

# Faculty Members, Graduate School of Pure and Applied Sciences - Master's Programs -

## Master's Program in Mathematics

| Field of Research          | Faculty   | Detailed Description of Research Field  |
|----------------------------|---|---|
| A l g e b r a              | AKIYAMA Shigeki<br>CARNAHAN Scott<br><br>SAGAKI Daisuke<br><br>FUJITA Hisaaki<br><br>MASUOKA Akira<br>[KIMURA Ken-ichiro]<br>[HOSHINO Mitsuo]<br>[MIKAWA Hiroshi] | Number theory, Ergodic theory, Self-similar structure<br>Moonshine, Automorphic forms, Algebraic geometry,<br>Vertex algebras<br>Representation theory of Lie algebras and quantum<br>groups<br>Non-commutative Noetherian ring theory, Structure of<br>orders<br>Hopf algebra, Quantum group<br>Algebraic cycles, Motives<br>Representatio theory of algebras<br>Prime number theory         |
| G e o m e t r y            | INOUCHI Jun-ichi<br>*(KATO Hisao)<br>KAWAMURA Kazuhiro<br>TASAKI Hiroyuki<br><br>HIRAYAMA Michihiro<br>[AIYAMA Reiko]<br>[ISHII Atsushi]<br>[NAGANO Koichi]       | Differential geometry (Integrable systems)<br>Geometric topology, Topological dynamics<br>Geometric topology<br>Differential geometry, Integral geometry and their<br>applications<br>Dynamical systems, Ergodic theory<br>Differential geometry, Submanifolds theory<br>Low dimensional topology, Knot theory<br>Global Riemannian geometry, Geometry of metric<br>spaces                    |
| A n a l y s i s            | KAKEHI Tomoyuki<br><br>TAKEUCHI Kiyoshi<br><br>KINOSHITA Tamotsu<br>TAKEYAMA Yoshihiro<br><br>LIANG Song<br>[KUBO Takayuki]                                       | Global analysis, Differential equations on symmetric<br>spaces<br>Algebraic analysis and its applications to singularity<br>theory<br>Weakly hyperbolic equation, Microlocal analysis<br>Mathematical physics, Quantum integrable system,<br>Difference equation<br>Probability, Stochastic calculus<br>Mathematical analysis of nonlinear partial differential<br>equation in fluid dynamics |
| Mathematics of Information | AOSHIMA Makoto<br><br>TSUBOI Akito<br>KOIKE Ken-ichi<br>SHIOYA Masahiro<br>YATA Kazuyoshi   | Statistical science, High-dimensional statistical<br>analysis, Bigdata analysis, Asymptotic theory<br>Mathematical logic, Model theory, Stability theory<br>Statistical sequential estimation<br>Axiomatic set theory<br>Multivariate analysis, Sequential analysis,  |

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|                      |   | High-dimension low-sample-size data analysis,<br>Asymptotic theory  |
| Mathematical Science | MORITA Jun<br><br>*(SAKAI Ko)<br>TERUI Akira<br>*([NISHIMURA Hirokazu]) | Algebraic groups, Lie algebras and aperiodic structures<br>Theoretical computer science, Applied algebra<br>Computer algebra, Symbolic-numeric computation<br>Synthetic differential geometry, Mathematical physics |

(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. Hisao Kato, Chair, Master's Program in Mathematics

Email: hkato#@#math.tsukuba.ac.jp (Remove “#” before sending an email)

