

# Degree Programs in Pure and Applied Sciences

## Graduate School of Science and Technology

### Master's 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
	[KANEKO Hajime]	Analytic number theory, uniform distribution theory and transcendental number theory
G e o m e t r y	INOUCHI Jun-ichi	Integrable systems
	ONO Hajime	Differential geometry, Canonical Kähler metrics, Canonical Sasaki metrics
	KAWAMURA Kazuhiro	Geometric topology
	ISHII Atsushi	Low dimensional topology, Knot theory
	TASAKI Hiroyuki	Differential geometry, Integral geometry and their applications
	TANGE Motoo	Low dimensional topology, 3, 4-manifold theory
	HIRAYAMA Michihiro	Dynamical systems, Ergodic theory
	[AIYAMA Reiko]	Differential geometry, Submanifolds 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
	TAKEYAMA Yoshihiro	Mathematical physics, Solvable models, Special functions
	HAMANA Yuji	Theory of stochastic processes, Stochastic analysis

Field of Research	Faculty	Detailed Description of Research Field
	KINOSHITA Tamotsu	Weakly hyperbolic equation, Microlocal analysis
	FUKUSHIMA Ryoki	Probability theory, Random media, Large derivation, Homogenization
	[KUWABARA Toshiro]	Representation theory, Microlocal analysis
Mathematics of Information	AOSHIMA Makoto	Statistical science, Large complex data, High-dimensional statistical analysis, Asymptotic theory
	OIKAWA Issei	Numerical analysis, Finite element methods, Discontinuous Galerkin methods
	SHIOYA Masahiro	Axiomatic set theory
	TERUI Akira	Computer algebra, Symbolic-numeric computation
	YATA Kazuyoshi	Multivariate analysis, Sequential analysis, High-dimension low-sample-size data analysis, Asymptotic theory
	[OHYAUCHI Nao]	Bayesian statistical estimation
	[TAKEUCHI Kota]	Mathematical logic, model theory

(Note)

- ◆ 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. Jun-ichi Inoguchi, Chair, Master's Program in Mathematics

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

Telephone: 81-29-853-4392

Website of Master's Program in Mathematics: <https://nc.math.tsukuba.ac.jp>

## Master's Program in Physics

Field of Research		Faculty	Detailed Description of Research Field
Particle physics	Theory	ISHIBASHI Nobuyuki KURAMASHI Yoshinobu ISHIKI Goro ISHIZUKA Naruhito TANIGUCHI Yusuke YAMAZAKI Takeshi YOSHIE Tomoteru [MOHRI Kenji] [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) (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 HARA Kazuhiko TAKEUCHI Yuji [SATO Koji] [IIDA Takashi] [HIROSE Shigeki]	(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) (2) Searches for neutrino decays and the determination of their masses using the cosmic neutrino background. (3) Development of new particle detectors for the LHC accelerator luminosity upgrade, linear electron-positron colliders, and other future experiments.
Astrophysics	Theory	UMEMURA Masayuki OHSUGA Ken MORI Masao YAJIMA Hidenobu [YOSHIKAWA Kohji] [WAGNER Alexander]	(1) Formation of Cosmic Structure and Observational Cosmology (2) Formation of the First Generation Objects (3) Formation and Evolution of Galaxies (4) Formation of Black Holes (5) Evolution of Planetary Systems and Astrobiology Theoretical researches on these issues by using simulations with supercomputers and by analytic methodology.
	Observation	KUNO Nario [NITTA Tom] [HASHIMOTO Takuya]	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 YABANA Kazuhiro [HASHIMOTO Yukio] [HINOHARA Nobuo]	(1) Theoretical researches on quantum many-body systems with the strong interaction, such as microscopic structure of unstable nuclei and neutron stars, nuclear reaction for element synthesis in the universe, etc. (2) Computational approaches to interaction between

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			ultra-short laser pulse and material.
	Experiment	OZAWA Akira ESUMI Shinichi SASA Kimikazu [CHUJO Tatsuya] [MORIGUCHI Tetsuaki] [NONAKA Toshihiro] [NIIDA Takafumi]	(1) Experimental Study of Nuclear physics using relativistic heavy ion collider (Quark Gluon Plasma, Big Bang Cosmology, Reaction mechanism of high energy nuclear collision) (2) Evolution of Nucleosynthesis using RI beam (Nucleosynthesis, Unstable nuclei, Precise mass spectroscopy of rare nuclei) (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 (4) R&D of new experimental devices (Accelerator, detector, new application of accelerator beam)
Condensed matter physics	Theory	OKADA Susumu TOKURA Yasuhiro HATSUGAI Yasuhiro TANIGUCHI Nobuhiko [YOSHIDA Kyo] [YOSHIDA Tsuneya] [MIZOGUCHI Tomonari] [MARUYAMA Mina] [GAO Yanlin]	(1) Nanoscale material sciences(Okada,Maruyama,Gao): 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. (2) Quantum transport (Tokura,K. 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. (3) Quantum theory of matter (Y. Hatsugai, T. Yoshida,T.Mizoguchi): 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.) (4) 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

