RESEARCH 2021-2022



Research at Tokyo Tech

Research Structure

Since its founding in 1881, Tokyo Tech has stood at the front line of research as one of the world's leading universities in science and engineering. Building upon the Institute's long-standing philosophy of monotsukuri, or technical ingenuity and innovation, Tokyo Tech consistently produces high-impact research across numerous science and technology fields, including physics, chemistry, mechanical engineering, materials science, environmental engineering, and life sciences.

Three Crucial Engagements in Research

Creation of Innovative Science and Technology for Sustainable Development of Humanity

Contribution to Society Through **Deployment of** Wisdom

From President Masu

As a national designated university corporation engaging in the world's highest levels of education and research, Tokyo Tech seeks new potential in science and technology and aspires to pioneer a new era in discourse with society. Focusing on the work of our researchers, this pamphlet describes the progress of our institution in creating innovative science and technology; searching for truth and acquiring new knowledge; and deploying that knowledge in society. I would be pleased, if the reader gains a sense of the future from the many research efforts at Tokyo Tech, a lens from which new alliances between industry and academia could emerge. The diversity groomed in a university setting provides opportunities to conduct exciting and intriguing research under fast-paced decision-making and execution. As we challenge ourselves to pursue research that will contribute to society, I ask you to look forward to the research prowess at Tokyo Tech.



Search for Truth

and Acquisition of **New Wisdom**

Staff/Students

Faculty 1,529 (International:	% Internati 176) 11,5%	onal
Research Staff 287		
Administrative Staff 598 (Female: 268)	% Female 44,8%	
Students (Female: 1, 10,448 (Internation	695) % Fe al: 1,721) % Interna	emale: 16,2% tional: 16,4%

Bachelor's 4,922 (Female: 634) (International: 283) Master's 4052 (Female: 773) (International: 848) Doctoral 1,474 (Female: 288) (International: 590)

Awards

Nobel Prize Yoshinori Ohsumi, Honorary Professor, 2016 Nobel Prize in Physiology or Medicine "Elucidating the Molecular Mechanisms and Physiological Significance of Autophagy, a Cellular Adaptive System to Environment" Hideki Shirakawa, PhD, 2000 Nobel Prize in Chemistry "For the Discovery and Development of Conductive Polymers' Japan Prize Hideo Hosono, Honorary Professor, 2016 "Creation of Unconventional Inorganic Materials with Novel Electronic Functions based on Nano-Structure Engineering" Yasuharu Suematsu, Honorary Professor, 2014 "Pioneering Research on Semiconductor Lasers for High-Capacity Long-Distance Optical Fiber Communication" Publications % International Co-Authorships Total Top 1% 13,030 1/942.0% Industry Collaboration Patent Income Tokyo Tech Ventures

118 companies (As of August 2020)

Income/Expenses

50,38 billion yen

93 million yen(2019)

(Personnel data as of May 2020; Publications, Top 1%; 2015-2019, 5-year span, Web of Science International Co-Authorship; 2019, Web of Science; Income/Expenses; estimated for fiscal year 2020)

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Em	pathizing with	Silent Voices (EISI	ESiV)		
Sc	hools			(776)	
	Conducting	education and	d research		
	School of	Science			
	School of	Engineering			
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	Chemical	Technology	L		
	School of	Computing			
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	School of	Life Science	and Technolo	ogy	
	School of	Environment	t and Society	·	
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TOKYO TECH RESEARCH MAP 2021-2022



Reconstruction of inctions on comp Yasuharu Koike

Institute of Innovative Research

Exploiting big data to model socio- and econophysics

Misako Takayasu Institute of Innovative Research

osting lithium-ion batteries and fuel-cell efficiency

Shuichiro Hirai School of Engineering

Soft robots that exploit artificial muscles

Koichi Suzumori School of Engineering

water use and enviror

Chihiro Yoshimura School of Environment and Society

Control of large-scale mplex network systen and its applications

Jun-ichi Imura School of Engineering

unctional-continuit and cit nstand earth

> Shoichi Kishiki Institute of Innovative Research

Geometric analysis on minimal submanifold and mean curvature flow

Yoshihiro Tonegawa School of Science

School of Science

Quantum sensor technologies for ultra-precise inertial navigation

> Mikio Kozuma School of Science

Theory of planet formation and evolution

Shigeru Ida Earth-Life Science Institute

Emerging Researcher Profiles 2021-2022

Chemistry, Materials

Solar energy conversion using solid photocatalysts Kazuhiko Maeda School of Science



trolled conditions, we are creating an efficient photocatalyst that is active for desired reactions.

Conversion of carbon dioxide into chemicals on allovs oaki Takayama School of Science



Using nanoparticulate alloys consisting of metals and half-metals of the dor n-block elements as catalysts carbon dioxide is converted into useful chemicals under mild conditions utilizing renewable energy and waste thermal energy.

Signal-amplification sensing with smart chemosensors Gaku Fukuhara School of Science



We have so far proposed a new amplification sensing methodology defined as "supramolecular allosteric signal-amplification sensing (SASS)", nabling to sense various analytes that re difficult to discriminate in a complex

Rational nanospace design and its functions

Masahiro Yamashina School of Science



combining various chemical bonds and organic molecules. Recently, we have succeeded in constructing a caged molecule based on an anti-aromatic nolecule and elucidating its properties.

In the future, we will explore for undiscovered molecules and chemical reactions that can only be observed in the nanospace

Development of novel catalysts for low-temperature ammonia synthesis Masaaki Kitano Materials Research Center for Element Strateov

I am working to develop a novel

ammonia synthesis catalyst that can

at lower temperature and pressure

than existing industrial ammonia

work under much more mild conditions

synthesis processes, which require high

temperature and pressure. In particular,



am focusing on developing a novel catalyst material that utilizes abundant elements and uses as little precious metals as possible

Rotaxane-based supramolecular mechanophores Yoshimitsu Sagara School of Materials and Chemical Technology



Aromatic polymers and carbons

efficiently promoting various reactions.