Telephone: 81-29-853-4009

Website of Mathematics major: <http://nc.math.tsukuba.ac.jp>

## Master's Program in Physics

| Field of Research |             | Faculty   | Detailed Description of Research Field   |
|-------------------|-------------|---|--|
| Particle physics  | Theory      | ISHIBASHI Nobuyuki<br>KANAYA Kazuyuki<br>KURAMASHI Yoshinobu<br>ISHIZUKA Naruhito<br>TANIGUCHI Yusuke<br>YAMAZAKI Takeshi<br>YOSHIE Tomoteru<br>[SATO Yuji]<br>[MOHRI Kenji]<br>[ISHIKI Goro] | (1) Research on nonperturbative aspects of elementary particle physics by numerical simulation based on lattice field theory (QCD, physics beyond the standard model including string theory)<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>[OKAWA Hideki]<br>[IIDA Takashi]<br>[YOSHIDA Takuo]<br>[IKEGAMI Yoichi]  | (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) Development of new particle detectors for the LHC accelerator upgrade, future linear electron-positron collider experiments, and cosmic neutrino background decay searches |
| Astrophysics      | Theory      | UMEMURA Masayuki<br>MORI Masao<br>[YOSHIKAWA Kohji]   | (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 Massive Black Holes<br>(5) Evolution of Stars and Planetary Systems<br>Theoretical researches on these issues by using simulations with supercomputers and by analytic methodology.  |
|                   | Observation | KUNO Nario<br>[NITTA Tom]<br>[WATANABE Yoshimasa]   | 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<br>[HASHIMOTO Yukio]   | (1) Theoretical researches on quantum many-body problems for nuclear structure and reaction, including microscopic theories for collective motion and correlated phenomena, nuclear reaction for element synthesis in the universe, etc.<br>(2) Computational approaches to interaction between ultra-short laser pulse and material.  |

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|                          | Experiment | OZAWA Akira<br>MIAKE Yasuo<br>ESUMI Shinichi<br>SASA Kimikazu<br>[CHUJO Tatsuya]<br>[MORIGUCHI Tetsuaki]<br>[SUZUKI Shinji]<br>[BUSCH Oliver]<br>[SAKAI Shingo]<br>[SAKO Hiroyuki]<br>[OZAWA Kyoichiro]<br>[YAMAGUCHI Takayuki] | (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>ONO Tomoya<br>TANIGUCHI Nobuhiko<br>[YOSHIDA Kyo]   | (1) Nanoscale material sciences(Okada): 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, Yoshida): 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): 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) Surface and interface physics (Ono): Development of first-principles calculation methods. Analysis and design of interfaces for novel devices using first-principles calculation and super computers. Systematization of computational material and device design technique.<br>(5) Nano Quantum Physics (Taniguchi): Quantum properties and quantum transport phenomena in semiconductor nanostructures; Quantum field theories of nonequilibrium steady states; Quantum field theories of low dimensional systems, random |

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|                   |            | <p>systems or chaotic systems.</p>   |
|                   | Experiment | <p>KANDA Akinobu<br/> NISHIBORI Eiji<br/> MORITOMO Yutaka<br/> IKEZAWA Michio<br/> ONODA Masashige<br/> NOMURA Shintaro<br/> [HIGASHIYAMA Kazuyuki]<br/> [KUBO Atsushi]<br/> [KOBAYASHI Wataru]<br/> [TOMIMOTO Shinichi]<br/> [MORISHITA Masashi]<br/> [KASAI Hidetaka]<br/> [NIWA Hideharu]<br/> [Hathwar, Venkatesha Rama]</p> <p>(1) Magnetism and Materials Science (Onoda):<br/> 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):<br/> Mesoscopic quantum electron transport in nanostructures: novel transport phenomena in graphene and other 2D materials, low dimensional superconductivity and vortices in high-Tc layered superconductors. Low dimensional quantum properties in quantum fluids and quantum solids.</p> <p>(3) Energy materials science (Y. Moritomo, W. Kobayashi, H. Niwa, and H.Higashiyama)<br/> Research of the energy materials and devices, such as, sodium-ion secondary battery, organic 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, Hathwar):<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.</p> <p>(5) Nanophotonics (Ikezawa, Kubo, Tomimoto):<br/> [Semiconductor Optics] We investigate optical properties, spin characteristics and quantum optics in low dimensional semiconductor nanostructures such as quantum wells, quantum dots and defects using various spectroscopy, including femto/pico-second laser spectroscopy.<br/> [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.</p> |

