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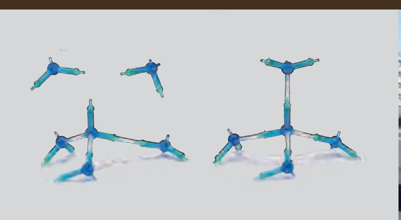
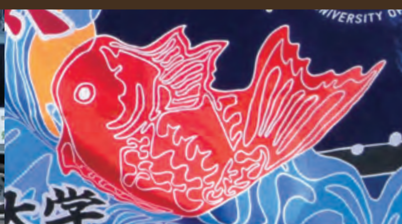
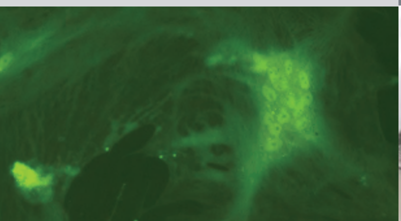
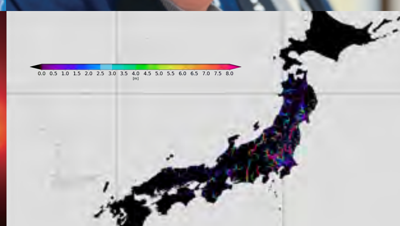






東京大学生産技術研究所
Institute of Industrial Science, The University of Tokyo

Soft and liquid matter: Focus on spatio-temporal hierarchy

Intelligent theoretical models and innovative experimental techniques yield unique insights into the fundamental physics of liquids and soft matter

Professor Hajime Tanaka

Soft matter and materials with structural hierarchy

"My interest in soft matter and liquid science was inspired during my masters and doctoral studies between 1977 to 1982 under the supervision of my adviser, Professor Yasaku Wada," says Professor Hajime Tanaka at the Institute of Industrial Science, The University of Tokyo (UTokyo-IIS). "I used experiments and theory to study critical phenomena and the acoustic properties of two-component mixtures of simple liquids. During this period, I developed my research style based on both experiments and theory. Spatio-temporal hierarchy forms the basis of critical phenomena, and this concept has influenced my future research on the physics of soft and liquid matter significantly."

The presence and importance of soft matter in the modern world is not apparent. But a closer look at materials used to produce television screens, biomedical devices, and household items such as shampoos, cosmetics, and pharmaceuticals, reveals the ubiquitous nature of soft matter: polymers, liquid crystals, colloids, biological materials, and aqueous solutions, including pure water.

The common thread that links these materials is that they are made of large building blocks that are huge in comparison with the size of individual atoms but orders of magnitude smaller than the actual macroscopic materials. Notably, soft materials are said to exhibit 'structural hierarchy', where the building blocks themselves have a well-defined unit structure. A typical example are macromolecular compounds made of long chains of polymers that are further composed of many repeated subunits (monomers). The large size and weak bonding between the building blocks results in the soft nature of such materials. On the other hand, liquids have been thought not to have such structural hierarchy. Intriguingly, in spite of the proliferation of applications of liquids, there are still gaps in our understanding of their basic properties compared to solids and gases. Tanaka has proposed that the recognition of structural hierarchy in liquids is the key to filling the gaps.

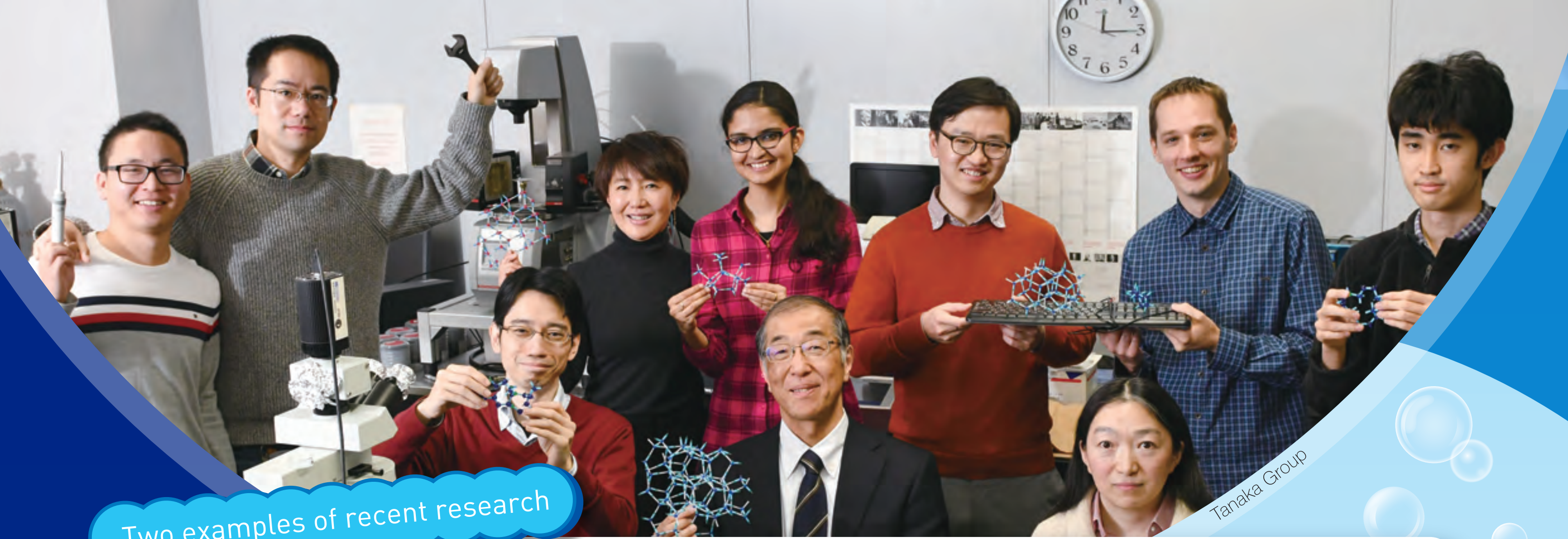
Spatio-temporal hierarchical structures

Tanaka and colleagues at UTokyo-IIS are addressing some of the unresolved issues related to liquids and soft matter including, demystifying the physics governing the peculiar behavior of water. "Our research covers the following seven research topics of liquids and soft matter," explains Tanaka. "Ultimately, we want to create a unified physical picture of these materials based on the common properties of their spatio-temporal hierarchical structures.

