-principles electronic states calculations and molecular dynamics simulations aiming for the design of emerging materials.                                                           |
|                                    | YAMAMOTO Tsuyoshi<br>(N E C)                                                              | Development of quantum-dot based infrared photodetector, which includes the energy-band engineering to improve the sensitivity and spectral resolution required for the remote sensing applications.                                                                                                    |
|                                    | YUGE Ryota<br>(N E C)                                                                     | Research on devices with carbon nanotubes and carbon nanobrushes. They contain the material preparation, characterization, and sensing and energy device applications.                                                                                                                                  |
|                                    | SASAKI Ken-ichi<br>(N T T)                                                                | We study the electronic properties of graphene and carbon nanotube using the method of condensed matter physics. We aim for theoretical proposal of new and versatile ideas.                                                                                                                            |
|                                    | SHINYA Akihiko<br>(N T T)                                                                 | Research on ultra-compact and ultra-low power photonic devices and circuits, novel photonic phenomena in nanostructures.                                                                                                                                                                                |

(Note)

- ◆ Applicants cannot choose faculty members who are surrounded by “[ ]” as an academic supervisor. Instead, choose from other members in the same research field, and you can conduct the research theme with their cooperation.
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- ◆ Those marked with ※ will be retiring by March 31, 2022. Only application of Ph.D. candidates for the Early Completion Program will be accepted. Applicants who wish to conduct research under their supervision should consult the faculty adequately prior to the application.

(1) Please refer to the website below. Applicants should have a thorough discussion with a professor of their research field about your research plan two weeks before the examination.

Inquiries about the entrance examination should be sent to:

Prof. Yasuhiro Hatsugai, Chair, Doctoral Program in Physics

Email: :hatsugai.yasuhiro.ge##@#u.tsukuba.ac.jp (Remove “#” before sending an email)

telephone: 81-29-853-4277

Website of Doctoral Program in Physics : <http://www.px.tsukuba.ac.jp/senkou/>

(Remarks) Two faculty members in the list of the “Advanced Interdisciplinary Physics” research field by cooperative graduate school system offer their instruction by joint cooperative graduate school system. If you wish to apply for this method of instruction, contact the person above prior to the application.

(JAEA) = Japan Atomic Energy Agency

(AIST) = The National Institute of Advanced Industrial Science and Technology

(RIKEN) = Institute of Physical and Chemical Research

(QST) = National Institutes for Quantum and Radiological Science and Technology

## Doctoral Program in Chemistry

| Field of Research                  | Faculty              | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inorganic and Analytical Chemistry | KOJIMA Takahiko      | <p>(1) Synthesis of transition-metal complexes and their reactivity in various redox and catalytic reactions; supramolecular redox chemistry of non-planar and fused porphyrins.</p> <p>(2) Design and synthesis of functional organic compounds applicable to host-guest and supramolecular chemistry.</p> <p>(3) Low-coordination and multiple-bonded compounds of heavier group 14 elements and organoelement chemistry of Group 13-14.</p> <p>(4) Material design and bio-molecular modeling based on computational chemistry.</p> |
|                                    | ※(SUEKI Keisuke)     | Studies of environmental long-lives radioisotopes and radioactive substances released from the Fukushima Daiichi Nuclear Power Plant accident; Trans-uranium chemistry.                                                                                                                                                                                                                                                                                                                                                                |
|                                    | NAKATANI Kiyoharu    | Studies on chemical processes at microdroplet/solution and microparticle/solution interfaces using electrochemical and spectroscopic techniques.                                                                                                                                                                                                                                                                                                                                                                                       |
|                                    | NIHEI Masayuki       | Creation of multi-nuclear metal clusters with controlled structures and electronic states; chemistry of functional metal complexes with controlled electronic states and structures.                                                                                                                                                                                                                                                                                                                                                   |
| Physical Chemistry                 | YAMAMURA Yasuhisa    | Structure and property of soft molecular systems, and dynamics and phase transitions in them.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                    | ISHIBASHI Taka-aki   | Studies on interfaces and condensed phases by linear and nonlinear molecular spectroscopy; Synthesis of emissive compounds and kinetic analyses of formation and deactivation processes of the emissive state by TCSPC; Studies on photofunctions and photochemical properties of newly fabricated molecular assemblies and inorganic particles in mesoscopic scale.                                                                                                                                                                   |
| Organic Chemistry                  | *(NABESHIMA Tatsuya) | Design and synthesis of functional organic compounds, responsive artificial receptors, hybrid functional supramolecules, self-assembled supramolecules, supramolecular sensors, host-guest chemistry, supramolecular chemistry.                                                                                                                                                                                                                                                                                                        |