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|                   |            |  | <p>Developments of novel ultrafast time-resolved microscopy methods.</p> <p>(6) Optical nanoscience(Nomura): Studies on optical and spin properties of semiconductor nanostructures by advanced optical techniques. Properties of electron systems such as in heterostructures, atomic layered compounds, and topological materials.</p>   |
| Biophysics        | Theory     | SHIGETA Yasuteru<br>[SHOJI Mitsuo]   | 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.  |
| Plasma            | Experiment | SAKAMOTO Mizuki<br>*(NAKASHIMA Yousuke)<br>KARIYA Tsuyoshi<br>MINAMI Ryutaro<br>YOSHIKAWA Masayuki<br>[KOHAGURA Junko]<br>[HIRATA Mafumi]<br>[NUMAKURA Tomoharu]<br>[IKEZOE Ryuya] | <p>(1) Study on plasma transport and confinement by magnetic and electric fields, and divertor simulation study using a tandem mirror device.</p> <p>(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.</p> <p>(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.</p> <p>(4) Theoretical analysis and computer simulation related to above experiments and its application to astrophysics.</p> <p>(5) Study on plasma-wall interaction.</p> |

◇ **Materials Science and Engineering Course**

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For details regarding this course, see here: [http://www.nims.go.jp/graduate/index\\_en.html](http://www.nims.go.jp/graduate/index_en.html)

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|-------------------|--------------------|--|
| Materials 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.   |
|                   | 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 properties 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.  |

**【Cooperative Graduate School System】**

| Field of Research                  | Faculty                      | Detailed Description of Research Field  |
|------------------------------------|------------------------------|---|
| Advanced Interdisciplinary Physics | MARUYAMA Toshiki<br>(JAEA)   | Simulation researches on dynamics of quark and hadrons (Maruyama)   |
|                                    | MIYAMOTO Yoshiyuki<br>(AIST) | Condensed matter physics: Ultra-fast phenomena by electron excitations (Miyamoto)   |
|                                    | NISHIMURA Shunji<br>(RIKEN)  | Study of nuclear astrophysics using new accelerator and new experimental techniques (Nuclear Structure, Nuclear Cosmology, Neutron-Rich Nuclei) (Nishimura) |
| Nuclear Fusion and Plasma Physics  | IDE Shunsuke                 | (1) Study on plasma heating system for a large nuclear fusion device.   |
|                                    | SAKAMOTO Keishi              | (2) Study on core-boundary plasma physics for a large nuclear fusion device.  |

| Field of Research          | Faculty                        | Detailed Description of Research Field   |
|----------------------------|--------------------------------|--|
|                            | NAKANO Tomohide<br>( Q S T )   | (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.   |
|                            | GOTOH Hideki<br>( N T T )      | Characterization of optical properties in semiconductor nanostructures with high-energy-resolution laser system and high-spatial-resolution spectroscopy. Exploration new physics on electron, exciton and spin properties and those applications to quantum devices and novel functional devices. |
|                            | 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.   |
|                            | YOKOO Atsushi<br>( N T T )     | Photonic nanostructure fabrication and its application. Development of photonic crystal devices by surface modification or installing functional material. Study of influence of photonic nanostructure on material property for new device proposal.  |

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(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. Yutaka Moritomo, Chair, Master's Program in Physics

Email: moritomo.yutaka.gf##@#u.tsukuba.ac.jp (Remove “#” before sending an email)

telephone: 81-29-853-4277

Website of Physics major: <http://www.px.tsukuba.ac.jp/senkou/>

- (2) Even though you passing the examination, the filed of research of your choice might not the one you choose. A notification regarding the field of research you pass will be sent from Physics major followed by the university sending the letter of acceptance.

