UTokyo-IIS Bulletin

Vol.1 February 2018

Institute of Industrial Science, The University of Tokyo

東京大学生産技術研究所

Institute of Industrial Science, The University of Tokyo

RCA-IIS Tokyo Design Lab：Fusing design and science

The RCA-IIS Tokyo Design Lab project is an international collaboration between the Royal College of Art (RCA), London and UTokyo-IIS on the ‘fusion of design and science’. The project was established in December 2016 as part of the Design Led-X initiative and with funding from Japanese Government Cabinet Office’s 'Cool Japan Center Collaboration Demonstration Project'.

The RCA-IIS Tokyo Design Lab was established to achieve three major goals:
Creating innovative prototypes of products and services by close collaboration between designers, engineers and scientists.

Disseminating knowledge and nurturing future talent by organizing forums, exhibitions and workshops to share design engineering methods with academia, industry, and government agencies.

Building a design engineering base by developing domestic networks between industry, academia, government and public-private domains. Furthermore, building international design engineering bases by bringing together internationally acknowledged creative design and engineering institutions.

People at the RCA-IIS Tokyo Design Lab

Miles Pennington

“I joined the RCA-IIS Tokyo Design Lab project in August 2017 after teaching for 15 years at the Royal College of Art in London,” says Miles Pennington, one of the newest members of faculty at IIS. “Our main mission is using design to turn science into deployable innovation and telling the world how we did it through design education. One of our major projects for 2018 is ‘Next Interface’ where we will focus on innovative design in the context of the connection between humans and technology.” Pennington emphasizes the importance of working in small entrepreneurially minded groups to quickly prototype ideas rather than planning and then pursuing ideas.
Recent projects undertaken by the Design Lab include exploring the future of bio-intelligent devices and interfacing between plants and humans. “In the Design Lab, we are trying to bring into reality what does not yet exist,” says Pennington. “In engineering there is often just one right answer. But in design there is no correct answer at all! We want to create a multidisciplinary and international environment to train innovative thinkers.”

Collaborative projects in progress

Bio-Intelligent Machines

(Aura – Health Monitor)

photo:Yasushi Kato

Aura is a conceptual health monitoring device that reads your biochemical signals and is the first deployment of a bio-intelligent machine.

Ikeuchi Lab

Chemical Synchronization

photo: Gottingham

Chemical Synchronization is a biological wearable device worn on the neck that enables you to sense other people's emotions and synchronize your own accordingly.

S. Takeuchi Lab

Plasmonics Lightpainting

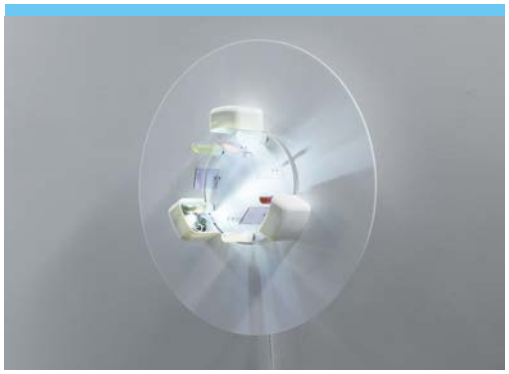

photo: Gottingham

Plasmonics Lightpainting is an interactive light sculpture comprised of small glass pieces colored by metallic nanoparticle dispersion.

Tatsuma Lab

Transparent Intent

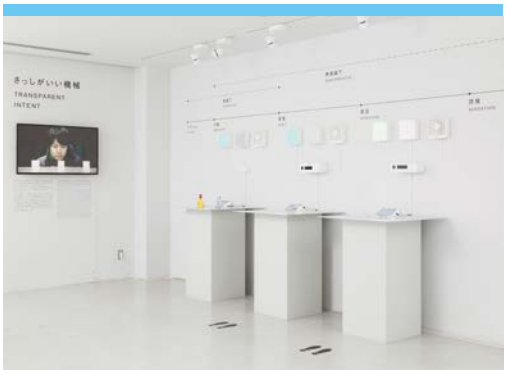

photo: Gottingham

Transparent Intent explores the future of the interface, predicting a future where products or systems can be controlled subconsciously.

Y. Sato Lab

BIOrigami

photo: Gottingham

BIOrigami is a DIY kit that lets you prototype bio-hybrid products by simply folding bio-sheets and connecting them to electronics.

Matsunaga Lab

MEMS Spray

photo: Gottingham

In the near future, components will get so small that one would be able to turn any electronics into energy-efficient MEMS particles which could be powered by an energy harvester.