School of Materials and Chemical Technology

performance solar cells and transistors.

technique and its application

Yu Kumagai Institute of Innovative Research

Development of materials informatics

the various characteristics of materials

along with its application. Also, through

machine learning based on acquired

big data, I am developing a technique

for quickly predicting characteristics,

and clarifying the origins of physical

Development of metal oxide catalysts for

elective oxidation, acid-base reaction, and biomass conversion.

selective chemical processes

High mobility semiconducting polymers

for catalysis

Tsuvoshi Michinobu

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properties.

We are working on the development of supramolecular mechanophores utilizing rotaxanes, which have been well investigated in supramolecular chemistry. The mechanophores can



Yuhei Hayamizu School of Materials and Chemical Technology We are researching new nanobiotechnology to connect biology and electronics. By using designed proteins with graphene. a promising new electronic material. we are developing new interfaces to convert biological information into

lectronic information in a controlled

Developments of sensors with

Development of new catalytic reactions by heterogeneous catalysts Yusuke Kita Institute of Innovative Research



Promotion of the use of renewable resources is required to build a sustainable society. Lam focusing on heterogeneous catalysts that synthesize high value-added compounds from non-edible biomass such as corn stalks that do not compete with food issues.

Microstructure control for improving



mechanical properties of metallic materials Nobuo Nakada School of Materials and Chemical Technology The characteristics of metallic materials can be dramatically improved by properly controlling their microstructure. In our group, we are researching the

relationship between the microstructure and mechanical properties, and optimal rmomechanical treatment processes aiming for creating ideal microstructures capable of innovatively improving the strength and toughness of metallic structural materials such as ferrous materials

Search for novel compounds focusing on anion



Takafumi Yamamoto Institute of Innovative Research By using anion as a parameter, I am synthesizing new solid state

Anion-engineering for novel electronic functional materials exploration Satoru Matsuishi Materials Research Center for Element Strategy



Focusing on "mixed-anion compounds" containing multiple types of anions and "electrides" in which electrons behave as anions, we are searching for novel functional materials such as superconductors, and electron onductors whose properties are changed by photo-irradiation.

properties, which cannot be accessed

by conventional solid state reaction

cusing on cation.



Functional materials based on

cyclic topology Daisuke Aoki School of Materials and Chemical Technology



new material design using cyclic molecules as a tool for developing functional materials

Redox chemistry for molecular conversion technology Shinsuke Inagi School of Materials and Chemical Technology



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Life Science and Technology

Exosome in disease etiology and detection

Ayuko Hoshino School of Life Science and Technology



Exosomes mediate cell-cell communication in physiology and disease. We aim to elucidate exosome driven disease pathology and develop novel treatments,

Elucidation of intestinal environment dynamics

Takuji Yamada School of Life Science and Technology



We have been engaged in elucidating the relationship between out microbiome and diseases based on community structure analysis of the bacteria that live in the human intestines. In addition, we also focus on the research for the dynamics of the microbial community structure during

the food fermentation process, data visualization of the netabolic pathway database, and a new analysis method.

Study on molecular mechanisms underlying autophagy

Hitoshi Nakatogawa School of Life Science and Technology



Autophagy, a major degradation system within cells, plays important roles in the maintenance and regulation of various biological/ functions, and its failure has been linked to different human diseases. We aim at clarifying mechanisms underlying autophagy at the

molecular level

Cell editing and cell design

Fumi Kano Institute of Innovative Research



I am creating a platform for editing and designing cells based on our two technologies: semi-intact cells system and cell-resealing technique for delivering molecules into cells. and image-based analytical method for creating the covariation network.

Nexus of nano, bio and electronics

Toshinori Fuile School of Life Science and Technology



Minimally invasive medicine is expected for human healthcare and biomedicine. Our group envisions the smart biodevice with integrated nano, bio, electronics.

technology using nanochemistry

- Takehiko Tsukahara Institute of Innovative Research We have developed a novel
 - environmentally-friendly chemical system which enables to separate/detect and recycle efficiency rare metal elements by means of functional nanomaterials, nanospaces, and nanosensing technologies. This system can realize
 - waste reduction, low environmental

- investigate the precision selfassembly of functional polymers. I have succeeded in controlling the self-assembly of π -conjugated
- oolymers by kinetic control, thereby
- Iding the nanofibers with controlled
- oths from nano to micrometer.

Degradable polymers via precision

- Tomohiro Kubo School of Materials and Chemical Technology
 - The development of on-demand
 - degradable plastics for a circular
 - economy is imperative as
 - environmental concerns loom large. I aim to construct a guiding principle
 - for degradable polymeric materials through unveiling novel synthetic strategies toward environmentally

Cyclic topologies are ubiquitous in a variety of chemical compounds and the compounds with cyclic topology exhibit unique functionality derived from their topology. In this research, based on the effective method for nthesizing cyclic molecules, we aim for establishment of a guideline for

Focusing on the features of bipolar electrochemistry such as wireless nature, gradient potential and reduced electrolyte, novel molecular conversion technology based on redox chemistry is developed to produce useful and

Emerging Researcher Profiles 2021-2022

Life Science and Technology

How energy organizes chemistry into life

Shawn McGlynn Earth-Life Science Institute



n biology, material (molecules) are rganized by energy flow. My lab works on multiple systems – from molecules n the lab to bot springs in the eld- with the goal of understanding v organization is governed by energy sfer reactions.

Driven to discover: Polymer-drugs equipped with smart functionality Yutaka Miura Institute of Innovative Research



Our areas of research features the development of polymer-drug discovery and biomaterials created through well-defined synthesis control of stereochemistry, and nanotechnology for medical applications such as drug delivery and

Engineering of *in cell* protein crystals

Satoshi Abe School of Life Science and Technology



I am focusing on protein crystallization reactions and am developing functional materials by complexation of various molecules and rapid structural analysis methods. In particular, I am pursuing the possibility biofunctional materials that overturn proventional wisdom by using protein crystal engineering in living cells.