(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

(NEC) = NEC Corporation Tsukuba Research Laboratories

(NTT) = NTT Basic Research Laboratories

## Master's Program in Chemistry

| Field of Research                  | Faculty            | Detailed Description of Research Field  |
|------------------------------------|--------------------|---|
| Inorganic and Analytical Chemistry | *(OSHIO Hiroki)    | Chemistry of functional metal complexes with controlled electronic states and structures.   |
|                                    | KOJIMA Takahiko    | Bioinspired redox chemistry of metal complexes; Supramolecular redox chemistry of non-planar porphyrins.  |
|                                    | SUEKI Keisuke      | Studies of environmental long-lives radioisotopes and radioactive substances released from the Fukushima Daiichi Nuclear Power Plant accident.  |
|                                    | NAKATANI Kiyoharu  | Studies on chemical processes at microdroplet/solution and microparticle/solution interfaces using electrochemical and spectroscopic techniques.  |
| Physical Chemistry                 | SAITO Kazuya       | Structure and property of soft molecular systems, and dynamics and phase transitions in them.   |
|                                    | MORIHASHI Kenji    | Computational quantum chemistry: Applications of density functional theory (DFT) to the molecular properties and reactivities of radical compounds. Development of DFT calculation method including solvent effect.             |
|                                    | ISHIBASHI Taka-aki | Studies on interfaces and condensed phases by linear and nonlinear molecular spectroscopy.  |
|                                    | SATO Tomoo         | 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. |
|                                    | ICHIKAWA Junji     | Studies on acceleration and control of synthetic organic reactions. Development of synthetic reactions using organofluorine and organometallic compounds.   |
|                                    | ICHINOHE Masaaki   | Main Group Element Chemistry. Synthesis, Structure, and Properties of Low-coordination and Multiple Bonded Compounds of Heavier Group 14 Elements.  |
| Interdisciplinary Chemistry        | YAMAMOTO Yasuhiko  | Investigation of architecture of metalloprotein and metalloenzyme structures; Nuclear magnetic resonance spectroscopy of paramagnetic metal complexes.  |

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|------------------------------------|-------------------|--|
| Nanomaterials<br>C h e m i s t r y | 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.                  |
|                                    | NAITO Masanobu    | Studies on adhesive and coating materials for aircraft, automobile, ship, and infrastructures. By using state-of-the-art surface analysis technique, polymerization method, and process techniques, we develop novel, high performance adhesive and coating materials. |

**【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<br>S c i e n c e | NAGASE Hiroshi | 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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Inquiries about the entrance examination should be sent to:

Prof. Yasuhiko Yamamoto, Chair, Master's Program in Chemistry/

Prof. Takahiko Kojima, Member of the Academic Committee Master's Program in Chemistry

telephone: 81-29-853-6505・4310

Website of Chemistry major: <http://www.pas.tsukuba.ac.jp>

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



| Field of Research                                | Faculty  | Detailed Description of Research Field  |
|--|--|---|
|  |  | from accelerators   |
| Nano-Technology                                  | SHIGEKAWA Hidemi<br><br>HASE Muneaki<br><br>UMEDA Takahide<br><br>TAKEUCHI Osamu<br><br>MAKIMURA Tetsuya | (12) Our research target is to understand and develop 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<br>(13) Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical device and controlling phase transitions<br>(14) Electron-spin-resonance (ESR)-based characterization on nano-electronics devices and power-electronics devices<br>(15) 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<br>(16) Nano- and Micro-machining and materials synthesis using laser produced plasma EUV light and laser light |
| Semiconductor Electronics<br>(Power Electronics) | UEDONO Akira<br><br>SANO Nobuyuki<br><br>SUEMASU Takashi<br><br>HASUNUMA Ryu                             | (17) Study of defects in electronic materials using a positron (antile particle of electron), and design/development of new positron annihilation technique<br>(18) Simulation and theoretical studies of Electron transport phenomena under nanoscale semiconductor structures, and device modeling and simulation of device characteristics<br>(19) High-efficiency Si-based solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements<br>(20) Development of highly reliable gate dielectric films on Si and SiC substrates.  |