Toshiyoshi Lab

Further information Design Lab website: https://www.designlab.tokyo/

Tohoku rejuvenation project with the american Pecan nuts

IIS and the Graduate School of Agricultural and Life Sciences (ALS) have launched the 'Pecans for Revitalizing Japanese Agriculture and Local Economy Project' to pecans to revitalize Japanese agriculture and local economies. The University signed an agreement on 28 July 2017 with City of Rikuzentakata, Iwate Prefecture, and confectionery manufacturer and distributor Salon de Royal (SDR) to "serve as a model for regional revitalization by utilizing Rikuzentakata's land to construct a base for pecan nut production from raw material to processing and commercial production and to make Rikuzentakata the home of Japan's domestic pecan crop in the same way that the Napa Valley is known for its wines."

Pecan nuts are members of the walnut family originating from Central and Southern North America known for their high nutritional value and antioxidant effects. Furthermore, Pecans are mass produced in the U.S. State of Arizona, and because of growing demand globally they are recognized as highly profitable agricultural crop. Notably, Japan currently continues to import 300 tonnes per year as they are not planted or produced there on a large scale.

In this project, the IIS and ALS are going to collaborate with Arizona-based North Bowie Farming and New Mexico State University to develop high-efficiency planting methods using Unmanned Aerial Vehicles (UAVs) and sensor net technology (developed by IIS) and select optimal crops for planting in Japan using genome data (developed by ALS).

In 2018 City of Rikuzentakata and the project team will begin trial planting of crops to develop products, and plans to establish tree nurseries and 2020 in the year set for planting domestic pecans for commercial sale.

Furthermore, the project has the backing of Salon de Royal, which handles one-third of all pecans imported by Japan. SDR established Rikuzentakata as the base for this project in order to support the revitalization of the city and of Japan's agricultural industries.

On 1 August 2017, SDR launched the company Golden Pecan in Rikuzentakata. Golden Pecan plans to construct trial facilities including stores, cafes, and processing factories in the city's elevated land area. Golden Pecan has already started selling pecans derived from Arizona with the brand name of "Arizona-no-Kiseki".

Reference https://www.iis.u-tokyo.ac.jp/en/news/2759/

Further information
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UTokyo New York Office welcomes collaborative activities

UTokyo New York Office was co-founded by UTokyo's IIS and the Institute of Medical Science (IMSUT) in September 2015 with the aim of promoting international collaboration and academic exchange with emphasis on engineering and medical science.

6 November 2015 — **Open Innovation for Future Medicine**

The multidisciplinary seminar was organized to commemorate the opening of the UTokyo New York Office and attracted more than 120 participants from academia, industry, as well as alumni associations of UTokyo in the USA. Speakers included Yoshinori Murakami, Dean of IMSUT; Teruo Fujii, Director General of IIS; Kevin Eggan, Harvard University; Michel Sadelain, Memorial Sloan Kettering Cancer Center; Roger M. Perlmutter, Merck Research Laboratories; and Ken Furuya, Executive Vice President of UTokyo.

20 January 2017 — **Aiming for a Fusion of Engineering and Medical Science -Activities and Prospects for the UTokyo New York Office**

The Symposium was held at the Convention Hall of IIS in Tokyo, and organized by the IIS and IMSUT in cooperation with the UTokyo New York Office. The main goal of the gathering was to share the latest activities of the Office with members of the audience.

8 September 2017 — **Tokyo – New York Stem Cell Summit**

This one day Summit was organized by The New York Stem Cell Foundation and UTokyo in order to promote stem cell research globally. Speakers from Japan and the USA described their latest findings research on stem cells and innovative engineering with a view to improving the translation of research from the lab to real-world applications.

This meeting was designed for those with an interest in translational medicine, and highlighted research and advances in the field of stem cells and engineering innovations that could improve translational research process.

3 November 2017 — **UTokyo NY Conference**

The Conference is held annually to highlight progress and challenges of initiatives launched by the UTokyo New York Office. Themes discussed at the 2017 meeting were 'Working with Deadly Viruses: Battling Ebola and Influenza' and 'Prevent Alzheimer's :Tohoku Rejuvenation Project with the American Pecan Nuts.'

March 2018 onwards — **Future events include a workshop in March 2018**

The details will be posted on the UTokyo New York Office.
http://utny.iis.u-tokyo.ac.jp/

The UTokyo New York Office welcomes donations for the management and activities of the office. We thank you for cooperation and understanding.
http://utny.iis.u-tokyo.ac.jp/donation.html

Blockchain Academic Synergized Environment (BASE) Alliance launched

The Center for Socio-Global Informatics, UTokyo-IIS and the Keio Research Institute announced the launch of a globally open industry-university collaborative organization on blockchain technologies.

Blockchain technology is a distributed ledger critical for recording transactions made in virtual currencies exemplified by Bitcoin.

