The University of Electro-Communications

UEC e-Bulletin

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

Vol.20, December 2018

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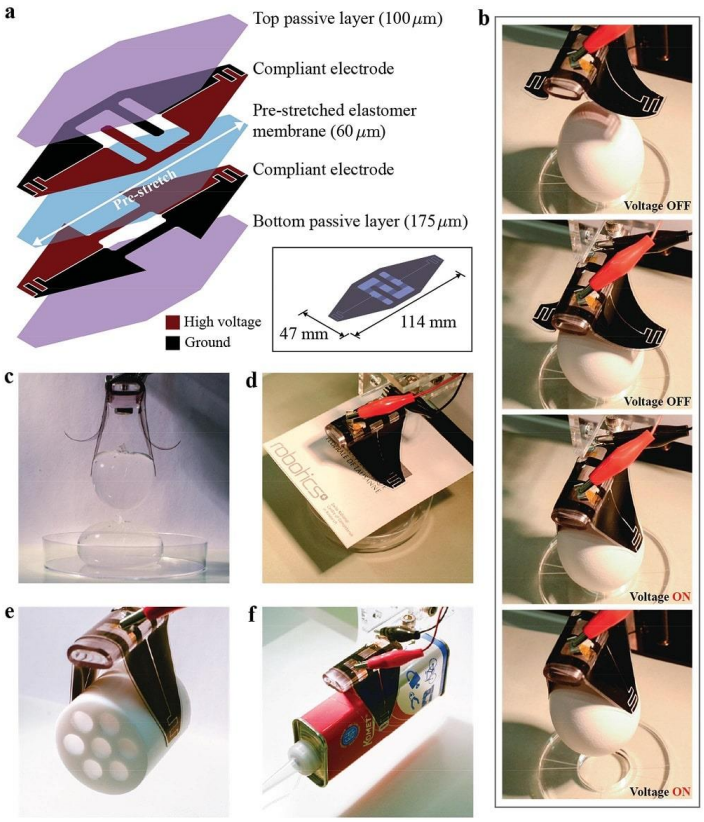
Soft robotic gripper based on dielectric elastomer actuators

Soft robots that are composed of compliant materials offer important advantages over conventional rigid robots, such as simplified body structure and control, as well as high robustness and versatility.

Dielectric elastomer actuators (DEAs) are soft actuators and promising technology for soft robotics. DEAs are compliant (typical elastic modulus of ~1 MPa), fast (1 kHz bandwidth), efficient (theoretically maximum 90 % of electromechanical efficiency), and exhibit large actuation strokes (more than 100 %). Because of these facts, DEAs have been applied to various robots and systems.

Shintake and colleagues at the University of Electro-Communications, Japan, and at the Swiss Federal Institute of Technology in Lausanne, Switzerland developed a DEA based soft biomimetic gripper than can handle diverse objects with its simple structure. The idea behind it is the modification of the electrodes in DEA that enables electrically controlled adhesion as well as actuation.



Structure of the electro-adhesion-enabled soft gripper, and demonstration of gripping different objects.

Reference

- Authors: Jun Shintake, Samuel Rosset, Bryan Schubert, Dario Floreano, Herbert Shea
- Title of original paper: Versatile soft grippers with intrinsic electroadhesion based on multifunctional polymer actuators
- Journal, volume, pages and year: *Advanced Materials*, vol. 28, no. 2, pp. 231-238
- Digital Object Identifier (DOI): 10.1002/adma.201504264
- Affiliations: Department of Mechanical and Intelligent Systems Engineering, The University of Electro-Communications. Previously School of Engineering, Swiss Federal Institute of Technology in Lausanne.
- Researcher Video Profiles: http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2018/jun-shintake.html

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Digital Public Media: Mid-air Display Technology

Recently, virtual reality technology plays an important role as an interface between current cyber physical systems and wearable displays, and HMD is HMD is a hot topic. The problem with wearables is that the same information cannot be shared by many users even though they are in the same space. It needs other information presentation and sharing methods that people share together.

Mid-air imaging technology is a promising approach to meet these requirements. Optical imaging is used to form a mid-air image through the reflection and refraction of a light source. It seamlessly connects a virtual world and the real world to superimpose visual images onto the real world. Previous research introduced light emitting displays as a light source. However, they have problems related to attenuation of the brightness under strong light environment.