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|-----------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             | ICHIKAWA Junji       | Studies on acceleration and control of synthetic organic reactions. Development of synthetic reactions using organofluorine and organometallic compounds.                                                                      |
|                             | YOSHIDA Masahito     | Isolation, structural elucidation, synthesis, and bioorganic studies of bioactive natural products. Design, synthesis and biological evaluation of novel biologically active molecules.                                        |
| Interdisciplinary Chemistry | ※(YAMAMOTO Yasuhiko) | Investigation of architecture of metalloprotein and metalloenzyme structures; Nuclear magnetic resonance spectroscopy of paramagnetic metal complexes; Development of molecular probes for second harmonic generation imaging. |
|                             | IWASAKI Kenji        | Study of proteins in soft-tissue sarcoma, chromatin remodeling factors and a photosensing flavoprotein. Structural biology and chemistry using single-particle electron microscopy and its development.                        |

【Cooperative Graduate School System】

| Field of Research             | Faculty                         | Detailed Description of Research Field                                                                                                                                                                                                                |
|-------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Materials Inorganic Chemistry | AKIMOTO Junji<br>( A I S T )    | Studies on inorganic solid state chemistry and electrochemistry for advanced functional materials (including lithium ion battery positive and negative electrode materials, and advanced solid electrolyte materials).                                |
| Solid State Chemistry         | KAMATA Toshihide<br>( A I S T ) | Studies on the super-structured thin film of molecular compounds and its application to the organic transistors.                                                                                                                                      |
| Surface Electrochemistry      | SATO Yukari<br>( A I S T )      | Functionalization of solid and electrode surfaces. Redox flow battery for renewable energy introduction. Construction of micro multi sensing devices for marine environment.                                                                          |
| Materials Organic Chemistry   | HAN Li-Biao<br>( A I S T )      | Studies on the efficient preparation of heteroatom compounds (organophosphorus chemicals in particular) via catalysis and development of heteroatom-containing functional materials.                                                                  |
| Organic Electronics Chemistry | YOSHIDA Yuji<br>( A I S T )     | Research on structural properties and photo-electrical properties of thin films based on polymers, molecular compounds and organic-inorganic hybrid materials, and chemistry on organic electronics such as organic photovoltaic cells (solar cells). |

| Field of Research                   | Faculty                        | Detailed Description of Research Field                                                                                                                                             |
|-------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nano-Carbon Materials Chemistry     | OKAZAKI Toshiya<br>( A I S T ) | Synthesis of the functionalized nano-carbons and their spectroscopic characterizations.                                                                                            |
| Organometallic Chemistry            | NAKAJIMA Yumiko<br>( A I S T ) | Design and synthesis of novel transition metal catalysts, Development of catalytic reactions for precise synthesis of new organometallic compounds containing main group elements. |
| Photofunctional Materials Chemistry | NORIKANE Yasuo<br>( A I S T )  | Photofunctional organic molecules especially showing photo-induced solid-liquid phase transitions and lightdriven mechanical motion.                                               |
| Functional Polymer Gel Chemistry    | HARA Yusuke<br>( A I S T )     | Research and development of functional polymers and polymer gels for application to soft actuators, soft robots, micro fluidic devices.                                            |

**【International Institute for Integrative Sleep Medicine】**

| Field of Research      | Faculty                               | Detailed Description of Research Field                                                                                                                                                                                      |
|------------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pharmaceutical Science | ※(NAGASE Hiroshi)<br>KUTSUMURA Noriki | Design and synthesis of orexin receptor agonists/Design and synthesis of opioid ligands/Research and development for narcorepsy, severe pain, depression, pollakiurea, malaria, other protozoal diseases, and cancer drugs. |

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- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. Takahiko Kojima, Chair, Master's Program in Chemistry/

Prof. Taka-aki Ishibashi, Member of the Academic Committee Master's Program in Chemistry