The BASE Alliance was established as a globally open industry-university collaborative research association to openly discuss/research and develop/experimentally demonstrate Blockchain technologies.

Specific activities include research and development on blockchain technology in general and applications using blockchains; construction and operation of test bets to demonstrate experiments using existing and implemented blockchain technology; and fostering an international industry-university collaborative community.

Reference http://www.kri.sfc.keio.ac.jp/ja/press_file/20170724_base_en.pdf

Further information http://www.base-alliance.org/

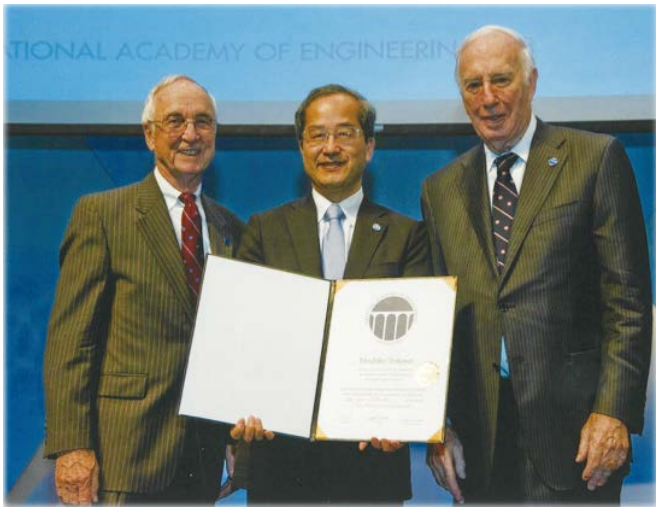
Yasuhiko Arakawa receives prestigious recognition for quantum - dot - research

The Japan Academy Prize 2017 was presented to Yasuhiko Arakawa at UTokyo-IIS on 12 June 2017 at the 107 Annual Award Ceremony in the presence of Their Majesties The Emperor and Empress of Japan. The award is in recognition for his research on quantum dots and their applications to photonic devices. "I am very honored to receive the Prize which is one of the most prestigious awards given to researchers in Japan," said Arakawa.

Arakawa has received numerous other awards including the Leo Esaki Prize, the Fujihara Award, and the Medal with Purple Ribbon.
http://www.qdot.iis.u-tokyo.ac.jp/index.html

Election as Foreign Member of the US National Academy of Engineering (NAE) was for his contributions to quantum dot lasers and related nanophotonic devices.

The NAE, National Academy of Sciences, and the National Academy of Medicine, are three of the most influential and prestigious academies in United States of America. The formal induction ceremony was held on 8 October 2017 in Washington, DC.

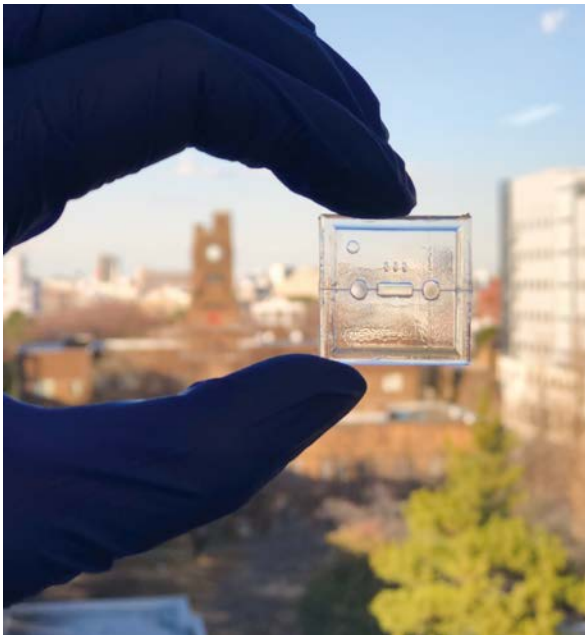


Reference

https://www.iis.u-tokyo.ac.jp/en/news/2685/

Video of the induction ceremony 2017.
https://www.iis.u-tokyo.ac.jp/en/news/2823/

Blood vessel-on-a-chips show anti-cancer drug effects in human cells



Researchers at UTokyo-IIS, CNRS and INSERM, report a new organ-on-a-chip technology for the study of blood vessel formation and drugs targeting this event. The technology recreates a human blood vessel and shows how new capillaries grow from a single vessel (parent vessel) in response to proper biochemical signaling cues. The technology can further be used to develop drugs targeting this growth as a therapeutic approach to treat cancer and blood-vessel-related diseases. The findings were published in *EBioMedicine*.