We are confident that this research will not only yield insights into the basic physics of these materials but also produce hints about potential applications."

Research topics under investigation

- ☑ Thermodynamic and kinetic anomaly of water and water-like liquids
- ☑ Mechanism of liquid-liquid transition in a single-component liquid
- ☑ Mechanism of liquid-glass transition
- ☑ Relationship between a hierarchical structure of liquid and its crystallization
- ☑ Nonlinear flow behavior of glassy liquids and granular matter and the mechanism of flow instability and fracture
- ☑ Roles of hydrodynamic interactions on the dynamics of soft and bio-matter
- ☑ Phase transition dynamics and pattern evolution in soft and bio-matter



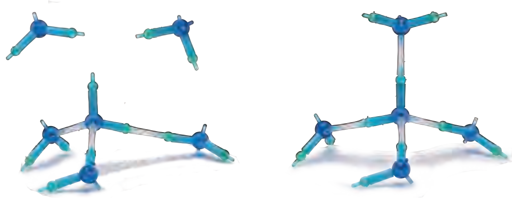
Two examples of recent research

Modeling the properties of supercooled water shows the existence of two co-existing liquid states that explain its unusual "fragile-to-strong" transition at low temperatures

High school children learn about the anomalous behavior of water. When cooled, water contracts until the temperature reaches four degrees Celsius. Cool it further, and it expands, and its density decreases. Thus, colder water goes to the surface of a lake, preventing the freezing of the entire lake. Another, more perplexing property of water is referred to as the "fragile-to-strong" transition that is related to the temperature dependence of the dynamics of water. When cooling liquids, their dynamics slow down, and they become more viscous. For some liquids, the rate of slowing is constant with temperature, and these are known as strong liquids. In contrast, for fragile liquids, the rate continually increases as the temperature drops. Water is unusual in this regard because it is fragile at room temperature but strong at low temperatures. During this crossover, the rate of viscosity increase exhibits a peak. This unusual behavior, known as "fragile-to-strong transition", has mystified researchers for decades.

Tanaka and his colleagues moved away from the conventional 'glassy dynamics' model of water. They took a new approach to explain its dynamics by assuming the co-existence of two states of water with different molecular arrangements but both obeying the Arrhenius law. Their molecular dynamics simulations revealed that the highly ordered "slow-state" with tetrahedral structures (dominant at low temperature) co-exists with the less ordered "fast-state" (dominant at high temperature). The crossover between these two states through a mixed state successfully explains the fragile-to-strong transition.

"Fragile water may be an illusion and the transition an artifact," says Tanaka. "The presence of two states reflects water's tendency to form locally favored tetrahedral structures, which is stronger at low temperature."



Reference

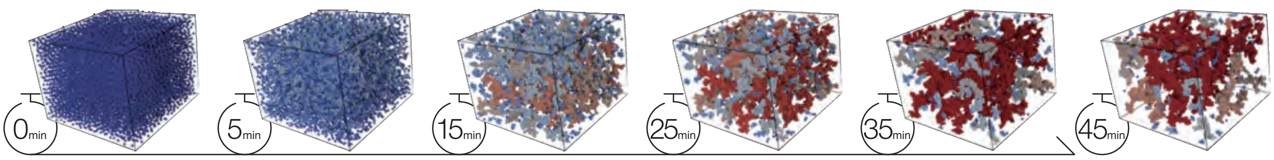
Rui Shi, John Russo, and Hajime Tanaka, "Origin of the emergent fragile-to-strong transition in supercooled water," ***Proceedings of the National Academy of Sciences (PNAS)*** (2018). **DOI:10.1073/pnas.1807821115.**

Confocal microscopy yields direct information about the mechanisms governing the formation and stability of colloidal gels

Colloidal gels are examples of soft matter. They are composed of colloidal particles embedded in a liquid solution and are widely used in cosmetics, food and beverages, and biomedical products. Surprisingly, the mechanisms governing the formation of stable gels remain unclear because of a lack of data from direct observations showing the behavior of the constituent phases of colloidal gels during the gelation process.

Tanaka and his colleagues at UTokyo-IIS collaborated with researchers in France, and the United Kingdom to develop a unique confocal microscopy system to observe and analyze the kinetics of the gelation process in real-time and with an optical resolution enabling the imaging of single particles.

Structural and rheological observations of the gelation process with microscopy showed that the appearance of solidity is a consequence of isotropic percolation of isostatic structures—clusters of particles in which the number of constraints equals the number of degrees of freedom. These results indicated that the percolation of isostatic structures in gels is directly associated with their mechanical stability. These results were possible because the confocal microscope used in this study enabled real-time and high-resolution imaging of the gelation process.



