OCARINA通信

The OCU Advanced Research Institute for Natural Science and Technology

VOL.7

Feature

What is the key to promoting multidisciplinary researches?

profile

Professor, Department of Biology and Geosciences (Functional Biosciences), Graduate School of Science, OCU

Taro Nakamura

Obtained a doctoral degree (Engineering) at the Department of Chemical Engineering, Graduate School of Engineering, Hiroshima University. Studying syngenesis by fission yeast, analyzing meiosis mechanisms and organizing yeast genetic resources (bio resource project) at OCARINA since 2017.

Three new projects in areas attracting attention started in OCARINA this year. During the course of research, we faced difficult problems such as the establishment of research space and support systems and the promotion of multidisciplinary research and industry-academia collaboration. Though the present condition is not ideal, various ideas were presented in order to approach the problems proactively.

Dr. Yoshida's new research topic adopted as a "GLOCAL Project"

Dr. Miyano/We had three standout topics for this year. First, the Okamura Award for excellent female researchers was awarded to Dr. Yoshida. Secondly, her new project was adopted as a project in the "GLOCAL base for constructing society with a smile, intelligence and health" initiative. Thirdly, Dr. Nakamura and Dr. Tsuboi launched a new collaborative project.
First of all, Dr. Yoshida, congratulations on your receiving of the Okamura Award and your project being adopted as a project for the "GLOCAL base". Could you introduce your new project?

Dr. Yoshida/Thank you very much. My main field of study is solid photocatalysts; however, this new research involves not only solid photocatalysts but also their interaction with various other types of optical energy. It was very lucky that the topic matched the aim of the GLOCAL base initiative, which is the integration of human health and science.

Dr. Miyano/Although the research has just started, how do you feel about it at present?

Dr. Yoshida/I am still in the stage of preparing the experiment environment. A new specially appointed professor was assigned to my team to increase the number of staff members. I'm proceeding with my research gradually with the help of others. I really appreciate it.

Dr. Miyano/Since you came, I had been concerned that perhaps we were not providing you with enough support. I'm glad to hear that your research is proceeding steadily.
Next, let us talk about new projects. Could you explain your project, Dr. Nakamura?

New projects begun and progressing steadily

Dr. Nakamura/I'm now participating in the National Bio-resource Project. It aims to construct a global base for the strategic collection, preservation and provision of yeast genetic resources.
Biological research needs biomaterials such as strains and DNA. If we have an institute that collects bio resources strategically, researchers can access materials easily, removing the need to write to various institutes to request them. Our project will make that possible. Therefore, this project is more a support project for many research topics rather than research.

Dr. Miyano/OCU is playing a leading role in this project as a representative of Japan, which we are very proud of. You have been involved in this project for a long time; have there been any notable points after it became a new OCARINA project?

Next mission of OCARINA where seven projects participated in:

profile
Professor, Department of Molecular Materials Science, Graduate School of Science, OCU

Yasuyuki Tsuboi

Completed a major in applied physics at the Graduate School of Engineering, Osaka University, then briefly worked for a company before returning to research. Taught at the Kyoto Institute of Technology and Hokkaido University while working as the director of PREST (sakigake), JST. Engaged in the foundation of LaserSystems Inc. and has worked as its technical advisor since 2004. Took up his present office in 2013. Holds a doctorate in engineering.

profile
Professor, OCARINA

Tomoko Yoshida

Obtained a doctoral degree (Engineering) at Graduate School of Engineering, Kyoto University. Awarded the Okamura Award, given to excellent female researchers, and her research was adopted as a project in the "GLOCAL base for constructing society with a smile, intelligence and health" initiative in 2017. Has studied optical functional material science at OCARINA since 2015.

Dr. Nakamura/Solving the problem of research space was quite notable. We are storing about 30 thousand strains and need a lot of space. As the project expanded, the storage problem had become our biggest issue.

Dr. Miyano/The research space problem had often been discussed, and I think that OCARINA's establishment was able to improve the situation.
What potential do you think this research has not only in scientific research but also in the fields of engineering, biology and medicine?

Dr. Nakamura/Firstly, we are able to collectively manage bio resources that are made and stored by researchers individually.
Also, we will be able to facilitate the efficient use of experimental instruments that are shared between researchers. At present, they are held by the researchers who bought them, and other researchers have to go to their location to use them. If they are stored in one place, everyone can use them easily and efficiently.

Dr. Miyano/I see. If this idea is realized, it will be a driving force for many research topics. Moving on: Dr. Tsuboi, could you tell us about your new project?

Dr. Tsuboi/We are studying technologies for the optical control of atoms and molecules. In short, we are currently depriving optically generated atoms of kinetic energy by cooling them, trying to control them more simply by catching molecules and nano-structures selectively.
We were having trouble finding space for our research, and applied to OCARINA. Now we have been accepted and can conduct our research here, and we appreciate it very much.

"Awareness" from varied perspectives leads to great projects.

Dr. Miyano/We have heard about new projects from three researchers. Now, could we have a few words from Vice Director Shigekawa?

Dr. Shigekawa/I started to work for OCARINA in addition to my work for OCU two years ago, and there is one thing I've been strongly aware of these days regarding one of its main purposes - multidisciplinary collaboration. I can see possibilities for collaboration here and there, but we are not making full use of them.
For instance, when we recognize one phenomenon, if we study it in a different field, we can become aware of different approaches for establishing the technology.
Unfortunately, however, that awareness is currently being lost. If even one percent of it can be captured and used in some way, it can become a great project.

Dr. Miyano/If joint research across different fields is activated, it can widen our perspectives and connections with other researchers. In turn, it will expand the research topic and may lead to obtaining external funding and establishing industry-academia collaboration.

Dr. Shigekawa/Yes, but in the meantime, researchers are very busy, and it's obstructing collaboration between projects. I used to work for a company, but to tell you the truth, I feel I am busier now than I was then. Even if we find something interesting, we can't afford the time to explore it.

Dr. Tsuboi/I think the situation is the same in other universities, too. University professors are too busy with work other than research.

Dr. Shigekawa/In addition, in the case of companies, all research resources are managed centrally by their research promotion department. Therefore, if they want to advance a certain research topic, they often stop funding other research to focus on the topic. But in universities, research funds are allocated to professors, so other collaborative projects have to manage with the remaining funds. Therefore, they tend to be temporary, thus it is difficult to foster research with a long-term perspective.

OCARINA has the potential to be a breakthrough mechanism in solving problems.

Dr. Tsuboi/I thing OCARINA can be a breakthrough for researchers. We are fortunate to have an independent organization for supporting research, as strong external support is required when taking concrete measures to promote projects.

Dr. Miyano/The larger the projects we apply for, the heavier the loads on researchers. Thus the establishment of businesslike support systems is a pressing issue. OCARINA should enhance this kind of support system, too. What do you think about this, Dr. Kamiya?

Feature

profile
Director and Vice President, OCU

Hiroyuki Sakuragi

Completed the PhD program of the Graduate School of Science, Kyushu University (Physics). Doctor of Science. Took up a post at OCU as professor of the Faculty of Science in 1999 after working as a researcher at the Institute for Nuclear Study, University of Tokyo. Became the dean of the faculty and the Graduate School of Science in 2010, and took up his present office in 2016. Specialized in nuclear physics. While actively involved in research, he is also engaged in lectures, exercise and academic supervision for students as well as classes for high school students and international exchange.

profile
Advisor to the President, OCU
Director, OCARINA

Michio Miyano

Completed the doctoral program of the Graduate School of Engineering, Tokyo Metropolitan University in March 1980. Doctor of Engineering. Became the dean of the Faculty and the Graduate School of Human Life Science in 2006, Vice President in 2010 and got the current position in 2016. Specialized in regional disaster prevention and housing safety engineering. Studying natural disasters such as earthquakes and wind and/or flood damage as well as daily accidents in living environment.