telephone: 81-29-853-6505・4310

Website of Doctoral Program in Chemistry: <http://www.pas.tsukuba.ac.jp>

(AIST) = The National Institute of Advanced Industrial Science and Technology

## Doctoral Program in Engineering Sciences Subprogram in Applied Physics

| Field of Research               | Faculty           | Detailed Description of Research Field                                                                                                                                                                                                   |
|---------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Optical and Quantum Engineering | * (ITOH Masahide) | (1) Optical Information processing and optical metrology. Development of optical instrumentation and devices.                                                                                                                            |
|                                 | HATTORI Toshiaki  | (2) Sensing using terahertz waves and terahertz spectroscopic study of bio-related materials                                                                                                                                             |
|                                 | YASUNO Yoshiaki   | (3) Fundamental, instrumentation, application research on optical tomographic imaging for medical and lifescience applications. It includes optical coherence tomography and quantitative three-dimensional functional microscopy.       |
|                                 | KANO Hideaki      | (4) Exploring new frontiers in biomedical molecular imaging using nonlinear Raman spectroscopy; Research on optical information processing and optical Metrology                                                                         |
|                                 | HADA Masaki       | (5) Femtosecond time-resolved electron diffraction measurements: filming “molecular movies” of photo-reactive or responsive materials                                                                                                    |
| Instrumentation Physics         | SASAKI Masahiro   | (6) Observations and controls of surface/interface properties by using supersonic molecular/atomic beams, scanning probe microscopes and other spectroscopic and microscopic techniques                                                  |
|                                 | SHIRAKI Kentaro   | (7) Technology of protein folding and application of biomaterials                                                                                                                                                                        |
|                                 | FUJITA Jun-ichi   | (8) Synthesis of carbon nanotube and graphene based low dimensional nanomaterials for application researches of realizing in-situ imaging using local electric field, revealing physical and catalytic properties for functional devices |
|                                 | SEKIGUCHI Takashi | (9) Basics of scanning electron microscope (SEM). Electron and material interactions and physics of secondary and reflective electron. New measurement method by the electron beam.                                                      |
|                                 | SOHDA Yasunari    | (10) Application of scanning electron microscope (SEM). Electron optics and measurement of electron beam. Enhancement of SEM system and proposal new system.                                                                             |
|                                 | ITO Yoshikazu     | (11) Synthesis, characterizations and fabrications of 3D materials using graphene and two dimensional materials for developments of catalysts, device applications and energy harvesting devices with renewable energy sources           |

| Field of Research                   | Faculty              | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | KOBAYASHI Nobuhiko   | (12) Condensed matter theory. Computational materials science. Density functional theory for nonequilibrium systems. Theory of charge, heat and spin transport in nanoscale systems.                                                                                                                                                                                                                           |
|                                     | TERADA Yasuhiko      | (13) Developemnt of new imaging methods based on NMR and MRI                                                                                                                                                                                                                                                                                                                                                   |
|                                     | YAMADA Yoichi        | (14) Surface and molecular sciences on the structure-property relationships of the self-organized organic semiconductors.                                                                                                                                                                                                                                                                                      |
| Quantum Beam and Plasma Engineering | EZUMI Naomichi       | (15) Study of plasma-gas interaction and plasma-wall interaction in boundary plasmas (edge-divertor plasmas) of magnetically confined nuclear fusion utilizing an open magnetic field structure of the largest tandem mirror plasma device GAMMA 10/PDX. To control the high heat flux boundary plasma, we are investigating the plasma behavior using advanced plasma measurement systems.                    |
|                                     | TOMITA Shigeo        | (16) Experimental studies on advanced atomic physics and atomospheric science using charged particle beams from accelerators                                                                                                                                                                                                                                                                                   |
| Nano-Technology                     | * (SHIGEKAWA Hidemi) | (17) Our research target is to understand and develop the nanoscale science and technologies of such as surface science, molecular physics, and new functional materials and devices. To realize these studies, we develop new microscopy techniques based on scanning probe microscopy and advanced laser technologies, which, for example, enable ultimate spatial and temporal resolutions, simultaneously. |
|                                     | HASE Muneaki         | (18) Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical devise and controlling phase transitions                                                                                                                                                                                                                                       |
|                                     | UMEDA Takahide       | (19)Electron-spin-resonance (ESR)-based characterization on nano-electronics devices and power-electronics devices                                                                                                                                                                                                                                                                                             |

| Field of Research                                      | Faculty           | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                        | TAKEUCHI Osamu    | (20) Development of new microscopy techniques by combining nanometer-resolving scanning probe microscopy and optical measurement techniques, in order to reveal nanometer-scale optoelectronic processes in solar cells, light emitting diodes, and spintronics devices and to improve their device performance                                                                                                |
|                                                        | MAKIMURA Tetsuya  | (21) Nano- and Micro-machining and materials synthesis using laser produced plasma EUV light and laser light                                                                                                                                                                                                                                                                                                   |
|                                                        | YOSHIDA Shoji     | (22) Our research target is to understand and develop the nanoscale science and technologies of such as surface science, molecular physics, and new functional materials and devices. To realize these studies, we develop new microscopy techniques based on scanning probe microscopy and advanced laser technologies, which, for example, enable ultimate spatial and temporal resolutions, simultaneously. |
| Semiconductor Electronics<br>(Power Electronics)       | UEDONO Akira      | (23) Study of defects in materials by means of positron annihilation, and developments of positron annihilation spectroscopy.                                                                                                                                                                                                                                                                                  |
|                                                        | SANO Nobuyuki     | (24) Simulation and theoretical studies of Electron transport phenomena under nanoscale semiconductor structures, and device modeling and simulation of device characteristics.                                                                                                                                                                                                                                |
|                                                        | SUEMASU Takashi   | (25) High-efficiency Si-based tandem solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements.                                                                                                                                                                                                                                                                 |
|                                                        | HASUNUMA Ryu      | (26) Development of highly reliable gate dielectric films for future LSI.                                                                                                                                                                                                                                                                                                                                      |
|                                                        | TOKO Kaoru        | (27) Research on materials and processes for highly functional thin films for flexible energy devices                                                                                                                                                                                                                                                                                                          |
| Optoelectronics and Spintronics<br>(Power Electronics) | OHNO Yuzo         | (28) Studies of electronic, optical, and spin properties of semiconductor nanostructures, and spin coherence for quantum information and low-power devices.                                                                                                                                                                                                                                                    |
|                                                        | SAKURAI Takeaki   | (29) Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices.                                                                                                                                                                                                                                                                  |
|                                                        | YANAGIHARA Hideto | (30) Thin film growth of advanced magnetic oxides for spintronics devices                                                                                                                                                                                                                                                                                                                                      |