Naoya Koizumi at the University of Electro-Communications, Tokyo, has proposed a novel mid-air imaging optical system that captures ambient light using a transparent LCD (liquid crystal display) and a diffuser. He built a prototype to confirm his design principles in sunlight and evaluated several diffusers.

He confirmed the principle of the mid-air imaging optical system in sunlight, chose an appropriate diffuser, and proposed a practical design which can remove disturbance light for outdoor use.

He measured the luminance of the mid-air image in an outdoor environment. The maximum luminance was 355 cd/m2 when the illuminance was 12,280 lx, which is bright enough to see the image outdoors.

"This is a novel approach for mid-air imaging. If I can install it in the public space, It will change the landscape of the city," says Koizumi.

Sunny Day Display. Mid-air image is visible and floats above hand using light from sun.

Reference

- Authors: Naoya Koizumi.
- Title of original paper: Sunny Day Display: Mid-air Image Formed by Solar Light
- Journal, volume, pages and year: *Proc. of the 2017 ACM International Conference on Interactive Surfaces and Spaces*, pp. 126 - 6 (2017).
- Digital Object Identifier (DOI): 10.1145/3132272.3134137
- Affiliations: Department of Infomatics. The University of Electro-Communications.
- Koizumi Lab. website: https://www.media.lab.uec.ac.jp/
- Researcher Video Profiles: http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2018/naoya-koizumi.html

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Molecular materials with ultralong-lived room-temperature triplet excitons: Persistent room-temperature phosphorescence and nonlinear optical characteristics under continuous irradiance

The lifetime of triplet state of molecular materials is generally shorter than 1 ms at room-temperature (RT) because nonradiative deactivation of the triplet state is usually rapid at RT.

However, if the fast nonradiative deactivation from the triplet state is largely suppressed, triplet excitons with a very long lifetime at RT can form. Molecular materials with the long exciton lifetimes could potentially lead to the realization of new applications that are unfeasible using conventional molecular materials with short exciton lifetimes.

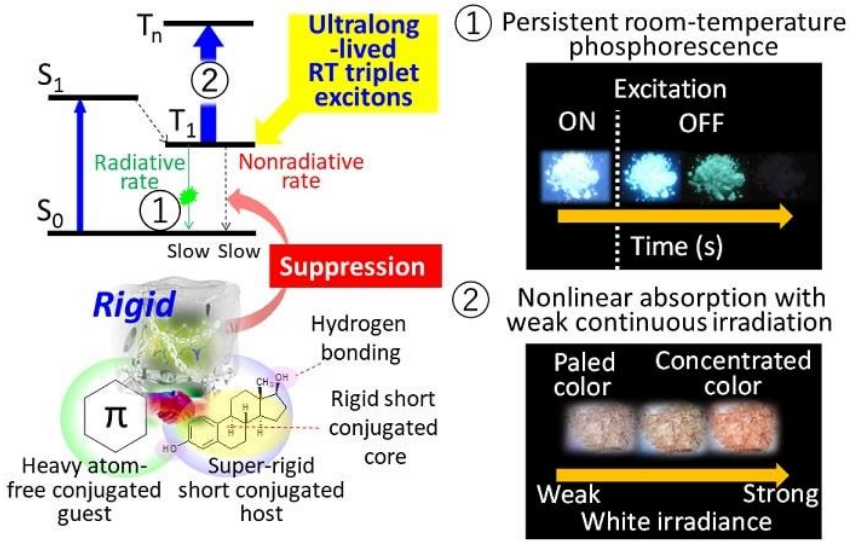
Shuzo Hirata and colleagues at the University of Electro-Communications, Tokyo, have proposed novel molecular materials with triplet excitons with lifetimes of longer than 1 s at RT, *i.e.*, ultralong-lived RT triplet excitons.

The materials consist of heavy atom-free conjugated guest molecules in an amorphous hydroxyl steroidal host.

The highly rigid short conjugated core as well as intermolecular hydrogen bonding of the host molecule minimized the nonradiative rate from triplet state of the guest molecules. Because of the small nonradiative rate, the molecular materials showed triplet lifetimes longer than 1 s at RT. The ultralong-lived RT triplet excitons enabled unique functions such as persistent room-temperature phosphorescence (pRTP) and nonlinear absorption characteristics under incoherent continuous irradiation.