Dr. Kamiya/I totally agree with you. When OCARINA was in the concept establishment stage, we had many discussions on that. Your thinking is the same as the basic concept we agreed upon. But, when we consider how much of the concept has been realized so far, I think we are still halfway through. Project groups supported by external funds naturally concentrate on the success of their own project. Unfortunately, it is difficult to find a new research topic through lateral collaboration.
I hope we will take a step forward within the next few years to boost the combined study aspect of OCARINA. It's easier said than done, but I will try my best.

Dr. Miyano/Thank you very much. That is precisely the aim for OCARINA that we've been targeting since the beginning. We must make an effort to realize it.
You have just joined from outside the university, Dr. Yoshida. Could we have your opinion from an external perspective?

Dr. Yoshida/It is excellent that OCARINA is not just a virtual mechanism. Since there is an actual, physical facility, when researchers come from outside for joint research, they can do experiments on the spot. Also, we are always aware of the locations of individual researchers, so we can find them easily when we want to ask them something.

Another advantage is that since the number of students is small, they study in one big room together. Thus, students from different laboratories can easily talk together about what kind of devices they have, in which places they are stored, and what kinds of collaborative research they can do. It's good that OCARINA is creating an atmosphere in which not only teachers but also students can exchange ideas from different fields.

There is, however, some difficulty in teaching students. Since the number of students admitted to OCARINA is limited, even if there are students who want to study at OCARINA, the door is not fully open to such students.
Another issue is that many of the researchers are specially appointed, temporary researchers. That may be good in that it facilitates the flow of staff; however, it is unfortunate that excellent researchers will not stay here for long. To promote collaboration among team members, we should increase the number of young researchers as permanent staff.

Dr. Miyano/As OCARINA is an organization specialized in research, its education system is not well established. We must consider this issue for the future, including the number of permanent teaching staff.

Dr. Tsuboi/Student support is indispensable in making OCARINA a strong organization that can represent our university. It takes time to realize that if we start from the bottom; we may need understanding and strong support from top management.

Strengthening industry collaboration through maintaining connections with graduates

Dr. Miyano/Do you have any ideas or comments regarding industry-academia collaboration, Dr. Tsuboi?

Dr. Tsuboi/There are many OCU graduates who have succeeded in the industry. I think we should use our connections with such people.
It often happens that technologies created through research at universities lack the concept of mass production, even though their individual performance is very good. Thus, they cannot be transformed into practical use cases. Therefore, we should collaborate with companies consistently, understanding their needs in order to prevent our technologies from being lost without being used.

Until now it was acceptable to simply write papers, without taking further steps. But this situation will change. In an age when many problems are solved by AI, it is important for each of us to recognize what the industry needs from universities.

Dr. Shigekawa/Now, patents are as important as papers. We sometimes fail to obtain large funding if we do not hold patents. I think the importance of patents should be recognized more. In the long run, that will lead to the acquisition of big funds.

Dr. Tsuboi/I think it's a good idea to bring in incentive systems or point systems for patents. If we have a system for clearly reflecting performance in personnel evaluations, it will stimulate motivation.

Dr. Miyano/On motivation, we have established an award system through the support of the university alumni

profile

Professor, OCU
Vice Director, OCARINA

Nobuo Kamiya

Graduated from the School of Science and completed the doctoral course at the Graduate School of Science, Nagoya University. Doctor of science. Worked as the guest researcher at the High Energy Physics Research Institute, Photon Factory (PF), the researcher and research sub head at RIKEN and the director of the R&D office of RIKEN Harima Center (Spring-8). Became the professor of the Graduate School of Science, OCU in 2005 and took up his present post in 2010. Awarded the Asahi Prize in 2012.

profile

Professor, Graduate School of Engineering, OCU

Naoteru Shigekawa

Graduated from the Department of Physics, Faculty of Science, University of Tokyo in March 1984, and completed the master's course at the Department of Physics, Graduate School of Science in March 1986. Studied chemical semiconductor hetero binding devices at NTT Atsugi Research Institute for Electrical Communication (present NTT Device Technology Laboratories) from April 1986 until Sep. 2011. Took up his present post in Oct. 2011. Doctor of science.

association; however it would be helpful if we could acquire further support from a range of providers.
Looking toward the future, what direction do you think our university should take, Dr. Sakuragi?

Dr. Sakuragi/One of the future directions for the university is multidisciplinary integration; in which OCARINA is leading the university. I expect that by integrating accomplishments from various fields, a totally new bud of research, characterizing OCU, may come forth. Another possibility is the academic strategy conference, which started when Dr. Miyano was in my place. It was changed to an academic open café style this year to strengthen lateral relationships in the university, so that students and general faculty staff can also participate.

As for industry-academia collaboration, companies related to graduates jointly established a limited liability company named Wellness Open Living Lab (WOLL), and we are planning to cooperate with it. The arrangement will provide interesting research with joint research opportunities and funding. The number of participating companies has increased to 17. I expect that we will be able to accomplish more through URA's connection with external organizations and the cooperation of the alumni association.

The university is a citizen asset. Aiming to become a university cherished by local residents.

Dr. Tsuboi/
I have another comment regarding industry-academia collaboration. Companies wish to strengthen their connection with universities partly because they desire motivation and technology, but they also want students.
I have observed many students to date, and I believe our students are especially remarkable. We should convey to the industry the advantages of employing our students. Therefore, we should publicize that point more.

Dr. Kamiya/
Perhaps digressing a little, but upon listening to the alumni association discussion I thought that the university should ask for contributions more proactively.

Dr. Tsuboi/
I agree. Compared to Japan, universities are collecting more contributions in the U.S.A. and European countries. The reason being, local governments and universities are more closely connected, and residents regard universities as their property. We should aim to be a university cherished by the people of Osaka City and nearby towns. We are the only university with a school of medicine in our city, and there are many noted people among our graduates. It's important to publicize these points more, bringing them to the attention of citizens. We should convey our large contribution to Osaka and foster an atmosphere of support for the university.

Dr. Sakuragi/
Information on OCARINA's symposiums should be shared more widely across the university. We should make an appeal to all members of the university, in order to increase participants. PR activities and visualization of our initiatives are important.

Dr. Yoshida/
I agree with you all. If we put effort into PR, it will also encourage our students.

Dr. Sakuragi/
When I was the Dean of the Faculty of Science, I felt I was more so the Director of the Department of Public Relations, and I worked hard at PR. If we ask for contributions, we should put a lot of effort into showing that we are a citizens' university.

Dr. Shigekawa/
Yes, we may be too reserved in both our pursuit of contributions and PR.

Dr. Tsuboi/
I hate to say "it's impossible". In a world where we are trying to go to Mars, nothing is impossible if we truly want to realize it.

Dr. Miyano/
I suppose we have clarified OCARINA's problems. At the same time, I have heard many encouraging words from you all. It's important that we work together to solve our problems, and also to realize the various ideas you have presented, step by step.