| Field of Research | Faculty          | Detailed Description of Research Field                                                                                                                                                                    |
|-------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power Electronics | IWAMURO Noriyuki | (31) Research on improvement of power semiconductor devices characteristics for achieving a low loss and high withstand capability                                                                        |
|                   | ISOBE Takanori   | (32) Study on circuit topologies and control for efficiency and power density improvement in power converters, and its emerging applications                                                              |
|                   | YANO Hiroshi     | (33) Research on ultra-low-loss SiC power semiconductor devices, particularly improvement in SiC-MOS device performance and understanding of its interface physics, toward power electronics innovations. |

【Cooperative Graduate School System】

| Field of Research               | Faculty                                                                                       | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Semiconductor Electronics       | MAKINO Toshiharu<br>(AIST)                                                                    | (34) Diamond growth, and electronic device fabrication using unique properties.                                                                                                                                                                                                                                                                                                                                                                                                     |
| Optoelectronics and Spintronics | YUASA Shinji<br>(AIST)                                                                        | (35) Research and development of magnetic tunnel junctions, magnetoresistive random access memory MRAM and other spintronic devices.                                                                                                                                                                                                                                                                                                                                                |
| Power Electronics               | OKUMURA Hajime<br>(AIST)<br><br>YAMAGUCHI Hiroshi<br>(AIST)<br><br>KOJIMA Kazutoshi<br>(AIST) | (36) Research and Development on widegap semiconductors such as SiC and GaN, and their electronics application.<br>(37) R&Ds of packaging and power circuit technologies for making the full potential use of wide bandgap semiconductor power devices such as SiC.<br>(38) Research and development on wide gap semiconductor epitaxial growth technique such as SiC and its characterization. Development of power device with new structure by using epitaxial growth technique. |

(Note)

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- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. TOSHIKI HATTORI, Chair, Subprogram in Applied Physics  
telephone: 81-29-853-4966

For more information, please refer to the following websites:

Website of the Degree Program in Pure and Applied Sciences: <http://www.pas.tsukuba.ac.jp/>  
Website of Doctoral Program in Engineering Sciences Subprogram in Applied Physics:  
<http://www.bk.tsukuba.ac.jp/>

(AIST) = The National Institute of Advanced Industrial Science and Technology

## Doctoral Program in Engineering Sciences    Subprogram in Materials Science

| Field of Research                    | Faculty             | Detailed Description of Research Field                                                                                                                                                                                                                                                                              |
|--------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quantum Physics<br>of Solid State    | KURODA Shinji       | (1) Experimental studies on spin-related phenomena in the solid state. We develop novel materials exhibiting spin properties, such as magnetic semiconductors, topological insulators and their nanostructures, and clarify the spin-related properties aiming at the application to spin-based electronic devices. |
|                                      | MATSUISHI Kiyoto    | (2) Study on optical properties and high-pressure physics of semiconductors (amorphous, low-dimensional nanostructured, organic-inorganic hybrid, etc.) for search of new optically-functionalized materials                                                                                                        |
|                                      | FUJIOKA Jun         | (3) Research on electronic, optical and thermal property in strongly correlated electron material and topological quantum material. Searching new quantum phenomena and functions by using state-of-the-art material synthesis technique, spectroscopy and fundamental characterization.                            |
|                                      | MARUMOTO Kazuhiro   | (4) Development and characterization of semiconductor materials, and their application to semiconductor devices such as solar cell, light-emitting diodes, transistors, etc. using functional materials such as organic materials, perovskites, low-dimensional materials, etc.                                     |
|                                      | [TSUJIMOTO Manabu]  | (5) Towards high-speed, high-sensitive and phase-sensitive applications, we are developing superconducting quantum devices utilizing high-temperature superconductivity. Our goal is to establish an epoch-making technology based upon front-line microfabrication and cryogenic techniques.                       |
| Theoretical Quantum<br>P h y s i c s | *(TAKEMORI Tadashi) | (6) Theoretical investigation of properties of condensed matters in a broad sense, and its application to analytical methods such as simulation techniques of quantum systems, function analysis of microscopic systems including biological molecules                                                              |
|                                      | HINO Ken-ichi       | (7) Theoretical studies of optical properties of condensed matter in non-equilibrium topological materials, ultrashort-pulse driven semiconductors, coherent phonon generation, exciton dynamics, photo-induced phase transitions                                                                                   |