Drug delivery systems for photodynamic therapy and neutron capture therapy titute of Innovative Research

Analysis of human metabolism for

Shunichiro Ogura School of Life Science and Technology

medical applications



Photodynamic therapy and neutron multiple and diffuse cancers. We develop light/neutron-responsive drug delivery systems to extend their plication

Humans maintain their health through

various metabolic processes. However,

if these metabolic processes become

abnormal, it can lead to disease. In our

metabolic processes are being studied

hemically in order to determine a

methodology for normalizing metabolic

laboratory, such abnormalities with

capture therapy have attracted recent attention as promising techniques for treating intractable diseases including

Hiroyuki Nabae School of Engineering

listurbance. We are working to create ew robotics that can resolve such ssues based on research into new actuators

Establishing groundbreaking robotics

through cutting-edge actuators

Surface reaction design in electrodes for carbon recycling Hirotatu Watanabe School of Engineering



Advanced laser diagnostics and reactive fluid engineering



Redox-based regulatory network for

Molecular design of thermoresponsive

aohiko Shimada School of Life Science and Technology

polymers for biomaterials

Development of innovative

surgical robot systems

biotechnology.

controlling plant functions

Masayasu Shimura School of Engineering



Turbulent reacting flow modeling with supercomputing and machine learning Yuki Minamoto School of Engineering



Mechanical Engineering, Civil Engineering, Architecture

Direct numerical simulations of turbulent reacting flows and investigation to obtain physical insights, Data-oriented (AI) physical modelling for non-linear phenomena based on large-scale numerical simulation database. Development of machine learning platform for

Mechanism design and control of robotic and mechanical systems Yusuke Sugahara School of Engineering



Based on the problem of consciousness i.e., "how to design, what kind of robot system to make the world better or living", I am pursuing the design and integration of various robots and nechanical systems. Specific research pics include: human-powered robotics able-driven parallel robots, locomotion

Systems and control theory for future energy management Takayuki Ishizaki School of Engineering



Based on the foundation of systems and control theory, we challenge surselves to advanced research tonics or future smart energy management. n particular, we focus on developing modular design theory for large-scale decentralized control systems.

Functional-continuity buildings and cities that withstand earthquakes Shoichi Kishiki Institute of Innovative Research



While working on further development of existing passively vibration control and seismic isolation technology. I am working to establish a technique for reducing damage to partitions,

door spaces in order to realize ctional and business continuity of buildings and cities via a monitoring system.

urban greening, and passive design. passive control and base-isolation systems. using big data and AI Takuya Oki School of Environment and Society cameras and aerial photographs, real estate property information, SNSs, people's flows, eve tracks, and so on, for urban environment flow fields with computer simulation. Design and maintain generation society.

Electrical and Electronic Engineering, Computer Science

World's fastest millimeter-wave transceiver

CMOS integrated circuits

Pursuing comfortable and healthy urban thermal environment Takashi Asawa School of Environment and Society



The research fields of our lab are urban nd built environmental engineering. inal goal of our research fields are alizing comfortable and healthy cities and buildings with less energy se. The research topics are urban note sensing, thermal environment

Design method of high-rise building against huge earthquakes and typhoons Daiki Sato Institute of Innovative Research



New approach to architectural planning



image processing, natural language processing, and spatiotemporal information processing methods ased on Al. The data include building nterior/exterior images from in-vehicle

Challenge to wind and snow related issues



We are investigating the mechanisms of wind oust at pedestrian space. pollutant dispersion snow drifting and other problems caused by wind and its related diffusion phenomena within built-up environments, and proposing termeasures with CFD (computational uid dynamics), which can predict the

the next generation infrastructure Nobuhiro Chiiiwa School of Environment and Society



I am developing a method for properly evaluating the performance of existing infrastructures and for selecting optimal maintenance methods, and developing innovative infrastructure materials, designs, and maintenance nethods through field fusion in order o realize a resilient and smart next-



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processes.

Kenichi Okada School of Engineering

I am working on research and development of millimeter-wave phased array transceivers for 5G and future wireless technologies through collaborative research with many companies. I am also studying terahertz and satellite communication and circuit design techniques using

Diamond quantum technologies

Takayuki lwasaki School of Engineering

Spin defects formed in diamond function as quantum sensors, and they are also expected to be used as solid-state quantum light sources for quantum network. I am proceeding with research on high-sensitivity magnetic and electric field sensors using NV nters, and studying new quantum light sources using Group IV elements.

Ultralow power spintronic devices

Nam Hai Pham School of Engineering

We develop novel materials such as topological insulators, topological half metals, and ferromagnetic semiconductors to realize ultralow power spintronic devices, including magnetoresistive random access memory, racetrack memory, and spir transistor

Terahertz electronics and applications

Safumi Suzuki School of Engineering

The terahertz frequency band is expected to be used for various purposes such as next-generation wireless communication. In our laboratory, we will open up the future of terahertz technology by researching extreme semiconductor devices capable of terahertz operation, giving them various functionality, and applying them to the various terahertz applications and actually showing the operations.

Semiconductor lasers and photonic circuits using heterogeneous integration technology Nobuhiko Nishiyama School of Engineering

sing semiconductor lasers and hotonic integrated circuits based on heterogeneous semiconductor ntegration and nanofabrication echnologies, we aim to realize ultra-high-capacity optical munication transceivers and nsors. We also focus on ultra-low

power photonic integrated circuits using semiconductor thin films to realize future photonic-electric convergence LSIs.

Periodic nanostructures opening a new field of photonics Tomohiro Amemiya Institute of Innovative Research





We are exploring the potential of "metamaterials" and "topological hotonics" for opening a new field of hotonics

High-efficiency solar cells and optical power converter for optical power transmission Shinsuke Miyajima School of Engineering



A production process of silicon solar cells without explosive and toxic gases are investigated for low-cost silicon solar cells. Hybrid tandem solar cell using silicon and a perovskite material and blue-light optical power converter for optical power transmission system re also our important topics.

Custom computing machine for deep learning applications

Hiroki Nakahara School of Engineering



Custom computing machine for deep learning applications

I am researching the development of high-speed hardware exclusively for machine learning and Al processing including deep learning along with its lications

Augmented reality using high speed vision and projection

Yoshihiro Watanabe School of Engineering



We explore the possibilities to invoke a new sense of reality based on the advanced technology centering on \rangle visual sensing and projection. The key is speed transcending the human capabilities. We believe the next reality is driven by the technological control of the unseen moment.