Reference

Hideyo Tsurusawa, Mathieu Leocmach, John Russo, and Hajime Tanaka, "Direct link between mechanical stability in gels and percolation of isostatic particles", ***Science Advances*** (2019). **DOI: 10.1126/sciadv.aav6090**

Further information Hajime Tanaka
http://tanakalab.iis.u-tokyo.ac.jp/

Real World Intelligent Transport Systems

UTokyo-IIS starts trial operation of an automated commercial bus service on public roads between Kashiwanoha-campus Station and the University of Tokyo Kashiwa Campus

"My motivation for initiating automated bus transportation between Kashiwanoha-campus Station and the UTokyo's Kashiwa Campus is to develop real world applications for intelligent transport systems after many years of leading feasibility projects on the technical aspects of advanced mobility systems," says Professor Yoshihiro Suda at the Advanced Mobility Research Center (ITS Center), UTokyo-IIS. Indeed, Suda has participated in many projects on the development of intelligent transport systems including ship anti-rolling systems with self-powered active control, advanced vehicle systems for automobile to prevent accidents by using 'vehicle to vehicle wireless communications, and energy-saving ITS by 'platooning' of heavy trucks. "Autonomous driving buses would alleviate the shortage of bus drivers and improve road safety in an era when Japan's population is aging rapidly with an increasing need for public transport, especially in rural areas."

The automated bus project in Kashiwa was launched by the Kashiwa ITS Promotion Council and covers a 2.6 km route between the Tsukuba Express Kashiwanoha-campus Station and UTokyo's Kashiwa Campus. The trials started on 1st November 2019 and will continue until 31 March 2020.

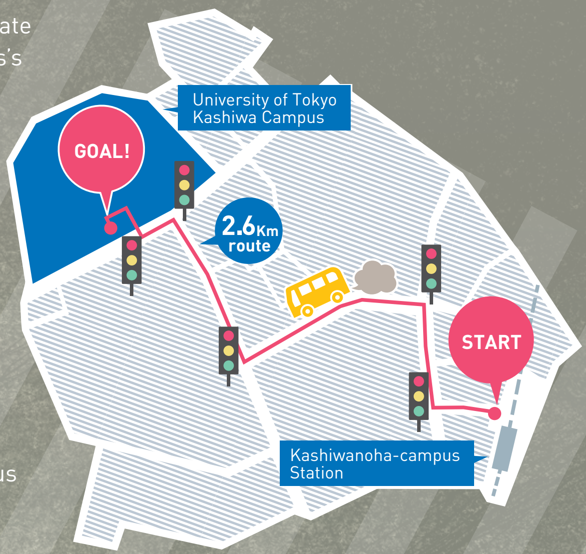
Professor Yoshihiro Suda is standing fourth from the right in this photograph.

Automated bus operating system

The goals of the project are to verify wide ranging critical aspects of operating an autonomous bus for the general public on public road. Issues include social acceptance of a bus without a driver; timing of bus maintenance; safety inside the bus in the absence of a driver or conductor; accepting payment from passengers. The trials will use a commercial bus equipped with an automatic driving system developed by Advanced Mobility Co., Ltd., and the business operation will be carried out by Tobu Bus East Co., Ltd. Currently, the trials are classed as being Automated Driving is Level 2, where the system performs sub-tasks of both longitudinal and lateral vehicle motion control in a limited area. The bus carries 17 passengers and there will be 4 buses per days operating in this route. "As a precaution, the trials will be carried out with a driver who will oversee the operation of the bus but not actually drive the bus," says Suda.

Core technology for the Kashiwa ITS automated bus system

The main components of the Kashiwa ITS automated bus system are sensors and control elements to operate the accelerator, brakes, steering and direction indicators. Specifically, the bus recognizes its position using a combination of advanced real time kinematic (RTK) GPS and inertia measurement units (gyro-sensors) that enable accuracy to within 2 cm. Furthermore, during motion the bus detects obstacles using radar (LiDAR) and millimeter radar, video camera image analysis by deep learning, and a digital map-based concept to delineate objects within and outside of the bus's path. "Our technology for operating the bus is mature and well tested," explains. "The real challenge has been getting consensus among the stake holders to participate in the project. The participants, who include representatives from local authorities and insurances companies, reflect commitment required from all parties to develop the infrastructure for long term commercial operation of autonomous buses for the public."



SAE level	SAE name	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability *(driving modes)*
Human driver monitors the driving environment					
0	No Automation	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	**System**	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment					
3	Conditional Automation	System	**System**	Human driver	Some driving modes
4	High Automation	System	System	**System**	Some driving modes
5	Full Automation	System	System	System	**ALL driving modes**

SAE International J30163

Mobility Innovation Collaborative Research Organization (UTmobI)

The Mobility and Innovation Collaborative Research Organization (UTmobI) was established in July 2018 by the Institute of Industrial Science, Graduate School of Frontier Sciences, and Information and Technology Research Center as an inter-departmental collaborative research organization.

In July 2019, five departments of science and humanities: Graduate School of Law and Politics, Graduate School of Engineering, Graduate School of Information Science and Technology, Future Vision Research Center, and Research Center for Advanced Science and Technology joined UTmobI, to enhance the organization's ability to contribute to mobility and innovation, promote the implementation of mobility innovation in local communities, and integrate academic research models that are truly linked to solutions to problems in the real world.

Further information

Yoshihiro Suda
http://www.nozomi.iis.u-tokyo.ac.jp/index-e.html

ITS Center
http://www.its.iis.u-tokyo.ac.jp/en/

News

Professor Toshiharu Kishi, Director General

Waving the flag: UTokyo-IIS launches the *Tairyo-bata Project* to connect with local communities throughout Japan

Toshiharu Kishi is the current Director General of UTokyo-IIS, taking up the three-year position in April 2018. He has spent his research career engaged in elucidating the physical properties and performance of cementitious materials and maintenance of concrete structures.