Research Introductions

profile
Professor, OCARINA

Tomoko Yoshida

Obtained a doctoral degree (Engineering) at Graduate School of Engineering, Kyoto University in 1996. Through a fellowship (PD) of the Japan Society for the Promotion of Science, she became an assistant of the Graduate School of Engineering, Nagoya University in June 1996. After working as an associate professor of the above graduate school and Eco Topia Science Institute of Nagoya University, she became a professor of OCARINA in April 2015.

OCU Research grant on GLOCAL Base for Constructing Society with Intelligence and Health "A new approach for the fusion of photochemical materials science and environmental health science"

For the realization of our slogan "a GLOCAL base for constructing society with a smile, intelligence and health", it is now important to start a new project for full-scale multidisciplinary integration. Fortunately, our research was adopted as a project in August 2017, and we have been making steady progress. This research started when Dr. Kamiya sent us an email, asking "are there any proposals from OCARINA or the Research Center for Artificial Photosynthesis (ReCAP) for new research through the integration of multiple fields of study?" I replied with what came to my mind, and he suggested starting a project based on my idea. This is how I obtained a chance to apply.

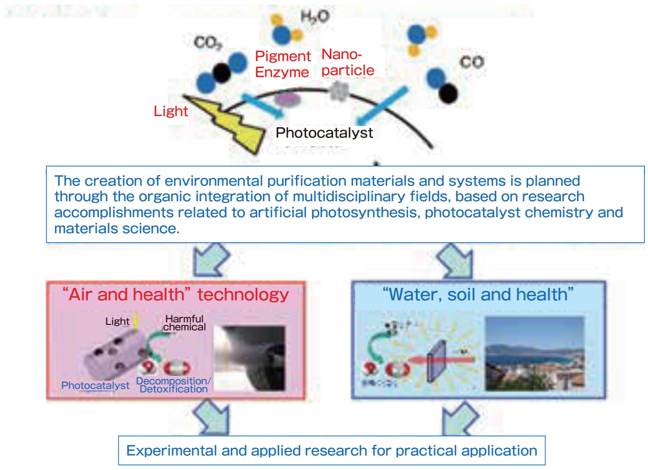
Since it was just a casual idea and I had not thought it over, I continued to ask myself if it could be a research topic regarding intelligence and health. I also discussed the research concept with my joint researchers several times. When we had finally settled upon the concept and were about to apply for research category B, Dr. Amao and Dr. Nango encouraged us to take on a larger challenge and apply for category A. I remember that while I was waiting for the hearing interview, Dr. Miyano happened to pass by and cheered me up with a fist pump. In this way, this research was born not only from the integration of many joint researchers' ideas, but by the encouragement and support from the teachers and staff of OCARINA. I am deeply grateful for their support.

This research is based on the study at OCARINA and ReCAP in the fields of artificial photosynthesis, photocatalyst chemistry and materials science. It was generated through the organic integration of studies at the graduate schools of engineering of OCU and Osaka Prefecture University and the Institute of Materials and Systems for Sustainability at Nagoya University. This core research project aims for the creation of environmental purification materials and systems based on innovative ideas. I feel honored to work with leading researchers in varied fields of study.

To accomplish our aim, it is important to develop and build the following two technologies.

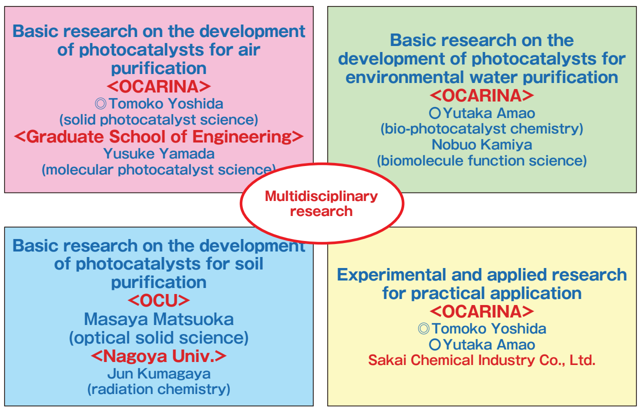
1) Development of photocatalysts for the efficient use of room light and sunlight, and air purification (sterilization, antibacterial function, mold prevention and deodorization) by means of photocatalysts ("air and health" technology)

Research topic "New approach for the integration of photochemical materials science and environmental health science"



Four research groups

◎Research leader
○Research subleader



2) Purification of environmental water and soil by means of energy conversion through interaction of high-energy radiation (X-rays/ γ-rays) and solid materials, which had been regarded as difficult ("water, soil and health" technology)

1) "Air and health" technology

Our research is characterized by multilateral and organic integration of photochemical materials knowledge and skills accumulated in the fields of artificial photosynthesis, photocatalyst chemistry and materials science, with various other fields of study. We aim to reconstruct the technology based on completely innovative ideas and perspectives in order to apply them to environmental health science. For instance, solid photocatalysts can absorb various gas molecules at high concentration, facilitating their chemical reactions through the absorption of light. ReCAP has synthesized chemical materials and fine chemicals from CO_2 and water, using various photocatalysts. In our research, photocatalysts are used to decompose harmful chemicals in air.

Harmful chemicals including environmental hormone have already been spread widely in the environment (air/ water/ soil). Although their concentration is very low (in the order of ppm), they have a large influence on human health and physical conditions. We intend to dissolve and detoxify harmful chemicals, which exist thinly in the air, quickly and efficiently by condensing them by means of the excellent molecule-absorbing ability of solid photocatalysts. Existing solid photocatalysts are mostly semiconductor photocatalysts; therefore, only ultraviolet light can be used. We aim to create solid photocatalysts that can use light ranging from the ultraviolet to visible spectrum by means of innovative, rational photocatalyst design, such as fine surface processing and the addition of functional nano-particles. Through this, we hope to realize the highly efficient decomposition and detoxification of harmful chemicals.

2) "Water, soil and health" technology

Photocatalysts, which use ultraviolet and visible light, cannot be used to dissolve harmful materials and contaminants that exist in places without light, such as cloudy environmental water (domestic wastewater, industrial wastewater, etc.) and soil. In contrast, high-energy radiation such as X-rays and γ-rays can penetrate environmental water and soil; however, due to their energy being so high, their efficiency in chemical reactions (such as the decomposition of harmful chemicals) is extremely low. Therefore, we need light or electrons with the same amount of energy as sunlight in order to produce efficient chemical reactions.

Thus, we aim to convert radiation into low-energy photons or electrons with a few eV to tens of eV, which are effective at inducing chemical reactions, using reactions (Compton effect, photoelectric effect, etc.) of high-energy radiation and solid materials. We will use this technology to attempt to dissolve and detoxify harmful materials and contaminants in environmental water and soil. Specifically, stable solid materials such as metal and metal oxide are placed in reaction fields (water or soil) to convert high-energy radiation into low-energy electrons and photons. This involves a totally new concept and technology: while utilizing radiation's high permeability (enabling it to spread widely throughout the water and soil), it is converted to electrons and photons (suited to chemical reactions in water and soil), for the efficient degradation and detoxification of harmful materials.

This technology should allow the energy distribution and number of electrons and photons emitted from solid materials to be changed freely, according to the constituent elements and volume of solid materials. Efficient energy conversion should be possible by controlling the shape of solid materials and their distribution in the reaction space and the constituent elements. We expect this technology to become an innovative approach to efficiently dissolving and detoxifying domestic wastewater, industrial wastewater and soil.