Field of Research		Faculty	Detailed Description of Research Field
			systems or chaotic systems.
	Experiment	KANDA Akinobu NISHIBORI Eiji MORITOMO Yutaka IKEZAWA Michio ONODA Masashige NOMURA Shintaro MORISHITA Masashi [HIGASHIYAMA Kazuyuki] [KUBO Atsushi] [KOBAYASHI Wataru] [TOMIMOTO Shinichi] [KASAI Hidetaka] [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 effects in graphene and other 2D materials, observation and manipulation of quantum states in mesoscopic 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 K. 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 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</p>

Field of Research		Faculty	Detailed Description of Research Field
			<p>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> <p>(6) Optical nanoscience (Nomura): Studies on optical and spin properties of semiconductor nanostructures by advanced optical techniques. Studies on quantum spin systems in diamond NV centers, electron systems such as in heterostructures, atomic layered compounds, and topological materials.</p>
Biophysics	Theory	SHIGETA Yasuteru [SHOJI Mitsuo] [HORI Yuta] [NISHIZAWA Hiroaki]	<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>
Plasma	Experiment	SAKAMOTO Mizuki KARIYA Tsuyoshi MINAMI Ryutaro YOSHIKAWA Masayuki [KOHAGURA Junko] [HIRATA Mafumi] [NUMAKURA Tomoharu] [HWANGBO Dogyun]	<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>

【Cooperative Graduate School System】

Field of Research	Faculty	Detailed Description of Research Field
Advanced Interdisciplinary Physics	MARUYAMA Toshiki (JAEA) MIYAMOTO Yoshiyuki (AIST) NISHIMURA Shunji (RIKEN)	Simulation researches on dynamics of quark and hadrons (Maruyama) Condensed matter physics: Ultra-fast phenomena by electron excitations (Miyamoto) 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  NAKANO Tomohide ( Q S T )	(1) Study on plasma heating system for a large nuclear fusion device. (2) Study on core-boundary plasma physics for a large nuclear fusion device. (3) Simulation study of a large nuclear fusion device.
Frontier Materials Science	YAMAMOTO Tsuyoshi ( N E C )	Research on superconducting quantum devices, such as qubits, low-noise amplifiers, and other peripheral devices for the application of quantum computation.
	YUGE Ryota ( 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 ( 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 ( N T T )	Research on ultra-compact and ultra-low power photonic devices and circuits, novel photonic phenomena in nanostructures.
	OGURI Katsuya ( N T T )	Research on ultrafast optical physics, in particular, attosecond physics. We are investigating lightwave-matter interaction dynamics on extreme short time scale by developing various attosecond time-resolved spectroscopic techniques.

(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.

(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. Fumihiko Ukegawa, Chair, Master's Program in Physics

Email: ukegawa#@#hep.px.tsukuba.ac.jp (Remove “#” before sending an email)

telephone: 81-29-853-4277

Website of Master's Program in Physics: <https://grad.physics.tsukuba.ac.jp/>

(2) Even though you passing the examination, the field 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

