The University of Electro-Communications

UEC e-Bulletin

Updates on research, innovation, and events at UEC:
Unique and Exciting Campus in Tokyo

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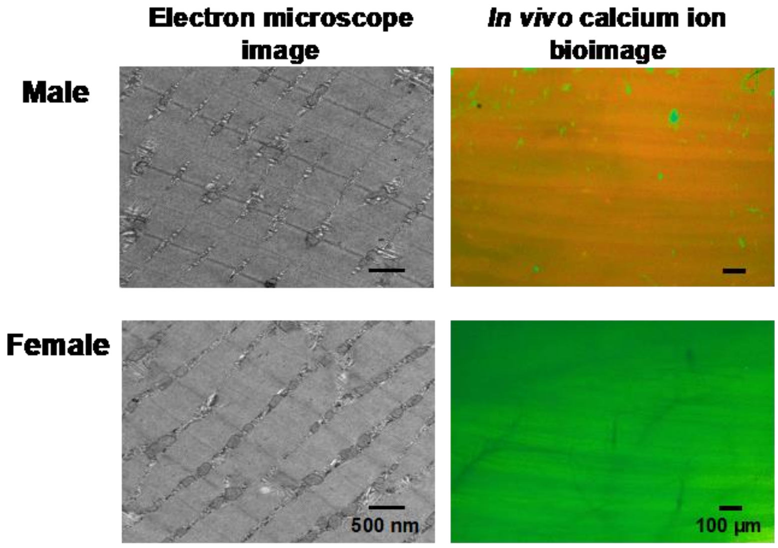
In vivo bioimaging: technology to elucidate sex-dependent differences in skeletal muscle function

It is widely accepted that there is a sex-dependent difference in physical performance. Specifically, it has been shown that females show superior fatigue resistance compared to males.

However, the relationship between sex differences in skeletal muscle function and mitochondrial ability—known as fatigue resistance—is still not clear.

Now, Yutaka Kano and colleagues at University Electro-communications and Kansas State University focused on calcium ion (Ca^{2+}) dynamics that regulate muscle contraction and mitochondrial function.



Left: Sex-dependent difference in ultrastructure of intermyofibrillar mitochondria. Right: Effects of Ca^{2+} uptake inhibition of sarcoplasmic reticulum (SR). The red color area has high Ca^{2+} concentration (Male). Green color indicates low Ca^{2+} area (Female). These images show the difference in mitochondrial Ca^{2+} buffering capacity.

Using *in vivo* bioimaging system for experimental animal models, they measured changes in cytoplasmic Ca^{2+} concentration after Ca^{2+} uptake inhibition of sarcoplasmic reticulum (SR) in male and female mice.

The results suggest that (a) mitochondrial Ca^{2+} uptake ability is greater in female than male myocytes; and (b) this superior Ca^{2+} uptake ability of female myocytes is due, partly, to the higher intermyofibrillar mitochondrial content.

If this observation is true for human muscles, as well as helping to explain sex-specific exercise adaptations this observation may also open the way for the development of new therapeutic strategies for patient populations characterized by muscle dysfunction and exercise intolerance.