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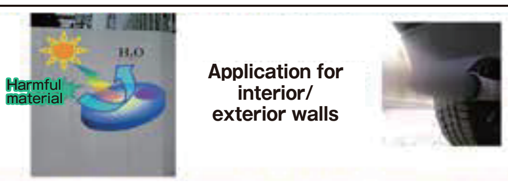
"Air and health" technology

Air purification by photocatalysts
(sterilization, antibacterial function, mold prevention and deodorization)

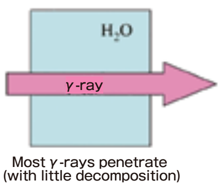


Response to visible light by means of fine surface processing of photocatalysts and the addition of functional nano-particles

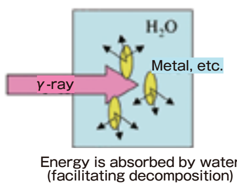
Development of photocatalysts for environmental purification with the efficient use of room light (ultraviolet ~ visible light)

"Water, soil and health"

Development of technology for environmental water and soil purification, using reactions (Compton effect/ photoelectric effect) of high-energy radiation and solid materials



Most γ-rays penetrate (with little decomposition)



Energy is absorbed by water (facilitating decomposition)

Utilize the high permeability (broad spread of energy throughout the water) of high-energy radiation (X-ray/ γ-ray) ⟷ Conversion to low-energy electrons and photons in water for the efficient decomposition and detoxification of harmful materials

Efficient decomposition and detoxification of harmful materials in environmental water and soil

Research Introductions

profile
Professor, Graduate School of Science, OCU
Yasuyuki Tsuboi

Completed the doctoral program of the Department of Applied Physics, Graduate School of Engineering, Osaka University (Doctor of Engineering).
Worked for Fujifilm Corporation, Kyoto Institute of Technology (assistant/ lecturer), and Hokkaido University (associate professor), and took up his present post in 2013.
He was also engaged in the following research activities:
2004: Participated in the establishment of LaserSystems Inc. and served as an executive member (technical consultant).
1998-2001: Researcher of Sakigake 21, PRESTO JST ("condition and revolution" section)
2010-2014: Researcher of PRESTO JST (optical energy and material conversion)
Worked as a part-time lecturer for Tokyo Institute of Technology, Kyoto University, Nagoya University, Kitami Institute of Technology, Mie University, Kyoto Institute of Technology, Shimane University and Osaka Prefecture University.

Nano-scale Manipulation through Optical Electric Field Controling

I joined OCARINA when I came to OCU in 2013. I was very fortunate to be given an opportunity to lead a project and have a place for experiments here. Although it has difficulty in funding, OCU shows a cold attitude toward researchers who have succeeded in obtaining large external funding, even though it receives a substantial kickback from the overheads. I have worked for various organizations including companies, national universities in various regions and the former imperial universities. Through these experiences, I must insist that OCU's system is too strict and, to be honest, the worst for earnest researchers. Even though they obtain external funding and accomplish research results, there is no recognition for staff. OCU is lagging behind Osaka Prefecture University, another public university in Osaka (in spite of receiving this external assessment). There is not even a system for young researchers including me (though I'm not sure if I'm included) to provide our opinions to the executives. Even other national universities have appointed researchers in their 30's as assistants for university presidents. Now, however, I have been given an opportunity to launch a project with OCARINA's support, and I appreciate it very much.

Now, changing the topic to research. When I was a student, people would often say that the 21st century would be the age of light. Now that nearly 20 years have passed in the new century, I feel strongly that light is becoming more and more important, exceeding the boundaries of the fields of chemistry and material science. From the perspectives of these fields, there are two approaches to becoming familiar with light and accomplishing technological breakthrough: one is the creation of molecules and material groups that can reveal special, valuable functions by absorbing light; the other is the innovative design and creation of reaction fields for the interaction of light and materials. The former has a long history of study and is still an active academic field, while the latter is a relatively new approach.
Originally, the interaction ratio (absorption ratio) of light (photons) and molecules is not very high. While the size of molecules is measured in nanometers, photons can only be localized to a few hundred nanometers due to their diffraction limit. We need to reconsider this initial reaction phase of light and materials to construct a highly efficient light-material reaction system. One potential approach is the reaction field for high-efficiency light collection. So, what is this?
Cooperative, collective oscillation of free electrons in precious metal is called "plasmon". Plasmon waves can be created by radiating resonance light (green or red light) on particles of precious metals such as gold and silver. In particular, in structures in which nanoparticles are positioned separated by 20 nm or less (nano-gaps), oscillatory electric fields are remarkably localized in nano-gaps by the radiation of resonance light (red and near infrared rays in most cases). This phenomenon is called gap mode localized surface plasmon. Most of Surface-Enhanced Raman Spectroscopy (SERS) is included in this phenomenon. In nano-gaps, electric field intensity E2 increases to thousands of times higher than that of the incoming resonance light. Due to this enhancing effect, the photoreaction yield of photoreactive molecules may increase if they exist near nanostructures of precious metals. Misawa (Hokkaido Univ.) and Tatsuma (Univ. of Tokyo) proposed the expansion of this concept into general photochemical reactions and photoelectric conversion.
We are proposing a reaction field based on an innovative concept; we use increased light pressure of optical antennas enhanced by plasmonic precious metal nano-gaps to collect functional nano particles and molecules, couple them with photons directly in the nano space and generate reactions without energy loss. We have conducted research on "plasmon optical tweezers" to establish highly flexible nanomaterial manipulation technology. The plasmon optical electric field enhancing effect of precious metals can be applied to the enhancement of optical pressure, that is, the "grasping power" of materials. (Fig. 1)

We succeeded in collecting light of semiconductor nanocrystals (quantum dots) in 2010. I will explain this using the simple example of DNA. We were the first in the world to succeed in collecting DNA plasmon light not combined with nanoparticles, such as glass particles, and confirmed characteristic collection behavior believed to be specific to DNA. Firstly, DNA was collected and formed a ring-shaped pattern when the plasmon was excited by a continuous wave (CW) laser. Even after suspending plasmon excitation, the DNA did not scatter but remained fixed in the ring pattern on the nanostructure

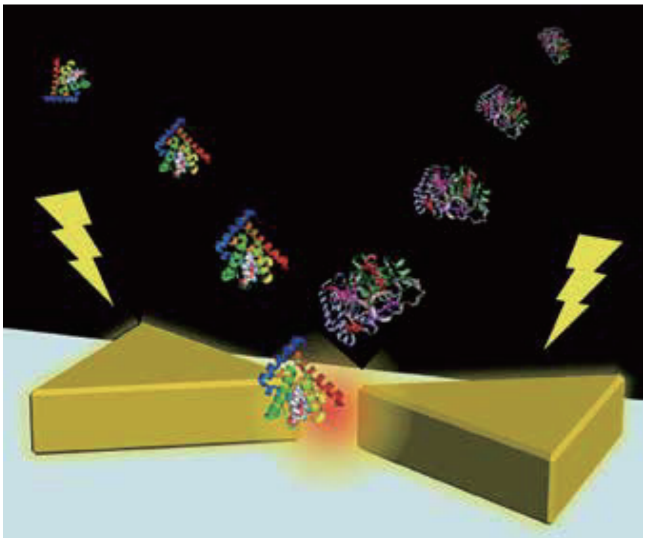


Fig. 1: Conceptual illustration of plasmon optical tweezers

substrate semi-permanently. (Fig. 2) Absorption due to electrostatic reactions between the DNA and glass surface is considered to be the cause of this fixation. Also, when a femtosecond-scale ultra-high frequency pulse wave laser was used instead of a CW laser, DNA showed “trap-and-release” type collection behavior as seen in polystyrene microspheres. Thus, by switching the excitation mode between CW and pulse waves, collection behavior can be switched between the fixation type and “trap-and-release” type. This is a unique optical collection method that has to date only been accomplished through our DNA method.