| Field of Research                     | Faculty           | Detailed Description of Research Field                                                                                                                                                                                                      |
|---------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                       | KOIZUMI Hiroyasu  | (8) Theoretical study of superconductivity in strongly-correlated materials and topological materials, and their application to fault-tolerant quantum computers.                                                                           |
|                                       | SUZUKI Shugo      | (9) First-principles study of structural and electronic properties of materials                                                                                                                                                             |
|                                       | TONG Xiao-Min     | (10) Understand dynamical processes of atoms, molecules and solids in an ultrashort intense laser field and search an effective way to control the processes with intense laser in femtosecond domain by first principles simulations.      |
| Materials Physics and Engineering     | KIZUKA Tokushi    | (11) Development of heat resistance materials for aircrafts and jet engines, carbon fiber-reinforced plastic, nanowires, photovoltaic power generation and light emitting nanodevices, and single molecular devices by electron microscopy. |
|                                       | KIM Hee Young     | (12) Development and characterization of novel functional alloys and biomaterials including biomedical superelastic alloy, high temperature shape memory alloy, high entropy alloy and gum metal                                            |
|                                       | TOKORO Hiroko     | (13) Development of novel materials with advanced light-responsive functionalities, accompanying changes of optical, magnetic, and electric properties. Metal complexes and metal oxides are the main target materials                      |
|                                       | KOYANO Tamotsu    | (14) Research on phase transformation and microstructure of high nitrogen steel. Our goal is production of the low alloy steel for automobile and molds without comprising rare metals                                                      |
|                                       | SUZUKI Yoshikazu  | (15) Development of new inorganic materials for energy and environmental applications such as solar cells and environmental purification filters                                                                                            |
|                                       | TANIMOTO Hisanori | (16) Research on characteristic properties and application of nanostructured materials such as nanocrystalline metals, amorphous alloys and metallic nanoparticles                                                                          |
| Materials Chemistry and Biotechnology | KANBARA Takaki    | (17) Development and characterization of novel functional polymers and organometallic compounds directed toward organic devices and catalysts                                                                                               |

| Field of Research | Faculty            | Detailed Description of Research Field                                                                                                                                                                                                                     |
|-------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | KIJIMA Masashi     | (18) Development of highly functionalized materials based on conjugated polymers, biomass (wood & algae), and carbon.                                                                                                                                      |
|                   | SUZUKI Hiroaki     | (19) Development of electrochemical and photonic biosensing devices, microfluidic devices, and micro/nanomotors.                                                                                                                                           |
|                   | NAKAMURA Junji     | (20) Methanol synthesis catalysts from CO <sub>2</sub> , fuel cell catalysts and surface chemistry of graphitic materials are studied using surface science techniques at the atomic level.                                                                |
|                   | NAGASAKI Yukio     | (21) Design of functional polymer materials for biomaterials and environmental friendly materials (Drug delivery systems, nanomedicines, biosensing, biodegradable polymers)                                                                               |
|                   | *FUJITANI Tadahiro | (22) Development and characterization of heterogeneous catalysts for biomass conversion, environment, and energy.                                                                                                                                          |
|                   | YAMAMOTO Yohei     | (23) Self-assembly of $\pi$ -conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.                                                                                                             |
|                   | KUWABARA Junpei    | (24) Development of new molecular catalysts, facile synthetic methodology for conjugated molecules, and luminescent metal complexes.                                                                                                                       |
|                   | KOBAYASHI Masami   | (25) Photosynthesis (pigment analysis). Photodynamic Therapy by Chlorophylls. Algae and algal oil.                                                                                                                                                         |
|                   | GOTO Hiromasa      | (26) Synthesis and properties of low-molecular mass compounds and polymeric materials having magnetism, electrical conductivity, photo-isomerization, optical rotation, and circular dichroism                                                             |
|                   | KONDO Takahiro     | (27) Formation and application of new two-dimensional materials of boron, development of a substitute material of Pt at the Fuel Cell electrode using nitrogen-doped carbon, and reaction dynamics at surface based on the fine experimental measurements. |
|                   | TSUJIMURA Seiya    | (28) Electrochemistry of redox enzymes and its application to biosensors and biofuel cells                                                                                                                                                                 |

【Cooperative Graduate School System】

| Field of Research                     | Faculty                 | Detailed Description of Research Field                                                                                                                                          |
|---------------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Materials Chemistry and Biotechnology | CHOI Jun-Chul<br>(AIST) | We aim at the development of high efficiency catalyst for green synthetic processes and material design of highly dispersed metal catalyst.                                     |
|                                       | KURITA Ryoji<br>(AIST)  | We conduct R&D from basic research to device development as regard a novel biomolecule analysis, and contribute to the development of next-generation medical and life science. |