References

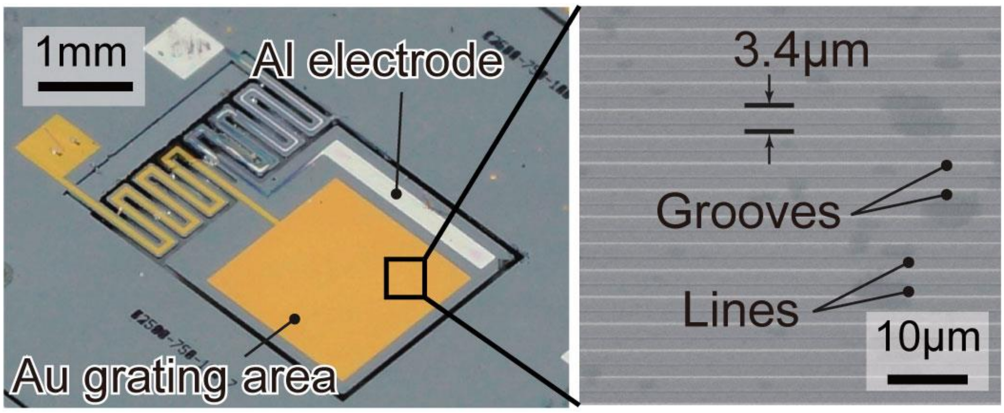
- Authors: Daiki Watanabe, Koji Hatakeyama, Ryo Ikegami, Hiroaki Eshima, Kazuyoshi Yagishita, David C. Poole, and Yutaka Kano.
- Title of original paper: Sex differences in mitochondrial Ca^{2+} handling in mouse fast-twitch skeletal muscle *in vivo*.
- Journal, volume, pages and year: *Journal of Applied Physiology* **128**, 241-251 (2020).
- Digital Object Identifier (DOI): 10.1152/japplphysiol.00230.2019.
- Affiliations: Center for Neuroscience and Biomedical Engineering, University of Electro-Communications. Clinical Center for Sports Medicine and Sports Dentistry, Tokyo Medical and Dental University. Departments of Anatomy & Physiology, Kansas State University.

MEMS technology for fabricating plasmonic near-infrared spectrometers

Near-infrared spectroscopy provides absorption spectrum unique to substances so that discrimination of gas species becomes possible. Miniaturization of spectrometers is thus required to realize compact gas sensors for monitoring air quality in living spaces.

However, conventional near-infrared spectrometers have gratings to disperse incident light into different wavelengths, so long optical path lengths are required for spectroscopy, which is an obstacle for miniaturization these devices.

Now, Oshita Masaaki and Kan Tetsuo at the University of Electro-Communications and collaborators have developed a gold diffraction-grating-type plasmonic photodetector on a MEMS—Micro Electro Mechanical Systems—deformable cantilever.



A gold diffraction-grating on a MEMS cantilever.

The device was fabricated using a bulk-micromachining technology using n-type silicon. A gold diffraction grating served the purpose as surface plasmon (SP) excitation. When the light is incident on the device, mechanical vibration of the cantilever dynamically changes the angle of incidence of the light, thereby alternating the SP coupling condition. Coupled to SPR, the light energy is transduced to photocurrent on the device.

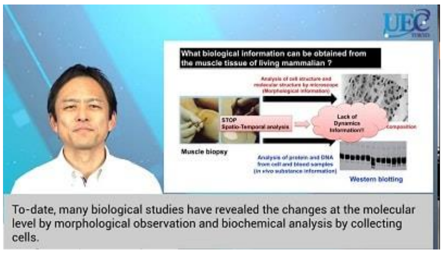
Using an angular change of the cantilever over −21-21 degrees, optical spectrum in the near-infrared light was numerically retrieved by analyzing the time-varying photocurrent.

Higly miniaturized near-infrared spectrometers were realized, and are expected to lead to new small sized IoT sensors.

References

- Authors: Masaaki Oshita, Hidetoshi Takahashi, Yoshiharu Ajiki, Tetsuo Kan
- Title of original paper: Reconfigurable Surface Plasmon Resonance Photodetector with a MEMS Deformable Cantilever.
- Journal, volume, pages and year: *ACS Photonics (in press)*.
- Digital Object Identifier (DOI): 10.1021/acsphotonics.9b01510
- Affiliations: Department of Mechanical Engineering and Intelligent Systems, Graduate School of Informatics and Engineering, The University of Electro-Communications.

Yutaka Kano Professor, Department of Engineering Science, University of Electro-Communications



Molecular mechanisms controlling muscle contraction in the body

Muscle contraction is controlled by changes in various molecules in the body. In cells, the contraction and relaxation of calcium ions in a short time are regulated. To-date, many biological studies have revealed the changes at the molecular level by morphological observation and biochemical analysis by collecting cells.

However, these methods lack spatial and temporal information in the living body, that is, information on the dynamics in the living body. Yutaka Kano is working on bioimaging research to visualize in vivo molecules in living animal bodies. "To date, many fluorescent proteins and compounds have been made to visualize the inside of living organisms, but we have developed bioimaging technology to introduce these into living organisms," says Kano.