In CW excitation, DNA forms a ring pattern while being collected. We examined this mechanism in detail, and confirmed that not only enhanced optical pressure but the following four types of forces work cooperatively to collect plasmon: (1) an electromagnetic force which draws the DNA into the plasmon excitation area (enhanced optical pressure), (2) a force that pulls the DNA away from the plasmon excitation area due to the steep temperature incline (~1K/μm) (thermophoretic force), (3) a force that moves DNA into the area under optical pressure (caused by heat convection) (4) a reaction between the plasmon generation field and DNA (coulomb force). We are proposing this model of collecting and fixing DNA in a ring pattern by means of these forces. If patterning of bio-molecules in a plasmon-generation field can be done in this way (Fig. 2(c)), the technology can also be expected to be applied to biosensor manufacturing. We are quantitatively evaluating optical pressure and thermophoresis operating in optical DNA plasmon collection. We evaluated the potential energy of thermophoresis in micro-ring formation and confirmed that thermophoresis operated more strongly in accordance with the increase in the number of base pairs. This finding explained why DNA with a larger number of base pairs formed a larger micro-ring. Both optical pressure energy and thermophoresis energy were in the range of 10-19J. Thus, it is expected that DNA can be collected and fixed at a desired position by controlling the number of base pairs, optical pressure and thermophoresis. Also, we succeeded in the basic demonstration of “plasmon photo-chromatography”, which separates two types of DNA with different numbers of base pairs from the mixed solution and fixes them.

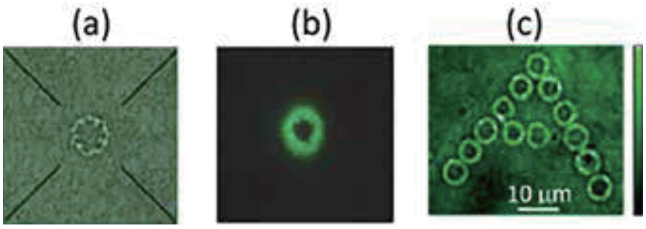


Fig. 2: The optical microscope photo (a) and fluorescence microscope image (b) of fluorescence-stained DNA fixed in a ring shape on the nanostructure substrate
Ring diameter: approx. 5 micron
DNA formation in a desired pattern on the nanostructure substrate (c) is also possible

In the future, we hope to examine the optical enhancement function in the nanostructures of semiconductors and dielectrics in addition to precious metals, and search for optical manipulation technology that can control nano materials freely. This enhancement function and high-efficiency collection have been accomplished for silicon nanostructures, and the future success of this methodology is highly anticipated. The content of this article is included in the following reports. Please contact me if you are interested. I will send a printout.

Applied Physics Vol. 86 (2017) p.45-49
Modern Chemistry No. 555 (June edition) (2017) p.50-54

I deeply appreciate the support from Dr. Tatsuya Shoji (OCU), our students, Prof. Hajime Ishihara (Osaka Univ./ Osaka Prefecture Univ.), Prof. Takashi Murakoshi (Hokkaido Univ.) and other people in OCARINA.

Research Introductions

profile
Professor, Graduate School of Science, OCU
Taro Nakamura
Completed the doctoral program of the Graduate School of Engineering, Hiroshima University in March 1996. Doctor of Engineering. Became a special postdoctoral researcher of RIKEN in April 1996. OCU: Became a professor's assistant in April 1997, a lecturer in April 2001, an associate professor in October 2006, and took up his present post in April 2010. Became the leader of NBRP Yeast in April 2007.

National BioResource Project (NBRP) – Yeast

~Resource Center Supporting Global Yeast Research~

NBRP Yeast is the largest resource center for fission yeast (*Schizosaccharomyces pombe*) in the world, providing nearly 5,000 bioresources to 30 countries annually. OCU forms the basis of this center, and I will now describe its activities.

About the National BioResource Project (NBRP)

In order to conduct research efficiently, it's needless to say that we require high-quality reagents and advanced equipment. However, it is particularly important in biological research that researchers can access bioresources (biological materials such as individuals, cells, strains and DNA) that have been used in studies presented in journals and conferences. NBRP began as a project by the Ministry of Education, Culture, Sports, Science and Technology in 2002 to establish a bioresource center, which collects bioresources from international researchers, preserving and making them available (currently managed by the Japan Agency for Medical Research and Development). The projects are renewed every five years. 2017 is the first year of the fourth period. Resource centers have been set up in universities and research institutes to each manage one of 30 species of model organisms (Fig. 1). OCU is responsible for the management of yeast, and we are working in collaboration with Osaka University and Hiroshima University, which are also in charge of yeast.

Yeast as a Research Material

Dr. Yoshinori Ohsumi, who was awarded the Nobel Prize in 2016, was mainly using yeast in his study of autophagy. Yeast is a truly vital research material in life science for the following reasons: i) it's safe and easy to use; ii) it can be used in various fields such as genetics, cell biology and biochemistry; iii) recombinant DNA techniques can be performed easily and efficiently; iv) it's cell structure is similar to those of higher whole genome sequence forms of life including humans'; and v) all genomic sequences having been decoded first in eukaryote, and information has been accumulated through the post-genome research of proteome and metabolome. Yeast is being studied across the world and there are many yeast researchers in Japan. Thus, it is indispensable to establish yeast resource centers for the development of life science.

NBRP Yeast – Activities and Main Resources

NBRP Yeast is administered by the Yeast Genetic Resource Center (YGRC) (Fig. 2). OCU and Osaka University are managing fission yeast (*Schizosaccharomyces pombe*) (Fig. 1) and budding yeast (*Saccharomyces cerevisiae*) respectively. These two types of yeast are the main research materials, and each yeast researcher should manage yeast appropriately to maintain the world-class resource organizations. At present, five researchers (two full-time, three part-time) are engaged in this work at OCU.

The three main responsibilities of the NBRP Yeast project are the collection, preservation and provision of bioresources. At present, around 23,000 strains are preserved, including mutations in cell cycles and syngenesis obtained through conventional mutation induction as well as gene-destructed strains. NBRP also holds proprietary resources including a library of strains created by integrating around 1,000 genes of fission yeast and green fluorescent protein (GFP). These strains are very popular since the localization of each gene is cataloged.

Strains can be preserved at -80°C for a long period of time. NBRP Yeast has six ultra-low temperature freezers. Also, in preparation for large-scale earthquakes, we are storing backup bioresources at Hiroshima University, located far from our university. So far, we have created and stored backups of strains that cannot be restored if lost efficiently. They account for one-third of the entire resources.

Yeast genes can be recombined freely; therefore, their DNA is also an important bioresource. We have a total of 100 thousand DNA materials such as basic plasmid vectors, various DNA libraries including genome libraries and clones that constitute the libraries. There is a lot of demand for chemical-resistant marker plasmid used for gene destruction and plasmid for expressing tag fusion genes such as GFP.

Last year, around 5,000 bioresource materials were provided to researchers, with two-thirds sent overseas. Over the last five years, we provided resources to 30 countries (Fig. 3).