Angiogenesis describes a specific process of blood vessel formation from pre-existing blood vessels. Yukiko Matsunaga, lecturer at the IIS, has been working in the SMMIL-E project, a joint French-Japanese project against cancer (involving the CNRS, COL, Universite de Lille, UTokyo), by using tissue engineering and organ-on-a-chip technology to study biological phenomena including angiogenesis. Her new technology provides a simple setting to study angiogenesis and other effects such as the dynamics of blood vessel permeability.

Vascular endothelial growth factors (VEGF) are the primary proteins responsible for angiogenesis. They signal to the parental vessel to initiate sprouting and the direction toward which the new capillaries must grow.

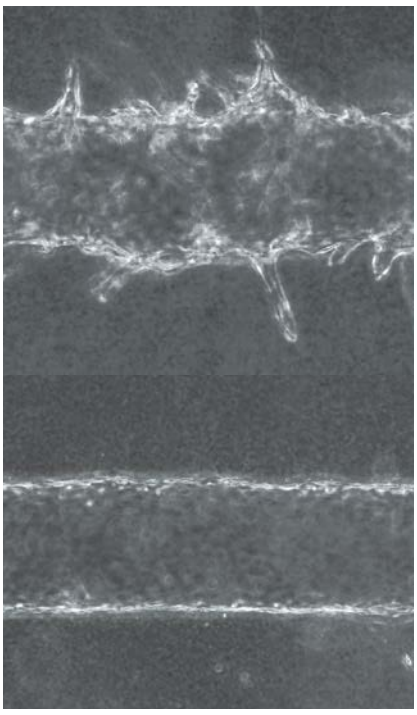
"The biochemistry of sprouting angiogenesis is well understood. VEGF leads endothelial cells to express DLL4, which activates NOTCH signaling. What is lacking is a good system to study drugs that are effective on angiogenesis," says Matsunaga.

Indeed, while necessary for organ survival, angiogenesis also sustains diseases like cancer. Several anti-cancer drugs such as sorafenib and sunitinib are effective in large part because of their anti-angiogenic effects.

In the new system, which was designed by Joris Pauty, a scientist in the Matsunaga laboratory, a single human blood vessel was fabricated into a collagen gel scaffold on a chip. Adding VEGF stimulated the formation of sprouts on the vessel, indicating the initiation of new blood vessels. Subsequent experiments performed with the support of a member of the SMMIL-E project, Fabrice Soncin, a research director at the INSERM, confirmed that VEGF activated NOTCH signaling through DLL4 just as in the human body. Adding either sorafenib or sunitinib inhibited the sprouting, but only sorafenib made the vessels highly permeable, which is a non-physiological condition. That both drugs prevented new vessel growth but with different effects on blood vessel permeability may explain why the two work differently in cancer treatment.

Since many diseases like cancer and diabetic retinopathy induce new vessels for their progression, Matsunaga notes that the chips could be used for even more advanced studies for drug effects on angiogenesis and cancer or diabetes.

"We can also use cancer cells in the chip to test their combined effects with the drugs on angiogenesis."



Effect of anti-angiogenic to prevent newly formed sprouts from the existing vessel.

Reference

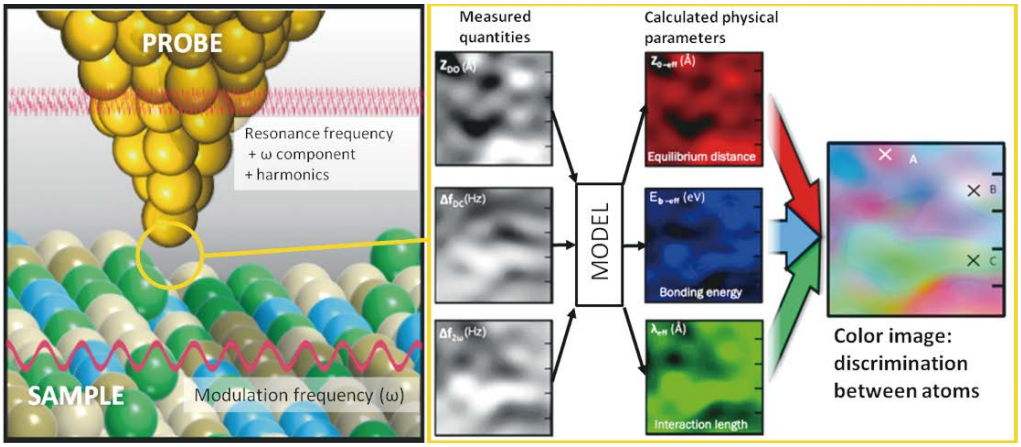
Joris Pauty, Ryo Usuba, Irene Gayi Cheng, Louise Hespel, Haruko Takahashi, Keisuke Kato, Masayoshi Kobayashi, Hiroyuki Nakajima, Eujin Lee, Florian Yger, Fabrice Soncin, Yukiko T. Matsunaga
A Vascular Endothelial Growth Factor-Dependent Sprouting Angiogenesis Assay Based on an in vitro Human Blood Vessel Model for the Study of Anti-Angiogenic Drugs
EBioMedicine (2018), doi: 10.1016/j.ebiom.2017.12.014