This video includes visualizations of the dynamics of calcium ions in muscle cells and examples of research using this observation method.

In skeletal muscle, there is a channel called TRPV1, which senses heat and allows calcium ions to flow into cells. In the video the fluorescence image shows that the more reddish the color, the higher the intracellular calcium ion concentration. In the middle heat-loaded group, heat increased the intracellular calcium ion concentration by heat, and inhibition of TRPV1 inhibited the increase in intracellular calcium ion concentration by heat.

"Hence, in this study, we succeeded in visualizing the dynamics of intracellular calcium ion concentration under thermal stimulation in an vivo environment," says Ryo Ikegami a graduate student in the Kano Laboratory.

Ayaka Tabuchi, a grad-student in the Kano Lab also appears in the video.
"I am focused on the change in intracellular calcium ion concentration due to exercise," says Tabuchi. "Changes in intracellular calcium ion concentration during exercise can be visualized by in vivo bioimaging."

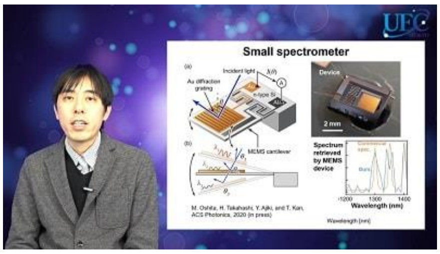
In this study, the Kano Lab clarified the pathway of calcium ion influx into cells by exercise and the existence of a mechanism that homogenizes the accumulated information on intracellular calcium ion concentration in cells.

They are also working on visualization of vascular networks using two-photon microscopy and mitochondrial networks using photothermographic microscopy.

The goal is to elucidate physiological systems by applying the latest technology by developing fluorescent molecular probes and optical systems to bioimaging research and visualizing molecular dynamics in vivo.

Further information
Research Highlight: *In vivo* bioimaging: technology to elucidate sex-dependent differences in skeletal muscle function
Department website: http://blsc.xsrv.jp/en/

Tetsuo Kan Associate Professor Department of Mechanical and Intelligent Systems Engineering



MEMS technology for fabricating plasmonic devices

Tetsuo Kan is developing new MEMS devices or sensors, that is microelectromechanical systems which are based on semiconductor fabrication techniques.

"MEMS technology provides us with very small size sensors such as force sensors or inertial sensors or photodetectors and so on," says Kan. "We are focusing on new optical devices by combining MEMS and plasmonics."

Plasmonics is optical oscillation of metal nano or microstructures. So, if meal nano or microstructures are illuminated with light, then oscillation occurs on the surfaces of the metals.

But conventional methods for detecting these resonances use huge optical microscopes, and since such plasmonics is very sensitive to the external environment, and is a fascinating phenomenon for sensing.

"If we put such nanostructures on top of semiconductors such as MEMS, we can electrically detect oscillations as electrical signals," explains Kan. "So, we no longer require huge optical setups, so we can minimize plasmonic sensors within a very small chip size.So, we are applying this basic technology for developing new cost-effective photodetectors, or new spectrometers or new chemical sensors and so on."

The structures are made using microfabrication facilities at UEC Tokyo located in clean rooms build for nanolithography or photolithography.

In addition to microfabrication, optical simulation is also indispensable and in order to get very good resonant structures, Kan and his team carry out optical simulations to design high resonance structures and the fabrication process required. Kan refers to this as their "recipe for the microfabrication".

Recently, Kan has succeeded in making a new and very small spectrometer, based on a combination of the MEMS cantilever structures and a gold grating on the surface of a cantilever.

In this structure, gold gratings generate plasmonic resonance when the structure is illuminated by the light, and the plasmonic response is measured as a photocurrent on the surface of the cantilever.

Kan and his colleagues found that when the cantilever is vibrated and light is incident on the gold surface, they could retrieve spectrum information by calculating the relationship between the vibration angle and the photocurrent at each angle.