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- ◆ Applicants cannot choose faculty members who are surrounded by “[ ]” as an academic supervisor. Instead, choose from other members in the same research field, and you can conduct the research theme with their cooperation.
- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. Shinji Kuroda, Chair, Subprogram in Materials Science  
Telephone: 81-29-853-4967

Prof. KIM Hee Young, Member of the Academic Committee, Subprogram in Materials Science  
Telephone: 81-29-853-6942

Related Websites ( <http://www.pas.tsukuba.ac.jp/>  
<http://www.ims.tsukuba.ac.jp/>  
<http://www.tsukuba.ac.jp/> )

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## Doctoral Program in Engineering Sciences Subprogram in Materials Science and Engineering

| Field of Research   | Faculty             | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Metals and ceramics | * (TSUCHIYA Koichi) | Research on the development of metallic functional/structural materials, such as, shape memory alloys, intermetallics, Ti alloys and metallic glass by phase transformation and deformation process, and clarification of the underlying physics and mechanisms of their functionality.                                                                                                                                                         |
|                     | HONO Kazuhiro       | Development of magnetic and spintronic materials for energy efficient devices such as high density recording media and read sensors for next generation hard disk drives, magnetoresistive devices for high capacity MRAMs and high performance permanent magnets for automotive applications. These materials and devices are developed based on atomistic characterizations using transmission electron microscopy and atom probe tomography. |
|                     | MITANI Seiji        | Development of magnetic materials and nanostructures by Atomic scale control based on state-of-the-art thin film growth techniques. Searching and understanding new functionalities in spin transport and their application to Spintronic devices.                                                                                                                                                                                              |
|                     | TAKANO Yoshihiko    | We are focusing on the physical properties of high-Tc superconductor, diamond superconductor, Fe-based superconductor and carbon nanotube. Development of novel devices, including optical and field effect devices, using superconductors and nano-technologies are targets.                                                                                                                                                                   |
|                     | MORI Takao          | We focus on developing highly functional energy environment materials, such as, thermoelectric and battery materials, through atomic network control, synthesis of new materials, nano/microstructure control of materials with strong structure-property relationships from their topology.                                                                                                                                                    |
|                     | WATANABE Ikumu      | We have developed a computer aided engineering framework to accelerate material research and development, based on multi-scale and multi-discipline modeling to characterize material behaviors and properties. We focus on especially structural materials for automotive and aviation industries.                                                                                                                                             |

| Field of Research | Faculty              | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                |
|-------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | UCHIDA Ken-ichi      | Development of novel science and technology of "Spin caloritronics", an interdisciplinary field between spintronics physics and thermal energy engineering. Spin caloritronics enables unconventional thermoelectric generation and thermal energy control, which are investigated by cutting-edge heat and spin detection techniques.                |
| Nanomaterials     | * (SASAKI Takayoshi) | Synthesis of functional nanosheets as a new class of nano-materials and organization of the nanosheets as a building block into nanostructured integrated systems with a sophisticated function such as photocatalytic, electronic, magnetic properties.                                                                                              |
|                   | TAKEDA Yoshihiko     | We investigate femtosecond spectroscopy of inorganic and organic nanomaterials to develop functional materials for photonic-applications. We also study control of nano-scale structures, surface modification of organic and inorganic materials with advanced ion beam technology and nanoparticle assembly with biomolecules for bio-applications. |
|                   | ※(NAKAYAMA Tomonobu) | Fabrication and characterization of inorganic- / organic- / bio-nanostructures toward realization of novel functionalities at the nanometer scale, for future nanoelectronics and information technology, by using multiple-scanning-probe microscopy and related techniques.                                                                         |
|                   | TANG Jie             | Design and fabrication of functional structures, characterization of properties, and development for industrial applications of one-dimensional nanomaterials including carbon nanotubes and rare-earth boride nanowires.                                                                                                                             |
|                   | HASHIMOTO Ayako      | Development and applications of transmission electron microscopy techniques and systems. We especially focus on in-situ observations of environmental and energy materials such as photovoltaic materials, fuel cells, rechargeable batteries and so on.                                                                                              |
|                   | YOSHIKAWA Genki      | Development of new molecular sensors/systems towards mobile breath diagnostics, global-standard artificial olfaction, and new blood/fluid test. Fusion of physics, chemistry, biology, engineering, and economics.                                                                                                                                    |