(NTT) = NTT Basic Research Laboratories



## Master's Program in Chemistry

Field of Research	Faculty	Detailed Description of Research Field
Inorganic and Analytical Chemistry	KOJIMA Takahiko [ISHIZUKA Tomoya] [KOTANI Hiroaki] [CHIBA Yusuke]	Synthesis of transition-metal complexes and their reactivity in various redox and catalytic reactions; supramolecular redox chemistry of non-planar and fused porphyrins.
	NAKATANI Kiyoharu [SAKAGUCHI Aya] [NAGATOMO Shigenori] [YAMASAKI Shinya] [MIYAGAWA Akihisa]	Studies on physical and chemical processes of microdroplet, microparticle, and biopolymer using spectroscopic and electrochemical techniques. Studies on naturally-occurring/anthropogenic radionuclides and radioactive substances in the environment.
	NIHEI Masayuki [SHIGA Takuya]	Chemistry of multi-nuclear metal clusters with controlled structures and electronic states; Creation of ultra-small metal/metal oxide nano-particles.
Physical Chemistry	SAITO Kazuya [YAMAMURA Yasuhisa] [HISHIDA Mafumi]	Structure and property of soft molecular systems, and dynamics and phase transitions in them.
	ISHIBASHI Taka-aki [SATO Tomoo] [NISHIMURA Yoshinobu] [MATSUI Toru] [KONDOH Masato] [NOJIMA Yuki]	Studies on interfaces and condensed phases by linear and nonlinear molecular spectroscopy (Ishibashi, Kondoh, Nojima); Synthesis of emissive compounds and kinetic analyses of formation and deactivation processes of the emissive state by TCSPC (Nishimura); Studies on photofunctions and photochemical properties of newly fabricated molecular assemblies and inorganic particles in mesoscopic scale (Sato); Material design and bio-molecular modeling based on computational chemistry (Matsui).
Organic Chemistry	ICHIKAWA Junji [FUCHIBE Kouhei] [FUJITA Takeshi] [NAKAMURA Takashi]	Studies on acceleration and control of synthetic organic reactions. Development of synthetic reactions using organofluorine and organometallic compounds.
	YOSHIDA Masahito [OHYOSHI Takayuki]	Isolation, structural elucidation, synthesis, and bioorganic studies of bioactive natural products. Design, synthesis and biological evaluation of novel biologically active molecules.

	<p><u><i>PROFESSOR</i></u>  <u>(To be appointed on Oct. 1<sup>st</sup>, 2020)</u>          [ICHINOHE Masatoshi]          [Lee Vladimir]          [MORISAKO Shogo]</p>	<p>Studies on synthesis of novel main-group-element compounds with unusual chemical bonds and elucidation of their chemical and physical properties. Redox-control of the properties of main-group-element compounds in pursuit of unique organic reactions utilizing main group elements.</p> <p>Low-coordination and multiple-bonded compounds of heavier group 14 elements and organoelement chemistry of Group 13-14.</p>
Interdisciplinary Chemistry	<p>IWASAKI Kenji          [MOMOTAKE Atsuya]          [MIYAZAKI Naoyuki]</p>	<p>Study of proteins in soft-tissue sarcoma, chromatin remodeling factors and a photosensing flavoprotein. Structural biology and chemistry using single-particle cryo-EM and its development. Development of molecular probes for second harmonic generation imaging.</p>

**【Cooperative Graduate School System】**

Field of Research	Faculty	Detailed Description of Research Field
Materials Inorganic Chemistry	AKIMOTO Junji ( 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).
Surface Electrochemistry	SATO Yukari ( 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 ( 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 ( 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).
Nano-Carbon Materials Chemistry	OKAZAKI Toshiya ( A I S T )	Synthesis of the functionalized nano-carbons and their spectroscopic characterizations.
Organometallic Chemistry	NAKAJIMA Yumiko ( 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.

Field of Research	Faculty	Detailed Description of Research Field
Photofunctional Materials Chemistry	NORIKANE Yasuo ( 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 ( 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
M e d i c i n a l C h e m i s t r y	KUTSUMURA Noriki	Design and synthesis of orexin receptor ligands regulating sleep/wakefulness, Synthesis of biologically active nitrogen-containing heterocycles, Studies on chemoselective reaction useful for drug discovery.

(Note)

- ◆ Applicants cannot choose faculty members in the parentheses “[ ]” 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, who intend to choose the underlined faculty member (to be appointed on Oct. 1st) as an academic supervisor, should contact prof. ISHIBASHI in advance.
- ◆ 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. Taka-aki Ishibashi, Chair, Master's Program in Chemistry/

Prof. Masayuki Nihei, Member of the Academic Committee Master's Program in Chemistry

telephone: 81-29-853-4011・4238

Website of Master's Program in Chemistry: <https://program.chem.tsukuba.ac.jp/?lang=en>