Computational neuroscience to understand neural mechanism of human motor control Hirovuki Kambara Institute of Innovative Research



To advance the knowledge about how our brain generates accurate and sophisticated motions. I am currently doing researches on the neural mechanisms underlying human motor control of a simple movement like eaching and a complex movement ike iuaalina

Emerging Researcher Profiles 2021-2022

Electrical and Electronic Engineering, Computer Science

Hardware accelerators for AI applications

Van Thiem Chu Institute of Innovative Research



Many Al applications have a high demand for computing performance and efficiency, which conventional deneral-purpose processors cannot rovide. My research aims to address this issue by developing novel domain specific hardware accelerators.

Artificial intelligence for understanding and generating human language Naoaki Okazaki School of Computing



Language is more than a communication tool. It is also a source for intellectual activities including thinking and logic. Incorporating linguistics, statistics, nachine learning, and recent deep earning, I am working to achieve

ligent computers that can speak puages to communicate with others. as we human beings do

Leverage math for sensing data processing and analysis Shunsuke Ono School of Computing



algorithms for extracting and analyzing valuable information from noisy and degraded sensing data by leveraging sparse modeling and mathematical optimization. In addition, we are tively engaged in the application of these algorithms to remote sensing and biomedical engineering.

We are developing signal processing

Vision augmentation by computation

Yuta Itoh School of Computing



between people and computers be in the future? Our aim is to extend the way people are in the computer society of the future. We thus research echnologies to calculate and interfere teraction between people and the eal world.

Biophysics on DNA nanotechnology and artificial cells

Masahiro Takinoue School of Computing



Living systems are autonomous. intelligent, non-equilibrium material systems that exhibit behaviors such as replication and evolution, which are not found in other material systems. In addition to constructing intelligent DNA nanodevices and molecular obots, and artificial cells inspired by these systems, we are also trying to understand their

Data-driven Intelligent Robotics

Singular solutions of nonlinear parabolic

partial differential equations

Mathematical optimization:

Makoto Yamashita School of Computing

numerical methods to various practical problems.

Cohomology in algebraic geometry

string theory, cryptography and data analysis.

research various mathematical

concepts of space, specifically,

Shane Kelly School of Science

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theory and applications



Mathematics, Physics, Earth and Planetary Sciences

Although the Standard Model representing the state-of-the-art of our understanding of particle nhysics is known to be incomplete. it is experimentally unbroken so far. Discovery of un-predicted new particles would unveil the mystery of the Standard Model, and I am propelling new particle searches using the LHC accelerator realizing scrutiny of

Exploration of new elementary particles

particle interactions at the ever highest energy scale.

Probing the fundamental laws of nature with elementary particles Yohei Yamaguchi School of Science



I am working to recreate the environment of the early universe using the world's highest energy LHC accelerator, and studying the nature of a vacuum filled with Higgs field. Elementary particles gained mass when the Higgs field symmetry was broken in the early universe. I am working to clarify the dynamics of the early universe by measuring the nature of the Higgs field.



Improvement of usability of Ultraviolet Time-domain Astronomy with **TSUBAME** supercomputer small satellites Yoichi Yatsu School of Science



Mathematical optimization provides

approaches for the optimal selection

under many constraints, for example,

mathematical optimization and apply

numerical methods for train route

searches and shift scheduling.

We study theoretical aspects of

solutions using mathematical

Time-domain Astronomy is a new category which focuses on transient elestial phenomena E.E. Ve are surveying those transient events making use of AI and unique small ellites. Currently we are developing icro-satellite for the ultra-wide

eld UV transient explore mission to be launched in 2022

Macroscopic quantum physics with single nanoparticles in vacuum Kivotaka Aikawa School of Science



By using ultracold single nanoparticles laser-trapped in a vacuum, we investigate whether macroscopic objects follow quantum mechanics. which has been successful with microscopic particles such as electrons and atoms. We also aim at developing oplications of our system in sensing.



Understanding solar system bodies

formation Kota Ogasawara School of Engineering



Leveraging innovations to build a sustainable society Yuva Kaiikawa School of Environment and Society





Transdisciplinary Science and Engineering, Humanities and Social Science

Update current practices by designing human-technology interaction Takumi Ohashi School of Environment and Society

 I am trying to contribute to a sustainable society by designing interactions between humans and technology

Specifically, Linvolve and analyze events from various fields such as the livestock ndustry, caregiving, education, and drug iscovery, and am working to reflect the results back to actual fields to co-design solutions for people in these fields.

Environmental toxicology and plasma reforming technology Shuo Cheng School of Environment and Society

My research investigates the uptake

and effects of microfibers on the indoor aquatic microcosm system with three trophic levels. The research results can provide an essential basis for the environmental risk assessment of nicroplastics.

Studying methods of changing attitudes and behavior through interaction design Katie Seaborn School of Engineering

Interactive technology can be designed to influence, motivate, and provoke. I research the design and evaluation of interactive agents, interfaces, and xperiences that use attitude and / ehavior change methods for personal d social good.

Mechanism of historical human capital

Ogasawara laboratory focuses on the mechanisms of human capital formation during industrialization. Utilizing unique long-term historical socioeconomic statistics with properly signed cliometrics, the lab studies w people accumulated human capital in the economic development process, especially from the economics viewpoint.

I am developing and practicing methodologies for innovation. In particular. I am working on research and levelopment management, planning for ew businesses, analysis of business nodels and business ecosystems, xtraction of social issues including potential issues, and designing and

Nationalism and religion found in contemporary politics Takeshi Nakajima

nstitute of Innovative Research/Institute for Liberal Arts



I am studying the relationship between politics and "mental" issues such as nationalism and religious faith. I am mainly looking at Japan and India. In both countries, a "rightward trend" that links religion and nationalism has been een. Why are non-scientific phenomen expanding as science and technology

are progressing? I am studying this mechanism.