"We think that this is very small or one of the smallest spectrometers ever made," says Kan. "We are now applying this very small spectrometer to gas sensing, for example, in a room or in automotive environment, as new IoT sensor. I think the combination of MEMS and plasmonics is a novel approach to fabricate high performance and versatile sensors. So, I we will continue explore MEMS and plasmonics fields."

Further information

Research Highlight: MEMS technology for fabricating plasmonic near-infrared spectrometers
Department website: http://www.ms.mi.uec.ac.jp

Self-regulated learning: English for students of science and engineering

Suwako Uehara
Associate Professor
Graduate School of Informatics and Engineering
Faculty of Informatics and Engineering Division of General Education

"My approach to teaching English to students majoring in science and technology is based on the so-called 'self-regulated learning,'" says Suwako Uehara, an associate professor at the Graduate School of Informatics and Engineering, Faculty of Informatics and Engineering Division of General Education, UEC Tokyo. "Amongst other things, this requires emphasizing motivation, awareness, setting goals, developing skill sets and technology for the mutual benefit of both students and their teachers. Teaching STEM students is a challenging and continuously evolving process of education."

Self-Access Park

The UEC Self-Access Park (UECSAP) was established by Uehara and her colleagues to support language learning outside of the classroom. "The UECSAP is our version of a SALC, "self-access learning center," explains Uehara. "It has been running for over five years and is managed by members of the English faculty and students. Activities include peer support on writing papers and presentations in English, organizing seminars and lectures on culture as well as giving talks on research to local high school students."

Uehara continuously assesses the degree of satisfaction of the students with the UECSAP program and shares the results at conferences and seminars. Recent results of a survey showed an above average user satisfaction for the level of support.

Uehara found that the development of the program depends on the needs of individual institutions and their stakeholders, and that it is imperative to share information about the program with relevant sections within institutes.

"The survey highlighted a need for discussion on the level of autonomy or forced autonomy each institution requires to have an active SALC," says Uehara. "More emphasis should be made on raising awareness of studies related to language learning to users, language educators, and student staff via research reports and papers. Additionally, there are benefits in organizing motivational talks by peer role models to foster autonomous learning based on internal motivation studies."

Teaching methods for graduate school technical English: English for specific purposes (ESP) and flipped learning

Uehara is also conducting research on developing methods to teach science and technology graduates how to make presentations at conferences. At UEC, Uehara and her colleagues work with faculty members specializing in science and engineering to run a 15-week course focused on teaching approximately 120 first year graduate students how to make presentations at international conferences. As part of the course, each student gives a short two-minute presentation about their undergraduate thesis in English. "This course is special because experts in English teaching and scientists and engineers work together to compliment their skill sets to motivate students to learn the art of presentations at international conferences. It's a unique course yielding encouraging results."

Surveys show that students are highly attentive with 97% attendance and 98% homework submission rate. Furthermore, questionnaires show that in the context of presentations, students want to improve their speaking strategies, level of English for writing slides, and delivery of the slides. Regarding writing, the demands are for preparing whole research manuscripts with emphasis on abstracts, grammar and style, and expressing technical terms. For reading, it is speed reading, skills to summarize papers in their own words, and critical analysis.

"We found that the vast majority of students were satisfied with the course," says Uehara. "However, the feedback showed that the more than 60% of students found it difficult to give the two-minute talk."

To circumvent the lack of time for longer talks during lectures, Uehara is planning to introduce 'flipped learning", a pedagogical approach in which classroom lectures are recorded on video for students watch for homework, and this gives more time for discussion and practical work in class. "According to studies in the field, the benefits of flipped learning include that students can take control of their learning, there is a collaboration between teachers and students, and there is an increased responsibility for both parties to make the course a success," says Uehara.

References

Uehara, S. (2019 May). Developing a self-access in a STEM University. *PanSIG2019 Conference*, 18-19 May 2019, Konan University, CUBE Campus, Hyogo, Japan.

Uehara, S., Terashima, S., & Shi, J. (2019 November). Needs analysis for graduate school technical English course design and materials development. *The 3rd Annual Conference of Asia ESP* & the 8th Chinese National Conference on ESP, 15-17 November 2019, Chongquing University China.