| Field of Research                                      | Faculty  | Detailed Description of Research Field  |
|--|--|---|
|  | TOKO Kaoru   | (21) Thin film synthesis technology and device application of highly functional materials to create new energy semiconductor electronics.   |
| Optoelectronics and Spintronics<br>(Power Electronics) | OHNO Yuzo<br><br>SAKURAI Takeaki<br><br>YANAGIHARA Hideto  | (22) Studies of electronic, optical, and spin properties of semiconductor nanostructures, and spin coherence for quantum information and low-power devices.<br>(23) Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices.<br>(24) Thin film growth of advanced magnetic oxides for spintronics devices   |
| Power Electronics                                      | IWAMURO Noriyuki<br><br>ISOBE Takanori<br><br>YANO Hiroshi | (25) Research on improvement of power semiconductor devices characteristics for achieving a low loss and high withstand capability<br>(26) Study on circuit topologies and control for efficiency and power density improvement in power converters, and its emerging applications<br>(27) 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. |

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|--|---------------|--|
| Optoelectronic<br>Nanomaterials<br>Engineering | SAKURAI Kenji | X-ray spectrometry and imaging. Novel X-ray analytical metrology to see changes of nano-meterscale structures and chemical states in realtime. |

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|-------------------|-------------------|---|
|                   | 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.   |
|                   | 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.   |
|                   | 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.   |
|                   | 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.  |
|                   | 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.  |



【Cooperative Graduate School System】

| Field of Research               | Faculty   | Detailed Description of Research Field  |
|---------------------------------|---|---|
| Semiconductor Electronics       | [YAMASAKI Satoshi]<br>(AIST)  | (28) Diamond growth, and electronic device fabrication using unique properties.   |
| Optoelectronics and Spintronics | YUASA Shinji<br>(AIST)  | (29) 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) | (30) Research and Development on widegap semiconductors such as SiC and GaN, and their electronics application.<br><br>(31) R&Ds of packaging and power circuit technologies for making the full potential use of wide bandgap semiconductor power devices such as SiC.<br><br>(32) 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)

- ◆ 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. Masahiro SASAKI, Chair, Master's Program in Applied Physics  
telephone: 81-29-853-4966

For more information, please refer to the following websites:

Website of the Graduate School of Pure and Applied Sciences: <http://www.pas.tsukuba.ac.jp/>  
Website of Applied Physics major: <http://www.bk.tsukuba.ac.jp/>

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

## Master's Program in Materials Science

| Field of Research              | Faculty           | Detailed Description of Research Field   |
|--------------------------------|-------------------|--|
| Quantum Physics 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 Kiyota  | (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.  |
|                                | *(IKEDA Hiroshi)  | (3) Development of oxide regenerator materials, high $J_c$ of oxide high temperature superconductor, Improvement and application of superconducting gravimeter   |
|                                | 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 Physics    | 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: ultrafast phenomena in ultrashort-pulse driven semiconductors, coherent phonon generation, Floquet topological insulators, exciton dynamics, photo-induced phase transitions.   |
|                                | KOIZUMI Hiroyasu  | (8) Theoretical study of high temperature superconductor in strongly-correlated system and its application to quantum computers  |
|                                | SUZUKI Shugo      | (9) First-principles study of structural and electronic properties of materials  |

| Field of Research                     | Faculty           | Detailed Description of Research Field   |
|---------------------------------------|-------------------|--|
|                                       | 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 and electron microscopy of next-generation metallic nanowires, heat resistance materials for aircrafts and engines, photovoltaic power generation and light emitting nanodevices, and single molecular devices.       |
|                                       | KIM Hee Young     | (12) Development and characterization of novel functional alloys and biomaterials including biomedical superelastic alloy, high temperature shape memory alloy and gum metal   |
|                                       | KOYANO Tamotsu    | (13) 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  | (14) Development of new inorganic materials for energy and environmental applications such as solar cells and environmental purification filters   |
|                                       | TANIMOTO Hisanori | (15) Research on characteristic properties and application of nanostructured materials such as nanocrystalline metals, amorphous alloys and metallic nanoparticles   |
|                                       | TOKORO Hiroko     | (16) 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                 |
| Materials Chemistry and Biotechnology | KANBARA Takaki    | (17) Development and characterization of novel functional polymers and organometallic compounds directed toward organic devices and catalysts  |
|                                       | KIJIMA Masashi    | (18) Development of highly functional materials based on conjugated polymers, biomass, and carbon.   |
|                                       | SUZUKI Hiroaki    | (19) Development of electrochemical and photonic biosensing devices, microfluidic devices, and micro/nanomotors  |