| Field of Research         | Faculty           | Detailed Description of Research Field                                                                                                                                                                                                                                                                     |
|---------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           | ISHII Satoshi     | Studies on developing novel photonic nanostructures for extraordinary optical properties and photoelectric/photothermal conversions. Includes both numerical and experimental works to develop, for examples, optical metamaterials and photonic nanostructures to harvest sunlight as well as solar heat. |
| Organic and Bio-Materials | TAKEUCHI Masayuki | Creation of new organic nanochemistry thorough the design, synthesis, and characterization of organic, macromolecular, and supramolecular materials with photo- and electro-active components, chemosensing functions, dynamic mechanical characters.                                                      |
|                           | CHEN Guoping      | Preparation of biocompatible and biofunctional polymer biomaterials with controlled porous and surface structures using biodegradable polymers and bioactive factors, and their application for tissue engineering.                                                                                        |
|                           | EBARA Mitsuhiro   | Our research group is interested in developing smart biotechnologies using stimuli-responsive polymers. These smart biomaterials are designed to act as an “on-off” switch for drug delivery technologies, gene therapy, affinity separations, chromatography, diagnostics.                                |
|                           | TAGUCHI Tetsushi  | Fundamental studies on the biomedical materials for minimal invasive therapy. We synthesize soft materials which show sol-gel transitions under the physiological environment and apply them for tissue/cell adhesives and drug-eluting stent, etc.                                                        |
|                           | NAITO Masanobu    | Design and creation of nano-composite materials with emergent functions. Especially, our research covers multimaterial adhesive and coating based on polymeric / organic nanomaterials.                                                                                                                    |
|                           | KAWAKAMI Kohsaku  | Development of pharmaceutical/cosmetic materials are of our research interests, where self-assembly and crystallization of organic molecules are utilized to add novel functions to those materials. Also focused is contribution to progress in physical chemistry behind the materials science.          |
| Condensed Matter Physics  | * (UJI Shinya)    | Using world-class superconducting magnet systems, we perform systematic measurements of various physical properties in strongly correlated superconductors and the related compounds, and try to find novel quantum phenomena.                                                                             |

| Field of Research        | Faculty            | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                   |
|--------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                          | ※(HU Xiao)         | Starting from the basic physics principles, we engage in exploring new frontiers of condensed matter physics and materials science, and discovering new quantum functionalities. Our recent focuses include topological electronic states in solids and novel topological phenomena in photonic & phononic metamaterials, as well as other wave systems. |
|                          | YAMAGUCHI Takahide | Research on superconductivity and quantum transport phenomena in carbon-based materials such as diamond and organic crystals. We perform sample fabrication using micro/nano-fabrication techniques and analysis at ultra low temperatures.                                                                                                              |
| Semiconducting Materials | FUKATA Naoki       | Fundamental and applied research on next-generation high-speed semiconductor transistors with low power consumption and new energy-related materials using functionalized semiconducting nanostructures and composite nanomaterials.                                                                                                                     |

(Note)

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- ◆ Those marked with ※ will be retired by March 31, 2022.  
Only application of Ph.D. candidates for the Early Completion Program will be accepted.  
Please consult the faculty adequately prior to the application.

Inquiries about the entrance examination should be sent to:

Prof. Seiji Mitani,

Chair, Subprogram in Materials Science and Engineering

e-mail: nims\_admin@pas.tsukuba.ac.jp

telephone: 029-859-2137

Relevant Homepages: <http://www.pas.tsukuba.ac.jp/>

[http://www.nims.go.jp/graduate/index\\_en.html](http://www.nims.go.jp/graduate/index_en.html)

## Doctoral Program in Materials Innovation

| Field of Research              | Faculty              | Detailed Description of Research Field                                                                                                                                                                                                                                                                                                                             |
|--------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Energy Materials Engineering   | SUEMASU Takashi      | High-efficiency Si-based tandem solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements                                                                                                                                                                                                                           |
|                                | NISHIBORI Eiji       | Structural Materials Science<br>: Structural materials science using advanced x-ray region photon sources. Ultra-high resolution charge density study; In-situ observation of nano-particle synthesis; structural studies of thermoelectrics, battery materials, molecular functional materials. International research collaboration using research unit project. |
|                                | MORITOMO Yutaka      | Energy materials science<br>: Research of the energy materials and devices, such as, sodium-ion secondary battery, perovskite solar cell. thermoelectrics, catalyst, superconductor, and so on with use of Synchrotron-radiation X-ray (SPRING-8, PF) and nano probes (NIMS), and so on.                                                                           |
|                                | SAKURAI Takeaki      | Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices.                                                                                                                                                                                                                           |
|                                | HONO Kazuhiro (NIMS) | Development of magnetic and spintronic materials and their devices for automotive and data storage applications. For nanostructure control of these materials and devices, atomistic structural characterizations using transmission electron microscopy and atom probe tomography are employed.                                                                   |
|                                | MORI Takao (NIMS)    | We focus on developing highly functional energy environment materials, such as, thermoelectric and battery materials, through atomic network control, synthesis of new materials, nano/microstructure control of materials with strong structure-property relationships from their topology.                                                                       |
| Environment-friendly Materials | NAKAMURA Junji       | Methanol synthesis catalysts from CO <sub>2</sub> , fuel cell catalysts and surface chemistry of graphitic materials are studied using surface science techniques at the atomic level.                                                                                                                                                                             |
|                                | YAMAMOTO Yohei       | Self-assembly of $\pi$ -conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.                                                                                                                                                                                                                          |