Further information

Suwako Uehara, Associate Professor
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http://kjk.office.uec.ac.jp/Profiles/66/0006520/prof_e.html
UECSAP Website: http://uec-selfaccesspark.wixsite.com/uecselfaccesspark

UEC signs general agreement with Hanoi Medical University

January 21, 2020

As of 6 January, 2020, the University of Electro-Communications (UEC) singed general agreement with Hanoi Medical University, Vietnam, to promote further international collaboration between the two universities.

Hanoi Medical University was established in 1902, and is the oldest medical school in Vietnam. It is a leading-edge medical school and has produced number of highly qualified medical doctors.

This agreement will enhance the tie between Hanoi Medical University and UEC and promote research and education exchange.

Industry-UCB-UEC-Keio Workshop 2019

January 17, 2020
https://www.uec.ac.jp/eng/news/announcement/2020/20200117_2335.html

From December 10 to 11, 2019, Industry-UCB-UEC-Keio Workshop 2019 (IUUKWS 2019) took place at Keio University (Keio). An interdisciplinary group of corporate executive officers, experts, and researchers from various industries, the University of California, Berkeley (UCB), Keio, and the University of Electro-Communications (UEC) came together for the workshop.

Opening Remarks by UEC

The workshop was originally co-organized by UCB and UEC in 2017.
IUUKWS 2019 is held to discuss the details of "Collaborative Construction of Service Infrastructure Technology/Platform" to realize a super smart society through industry-academia collaboration. To devise effective strategies to realize the Intelligence Service Infrastructure Technology/Platform, it is essential to promote close cooperation between industries, UCB, Keio, and UEC. The participation of Keio's Faculty of Science and Technology has greatly contributed to the further development of the workshop.

The workshop started with an opening address by UEC President Fukuda and a welcome speech from Dr. Nakano. Afterward, 5 sessions covered the fields of control systems, bioengineering, quantum information, materials science 1, and material science 2. Keio and UEC students held a poster session. Mr. Peter Fitzgerald, the president of Google Japan LLC, delivered a planerary lecture, and Mr. Sato Koji, the president of Hitachi Metals, Ltd., concluded the closing session. The workshop was successful thanks to the participation of many researchers and students.

The upcoming IUUKWS 2020 is scheduled to be held at UCB and aims to advance future international research collaboration and industry-academia collaboration.

UEC signs general agreement with UNS

January 21, 2020
https://www.uec.ac.jp/eng/news/announcement/2020/20200121_2348.html

On January 9, 2020, the University of Electro-Communications (UEC) has singed general agreement with Universitas Sebelas Maret (UNS), Indonesia, to promote further international collaboration.

Group photo

5 UEC members including UEC president Fukuda, and Dr. Nakano, the member of Board of Directors visited UNS campus to attend the signing ceremony. The meeting at UNS was initiated by the welcome speech from Prof. Dr. Wiwoho, the president of UNS. Followed by president Fukuda's speech and presentations on overview of the universities, President Wiwoho and Presidnet Fukuda put their signatures on the general agreement.

After the signing ceremony, members of UNS and UEC exchanged ideas for further research and student exchange, and the UEC delegation members was taken on a tour of the campus including Center for Japanese Studies at UNS.

This agreement will further promote research and educational collaboration between UNS and UEC.

The University of Electro-Communications (UEC) in Tokyo

is a small, luminous university at the forefront of pure and applied sciences, engineering, and technology research. Its roots go back to the Technical Institute for Wireless Commutations, which was established in 1918 by the Wireless Association to train so-called wireless engineers in maritime communications in response to the Titanic disaster in 1912. In 1949, the UEC was established as a national university by the Japanese Ministry of Education, and moved in 1957 from Meguro to its current Chofu campus Tokyo.

With approximately 4,000 students and 350 faculty, UEC is regarded as a small university, but with particular expertise in wireless communications, laser science, robotics, informatics, and material science, to name just a few areas of research.

The UEC was selected for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities as a result of its strengths in three main areas: optics and photonics research, where we are number one for the number of joint publications with foreign researchers; wireless communications, which reflects our roots; and materials-based research, particularly on fuel cells.

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