The most-supplied resources include DNA libraries and GFP gene fusion strains. We provide resources not only for veteran yeast researchers but also basic resources that are useful for first-time yeast researchers. Information on newly collected resources is sent to our 2,000 users via our mailing list.

It is difficult to accurately evaluate how much resource projects such as NBRP have contributed to the progress of research. However, bioresources provided by NBRP Yeast have been used in over 660 scientific papers. Most of them are presented in high-level international journals including some prestigious journals such as Nature, Cell and Science. We have been contributing to the progress of studies that have attained high evaluation internationally.

NBRP Yeast – Database and Provision Systems

We created our website in collaboration with the NBRP Information Center of the National Institute of Genetics, in order to promote our activities efficiently (Fig. 4). We also created our database, Genomic Viewer, which links genome information and bioresource information (Fig. 5).
With Genomic Viewer, you can visually check the preserved strains and DNA resources and their location information (where they are positioned in which chromosomes). The bioresource information is linked to the PomBase (Britain) webpage - the largest international gene database of *S. pombe* - allowing you to examine the details of related gene information. Likewise, PomBase is connected to the NBRP Yeast website, allowing for streamlined ordering of resources.
You can order bioresources as easily as you enjoy Internet shopping. Resources can be delivered in a week or so to any country in the world after ordering.

This year marks the 16th anniversary of NBRP Yeast. It has become the leading resource center of fission yeast in the world both in quality and quantity. It is vital for us to reinforce our stock of bioresource through strategic collection, in order to maintain a world class standard. At the same time, research continues to progress, creating new fields of study; bioresources required for research are ever changing. It is not easy to identify research trends and prepare truly necessary bioresource at all times. We think it's essential to proactively develop bioresources independently as well as jointly with researchers by supporting them. Also, as the liquidity of research units increases, it becomes more difficult to pass over bioresources to successors when researchers retire or transfer. Thus the work of NBRP becomes evermore diversified in ensuring this succession. In contrast to general research, the bioresource project is a project that supports research; it is difficult to accomplish highly noticeable success. However, bioresources are the products of past research, and they cannot be restored once lost. The most important mission of NBRP Yeast is to continue its business ensuring its relevance and to pass on precious resources to future generations.

Acknowledgement:
Our project could not have been implemented without the support of various organizations, such as the provision of adequate space and the processing of large amounts of paperwork. I would like to extend my sincere appreciation for the support received from the Graduate School of Science, OCU, OCARINA and the administration office.

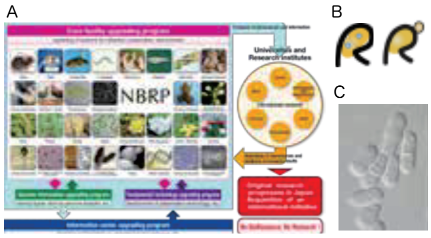


Fig. 1: What is NBRP?
(A) NBRP Website
http://www.nbrp.jp/about/about.jsp
(B) NBRP yeast logo mark
(C) A microphotograph of differential interference of fission yeast (*Schizosaccharomyces pombe*)


Room for preservation Laboratory
Bioresource preservation space
Culture/ Experiment space
Fig. 2: NBRP Yeast work spaces

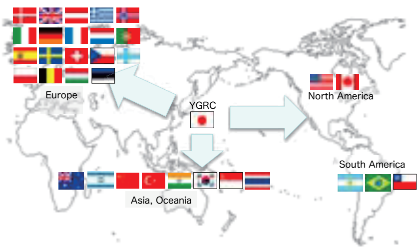


Fig. 3: NBRP Yeast - providing countries (2012—2016)


Fig. 4: NBRP Yeast website

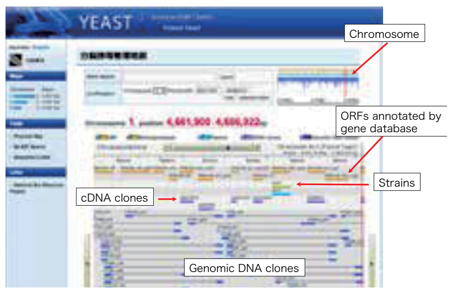


Fig. 5: NBRP Yeast database (Genomic Viewer)

Research Introductions

profile
Specially-appointed assistant professor, OCARINA
Shusaku Ikeyama
Obtained the doctoral degree at the Department of Molecular Materials Science, Graduate School of Science, OCU in March 2017. Doctor of Science. Took up his present post in April 2017.

Conversion of Carbon Dioxide into Organic Molecules with Biocatalysts

I began working at OCARINA as a specially appointed assistant professor in April 2017. Since then, I have studied the conversion of carbon dioxide into organic molecules with biocatalysts. At present, I am working on the conversion technology, using biocatalysts and visible light energy (artificial photosynthesis).
Industrial and economic development of urban areas including Osaka City has supported our daily life and social infrastructure. At the same time, however, it has caused urgent problems such as global warming caused by greenhouse effect gases such as carbon dioxide, as well as energy problems. For the sustainable development of society, we need to construct environmentally friendly energy circulation systems and energy conversion systems through the effective use of harmful materials.
OCARINA is now implementing projects for solving urban environmental problems and developing next-generation energy. Our artificial photosynthesis project team has been studying the conversion of carbon dioxide into organic molecules using optical energy, modeled on natural photosynthesis, as shown in Fig. 1.

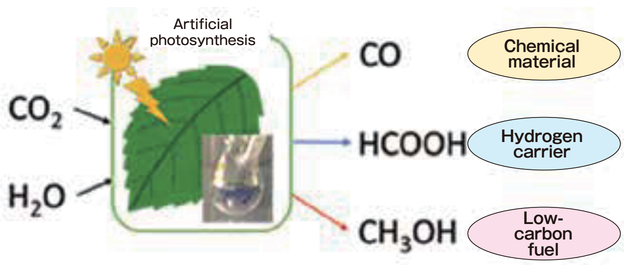


Fig. 1: Development of artificial photosynthesis for the resourcification of carbon dioxide

In natural photosynthesis, collected optical energy is used as the driving force to facilitate electron transfer and finally convert carbon dioxide into organic molecules. In artificial photosynthesis as well, electron transfer from light-harvesting photosensitizers to catalysts is a key issue. Also, the construction of a catalytic reaction process is indispensable for reducing environmental loads and reduction and converting carbon dioxide. Biocatalysts can convert carbon dioxide to organic molecules in high selectively at ambient conditions thus becoming ideal functional materials for environmentally friendly photosynthesis. We aim to improve the efficiency of the conversion from carbon dioxide into formic acid through deoxidization with formate dehydrogenase.

I would like to describe our two research topics below.
1) Improvement in conversion efficiency by reducing carbon dioxide to formic acid with formate dehydrogenase.
We are working to improve the efficiency of the conversion from carbon dioxide into formic acid by deoxidization with formate dehydrogenase. As shown in Fig. 2, in the natural environment, FDH activates the oxidization of formic acid and reduction of co-enzyme NAD^+ to NADH. In this process, as a reverse reaction, carbon dioxide is reduced and converted into formic acid. We are studying the reaction process using carbon dioxide reduction catalytic activity. Until now, this conversion efficiency was dependent on the NADH concentration in the system. Therefore, as formic acid generation proceeded, the reverse reaction of its oxidization occurred due to NAD^+ generation and FDH activity, and control of this reverse reaction was an issue.
Thus, as a solution for this problem, viologen derivative (BP) is used instead of NADH as shown in Fig. 2. In the conversion process from carbon dioxide to formic acid, the one-electron reduced viologen derivative ($BP^{\bullet+}$) acts as an artificial co-enzyme for FDH. In contrast, the conversion reaction to carbon dioxide through formic acid oxidization with FDH and oxidized viologen derivative (BP^{2+}) does not occur. Therefore, only the carbon dioxide reduction catalytic activity of FDH can be used. [1]
Furthermore, we have identified that carbon dioxide reduction catalytic efficiency of FDH can be controlled through the optimal design of the viologen derivative as an artificial co-enzyme for FDH. [2,3]

We discovered that the catalytic efficiency of improves 560 times by using viologen derivative with amino group (DAV) instead of NADH.