Bringing the atomic world into full color

A French and Japanese research group has developed a new way of visualizing the atomic world by turning data scanned by an atomic force microscope into clear color images. The newly developed method, which enables observation of materials and substances like alloys, semiconductors, and chemical compounds in a relatively short time, holds promise of becoming widely used in the research and development of surfaces and devices.

Individual molecules and atoms are much smaller than the wavelengths of visible light. Visualizing such tiny structures requires special instruments that often provide black-and-white representations of the positions of atoms. Atomic force microscopes (AFMs) are among the most powerful tools available for probing surfaces at the atomic scale. A nanoscale tip moving over a surface can not only give information about the physical positions of atoms but also yield data on their chemical properties and behavior. However, much of this information is lost when AFM signals are processed.

Now, researchers centered at UTokyo-IIS, led by Hideki Kawakatsu, have created a new way of operating AFMs and visualizing the data to extract structural and chemical information into clear, full-color images. These findings were recently published in *Applied Physics Letters*.



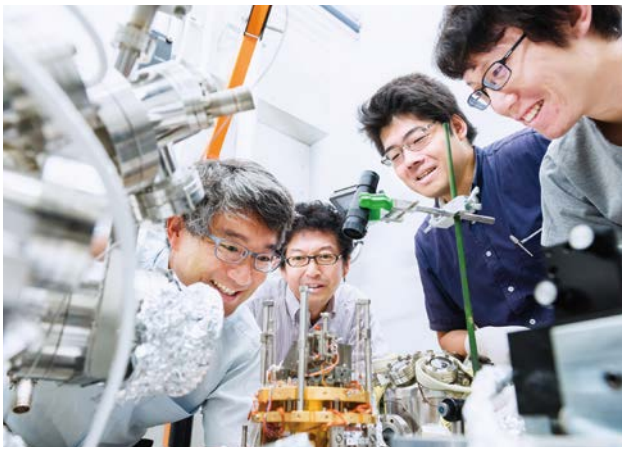
"AFM is an extremely versatile technique and our approach of linking the AFM tip height to the bottom of the frequency curve enabled us to perform measurements at the same time but without the risk of losing information from the surface," says study lead author Pierre Etienne Allain, a LIMMS/CNRS-IIS postdoctoral researcher.

People often perform AFM measurements by keeping the AFM tip at a fixed height while measuring changes in its vibrations as it interacts with the surface. Alternatively, it is possible to move the AFM tip up and down so that the frequency of the vibrations stays the same. Both these approaches have their advantages, but they also carry disadvantages in that one can be very time consuming, and the other can result in loss of information.

The IIS-led research has produced a way of moving the AFM tip and transforming the data so the tip stays above the surface in a position where the vibrational frequency is strongly influenced by the surface.

Another benefit of this approach is that the model yields three variables, to which the researchers assigned the colors red, blue, and green, respectively, thereby enabling them to produce full-color images. They also successfully tested their method on a silicon surface.

"If the colors in the image are the same, we can say the signals come from the same type of atom and surroundings," says coauthor and fellow postdoctoral researcher Denis Damiron. "This new way of representing complex chemical and physical information from a surface could let us probe the movements and behavior of atoms in unprecedented detail."



Reference

P. E. Allain, D. Damiron, Y. Miyazaki, K. Kaminishi, F. V. Pop, D. Kobayashi, N. Sasaki, and H. Kawakatsu
Color Atomic Force Microscopy: a method to acquire three independent potential parameters to generate a color image
Applied Physics Letters (2017), doi: 10.1063/1.4991790

Kazuyuki Aihara of UTokyo-IIS is collaborating with colleagues in Germany and the United Kingdom on the statistical analysis of 'big-data measurements' of frequency fluctuations in power grids of North America, Europe and Japan. The research is expected to play an important role to improve the design of power grids for sustainable energy solutions.

Getting to grips with frequency fluctuations of power grids

The electrical energy retrieved from a socket, when connected to a device, is provided by a power grid. For an electrical power grid to operate in a robust way, its frequency needs to be as constant as possible. Fluctuations, however, are unavoidable because of fluctuating demands and supplies. Whereas procedures exist for compensating consumer-induced fluctuations, maintaining a quasi-constant nominal grid frequency becomes more difficult when wind or solar power is fed into the grid, given the widely varying power-production timescales involved. A team of researchers including Kazuyuku Aihara has now analysed the fluctuations observed from various power grids around the world, and come up with ways of modelling them — an important step towards the improved design of power grids based on sustainable energy solutions.