"With a view to commemorating our 70th anniversary, we established the *Inter-Regional Network for Sustainable Coexistence with Nature* on July 23, 2019 to connect and collaborate with communities throughout Japan" says Kishi. "The network started as a consortium of towns, cities and a research institute that played leading roles in the development of Japan's rocket and space programs. One of the initiatives is the "*Tairyo-bata Project*", where the term *Tairyo-bata* or literally, "*big catch flag*" denotes the large, colorful flags hoisted by Japanese fishermen in their boats to share their joy of a large catch with their communities when they docked at their fishing ports."

The consortium and goals of the *Tairyo-bata Project*

The current members of the consortium are local governments throughout Japan (Chiba City, Chiba; Suginami City, Tokyo; Kokubunji City, Tokyo; Yurihonjo City, Akita; Noshiro City, Akita; Kimotsuki Town, Kagoshima) and UTokyo-IIS, where Hideo Itokawa, the pioneer of Japan's rocket science and space development, worked on his ingenious 'pencil rocket'. The goal of the consortium is to 'build on the footprints of rocket development and harness the power of science and technology to create a society with dreams and vitality'.

"Through inter-regional collaboration we will share wisdom and experience, engage with nature and work on creating lively local communities throughout Japan," explains Kishi. "In the future we intend to expand the circle of cooperation with local governments and research institutes that support this initiative. The important keywords describing this project are "connect and connecting".

The *Tairyo-bata project* encourages municipalities to create a future vision for their communities and to highlight their attractiveness in the designs of their own originally-designed flags. The project will culminate with an event at UTokyo's Yasuda Hall where all the flags gathered during the project will be displayed.

Events related to the *Tairyo-bata Project* to date

Rocket Koshien 2019 in Fujinomiya Asagiri Food Park, Hosted by the Japan Association of Rocketry

October 5, 2019

***Tairyo-bata* exchange meeting in Kamaishi fish shore terrace**

October 6, 2019

Workshop for Creating a future vision of Hakodate

October 20, 2019

Workshop for Creating a future vision of Maizuru

November 2, 2019

UTokyo-IIS pioneered Japan's research on rockets and space

The development of rockets in Japan began at the UTokyo-IIS under the leadership of Hideo Itokawa, who was a professor at the institute at the time. Itokawa had proposed aircraft for hypersonic travel across continents at high altitude, and in 1954 he established the Avionics and Supersonic Aerodynamics Engineering research group at IIS to realize his dreams. In April 1955, Itokawa and his colleagues tested the horizontal launch of the "pencil rocket", opened the Akita Experimental Station in August 1955 and carried out tests of the oblique launch of the "Pencil 300" and the so-called "baby" rocket. From 1957 to 1958, UTokyo-IIS took part in the International Geophysical Year (IGY) and was responsible for one of nine observatories around the world. During this time the "Kappa" rocket was developed for the IGY observations. In 1958 the two-stage kappa (K) -6-4 reached an altitude of 40 km, and succeeded in observing the upper atmosphere—the target of IGY—for the first time. Furthermore, in 1960 the K-8-1 reached 190 km, making the world's first ion density measurements of the Earth's atmosphere.

Later, the rockets reached higher altitudes: in 1961 the K-9L-2 reached 300 km, enabling the measurement of electron density and temperature. These advances led to the movement of the Akita Rocket Experimental Station to the Kagoshima Space Station (Uchinoura) in 1962, where the Noshiro Rocket Experiment Station was established for conducting ground combustion experiments of rocket engines.
Later, the early research at UTokyo-IIS on rockets evolved into other areas, including conducting communication observations with scientific satellites, the development of large antennas for receiving signals from rockets, and the construction of launch test sites.

Then in April 1964, research on rockets at IIS was transferred to the Institute of Space and Aeronautical Science University of Tokyo, then later transferred from the Institute of Space and Aeronautical Science University of Tokyo to the Institute of Space and Astronautical Science (ISAS). These institutional transformations eventually led to the formation of the Japan Aerospace Exploration Agency (JAXA) by the amalgamation of ISAS and two other institutes.

A New Vaccine for Saving Lives

Nipah Vaccine International Project to fight against a deadly virus with global funding

Members of Nipah Vaccine International Project.

Emerging virus infections are causing great damage in developing countries and becoming a serious threat to the humankind.

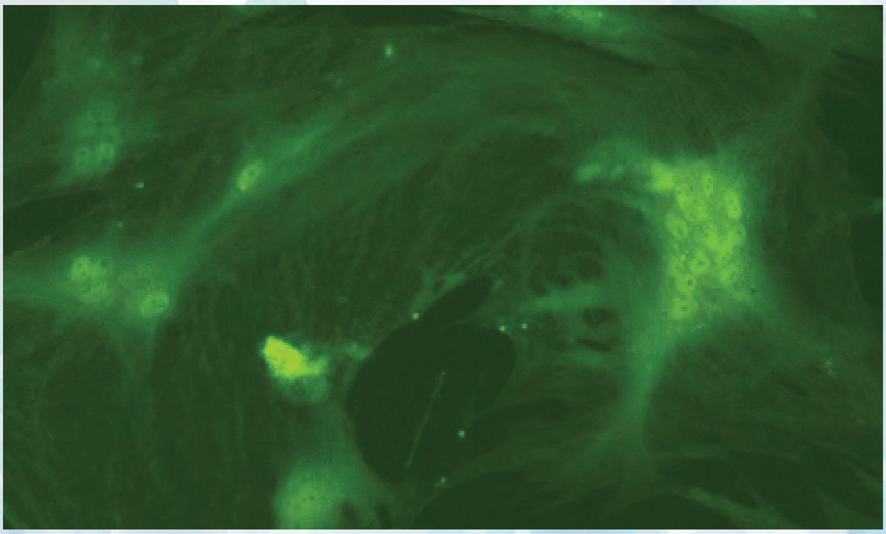
Nipah virus first emerged in Malaysia in 1998. It has a high fatality rate ranging between 40% and 90%. Bats are the main reservoir for this virus, and human and animal outbreaks of Nipah virus have been occurring in Asian countries such as Bangladesh and India every year. There are currently no effective therapeutics.