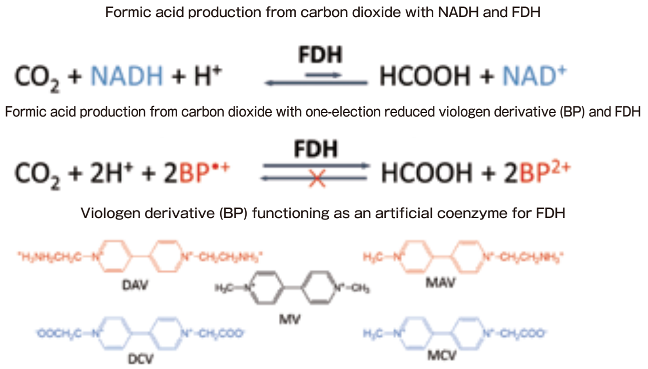


Fig. 2: Improvement of the CO_2 reduction catalytic efficiency of formate dehydrogenase with one-election reduced viologen derivative (FDH)

2) Improvement of formic acid production efficiency in the artificial photosynthesis system with FDH.

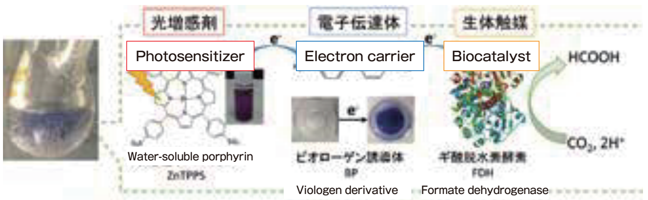


Fig. 3: The artificial photosynthesis system with FDH converting carbon dioxide into formic acid by use of FDH

The viologen derivative used for improving carbon dioxide reduction efficiency can be easily reduced by visible light by use of photosensitizers, such as a water-soluble porphyrin derivative. It is, therefore, possible to construct an artificial photosynthesis system that uses visible light to convert carbon dioxide into formic acid with FDH. In the system, viologen derivative acts an electron carrier that receives electrons from photosensitizers and provides them to FDH, for converting carbon dioxide into formic acid.

In conventional methods, methyl viologen (MV) was used as the electron carrier. By replacing MV with the viologen derivative with amino group (DAV, MAV in Fig. 2), the efficiency of electron transfer from photosensitizers to FDH is improved. We have succeeded in doubling the amount of formic acid generation per one hour of visible light radiation. [5]

Also, when the viologen derivative containing a carboxyl group was used (DCV, MCV in Fig. 2), the amount of formic acid generation decreased. We have found out that we can be controlled the conversion efficiency of the artificial photosynthesis by changing the type of the viologen derivative used as an electron carrier. [6]

Based on these findings, we are now developing viologen derivatives that can improve FDH catalytic efficiency as well as artificial photosynthesis systems that use viologen derivatives as artificial coenzymes for other biocatalysts such as alcohol dehydrogenase and malic enzyme. [7, 8]

References

[1] Y. Amao, S. Ikeyama, *Chem. Lett.*, 2015, **44**,1182

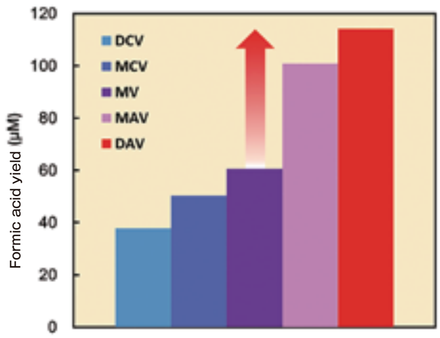


Fig. 4: Improvement in the conversion efficiency of carbon dioxide to formic acid in an artificial photosynthesis system with formate dehydrogenase

[2] S. Ikeyama, R. Abe, S. Shiotani, Y. Amao, *Chem. Lett.*, 2016, **45**, 907

[3] S. Ikeyama, Y. Amao, *ChemCatChem*, 2017, **9**, 833.

[4] S. Ikeyama, Y. Amao, *Chem. Lett.*, 2016, **45**, 1259.

[5] S. Ikeyama, Y. Amao, *Sustinable Energy & Fuels*, 2017, **1**, 1730.

[6] S. Ikeyama, Y. Amao, *Photochem. Photobiol. Sci.*, 2018, **17**, 60.

[7] S. Ikeyama, T. Katagiri, Y. Amao, *J. Photo. Photobiol. A. Chem*, 2017, DOI: 10.1016/j.jphotochem.2017.09.044

[8] Y. Amao, S. Ikeyama, T. Katagiri, K. Fujita, *Faraday Discuss*, 2017, **198**, 73.

Activity Report

8th OCARINA International Symposium

Invited speakers

Masakazu Sugiyama (Professor, Graduate School of Engineering, University of Tokyo)
Hiromi Yamashita (Professor, Graduate School of Engineering, Osaka University)
Takeharu Nagai (Professor, Institute of Scientific and Industrial Research, Osaka University)

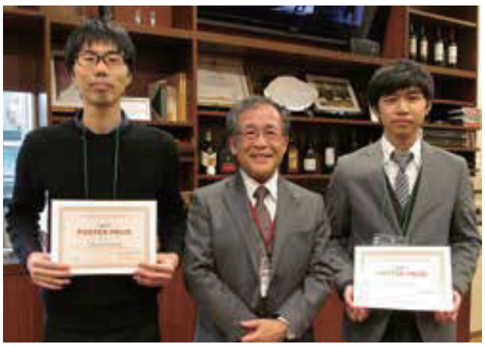
Long-Jiang Yu (Assistant professor, Research Institute for Interdisciplinary Science, Okayama University)
Yukihiro Kimura (Assistant professor, Graduate School of Agricultural Science, Kobe University)
Mai Watanabe (Specially-appointed researcher, Graduate School of Arts and Sciences, The University of Tokyo)

Invited speakers in OCARINA project team

Naoteru Shigekawa (Vise Director of OCARINA / Professor, Electronic information system, Graduate School of Engineering, OCU)
Seiya Kobatake (Professor, Applied Chemistry and Bioengineering, Graduate School of Engineering, OCU)
Masatoshi Kozaki (Professor, Molecular Materials Science, Graduate School of Science, OCU)
Kazunobu Sato (Professor, Molecular Materials Science, Graduate School of Science, OCU)
Makoto Miyata (Professor, Biology & Geosciences, Graduate School of Science, OCU)
Akihisa Terakita (Professor, Biology & Geosciences, Graduate School of Science, OCU)
Muneki Mitamura (Professor, Biology & Geosciences, Graduate School of Science, OCU)
Masatoshi Nishioka (Professor, Urban Design & Engineering, Graduate School of Engineering, OCU)

The 8th OCARINA International Symposium was held in the OCU Media Center (Conference room, 10th floor) on March 7 and 8, 2017.This symposium serves as an annual meeting of OCARINA and holds it in an international conference form approximately every year to promote mutual knowledge exchange between research projects participated in OCARINA, including study for artificial photosynthesis, advanced materials urban energy disaster prevention, and advanced biotechnology and frontier biomedical engineering. This year, seven researchers from five OCARINA research projects presented their recent progresses, and six guest researchers gave three keynote lectures and three topical presentations. In the keynote lectures, large-scale proposals for next-generation energy were given, such as plant lanterns that illuminate the leaves of roadside trees or 4th generation solar batteries combining solar batteries and fuel batteries. These proposals brought about discussions, which were indicative of OCARINA-'s future direction.
In the poster session, 38 subjects were presented by students and younger staffs from the graduate school of Human Life Science, Engineering, and Science in OCU. Active discussions were made during short oral presentation followed by the poster viewing session. Director of OCARINA awarded two posters selected among 30 entries by a vote held among the symposium participants. In total, 125 researchers from both academia and companies participated at the symposium.