Aihara and colleagues investigated power grids in Japan, North America and Europe, operating at nominal frequencies of 50 Hz or 60 Hz. They made the important observation that frequency distributions are non-Gaussian, with heavy tails and 'skewness'; many natural phenomena display Gaussian distributions that are symmetric around an average value and have rapidly vanishing tails. The researchers were able to pinpoint an important source of the fluctuations: trading. Electrical energy, as a commodity, is usually traded in intervals of 15 or 30 minutes; after the start of each interval, production changes and the grid needs to relax to a new operational regime.

Based on these observations, the researchers developed mathematical models that not only enabled reproducing the behaviour of the studied grids, but also predicting fluctuations when varying a grid's size. The findings of Aihara and colleagues call for a rethink of the design and operation of present and future energy systems.

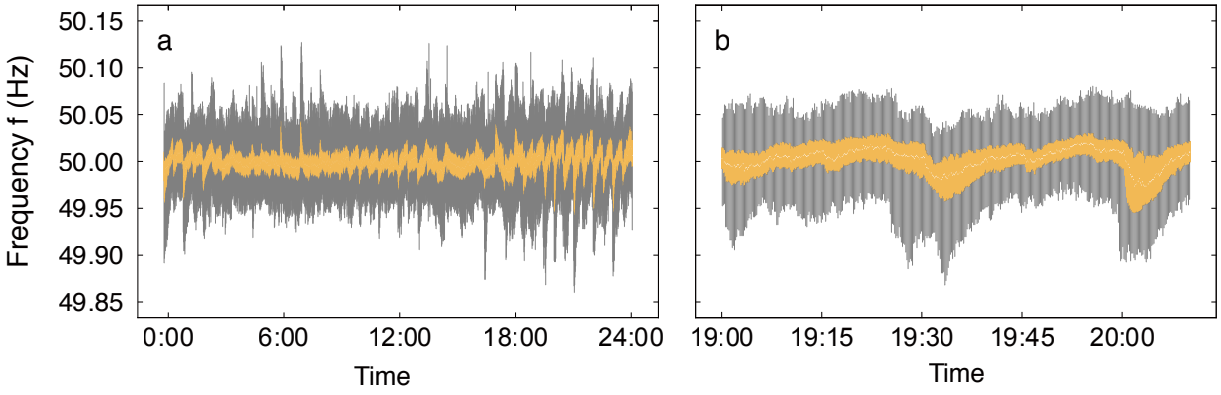


Fig. 1 : Frequency fluctuations around the nominal frequency of 50 Hz in the European power grid.

Reference Benjamin Schäfer, Christian Beck, Kazuyuki Aihara, Dirk Witthaut and Marc Timme
Non-Gaussian power grid frequency fluctuations characterized by Lévy-stable laws and superstatistics.
Nature Energy(2018), doi:10.1038/s41560-017-0058-z

Other recent publications by Kazuyuki Aihara's group

1. Peter L. McMahon, et al., A fully-programmable 100-spin coherent Ising machine with all-to-all connections, *Science,* 354(6312), 614-617 (2016). doi: 10.1126/science.aah5178

2. Takahiro Inagaki, et al., A coherent Ising machine for 2000-node optimization problems, *Science,* 354(6312), 603-606 (2016). doi: 10.1126/science.aah4243

3. Emyo Fujioka, et al., Echolocating bats use future-target information for optimal foraging, *Proceedings of the National Academy of Sciences of the United States of America,* 113(17), 4848-4852 (2016). doi: 10.1073/pnas.1515091113

4. Nozomu Takahashi, et al., A hierarchical multi-oscillator network orchestrates the Arabidopsis circadian system, *Cell,* 163(1), 148-159 (2015). doi:10.1016/j.cell.2015.08.062

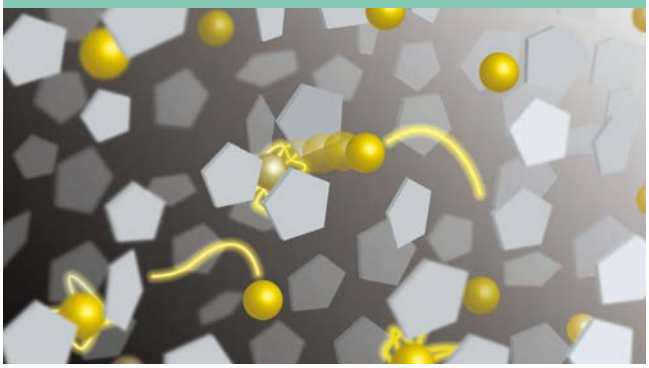
Windows of Opportunity :Solar Cell with Improved Transparency

A research group of IIS led by Tetsu Tatsuma has developed a semi-transparent solar cell. Instead of conventional silicon, the cell uses an organic-inorganic hybrid material (perovskite) to generate electricity. This material efficiently absorbs blue light, and nanocubes of metallic silver improve the capture of red light, while letting visually important green light through. Because of the efficient light capture, the perovskite layer can be made very thin, improving its transparency. The cell could therefore be used to coat windows.