Professor Chieko Kai's research group started their studies on Nipah virus more than 16 years ago, in the hopes of giving people a remedy to fight against this deadly virus. Based on their research on measles for nearly 30 years and their established virus engineering technology, Kai and Associate Professor Misako Yoneda succeeded to develop a highly efficient recombinant vaccine, inserting Nipah virus genes into an attenuated measles viral vaccine, causing immune responses that could fight off Nipah. The efficacy and safety of this vaccine have already been proven in animal models.

The Coalition for Epidemic Preparedness Innovations (CEPI) was launched at Davos in 2017, as an innovative global partnership between public, private, philanthropic, and civil society organizations and developed countries including Japan. The mission of CEPI is to accelerate the development of vaccines against emerging infectious diseases and to enable access to these vaccines for people during outbreaks. In February 2019, CEPI awarded a contract of up to US$ 31 million to UTokyo to develop a vaccine against Nipah Virus with Kai as Lead Investigator. This significant project has been launched in partnership with the European Vaccine Initiative, Stanford University School of Medicine and the International Centre for Diarrheal Disease Research in Bangladesh that will undertake phase 1 and phase 2 trials, and Batavia Biosciences for vaccine manufacturing and stockpiling.

Co-sponsored by CEPI and IIS, the international symposium "New Vaccine for Saving Lives: Focusing on Nipah Virus Infection" was successfully held on 30 September 2019 at Ito Hall in UTokyo's Hongo Campus to introduce the Nipah vaccine project, inviting the project members and experts from across the globe as speakers to provide the latest firsthand updates on the project and the field of emerging infectious diseases. Q & A sessions after their presentations were very active and showed a high level of interest and awareness of the audience in the efforts to fight against the threats of various infectious diseases.

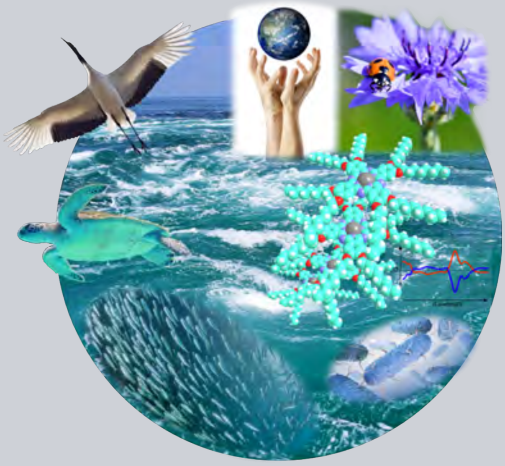
Kai has long struggled with the so-called Valley of Death, which denotes the gap between basic research and its application for public use. Even when her research showed a good potential for vaccine development, huge amount of money was needed to cross the Valley, and no companies were interested in developing vaccines or medicines for poor countries. It was when she was struggling to find resources and was close to giving up that CEPI was established. The construction of a bridge over the Valley of Death with the support of CEPI has been a huge step forward. There is no doubt that the significant progress made in this project will contribute to the suppression of epidemics and give hope to people. It is Kai's wish that similar bridges will be made for other diseases.



Multinucleated giant cells caused by the Nipah virus.

Further information Chieko Kai : http://www.kailab.iis.u-tokyo.ac.jp/cn3/topen.html

A New Spin on Life's Origin?



A research team at UTokyo-IIS has reproducibly synthesized staircase-like supramolecules of a single handedness, or chirality, using standard laboratory equipment. By gradually removing the solvent from a rotating solution containing non-chiral precursors, they were able to produce helixes that twist preferentially in a particular direction. This research may lead to new and cheaper drug production methods, as well as finally addressing one of the lingering quandaries about how life began.

One of the most striking features of the molecules most important to life--including DNA, proteins, and sugars--is that they have a "handedness," referred to as chirality. That is, all living organisms chose to rely on one molecule, while the non-superimposable mirror image does nothing. This is a little like owning a dog that will only fetch your left-handed gloves, while completely ignoring the right-handed ones. It becomes even more puzzling when you consider that chiral pairs behave identically chemically. This makes it extremely difficult to produce just one kind of chiral molecule when starting with nonchiral precursors.

How and why early life chose one type of handedness over the other is a major question in biology, and is sometimes called "the question of homochirality." One hypothesis is that some early imbalance broke the symmetry between left- and right-handed molecules, and this change was "locked in" over evolutionary time. Now, researchers at UTokyo-IIS have demonstrated that, under the right conditions, macroscopic rotation can lead to the formation of supramolecules of a particular chirality.

This was accomplished using a rotary evaporator, a standard piece of equipment in chemistry labs used for concentrating solutions by gently removing the solvent. "It was previously believed that macroscopic rotation could not cause nanoscale molecular chirality, because of the difference in scale, but we have shown that the chirality of the molecules can indeed become fixed in the direction of rotation," says first author Mizuki Kuroha.