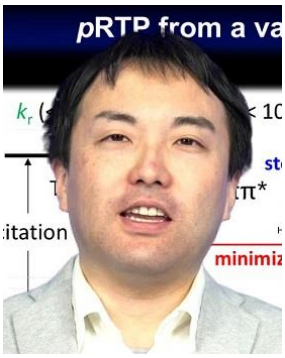
Because pRTP is observed for a few seconds after ceasing excitation and can be detected using conventional small-scale low-cost detectors depending on the autofluorescence of impurities, molecular materials with pRTP are becoming important for use in future ubiquitous optical sensing systems applied in healthcare and security for general consumers. For nonlinear absorption under incoherent continuous irradiation, the absorbance of the materials increased with increasing power of the continuous, incoherent, white-light irradiation from a xenon lamp. The characteristics are useful for broaden applications such as smart windows that save energy at low cost and nonlinear colorants for printing and security applications.

Naoya Koizumi at the University of Electro-Communications, Tokyo, has proposed a novel mid-air imaging optical system that captures ambient light using a transparent LCD (liquid crystal display) and a diffuser. He built a prototype to confirm his design principles in sunlight and evaluated several diffusers.



Molecular materials with ultralong-lived RT triplet excitons and their function

Reference



- Authors: Shuzo Hirata.
- Title of original paper: Materials science using ultralong-lived room-temperature triplet excitons: Molecular persistent room-temperature phosphorescence and nonlinear optical characteristics under continuous irradiance.
- Journal, volume, pages and year: Journal of Materials Chemistry C, 2018 Emerging Investigators Issue, Review Article.
- Digital Object Identifier (DOI): 10.1039/C8TC01417E
- Affiliations: Department of Engineering Science. The University of Electro-Communications.
- Hirata Lab. website: http://uec-hirata.researcherinfo.net/en/index.html
- Researcher Video Profiles: http://www.ru.uec.ac.jp/e-bulletin/researcher-video-profiles/2018/shuzo-hirata.html

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Jun Shintake, Assistant Professor, Department of Mechanical and Intelligent Systems Engineering

Jun Shintake is developing actuators, sensors, and robots that are made of soft materials. Soft actuators are also known as artificial muscles. These type of actuators can be applied to human assistive wearable devices as well as robots. Compliant sensors can be used as strain gauges that detect movement and deformation of objects, and also be exploited as pressure sensors to measure foot pressure of a person walking, for example.

In addition, Shintake would like to study soft robots where the two robotic elements mentioned previously are integrated. The type of robots I would like to develop are bio-inspired systems such as fish-like machines and flying devices. Through these research activities he would like to contribute to society, while expanding my research field and collaborating with industry.

Further information

Jun Shintake
Assistant Professor, Department of Mechanical and Intelligent Systems Engineering, The University of Electro-Communications, Tokyo.

Website: http://kjk.office.uec.ac.jp/Profiles/74/0007381/prof_e.html
Research Highlight:
http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2018/soft-robotic-gripper-based-on-dielectric-elastomer-actuators.html

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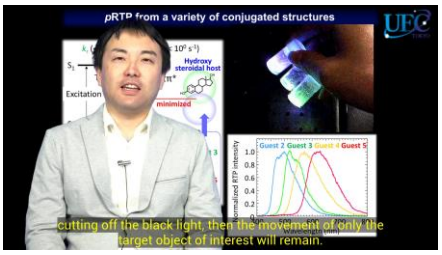
Shuzo Hirata, Assistant Professor, Graduate School of Informatics and Engineering



Shuzo Hirata is using molecules for the development of materials that show new types of luminescence and absorption. The absorption of light by a molecule results in the formation of an electron-hole pair inside it. This is referred to as the excited state of the molecule. Usually the lifetime of this excited state is as short as 1 ms or less, but he has succeeded in increasing this to more than one second.

Some molecular materials that exhibit such long excited states are those that continue to emit light for a while after turning off the black light (UV light). If such a materials are attached to a target, then even if there are other luminescent impurities around it, if only the long luminescence remaining after cutting off the black light is followed, then the movement of only the target object of interest will remain. These techniques can be applied to highly sensitive sensors and high contrast bio-imaging.