Scientific Reports(2017), doi:10.1038/s41598-017-11193-1

Further information : https://www.iis.u-tokyo.ac.jp/en/news/2812/

Scientists win a gold metal for liquid behavior

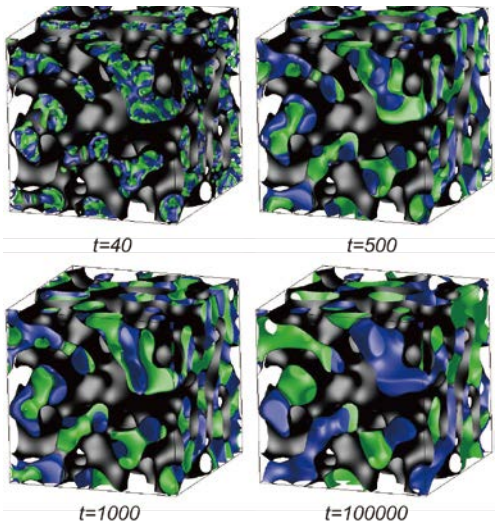


IIS researchers Teruyasu Mizoguchi and Tomohiro Miyata report the first direct observation of atoms moving in liquid by collaborating with National Institute of Materials Science. Using Scanning transmission electron microscopy, they find gold ions diffuse through ionic liquid by a phenomenon they describe as a 'cage-jump.' Image analysis determined the diffusion coefficient and activation energy of the diffusion. Quantification of liquid at the atomic level is expected to contribute to the design of energy efficient devices.

Science Advances(2017), doi: 10.1126/sciadv.1701546

Further information : https://www.iis.u-tokyo.ac.jp/en/news/2821/

Shape separates substance

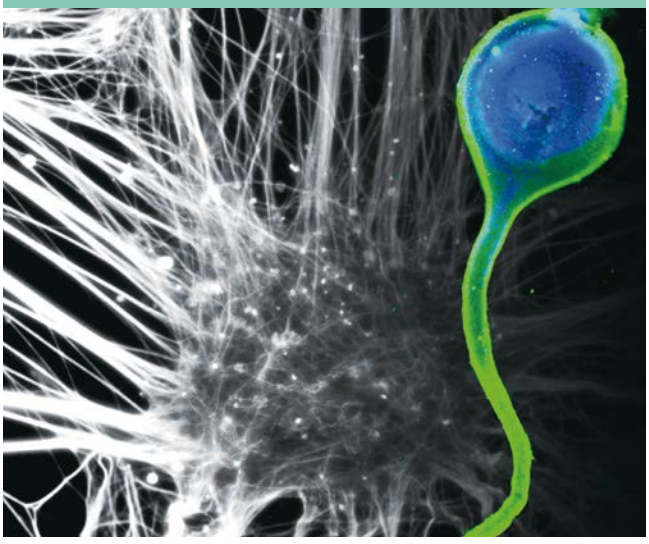


A research group of IIS Hajime Tanaka reports a new physical model that shows how the topology of a porous material influences the phase separation of binary mixtures. The model uses two variables, the density field of a porous structure and the composition field of a binary mixture, to show that topology has very different effects on phase separation depending on the porous structure being random and either 2D or 3D.

Science Advances(2017), doi: 10.1126/sciadv.aap9570

Further information : https://www.iis.u-tokyo.ac.jp/en/news/2829/

3D axon assemblies pave the way for drug discovery



Japanese and American scientists have together designed a microdevice that efficiently promotes the formation of axon fascicles from stem cell-derived neurons. The 3D structures are common in the body, but have proven difficult to prepare in the lab. The microdevice is expected to be a resourceful tool for drug discovery against neurodegeneration.