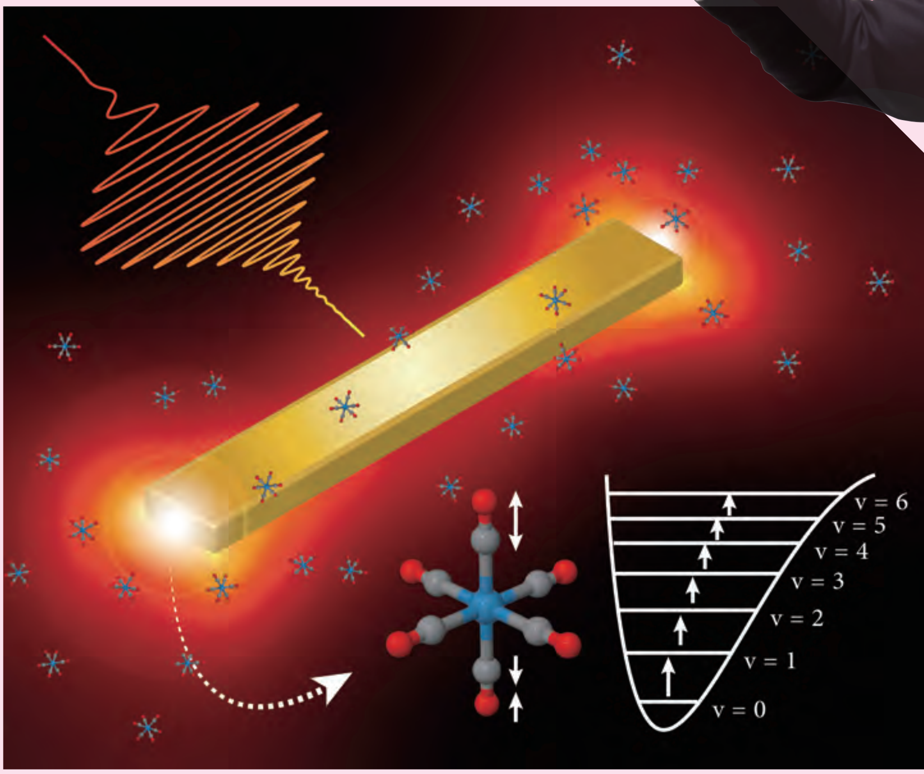
According to her theory, some ancient biomolecules caught in a primordial vortex are responsible for the choice of handedness that we are left with today.

"Not only do these results provide insight to the origin of the homochirality of life, they also represent a pioneering look in the combination of nanoscale molecular chemistry and macroscopic fluid dynamics," says senior author Kazuyuki Ishii. This research may also enable new synthesis pathways for chiral drugs that do not require chiral molecules as inputs.

Professor Kazuyuki Ishii

Reference Mizuki Kuroha, Shohei Nambu, Shingo Hattori, Yuichi Kitagawa, Kazuhiro Niimura, Yuki Mizuno, Fujihiro Hamba, and Kazuyuki Ishii. *"Chiral Supramolecular Nanoarchitectures from Macroscopic Mechanical Rotations: Effects on Enantioselective Aggregation Behavior of Phthalocyanines"* ***Angewandte Chemie International Edition*** **(2019), doi: 10.1002/anie.201911366**

Better Chemistry Through Tiny Antennae



Associate Professor
Satoshi Ashihara

A research team at UTokyo-IIS has introduced a powerful method for actively breaking chemical bonds using excitations in tiny antennae created by infrared lasers. This process may have applications throughout chemistry as a way to direct chemical reactions in desired directions. In particular, the reactions used in the energy, pharmaceutical, and manufacturing sectors may become much more efficient by increasing yields while reducing waste.

Chemistry is a messy undertaking, since there may be a variety of ways the starting chemicals can react, and each pathway might lead to the formation of a different product. Over the years, chemists have developed many tools--including changing the temperature, concentration, pH, or solvent--to nudge the reaction to maximize the yield of the desired molecules.

However, if given the ability to selectively control the making or breaking of individual bonds within a molecule, scientists could greatly enhance the efficiency of these reactions, while minimizing unwanted side products. "Being able to control chemical reactions on a molecular level--that is, the ability to selectively break or form chemical bonds, is a major goal for physical chemists," says first author Ikki Morichika.

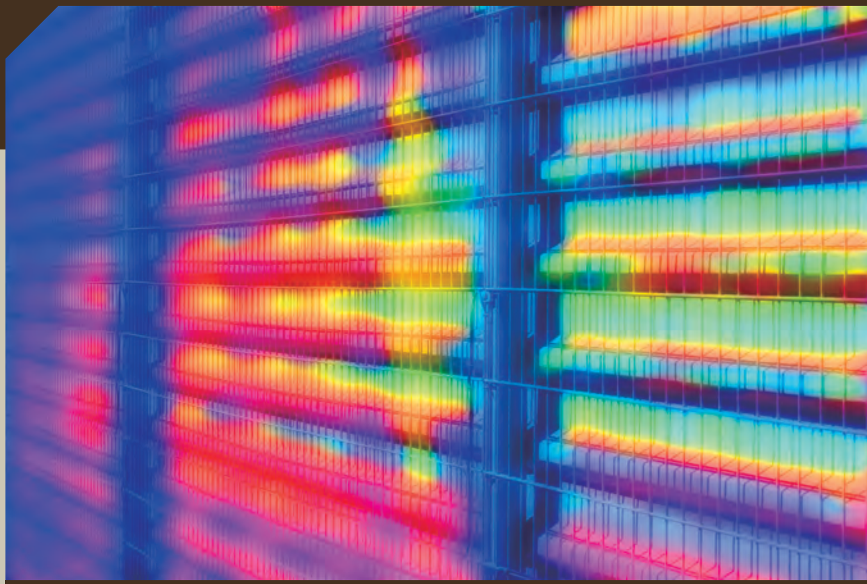
One way to control which bonds are broken during a chemical reaction is to get molecules vibrating by exciting them with infrared laser light. Since each type of chemical bond absorbs a particular wavelength of light, they can be activated individually. Unfortunately, it is difficult to deliver enough energy throughout the sample to generate the vibration intensity required. The team at UTokyo-IIS was able to overcome this problem by fabricating tiny gold antennae, each just 300 nanometers wide, and by illuminating them with infrared lasers.