Analyzing visual culture of celebrity constructed by media

Kyohhei Kitamura Institute for Liberal Arts



In the 20th century, the appearance of celebrities such as movie stars and idols completely changed due to movies and television, and in the 21st century. new celebrities including YouTubers and VTubers appear over the internet. I m studying "celebrity" that is created ough media and its visual culture.

The relation of new technology and social and political issues **Byosuke Nishida**

Tokyo Tech Academy for Leadership / Institute for Liberal Arts



I handle the multifaceted relationship between new information technologies/ services and politics (elections) institutions, and society through policy analysis, historical research, and quantitative analysis, etc. Recent esearch is on policy processes and the social impact of COVID-19 measures. A

recent publication is "Sociology of the Corona Crisis" (2020, Asahi Shimbun Publications Inc.)

Research on educational practice, policy, and school reform Yuta Suzuki Institute for Liberal Arts



I am engaged in educational research with the emphasis on learning from school sites and listening to school sites. In particular, I am interested in the learning of teachers, who are the change agent in reform of teaching and schooling. "Formation and Development of Teachers' Professional Community: A Genealogy of Research on School Reform in the United

States" (Keisoshobo Tokvo 2018)



Creating true innovation at the front line of science and technology Contributing to solving future social and industrial problems by applying our knowledge of science and technology to create new value

The mission of the IIR is twofold — to promote active cooperation within and beyond the organization by providing an open research environment, and to continuously improve this environment so that researchers can focus fully on their work and make the most of their abilities. By accomplishing this mission, the IIR can create new research areas and technologies that address existing problems in society and lay the foundations of future industry. In the long run, the IIR aims to become a leading global innovation center.

AIA	As of May, 2020
aculty/International	324/59
esearch staff/International	110/39
raduate Students/ ternational Graduate Stude	nts 992/282

IIR is committed to creating new research areas, promoting interdisciplinary research,

solving the problems of human society, reinforcing its industry-academia alliance, and enhancing the industrial platform of the future, by applying the wisdom of science and technology to add new value and solving social and industrial issues, while training the personnel who will take charge of the academia and industry of the future.

IIR consists of multiple research labs, research centers, and research units that are spread across both the Suzukakedai and Ookayama campuses, where cutting-edge research covering a variety of fields including life sciences, materials, energy, electronic information, machinery, and disaster-prevention is progressing. We value the free-flowing ideas of our researchers, and by organic cooperation between and among research labs, centers, and units, we aim to contribute to society through new intellectual creations. As an organization engaged in science and technology creations, covering basic to applied technology, we conduct innovative research to produce results that contribute to society and plant the seeds of future industry in response to the increasingly sophisticated needs of society through the training of high-quality personnel and creative research activities.

Research Centers

Our aim is to make social contributions by enhancing our research capabilities and creating new knowledge through the maximum use of the various advantages inherited from the research units and by developing the organizations for our research base.



Solution Research Center for Advanced Energy Systems (AES Center)

The AES Center and partner entities pursue development of fundamental next-generation energy technology. They aim to realize "smart communities" that fully incorporate renewable energy sources and energy-conservation, practices which are central to achieving a low-carbon society.

Center Director: Institute Professor Takao Kashiwagi

Advanced Research Center for Social Information Science and Technology (ASIST)

ASIST develops safe and secure social information distribution infrastructures that allow individuals to acquire, confirm, and utilize personal information managed by public administrations and medical institutions. They are also engaged in research and development of systems that provide one-stop service by public administrations and life-long individual health management.

Center Director: Institute Professor Nagaaki Ohyama



Cell Biology Center

The activities in this Center are oriented around understanding molecular mechanisms, from gene expression and editing, to synthesis, modification, and the resolution of proteins, and elucidating the dynamics of cellular functions with applications in next-generation cell engineering.

Center Director: Honorary Professor Yoshinori Ohsumi



Future of Humanity Research Center

Keeping in step with cutting-edge research of science and technology, this center deals with practical and essential questions regarding what humanity will be like in the decades or centuries to come, and explore the changes that technology will bring to humanity, the values to be protected, and the possibilities as viewed from various perspectives. Research results will be disseminated in various ways, including books, web articles, and radio.

Center Director: Associate Professor Asa Ito

Research Laboratories

We are conducting front-line research in a wide range of fields. The aims of this research are as follows: to create new research areas; to promote interdisciplinary research; to solve problems found in human society; to strengthen industry– academia collaboration; and to foster a future industrial base. The research involves four research organizations in four different fields.

Laboratory for Future Interdisciplinary Research of Science and Technology (FIRST)

FIRST is dedicated to fostering human society's future development and prosperity by promoting technical progress in industry to meet the needs of the era. FIRST creates new industrial technologies through the fusion of mechanical engineering, electrical and electronic engineering, metallurgy, environmental engineering, disaster prevention engineering, social engineering, chemical engineering, and physical electronics. FIRST focuses on not only science and engineering, but also humanities and sociology, such as industrial sociology, as well as economics and law, to promote interdisciplinary research. The ultimate target is to conduct advanced science and engineering research that will lead to the creation of new industrial technologies to realize a prosperous future for the world.



Laboratory for Chemistry and Life Science (CLS)

CLS, which consists of four major divisions - "molecular synthesis," "molecular assembly," "molecular functions," and "molecular bioscience" - carries out a wide range of research on molecular science, covering not only fundamental and applied chemistry, but also life science. By bringing domestic and international research activities together, CLS aims at creating new principles of molecular-based chemistry and bioscience, thereby making breakthroughs toward next-generation science and technology. The final goal of CLS is to contribute to the realization of the sustainable development of human society through front-line chemical research.



Laboratory for Materials and Structures (MSL)

MSL aims to create innovative materials with conspicuous properties and functions via interdisciplinary materials science based on inorganic materials extending to metals and organic materials. The ultimate goals of our lab include: a. Development of innovative materials based on novel concepts; b. Design of innovative materials in pursuit of novel guiding principles based on underlying materials science and theories in different scientific fields; c. Contribution to the solutions of social problems, including safety and environmental problems, through the application of innovative structures and materials.