Also, some materials that exhibit such a long excited state lifetimes include materials that become darker as their surroundings become brighter. Application of this technology include sun glass-type materials that become darker when their surroundings become lighter.

Hirata's research also includes improving the performance of such materials. But he is also carrying out wide ranging calculations, organic synthesis, and measurements to search for other interesting materials that exhibit interesting luminescent and absorption functions.

Further information

Shuzo Hirata
Assistant Professor, Graduate School of Informatics and Engineering, The University of Electro-Communications, Tokyo.

Website: http://kjk.office.uec.ac.jp/Profiles/74/0007342/prof_e.html
Research Highlight:
http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2018/molecular-materials-with-ultralong-lived-room-temperature-triplet-excitons.html

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Naoya Koizumi, Assistant Professor, Media Information Science Course, Department of Informatics

Naoya Koizumi's research is on building digital expression technology for public spaces. He is pursuing information technology to add color to public spaces such as parks and halls, build a new media expression suitable for mature cities to surprise and inspire people.

Virtual reality technology plays an important role as an interface in current cyber physical systems and wearable type information presentation equipment mainly HMD is a hot topic. The problem with wearables is that even though it is in the same space, the same information cannot be shared. He is thinking about information presentation and sharing methods that people share together.

Currently his mainly focusing on spatial projection type information presentation technology, and with the challenge being to display aerial images in many different kinds of places in real space. In particular, he has achieved good results in a system based on using reflection from environmental materials, display separation method, and designing ambient lighting aerial image. This research was were selected for the "innovative technologies awards" for 2017 and 2018.

He would like to establish this expression technology for actual public spaces. Please contact us for more information about our research.

Further information

Naoya Koizumi
Assistant Professor, Media Information Science Course of the Department of Informatics.

Website: https://www.media.lab.uec.ac.jp/?page_id=180
Research Highlight:
http://www.ru.uec.ac.jp/e-bulletin/research-highlights/2018/digital-public-media-mid-air-display-technology.html

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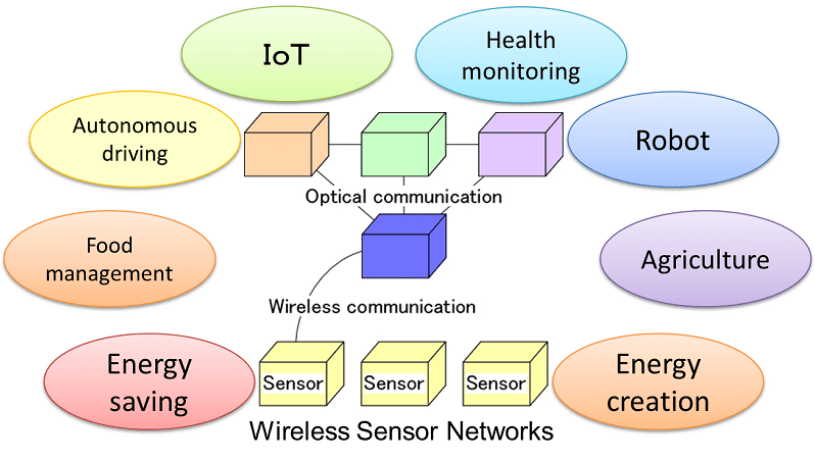
Advanced group IV materials and their applications for ICT devices

Near-infrared photodetectors on Si substrates have important applications in optical communications on a chip, and GeSn can improve infrared performance. At high Sn content, the Sn segregates causes fluctuations of the Sn content in GeSn layers, which degrades device performance. So there is strong motivation for developing growth techniques and improving the crystallinity of GeSn layers with high Sn content without Sn segregation. Furthermore, understanding physical mechanisms responsible to Sn segregation would clarify growth mechanisms and for the development of growth techniques of GeSn layers with high crystallinity.

Takahiro Tsukamoto has successfully formed GeSn layers on Si substrates by a unique sputter epitaxy method. Sputtering has low environmental impact and advantageous characteristics of high resource usability, high safety, and large-area deposition capability.