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

## Master's Program in Engineering Sciences Subprogram in Applied Physics

Field of Research	Faculty	Detailed Description of Research Field
Optical and Quantum Engineering	HATTORI Toshiaki	(1) Sensing using terahertz waves and terahertz spectroscopic study of bio-related materials
	YASUNO Yoshiaki	(2) Fundamental, instrumentation, application research on optical tomographic imaging for medical and lifescience applications. It includes optical coherence tomography and quantitative three-dimensional functional microscopy.
	HADA Masaki	(3) Femtosecond time-resolved electron diffraction measurements: filming “molecular movies” of photo-reactive or responsive materials
Instrumentation Physics	SASAKI Masahiro	(4) Observations and controls of surface/interface properties by using supersonic molecular/atomic beams, scanning probe microscopes and other spectroscopic and microscopic techniques
	SHIRAKI Kentaro	(5) Technology of protein folding and application of biomaterials
	FUJITA Jun-ichi	(6) 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	(7) 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	(8) Application of scanning electron microscope (SEM). Electron optics and measurement of electron beam. Enhancement of SEM system and proposal new system.
	ITO Yoshikazu	(9) Synthesis, characterizations and fabrications of 3D materials using graphene and two dimensional materials for developments of catalyts, device applications and energy havesting devices with renewable energy sources
	KOBAYASHI Nobuhiko	(10) Condensed matter theory. Computational materials science. Density functional theory for nonequilibrium systems. Theory of charge, heat and spin transport in nanoscale systems.
	TERADA Yasuhiko	(11) Developemnt of new imaging methods based on NMR and MRI

Field of Research	Faculty	Detailed Description of Research Field
	YAMADA Yoichi	(12) Surface and molecular sciences on the structure-property relationships of the self-organized organic semiconductors.
Quantum Beam and Plasma Engineering	EZUMI Naomichi	(13) 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	(14) Experimental studies on advanced atomic physics and atomospheric science using charged particle beams from accelerators
Nano-Technology	HASE Muneaki	(15) Ultrafast laser spectroscopy on semiconductors and dielectric materials using femtosecond laser and application to optical devise and controlling phase transitions
	UMEDA Takahide	(16) Electron-spin-resonance (ESR)-based characterization on nano-electronics devices and power-electronics devices
	TAKEUCHI Osamu	(17) 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	(18) Nano- and Micro-machining and materials synthesis using laser produced plasma EUV light and laser light.
	YOSHIDA Shoji	(19) 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.

Field of Research	Faculty	Detailed Description of Research Field
Semiconductor Electronics (Power Electronics)	UEDONO Akira	(20) Study of defects in electronic materials using a positron (antile particle of electron), and design/development of new positron annihilation technique
	SANO Nobuyuki	(21) Simulation and theoretical studies of Electron transport phenomena under nanoscale semiconductor structures, and device modeling and simulation of device characteristics
	SUEMASU Takashi	(22) High-efficiency Si-based tandem solar cells, thermoelectric devices, and spintronics materials using safe, stable, and abundant elements
	HASUNUMA Ryu	(23) Development of highly reliable gate dielectric films on Si and SiC substrates.
	TOKO Kaoru	(24) Research on materials and processes for highly functional thin films for flexible energy devices
	OKUMURA Hironori	(25) Crystal growth of wide bandgap semiconductors and development of their optical and electrical devices
Optoelectronics and Spintronics (Power Electronics)	OHNO Yuzo	(26) Studies of electronic, optical, and spin properties of semiconductor nanostructures, and spin coherence for quantum information and low-power devices.
	SAKURAI Takeaki	(27) Development of highly efficient organic and inorganic thin-film solar cells. Characterization of defects in power semiconductor devices.
	YANAGIHARA Hideto	(28) Thin film growth of advanced magnetic oxides for spintronics devices
Power Electronics	IWAMURO Noriyuki	(29) Research on improvement of power semiconductor devices characteristics for achieving a low loss and high withstand capability
	ISOBE Takanori	(30) Study on circuit topologies and control for efficiency and power density improvement in power converters, and its emerging applications
	YANO Hiroshi	(31) 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.

### (Materials Science and Engineering Class)

Materials Science and Engineering Class is designed as a Master's course jointly operated by National Institute for Materials Science and Degree Programs in Pure and Applied Sciences, corresponding to Doctoral Program in Engineering Sciences, Subprogram in Materials Science and Engineering.

For details regarding this class, see here: <https://www.nims.go.jp/tsukuba/en/>

Field of Research	Faculty	Detailed Description of Research Field
Optoelectronic Nanomaterials Engineering	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.
	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.
	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-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.
	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.

Field of Research	Faculty	Detailed Description of Research Field
	YAMAGUCHI Takahide	Research on fundamental electronic properties of diamond and device applications such as the fabrication of two-dimensional material/diamond heterostructures for high performance electronic devices.
	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.
	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.
	ISHII Satoshi	Studies on developing novel photonic nanostructures for extraordinary optical properties and photoelectric/photothermal conversions.