| Field of Research | Faculty                     | Detailed Description of Research Field   |
|-------------------|-----------------------------|--|
|                   | 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<br>(AIST) | (22) Development and characterization of heterogeneous catalysts for biomass conversion, environment, and energy.  |
|                   | KOBAYASHI Masami            | (23) Photosynthesis (pigment analysis). Photodynamic Therapy by Chlorophylls. Algae and algal oil.   |
|                   | GOTO Hiromasa               | (24) Synthesis and properties of low-molecular mass compounds and polymeric materials having magnetism, electrical conductivity, photo-isomerization, optical rotation, and circular dichroism   |
|                   | KONDO Takahiro              | (25) A substitute material of Pt at the Fuel Cell electrode using nitrogen-doped carbon, two-dimensional material of boron and reaction dynamics at surface based on the fundamental surface science and fine experimental measurements. |
|                   | CHOI Jun-Chul<br>(AIST)     | (26) We aim at the development of high efficiency catalyst for green synthetic processes and material design of highly dispersed metal catalyst.   |
|                   | TSUJIMURA Seiya             | (27) Electrochemistry of redox enzymes and its application to biosensors and biofuel cells   |
|                   | YAMAMOTO Yohei              | (28) Self-assembly of $\pi$ -conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.   |

◇ **Materials Science and Engineering Course**

Materials Science and Engineering Course is designed as a Master's course jointly operated by National Institute for Materials Science and Graduate School of Pure and Applied Sciences, corresponding to Doctoral Program in Materials Science and Engineering. Applicants who wish to apply this course should contact the expected supervisor of your choice prior to the application.

For details regarding this course, see here: [http://www.nims.go.jp/graduate/index\\_en.html](http://www.nims.go.jp/graduate/index_en.html)

| Field of Research          | Faculty          | Detailed Description of Research Field   |
|----------------------------|------------------|--|
| Nanostructural Engineering | SASAKI Takayoshi | Studies on novel two-dimensional nanosheets as a graphene analogue and their organization into artificial systems for state-of-the-art applications in electronics and environmental/energy technologies, i.e., the developments of new capacitor materials, catalysts, energy storage devices showing unprecedented performance |
|                            | CHEN Guoping     | Development of porous and hybrid scaffolds of biodegradable polymers, biomimetic extracellular matrices, nano- and micro-patterned surfaces and bio-functional nanoparticles for tissue engineering and stem cell function manipulation  |
|                            | 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 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.                                 |
|                            | 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.  |

| Field of Research | Faculty         | Detailed Description of Research Field  |
|-------------------|-----------------|---|
|                   | 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.  |
|                   | 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. |

**【Cooperative Graduate School System】**

| Field of Research                     | Faculty                     | Detailed Description of Research Field   |
|---------------------------------------|-----------------------------|--|
| Materials Physics and Engineering     | KATAURA Hiromichi<br>(AIST) | 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. |
| Materials Chemistry and Biotechnology | 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.                                    |

(Note)

- ◆ Those marked with \* will be retired by March 31, 2019. Applicants who wish to do research under their supervision should consult the faculty adequately prior to the application.
- ◆ 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. Ken-ichi Hino, Chair, Master's Program in Materials Science  
Telephone: 81-29-853-4994

Prof. Masashi Kijima, Member of the Academic Committee, Master's Program in Materials Science

Telephone: 81-29-853-5295

Related Websites

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

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