When infrared light of the right frequency was present, the electrons in the antennae oscillated back and forth in resonance with the light waves, which created a very intense electric field. This phenomenon is called a "plasmonic resonance," and requires that the antennae be just the right shape and size. The plasmonic resonance focused the laser's energy on nearby molecules, which started vibrating. The vibration was further boosted by shaping the waveform of the infrared laser so that the frequency changed rapidly in time, reminiscent of the chirping of birds. "This successfully demonstrated that the combination of ultrafast optics and nano-plasmonics is useful for efficient, selective vibrational excitation," says senior author Satoshi Ashihara.

In the future, this technique may be applied to the production of cleaner fuels or cheaper pharmaceuticals as the chemical processes become optimized.

Reference
Ikki Morichika, Kei Murata, Atsunori Sakurai, Kazuyuki Ishii and Satoshi Ashihara.
"Molecular Ground-State Dissociation in the Condensed Phase Employing Plasmonic Field Enhancement of Chirped Mid-Infrared Pulses"
Nature Communications **(2019), doi: 10.1038/s41467-019-11902-6**

Keeping Cool with Quantum Wells

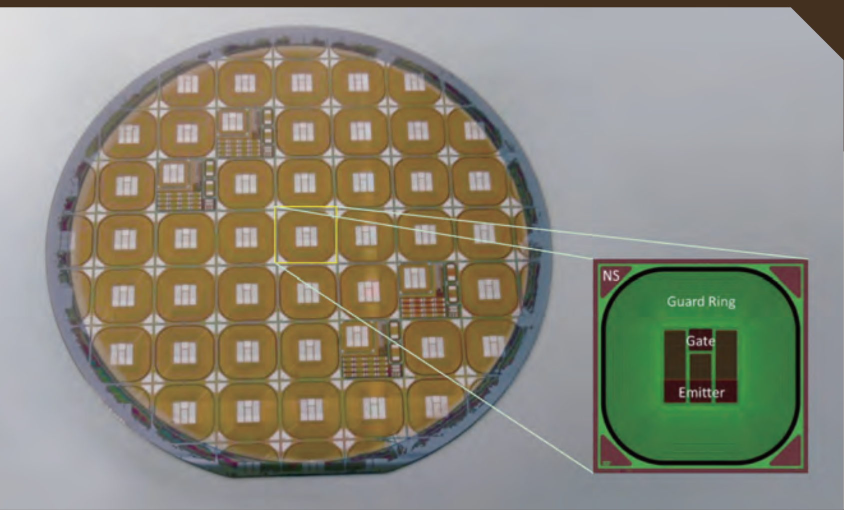


A research team at UTokyo-IIS invented a semiconductor quantum well system that can efficiently cool electronic devices using established fabrication methods. This work can allow for smaller and faster smart devices that consume less power.

Nature Communications **(2019),**
doi: 10.1038/s41467-019-12488-9

Further information

https://www.iis.u-tokyo.ac.jp/en/news/3164/



Remaining switched on to silicon-based electronics

It has been assumed that we are approaching the performance limits of silicon-based power electronics. UTokyo-IIS challenged this belief by developing a miniaturized silicon insulated gate bipolar transistor (IGBT) that overcame previous performance limits. The rated voltage was 3300 V. Their miniaturized IGBT displayed stable switching at an operating voltage of just 5 V, and the power consumption of its drive circuits was only 10% of that of a traditional IGBT operating at 15 V.

Further information

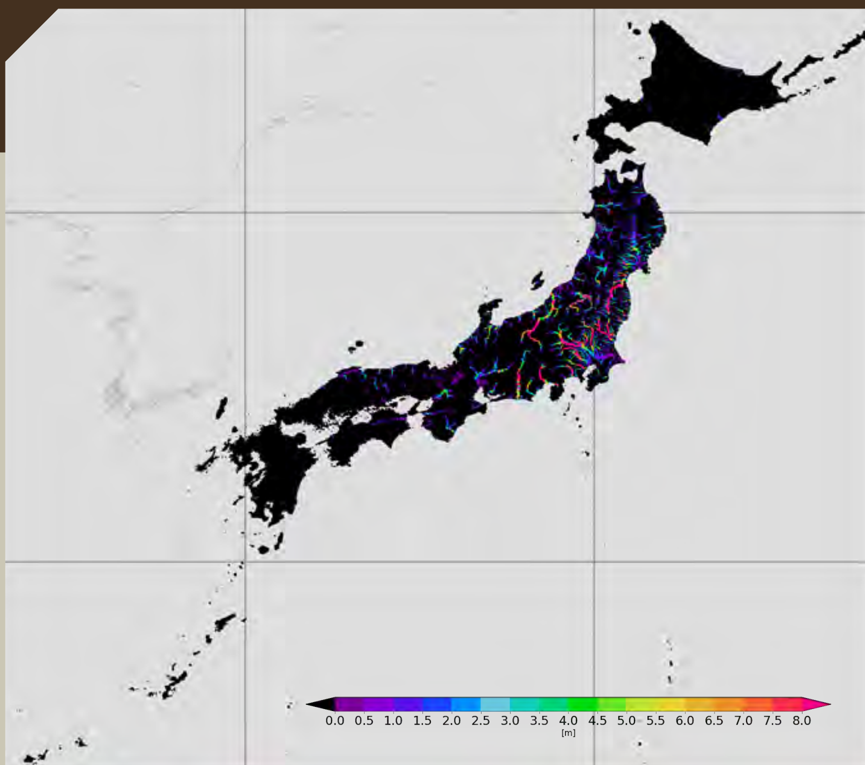
https://www.iis.u-tokyo.ac.jp/en/news/3109/