**【Cooperative Graduate School System】**

Field of Research	Faculty	Detailed Description of Research Field
Semiconductor Electronics	MAKINO Toshiharu (AIST)	(32)Diamond growth, and electronic device fabrication using unique properties.
Optoelectronics and Spintronics	YUASA Shinji (AIST)	(33)Research and development of magnetic tunnel junctions, magnetoresistive random access memory MRAM and other spintronic devices.
Surface Science	MIYAKE Koji (AIST)	(34)Surface functionalization by nano-/micro-structures and surface modifications.
Power Electronics	YAMAGUCHI Hiroshi (AIST)  KOJIMA Kazutoshi (AIST)	(35)R&Ds of packaging and power circuit technologies for making the full potential use of wide bandgap semiconductor power devices such as SiC.  (36)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.

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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. TOSHIAKI 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 Master's Program in Engineering Sciences Subprogram in Applied Physics:  
<https://applphys.bk.tsukuba.ac.jp/>

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

## Master's Program in Engineering Sciences Subprogram 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 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.
	JUNG Min-Cherl	(5) Understanding of defect, phonon-dispersion, and electronic structures in organic-inorganic hybrid perovskite materials and new applications such as THz-wave sensing, modulating, and imaging devices.
	TSUJIMOTO Manabu	(6) 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	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..
	KOIZUMI Hiroyasu	(8) Theoretical study of superconductivity in strongly-correlated materials and topological materials, and their application to fault-tolerant quantum computers.

Field of Research	Faculty	Detailed Description of Research Field
	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
	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

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)
	YAMAMOTO Yohei	(22) Self-assembly of $\pi$ -conjugated molecules, polymers, and biomolecules to construct electronic, optical, and energy conversion devices.
	OISHI Motoi	(23) Development and design of novel point of care testing (POCT) devices and nano-machines based on DNA nano-system.
	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

**(Materials Science and Engineering Class)**

Materials Science and Engineering Class is designed as a Master's course jointly operated by National Institute for Materials Science and Degree Programs in Pure and Applied Sciences, corresponding to Doctoral Program in Engineering Sciences, Subprogram in Materials Science and Engineering.

For details regarding this class, see here: <https://www.nims.go.jp/tsukuba/en/>

Field of Research	Faculty	Detailed Description of Research Field
Nanostructural Engineering	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.
	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	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
	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.
	HONO Kazuhiro	Nanostructure analysis of metallic materials by using state-of-the-art atom probe tomography and electron microscopy, and the development of advanced metallic materials including next-generation magnetic recording media, magnetic sensors, high-performance permanent magnets and lightweight alloys.
	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.

Field of Research	Faculty	Detailed Description of Research Field
	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.
	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.
	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.
	KAWAI Shigeki	Single molecular chemistry with high-resolution atomic force microscopy/scanning tunneling microscopy. Development of local probe chemistry. Functionalized nano-carbon materials synthesized by on-surface chemical reaction.
	SODEYAMA Keitaro	The working mechanism of energy-related materials such as lithium-ion batteries will be clarified by first-principles molecular dynamics simulations using a supercomputer. We also use the machine learning techniques to find new feasible materials with experimentalists.

【Cooperative Graduate School System】

Field of Research	Faculty	Detailed Description of Research Field
Materials Chemistry and Biotechnology	CHOI Jun-Chul (AIST)	We aim at the development of high efficiency catalyst for green synthetic processes and material design of highly dispersed metal catalyst.
	KURITA Ryoji (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)

- ◆ 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  $\left( \begin{array}{l} \text{http://www.pas.tsukuba.ac.jp/} \\ \text{http://www.ims.tsukuba.ac.jp/} \\ \text{http://www.tsukuba.ac.jp/} \end{array} \right)$

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

## Master's 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 : 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 : 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.
	SHIRAKI Kentaro	Technology of protein folding and application of biomaterials



Field of Research	Faculty	Detailed Description of Research Field
	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.
	TSUJIMURA Seiya	Electrochemistry of redox enzymes and its application to biosensors and biofuel cells
	TAKEUCHI Masayuki (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-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 optoelectronicprocesses in solar cells,

Field of Research	Faculty	Detailed Description of Research Field
		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.
	TAKANO Yoshihiko (NIMS)	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.
	MITANI Seiji (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, Master's Program in International Materials Innovation  
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Prof. Yohei Yamamoto, Member of the Academic Committee,  
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