| Field of Research    | Faculty                     | Detailed Description of Research Field                                                                                                                                                                                                                |
|----------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | SHIRAKI Kentaro             | Technology of protein folding and application of biomaterials                                                                                                                                                                                         |
|                      | KONDO Takahiro              | Formation and application of new two-dimensional material of boron, development of a substitute material of Pt at the Fuel Cell electrode using nitrogen-doped carbon, and reaction dynamics at surface based on the fine experimental measurements.  |
|                      | KANO Hideaki                | Exploring new frontiers in biomedical molecular imaging using nonlinear Raman spectroscopy; Research on optical information processing and optical metrology                                                                                          |
|                      | TSUJIMURA Seiya             | Electrochemistry of redox enzymes and its application to biosensors and biofuel cells                                                                                                                                                                 |
|                      | TAKEUCHI Masayuki<br>(NIMS) | Creation of new organic nanochemistry thorough the design, synthesis, and characterization of organic, macromolecular, and supramolecular materials with photo- and electro-active components, chemosensing functions, dynamic mechanical characters. |
|                      | NORIKANE Yasuo              | Photofunctional organic molecules especially showing photo-induced solid-liquid phase transitions and lightdriven mechanical motion.                                                                                                                  |
| Electronic Materials | HASE Muneaki                | Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical devise and controlling phase transitions                                                                                   |
|                      | YANAGIHARA Hideto           | Thin film growth of advanced magnetic oxides for spintronics devices                                                                                                                                                                                  |
|                      | OKADA Susumu                | Using the first-principles techniques based on the quantum mechanics, we study physical and chemical properties of nanoscale materials, ranging from the semiconductor to biomaterials.                                                               |
|                      | OHNO Yuzo                   | Studies of electronic, optical, and spin properties of semiconductor nanostructures, and spin coherence for quantum information and low-power devices.                                                                                                |
|                      | TOKURA Yasuhiro             | Theory of quantum transport in nano-structures made of various semiconductors. Non-equilibrium dynamics and quantum coherence in compound quantum system and possible application to quantum computations.                                            |
|                      | TOKORO Hiroko               | Development of novel materials with advanced light-                                                                                                                                                                                                   |

| Field of Research | Faculty                    | Detailed Description of Research Field                                                                                                                                                                                                                                                                     |
|-------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |                            | responsive functionalities, accompanying changes of optical, magnetic, and electric properties. Metal complexes and metal oxides are the main target materials                                                                                                                                             |
|                   | TAKEUCHI Osamu             | Development of new microscopy techniques by combining nanometer-resolving scanning probe microscopy and optical measurement techniques, in order to reveal nanometer-scale optoelectronic processes in solar cells, light emitting diodes, and spintronics devices and to improve their device performance |
|                   | FUJIOKA Jun                | Research on electronic, optical and thermal property in strongly correlated electron material and topological quantum material. Searching new quantum phenomena and functions by using state-of the art material synthesis technique, spectroscopy and fundamental characterization.                       |
|                   | YUASA Shinji               | Research and development of magnetic tunnel junctions, magnetoresistive random access memory MRAM and other spintronic devices.                                                                                                                                                                            |
|                   | KATAURA Hiromichi          | We have realized precise structure sorting of single-wall carbon nanotubes. By using the structure controlled nanotubes, we will clarify physical properties of nanotubes and will develop new electronic devices.                                                                                         |
|                   | TAKANO Yoshihiko<br>(NIMS) | We are focusing on the physical properties of high-T <sub>c</sub> superconductor, diamond superconductor, Fe-based superconductor and carbon nanotube. Development of novel devices, including optical and field effect devices, using superconductors and nano-technologies are targets.                  |
|                   | MITANI Seiji<br>(NIMS)     | Development of magnetic materials and nanostructures by Atomic scale control based on state-of-the-art thin film growth techniques. Searching and understanding new functionalities in spin transport and their application to Spintronic devices.                                                         |

(Note)

- ◆ Applicants should have a thorough discussion with a professor of their research field about your research plan in advance.

Inquiries about the entrance examination should be sent to:

Prof. Junji Nakamura, Chair, Doctoral Program in International Materials Innovation

Telephone: 81-29-853-5279

Prof. Yohei Yamamoto, Member of the Academic Committee,

Doctoral Program in International Materials Innovation

Telephone: 81-29-853-5030

(AIST) = The National Institute of Advanced Industrial Science and Technology

(NIMS) = The National Institute for Materials Science