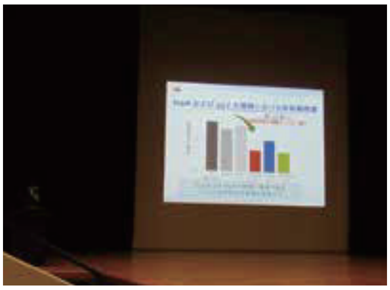
Okamura Award for Female Researchers (Award ceremony and commemorative lecture)

The award ceremony and commemorative lecture meeting of 4th Okamura Award for female researchers were held in the OCU Media Center (conference room, 10th floor) on December 21, 2017.
The special award was given to OCARINA professor Tomoko Yoshida, and the encouragement award for doctoral research fellows was given to Isil TULUM of the Graduate School of Science. Four award winners gave presentations on research topics at the commemorative lecture meeting.

■ The "Okamura Award" is given to female researchers who are engaged in outstanding research and education activities and contributing to the promotion of gender equality. This award aims to encourage female researchers to continue research activities and produce the next-generation of excellent female researchers.

Professor Tomoko Yoshida (front, second from left), doctoral research fellow Isil TULUM (third from left)

OCU Tenure Track Study Conference



The OCU Tenure Track Study Conference was held at Tanaka Memorial Hall on December 4, 2017. The conference was organized and administered by tenure-track instructors. After the opening speech and the explanation of the tenure-track project by OCU vice-president Hiroyuki Sakuragi, OCU president Tetsuo Arakawa delivered a lecture.
Following the lecture, a concert by the members of "Otoasobi-no-kai" (music enjoyment group) and "Otoasobi Kobo" (music enjoyment studio) was held, and three tenure-track instructors gave presentations. Fuminori Kato, assistant professor of Hiroshima University and Norihide Nakada, assistant professor of Kyoto University provided questions and suggestions for the presentations as guest commentators. Many questions were asked by students and instructors participating in the conference, and a lively discussion ensued.

OCARINA Seminars

OCARINA seminars are held to provide opportunities for the members of OCARINA to talk with domestic and foreign researchers and give presentations on their research results. In addition to seminars inviting leading scientists from inside and outside of the country, a wide variety of activities such as study tours and PR activities are also held.

34th	Date	Feb. 17, 2017	Venue	Faculty of Science, Lecture Room 10
	Guest	Isao Suetake (Associate Professor, Institute for Protein Research, Osaka University)		
	Theme	Clarification of the molecular mechanism of "Heredity without change in base sequence"		
35th	Date	Apr. 24, 2017	Venue	Faculty of Science, Lecture Room 10
	Guest	Satoshi Awata (Associate Professor, Graduate School of Science, OCU)		
	Theme	"Diversity and evolution of reproduction-related traits in mating/non-mating species of marine sculpin"		
36th	Date	Apr. 26, 2017	Venue	Faculty of Science, Lecture Room 4
	Guest	Taro Fuchikawa (Associate Professor, Graduate School of Science, OCU)		
	Theme	"Social entrainment and biological clock of circadian rhythm in bees with a breeding role"		
37th	Date	Sep. 15, 2017	Venue	Faculty of Science, Lecture Room 10
	Guest	Bob Robinson (Professor, National University of Singapore, Okayama University)		
	Theme	"The Evolution of Actin Filament Systems"		
38th	Date	Dec. 15, 2017	Venue	Faculty of Science, Lecture Room 9
	Guest	Toshiaki Arata (Specially-appointed Professor, Cell Function Lab, Graduate School of Science, OCU)		
	Theme	"Protein structure and motion detected by electron spin resonance = reaction × motion ÷ electrons"		
39th	Date	Dec. 19, 2017	Venue	Faculty of Science, Lecture Room 9
	Guest	Ken-ichi Sano (Professor, Faculty of Engineering, Nippon Institute of Technology)		
	Theme	"Nano biotechnology based on living organisms and materials: the creation of DDS carriers in highly efficient cells"		

What is OCARINA?

> The mission of OCARINA (OCU Advanced Research Institute for Natural Science and Technology) is to find solutions for global-level energy and environmental issues and complex and advanced research subjects, and contribute to the establishment of a sustainable society. As an urban-type university that promotes multidisciplinary research, we set up research projects across the graduate schools.

Since its foundation in 2010, OCARINA has been carrying out large-scale projects with competitive research funds, while promoting globalization, integration of different fields, training of young researchers, and recruitment of female researchers.
Currently, we have seven big projects at the four OCU research departments of Graduate School of Science, Graduate School of Engineering, Graduate School of Life Science and Graduate School of Medicine. The most distinguishing feature of OCARINA is the integration of different fields, which is conducted by a small number of selected researchers. With the major city of Osaka as our base, we will continue to promote original research, including collaborative research related to medicine.

History of the Osaka City University Advanced Research Institute for Natural Science and Tehnology

2008	March	Founding Anniversary International Symposium held
	April	The OCU strategic key research project (2008-2011) started
	December	International Workshop held on the efficient use of sunlight energy
2010	March	Enforcement of official regulations(start of activities as an official bureau)
	March	1st International symposium held
	October	2nd International symposium held
	November	Building 2 renovated for research floors of OCARINA
	December	Opening symposium for building 2 of OCARINA held
2011	March	3rd International symposium, "Kakuno memorial," held
2012	March	Annual meeting and the OCU strategic key research project(2008-2011) debriefing held
	April	The OCU strategic key research project (2012-2014) started
	July	School of Science Building C completed, partial occupation
2013	March	4th International symposium held
	April	2 new full-time staff members appointed
	April	New projects started
	June	**Research Center of Artificial Photosynthesis opened**
2014	February	Partial occupation for the new School of Science Building
	February	One new full-time tenure track staff member appointed
	March	One new full-time tenure track staff member appointed
	March	5th International symposium held
	April	One new full-time tenure track staff member appointed
	April	The OCU strategic key research project (2014-2015) started
2015	March	6th International Symposium held
	April	One new full-time staff member appointed
	April	Three new project started
2016	March	7th International Symposium held
	April	The OCU strategic key research project (2016-2017) started
	April	ReCAP authorized as a Joint Usage/Research Center by Ministry of Education, Culture, Sports, Science and Technology (MEXT)
	April	One new project started
2017	March	8th International Symposium held
	April	One new project started
	August	One new project started There are currently seven projects being promoted

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