Flood Alert! Researchers devise powerful new flood monitoring system for Japan

Today's Earth Japan (TE-Japan), a powerful new flood monitoring system, has been created by UTokyo-IIS in partnership with the Japan Aerospace Exploration Agency (JAXA) to enable early warning of flood disasters. The TE-Japan system was validated for Typhoon Hagibis, which hit Japan in October 2019; most flooded areas were successfully predicted. Near-real-time monitoring data are now distributed and publicly available.

Further information

https://www.eorc.jaxa.jp/water/
https://www.iis.u-tokyo.ac.jp/en/news/3193/



UTokyo-IIS

Since its establishment in 1949, the Institute of Industrial Science at the University of Tokyo(UTokyo-IIS) is one of the largest university research institutions in Japan and its history reaches 70 years.

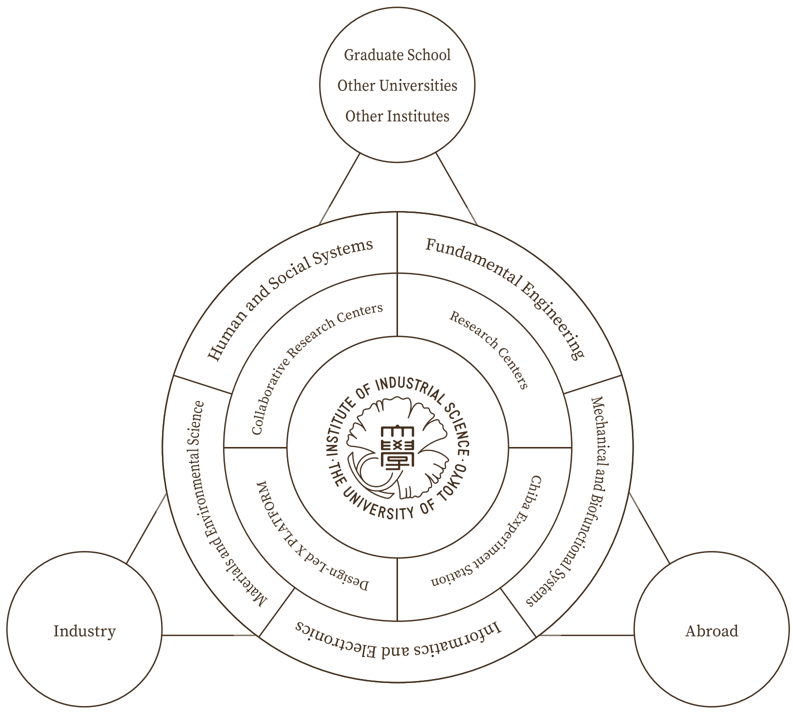
Our multidisciplinary research covers nearly all fields of engineering, and our professors, associate professors, and lecturers each lead dedicated laboratories, about 120 in total. More than 1,000 personnel, comprising approximately 300 faculty members including staffs and 750 graduate students, participate in educational and research activities that are responsible for producing excellent research outcomes and fostering outstanding talent. All our laboratories belong to one of five core research departments and some straddle multiple departments, providing the warp and weft for nine research centers, three collaborative research centers, and two international collaborative research centers. As well as promoting original research in each specialist field, we as an institution encourage cross-disciplinary and international activities. Last year saw the functions of the Chiba Experiment Station transferred from its original home in Nishi-Chiba to our Kashiwa campus, and the launch of the new Design-Led X Platform.

Since the foundation of the Institute, we have been acutely aware that the significance of academic research into engineering lies in its real-world implementation, and together with the seeding of new academic disciplines through enhanced specialization and cross-disciplinary collaboration, we have developed and deployed new technologies that contribute to solving problems in the real world. We have also made it our mission to nurture talented people to shoulder the responsibility of technological development and dissemination, especially in the industrial world. Such a philosophy and sense of mission has been programmed into our DNA since the foundation of the Institute, and we have taken a hands-on approach to address engineering challenges as a pioneer of advocacy for collaboration between industry and academia. We also take pride in the fact that our achievements and proactive stance are widely recognized together with the name *Seiken*.

Professor Toshiharu Kishi, Director General

Society is facing diverse problems today, and expectations are growing for the role that engineering plays in solving these problems. At the same time, the challenge for conventional engineering is that it is unable to make widely-accepted and compelling products with an approach that focuses only on technological development. For such situations that are difficult to address with engineering alone, we are seeking to build a new *Seiken* style—one that contributes to the creation of compelling value through innovation, founded on the pursuit of academic truth as a university research institute, and adding a multidisciplinary approach integrating humanities and sciences that incorporates exit strategies for real-world implementation, to the style that it is long known for: barrier-free, cross-disciplinary, practical industry–academia collaboration, and ambitious international collaboration.

Even though it is the largest of its kind in Japan, *Seiken* is perfectly sized to maintain a strong sense of organizational unity, and through our agility and collective strength as a world-class research institute in the field of engineering, we hope to continue helping to make everyone's dreams come true.



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