Stem Cell Reports(2017), doi: 10.1016/j.stemcr.2017.09.021

Further information : https://www.iis.u-tokyo.ac.jp/en/news/2794/

About UTokyo-IIS

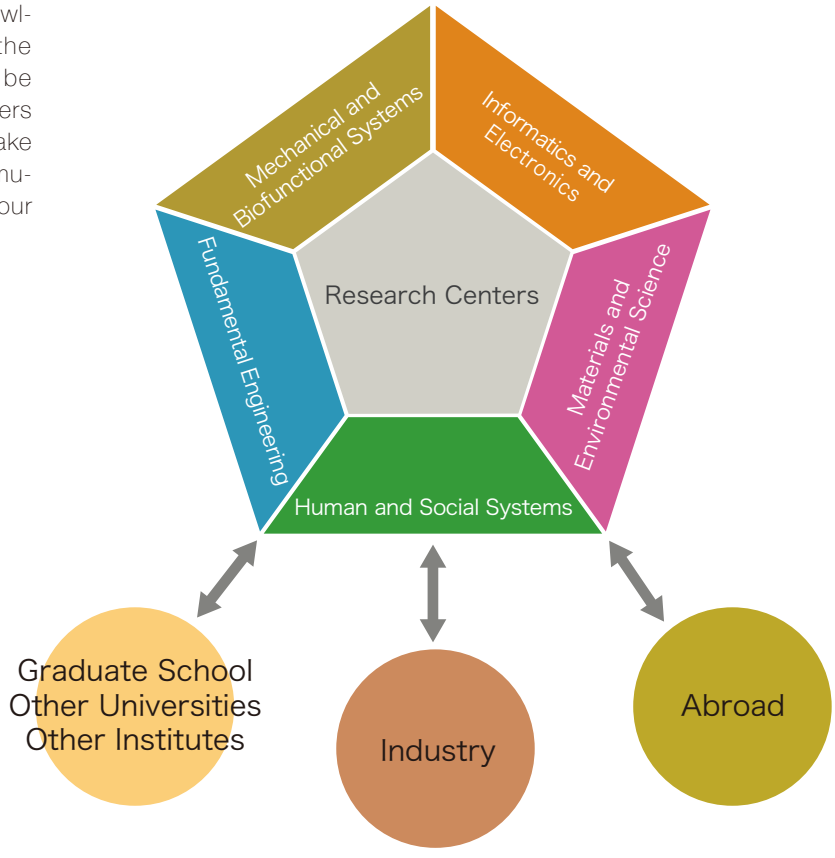
Institute of Industrial Science (IIS), the University of Tokyo (UTokyo), is one of the largest university-attached research institutes in Japan. More than 120 research laboratories, each headed by a faculty member, comprise IIS, with more than 1,000 members including approximately 300 staff and 700 students actively engaged in education and research. Our activities cover almost all the areas of engineering disciplines.

Since its foundation in 1949, IIS has worked to bridge the huge gaps that exist between academic disciplines and real-world applications. Through the pursuit of its mission to tackle the problems lying between engineering science and practice, and foster the next generation of engineers who will fulfill major roles in tomorrow's industry, it can be said that IIS has greatly contributed to industrial innovation by actively promoting collaboration between industry and academia. The capacity of IIS to cope with industrial practice originates from its flexible organizational structure, which allows it to dynamically organize interdisciplinary research activities, to initiate the formation of new research areas and explore solutions to practical issues in the real world. Currently IIS has 10 research centers, 5 collaborative research centers, and 2 international collaborative research centers, as organizational structures that have taken initiatives in various interdisciplinary research fields.

Recently it is becoming more and more apparent that we need to take action against the issues faced by modern society, such as those regarding the environment, energy, and resources as well as social infrastructure and aging societies to name but a few. It is expected that the university utilizes its knowledge and findings to pave the path for solutions to the issues faced by today's society, and foster the human resources necessary to address tomorrow's challenges. The above-mentioned interdisciplinary approach of IIS makes it an effective place for the construction of methodologies to solve real-world problems, and further educate the people that will be engaged in their practice. Most issues faced by modern societies are the product of multiple and complex factors. Sometimes it is difficult to address these with only engineering expertise, and an increasing number of issues require a global approach combined with efforts to cross the borders. In light of this, IIS has initiated trials to implement its research advances in society, taking into account our social systems, economy and social needs, in an effort to try and co-create engineering knowledge through practice, and in doing so take a step beyond standard industry-academia collaboration. This “social implementation” is to be carried out not only in Japan, but also in foreign countries, where laboratories are being newly established to promote co-creation with a global perspective.

As one of the leading institutes in the field of engineering, while we will continue to create new knowledge in each of the fundamental disciplines, the capacity to cope with engineering practice will be cultivated by mutual stimulation among researchers with different academic backgrounds. We will make the utmost effort to nurture the dynamic and stimulating atmosphere of IIS, and successfully fulfill our mission.

Director General
Teruo Fujii



Five Research Departments and Research Centers

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