Laboratory for Advanced Nuclear Energy (LANE)

As one of the top laboratories leading in applied research as well as pursuing the scientific principles related to nuclear energy, LANE aims to contribute to the sustainable development of the world. The fundamental research of peaceful use of nuclear energy is of great significance to solve the global energy shortage and carbon dioxide emission problems. Innovative nuclear energy systems research, actinide management research, global nuclear security research, and advanced radiation medical research are promoted as mission-driven research objectives. The laboratory also studies some important issues Japanese society has to cope with – reactor decommissioning toward recovery from the Fukushima Daiichi nuclear power plant accident and environmental pollution recovery.



Research Units

The establishment of Research Units allows Tokyo Tech to select prominent research leaders and topics in fields where growth is expected in the future, and to provide funding, space, and human resources to individual projects. The system places priority on promoting cutting-edge research, and allows researchers at other universities, institutions, and companies to participate in joint projects.



Hybrid Materials Unit

Creates new materials based on the precision synthesis of sub-nano metal particles using original dendritic polymers; works to open up a frontier field of science for the next peneration of functional materials

Performs research to understand how the brain controls the

body and develop devices that can be controlled by thought





Biointerfaces Unit

alone; also creates new methodologies and instruments to evaluate organ status for early detection of diseases. Unit Leader: Professor Yasuharu Koike



Nanospace Catalysis Unit

Creates nanospace catalysts and develops processes that make efficient use of carbon resources to contribute to the greening of chemical production.



Unit Leader: Associate Professor Toshiyuki Yokoi

Quantum Computing Unit

Basic theory of quantum annealing is our main topic of research. We have been leading the world in this field since our first proposal of quantum annealing in 1998.

Unit Leader: Professor Hidetoshi Nishimori



Sustainable Chemical Resource Production Unit Seeks to establish sustainable production methods for indispensable chemical resources to human society without using

petroleum resources, and to establish a new industry.

Unit Leader: Professor Michikazu Hara



Heterogeneous and Functional Integration Unit

The development of large scale 3D integration technology for Tera-byte memory, ultra-small system module, bio-de vices, and functional sensor to recognize thoughts of plant are being conducted by research platform in cooperation with industries, so-called WOW Alliance.

Unit Leader: Professor Takayuki Ohba

AI Computing Unit



200

Unit Leader: Professor Masao Motomura

Homeostatic Mechanism Unit



Unit Leader: Professor Masaharu Noda



Nano Sensing Unit



We are developing fundamental technology for environmental restoration and for promoting the decommissioning of reactors, with the goal of early recovery for Fukushima following the unprecedented accident at the Fukushima-Daiichi nuclear power plant in 2011. Unit Leader: Professor Kenji Takeshita

system through integrated circuit technology and integrated

Unit Leader: Associate Professor Hiroyuki Ito

Our goal is to commercialize an ultrasensitive accelerometer MEMS technology, and to apply it to sustainable medical and food production by open innovation.

Research Unit for All Solid-state Battery Unit

We are working on the development of all solid-state batteries, an innovation expected to lead to the next-generation of energy storage. A key technology in this endeavor is our superionic conductors (solid electrolytes). We will contribute to the early adoption of solid-state batteries by establishing the basic technology through industry-academic collaboration.

Unit Leader: Professor Ryoji Kanno

The organization will be expanded to a research center in April 2021.

Strategic Research Hubs

Promotes cutting-edge global research supported by large-scale government funding

Earth-Life Science Institute (ELSI)

Director: Kei Hirose

ELSI is a unique research institute that seeks to discover the "origins of the Earth and life" by bringing together world-class researchers in geoscience, life science, and planetary science from both Japan and overseas. With about half of its nearly 60 researchers coming from abroad, English is the official language of ELSI. The administration office has a dedicated staff to provide daily-life support for non-Japanese researchers. They also provide weekly Japanese classes, ELSI was selected by the MEXT - World Premier International Research Center Initiative (WPI). (Established in 2012)



Materials Research Center for Element Strategy (MCES)

Director: Hideo Hosono

The MCES creates useful innovative materials from abundant elements such as gravel and cement. The only center for electronic materials in Japan, it was adopted by the MEXT Element Strategy Initiative Project (Core Research Center Formation). (Established in 2012)



Research Institute for the Eeath Inclusive Sensing

Director: Hitoshi Wakabayashi

Research Center for the Earth Inclusive Sensing with Silent Voices (EISESiV)

The research center aims to solve social / earth issues for humans and nature to coexist using sensing technology and AI / IoT edge technologies. We are proceeding the research aimed at realizing a society of mutual assistance and coexistence and co-prosperity with the global environments by sensing phenomena that have not been noticed so far, providing them as interpretable information, and encouraging people to take voluntary actions. Selected as a Center of Innovation (COI) Program of the MEXT.

Industry-University Consortium for Integrated Systems-Materials (iSyMs)

A consortium to accelerate the growth of integrated-circuit industry has just launched to research new materials, devices and architectures with novel operating principles. It aims to make a leap forward in the industry based on IoT/AI technologies achieving ultra low power consumption systems, which is the most important for the conservation of the global environments.









4. Institutes and Schools



https://www.mces.titech.ac.jp/en/





https://www.coi.titech.ac.jp/ri-eis

Laboratory for Design of Social Innovation in Global Networks (DLab)



School of Science

Developments in science and technology offer us infinite possibilities for a better tomorrow. By gauging the needs and desires of society through dialogue with the public, and by designing our future together, DLab aims to create a brighter, more prosperous world.

Together Designing our future. DLab

Open platform to create the future we want

Since its establishment in 2018, DLab has brought together Tokyo Tech students, faculty, and staff with members of the public at workshops and other events to brainstorm together the future we want. In January 2020, DLab unveiled a jointly created image of future society, the Transchallenge concept which summarizes this vision, and the Tokyo Tech Future Chronology — currently consisting of 24 Future Scenarios — at a public event in central Tokyo. With the tools created so far, DLab continues to develop its future image through a broad perspective while encouraging all interested parties to join the conversation.





Tokyo Tech Future Chronology

Supporting future-oriented research The DLab Challenge Research Grant supports research connected to the realization of the future image and scenarios created by DLab, and research that contributes to the creation of new disciplines required to realize this image.