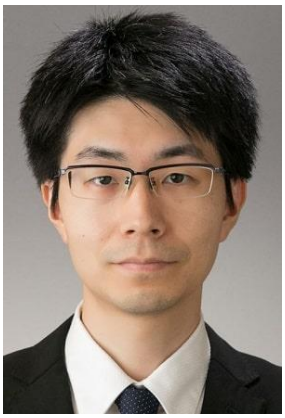
Tsukamoto has previously used sputter epitaxy for the fabrication of group IV semiconductor devices. Here, flat GeSn layers with 11.5% Sn content were obtained at a high deposition rate [1, 2]. These results showed that a high deposition rate limits Sn surface segregation and enables the growth of GeSn layers at relatively high temperatures, resulting in improved crystallinity. The band gap of the GeSn layers with 8.4% Sn content was determined by Fourier transform infrared spectroscopy (FT-IR) measurements and was about 0.52 eV, which indicates that band-gap narrowing occurs.

GeSiSn is a promising material for future electronic devices because the band-gap and lattice-constant can be controlled separately and group IV lattice-matched heterojunction devices can be achieved. Tsukamoto formed GeSiSn layers on Ge substrates by sputter epitaxy. The theoretical band offset of the GeSiSn/Ge heterojunction is about 0.2 eV in the conduction band. TEM observation showed that a highly crystalline GeSiSn/Ge hetero epitaxial layer was obtained. Furthermore, Tsukamoto successfully formed group IV lattice-matched quantum well structures. The interface between GeSiSn and Ge was sharp and with a GeSiSn barrier layer with about 2 nm thickness. These quantum wells can be applied for the formation of quantum effect devices.



Goals of the research to develop semiconductor materials and devices for wireless sensor networks.

Reference



・T. Tsukamoto et al., J. Mater. Sci. 50, 4366-4370, 2015.
・T. Tsukamoto et al., Appl. Phys. Lett. 106, 052103, 2015.
・Tsukamoto Lab. website: www.tsukamoto.es.uec.ac.jp

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Report：UEC participated in WUST'S 120th Anniversary Celebration

On 26 October, Prof. Abe, the Vice President of UEC, and Assist. Prof. Sasaki visited Wuhan University of Science and Technology (WUST) and attended the 2018 University President Forum and 120th Anniversary Celebration of WUST. Prof. Abe participated in the President Forum as a presenter together with WUST's overseas partners from England, the U.S., Germany, Singapore and others. Prof. Abe started his presentation with congratulatory speech, and then gave introductory presentation of UEC's research and education strategies. In the panel discussion, panelists and audience shared their insights and had active discussion on growing impact of AI on society.

After the 2018 University President Forum, Celebration ceremony of 120th Anniversary of WUST was held in which Chinese government officers and notable WUST alumni gave congratulatory speeches; and entertainments performed by students and alumni of WUST delighted the audience.

During the visit to WUST, UEC delegates had the opportunity of having individual meeting with WUST President Ni and Prof. Geng, the Director of Office of International Relations, and had fruitful discussion for the future collaboration.

President Ni and Prof. Abe

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The Irago Conference 2018

"360-degree outlook on critical scientific and technological challenges for a sustainable society"

The Irago Conference 2017 was held on 1 November 2018 at the Shinjuku Washington Hotel, Tokyo. The conference was organized by University of Electro-Communications, Toyohashi University of Technology, and Tokai University. This was 8th in this series of conferences providing a platform for networking between scientists, graduate students, and policy makers to interact and share ideas to find solutions for some the major issues of the 21st century.

The participants of the Irago Conference 2018. Shinjuku Washington Hotel, 1 November 2018.

This core theme of this year's conference was "Tomorrow's World@2050" and the proceedings included 12 invited speakers, one 'Premium Poster', and 106 poster presentations. A total of 150 participants attended the conference including the invited speakers from Spain, India, USA, and Japan.

In addition to the scientists and graduate students, high students from Seiko Gakuin High School in Kanagawa Prefecture and Toshimagaoka-Joshigakuen, Tokyo, also participated in the conference, presenting posters and actively asking questions during the sessions.

The evening session was organized in partnership with Springer Nature and included shorts speeches by guests from MEXT, the headmasters of the high schools, and representatives from Springer Nature.

Refereed manuscripts from the conference will be published in the Proceedings of the AIP.

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Reference Information

Irago Conference

http://iragoconference.jp/

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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