DLab Partners — Connecting with the business sector

DLab welcomes the participation of businesses and organizations. After joining DLab on a membership basis, DLab partners Partners can expect a setting where ideas are freely shared regardless of affiliation or position — an open place to think about the future. In principle, all information shared and ideas created during these sessions are open to the public.



Exploring and creating knowledge

The School of Science comprises four departments, the Departments of Mathematics, Physics, Chemistry, and Earth and Planetary Sciences. The School is committed to advancing science as the culture and knowledge of humankind and to taking a leading role in research and exploration at the frontiers of the natural sciences. While scientific research is independent of immediate applications, the concepts developed and the knowledge obtained through scientific activities have not only enriched the culture of human beings but also, eventually after ten or more years, contributed to solving the problems society and nature were facing.







DATA	As of May 1, 2020
Faculty/International	149/5
Research staff	19
Total Students/International Student	s 1,133/59
Students in Bachelor's Program/ International Students	665/17
Students in Master's Program/ International Students	335/22
Students in Doctor's Program/ International Students	133/20

■ Earth and Space Science ■ Space Planetary Science ■ Earth Internal Science

Creating new industries and advancing civilization

The School of Engineering comprises below five Departments.

Mechanical Engineering: We will educate and research to discover new phenomena, principles and methods, and create new machines that harmonize the environment with humankind.

Systems and Control Engineering: We will create new value in the future society by integrating the real world (physical) and information (cyber) as a system.

Electrical and Electronic Engineering: We will educate and research the core technologies of energy technology, electronics, communication technology, etc., which are the core technologies of the diversified and sophisticated modern society.

Information and Communications Engineering: We conduct research and education on basic technologies and applied systems that support a human-friendly and sustainable advanced information and communications society.

Industrial Engineering and Economics: Aiming to solve social issues in corporate management and economic systems from scientific and engineering perspectives.

We promote basic research aiming to expand the subjects in each technological field and promote interdisciplinary research through the establishment of cross-sectional groups with a focus on issues related to future society.

Industry-University Cooperation Office in School of Engineering organizes research teams made up of the best faculty members for each issue to respond to specific needs from industries. Through these systems, we advance technical development to identify solutions for a wide range of social issues and explore new industries such as renewable energy and energy saving technology, diversified spatial temporal system management, innovative interface devices and information networks that make use of the five senses, innovative sensing technology and information processing technology.

Structure and Research Fields



As of May 1, 202 192/41 Faculty/International Research staff 41 Total Students 3,230/544 International Students Students in Bachelor's Programs/ 1,636/79 International Students Students in Master's Programs/ 1,231/281 International Student Students in Doctor's Programs/ 363/184 International Student

School of Materials and Chemical Technology

Creating of new compounds and new materials – Towards the foundation of an unlimited future

The School consists of two departments — Materials Science and Engineering, with its roots in solid state materials, and Chemical Science and Engineering, with its roots in molecular chemistry.

We also have affiliated research centers designated as national research hubs for research in chemistry and materials.

The department of Materials Science and Engineering 'creates new materials and new processes that contribute to the development of industry, and trains human resources that contribute to society', and the department of Chemical Science and Engineering 'applies the knowledge of chemistry and the latest technology with the aim to research chemistry that realizes dreams and create an infinite future'.

At the School of Materials and Chemical Technology, world-class researchers interact and cooperate with each other to study "theories and methods that give various new functions to substances and materials by manipulating chemical transformations." By creating substances and materials with new functions, we would like to contribute to improving the quality of our lives and solving issues such as the environment, resources, and energy.

Furthermore, through research, we are training researchers and engineers who can lead future material development with a high sense of ethics. We are also promoting education and research in close cooperation with industry through mechanisms such as "Research Alliance Program" and "Collaborative Research Cluster."

Composition and research fields





DATA	s of May 1, 2020
Faculty/International	146/6
Research Staff	31
Total Students/ International Students	1,934/298
Students in Bachelor's Programs International Students	/ 799/31
Students in Master's Programs/ International Students	876/146
Students in Doctor's Programs/ International Students	259/121

School of Computing



of May 1, 202

18

949/165

446/19

366/98

137/48

76/5

Faculty/Internationa

nternational Student

International Students

International Students

International Students

Students in Bachelor's Programs/

Students in Master's Programs,

Students in Doctor's Programs/

Research Staff

Total Students

School of Life Science and Technology

Creating a Future Information Society

Information plays a key role in connecting people, advancing science and technology, and enriching our lives and society by making everything intelligent. Our mission is to contribute to the development of an information society by searching for truth in information and developing innovative technologies.

Our aim is to achieve our mission by pursuing truth in information, developing information technologies, and also expanding the applications of information technologies. To do this, we search for mathematical truth in information itself, as well as the computations that process information. Included in our scope is establishing fundamental technologies for software and computing platforms and also creating novel applications of advanced information technologies by overcoming technical challenges.

Structure and Research Fields



Promotion of Academia-industry Collaboration and Social Partnership

Data Science & Artificial Intelligence Research Group for Social Good (DSAI) tackles various problems in our society through promoting research on data science and artificial intelligence with universities, research institutes, and companies all over the world.

Cybersecurity Research Center serves as a hub for collaborative research between industry, academia, and government, and responds to the demand for information security from industry. The center promotes practical research on information security through cooperation with universities, research institutes, and companies all over the world.

Unlocking life's code and transferring the knowledge to the benefit of society

The School of Life Science and Technology's basic policy is "to unlock life's code, transfer the knowledge to the benefit of society, and contribute to establishing intellectual foundation shared by all humankind." In line with its policy, the School is promoting research exploring the truth, research creating the buds of next-generation industry, and research aiming at solving various issues for sustainable development of humankind, while creating better research environments for young scientists. In the School, over 100 faculty members are engaged in a wide spectrum of disciplines including structural biology, molecular biology, microbiology, biochemistry, genome informatics, evolutionary developmental biology, neurobiology, reproductive medicine, plant science, bio-imaging, organic chemistry, biophysics, biotechnology, bioengineering, and medical engineering, attempting to answer the question "What is life?" and transfer the knowledge to industrial applications. Moreover, to further attract researchers inside and outside and lead innovative science and technology, the School has identified bio-functional material sciences, synthetic biology & genome engineering, and health & medical sciences as three priority areas and is pioneering Holistic Life Science, an interdisciplinary research field aiming at the realization of bio-driven society.

Structure and Research Fields



Promotion of Academia-industry Collaboration and Social Partnership

Life Science and Technology Open Innovation Hub (LiHub), as a center of knowledge for life innovation, fulfills its mission to serve as a bio-creative interface between frontier research and industry.





DATA	As of May 1, 2020
Faculty/International	94/2
Research staff	24
Total Students/International Student	s 1,195/147
Students in Bachelor's Program/ International Students	625/13
Students in Master's Program/ International Students	412/70
Students in Doctor's Program/ International Students	158/64

Open Research Facilities for Life Science and Technology (ORFLT) has been established for the sharing of advanced life science-related equipment at university-wide level at the School of Life Science and Technology. In 2019, we have started to accept users from outside the university.



School of Environment and Society

Solving complex social issues through the integration of humanities and science for inclusive and sustainable global development

The School of Environment and Society pursues academic and technological excellence not only in the construction of individual buildings, but also in the creation of sustainable environments on regional, national, and global scales. Contemporary issues relating to our environment, be it preparedness for large-scale natural disasters, the preservation of biodiversity, or a balance between the global economy and local historical and cultural traditions, cannot be achieved through expertise in one single discipline. Collaborative action across traditional borders is crucial. The School's departments of Architecture and Building Engineering, Civil and Environmental Engineering, Transdisciplinary Science and Engineering, Social and Human Science, and Innovation Science/Technology and Innovation Management utilize hard and soft technologies, technical ingenuity and creative action, and a wide range of interdisciplinary academic fields to address a variety of problems confronting the world.

Structure and Research Fields

Covering a wide range of fields, including design theory, the history of architecture, architectural planning, structures and materials, and urban design and built environment

- Architectural Design
- Sustainable Architecture
- Architecture Engineering
- Architecture Project Management
- Urban Space Management





Building our environment and societies, protecting life, and committing to future prosperity

- Next-Generation Infrastructure and Space Management
- Systems for Sustainable Society
- Social Safety Systems
- Urban Space Management

Department of Department of Architecture and Transdisciplinary Building Science and Engineering Engineering

Department of **Department of** Civil and Innovation Environmental Science Engineering



Establishing new theories and practical academic disciplines for innovation Intellectual and Technological Value Creation Economic Value Creation Social and Public Value Creation

Solving global problems with knowledge from

science and technology

Human-Societal Systems Environment-Natural Systems

Expert and Artificial Systems

Integration-Harmonization Systems



Institute for Liberal Arts

Envisioning an alternate future through the fundamental and ethical integration of knowledge in science and engineering, and the utilization of logos, pathos, and ethos from the liberal arts

The Institute for Liberal Arts (ILA) carries out interdisciplinary research centering on the fields of humanity and social science. We seek to truly understand what we are and what the world is to discover new bases of intellect and knowledge to enhance lifestyles.

At the same time, the ILA also plays a role as a think tank to implement science and engineering knowledge into society, which contributes to large-scale research projects developed by Tokyo Tech.

Structure and Research Fields

The ILA provides liberal arts education to all Tokyo Tech students. The ILA provides different courses in the Humanities and Social Science, English Language, Second Foreign language, Wellness, Japanese Language and Culture, and Teacher Education. The ILA also provides initial education immediately after enrollment, leadership education given in master's programs, and interdisciplinary research and education related to social issues given in doctoral programs, all beyond the boundary of specialization.

The ILA offers opportunities to conduct research in a wide variety of fields that cover an extensive range of research themes. For example, instructors in charge of language carry out research on art, or instructors in charge of humanities and social science handle mathematical models. Please see the table for the research fields of individual instructors.

The ILA oversees knowledge in science, engineering and society, and has come to play a role as a bridge to building better lifestyles.

Approaches to Research

— Future Vision —



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Faculty/International

Publications



5. Publications













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CAMPUS LOCATION & ACCESS Saitama Tokyo 0 b Haneda Airport Kanagawa Chiba Komagome <u> Olkebukuro</u> Keisei Skyliner Yamanote Line Nippori Tokyo Metro Namboku Line Keisei Ueno 🖒 Narita Airport Uend Shinjuku Akihabara Narita Express Chuo Line / Sobu Line Odakyu Line Machida Shibuya Tokyo Nagatsuta Futako-tamagawa TCAT)·· Mizonokuchi Den-en-toshi Line Chuo-rinkan TCAT (Tokyo City Air Terminal) Toyoko Line Hamamatsucho Suzukakedai Meguro Shinagawa Jiyuqaoka Tamachi \mathcal{L} Den-en-chofu Meguro Line Suzukakedai Ookayama Campus Tokyo Monorail Tamachi Campus Keihin-Tohoku Line Yokohama Higashi-Kanagawa Oimachi Keikyu Line Haneda Airport YCAT ····· Airport Limousine Bus YCAT (Yokohama City Air Terminal)

Suzukakedai Campus

4259 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8503 JAPAN

- S-minute walk from Suzukakedai Station on the Tokyu
 Den-en-toshi Line
- 70 minutes from Haneda Airport
- 130 minutes from Narita Airport

Ookayama Campus

2-12-1 Ookayama, Meguro-ku, Tokyo 152-8550 JAPAN

- 1-minute walk from Ookayama Station on the Tokyu
 Oimachi & Tokyu Meguro Lines
 45 minutes from Haneda Airport
- 85 minutes from Narita Airport
- 85 minutes from Narita Airport

東京工業大学 Tokyo Institute of Technology

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Tamachi Campus

3-3-6 Shibaura, Minato-ku, Tokyo 108-0023 JAPAN

- 2-minute walk from Tamachi Station on the JR Yamanote Line & Keihin-Tohoku Line
- 25 minutes from Haneda Airport
- 65 minutes from Narita Airport