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Leader's Voice

Create your own path in life, without fearing change

Yasuhiko Arakawa

Asking the Researcher

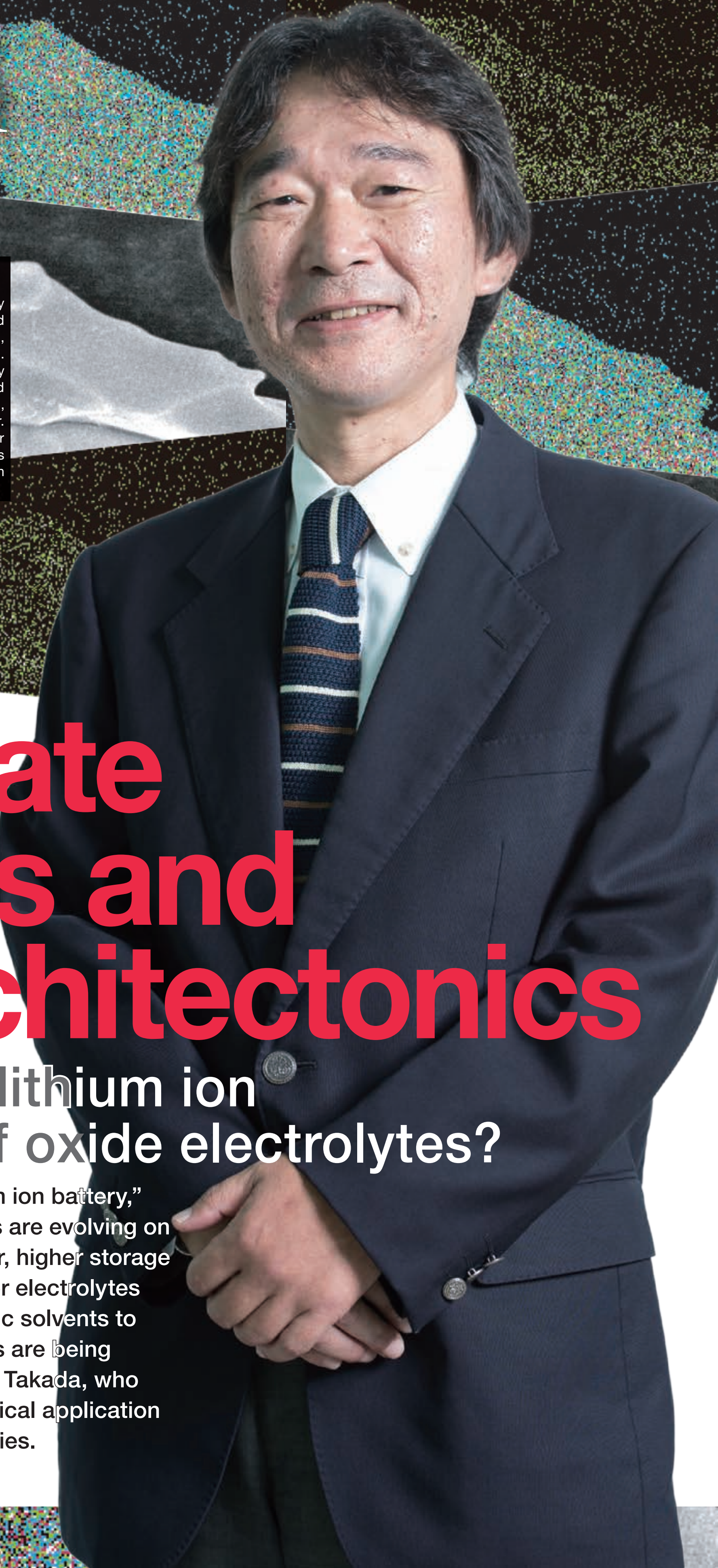
Kazunori Takada

Solid-State Batteries and Nanoarchitectonics

Do all-solid-state lithium ion batteries dream of oxide electrolytes?

MANA Principal Investigator,
Nano-Power Field and
Unit Director, Soft Ionics Unit

Kazunori Takada



PROFILE

Completed the first half of the doctoral course at the Osaka University Graduate School of Science specializing in physics in 1986, and joined the Central Research Laboratories of Matsushita Electric Industrial Co., Ltd. (now Panasonic Corporation) the same year. Received his Ph.D. (Engineering) from Osaka City University in 1991. Joined the Technology Laboratory of Matsushita Battery Industrial Co., Ltd. in 1991, and entered the National Institute for Research on Inorganic Materials, one of the predecessors of NIMS as a Special Researcher in 1999. Dr. Takada currently has a number of affiliations, including Unit Director of the Battery Materials Unit in the Environment and Energy Materials Division, NIMS. He has also participated in MANA since its inception in 2007 and has been a MANA Principal Investigator since 2008.

Asking the Researcher

Solid-State Batteries and Nanoarchitectonics

Do all-solid-state lithium ion batteries dream of oxide electrolytes?

Even though we use the same term "lithium ion battery," the component materials of these batteries are evolving on an almost daily basis. Toward higher power, higher storage capacity and greater safety. The horizon for electrolytes has also expanded from the original organic solvents to the all-solid-state type, and novel materials are being studied. Here, we interviewed Dr. Kazunori Takada, who has spent many years in research on practical application in view of the requirements of future batteries.

Interviewer: Akio Etori, Science Journalist

The advent of the lithium ion battery

With the popularization of laptop computers and mobile phones, secondary cells, and particularly lithium ion batteries, have become a necessity of life in the modern age. Their range of applications is also continuing to expand, as seen in onboard batteries for hybrid vehicles, large-scale storage batteries in smart grids for efficient use of solar power, etc.

However, when Dr. Takada finished graduate school, joined a private-sector company, and began research and development on solid electrolytes, there was still no prospect that solid-state cells would become a reality. "I joined the Central Research Laboratories of Panasonic Corporation (then Matsushita Electric Industrial Co., Ltd.) in 1986 and began research on solid electrolytes. Among solid electrolytes, the object of research at the time was electrolytes that transport copper ions and silver ions, which have comparatively high ion conductivity. However, since their ionization energy is small and we cannot take out an adequate voltage, I was doing research on the possibility of using those materials in ion devices rather than in secondary cells."

Later, Sony introduced commercial lithium ion batteries in 1991, and the world's attention was focused on battery development. Lithium ion batteries operate by movement of lithium ions back and forth through an electrolyte which electrically joins the positive electrode and negative electrode. Other secondary types of cells, for instance, nickel-metal hydride batteries, those cells can only produce a voltage of 1.2 V because an aqueous solution is used in the electrolyte. Among lithium ion batteries, which aim at high energy density, voltages of 3.5-3.7 V have been obtained in commercial products by using an organic solvent in the electrolyte, and voltages of approximately 5 V have been obtained at the research level.

A breakthrough toward the realization of all-solid-state batteries

However, because the organic solvents used in lithium ion batteries are flammable substances, the realization of all-solid-state batteries, which use a solid in the electrolyte, is desired from the viewpoint of safety. Moreover, since solid substances with high ionic conductivities have been discovered in recent years, solid electrolytes are now regarded as the more reliable materials. However, in the battery as a whole, high output power cannot be obtained unless accompanied by the high ionic conduction between the materials, that is, between the electrolyte and electrodes, the electrolyte interface and grain boundaries, and so on.

"A substance with strong oxidizing power is required in the positive electrode of a battery, and a substance with strong reducing power is needed in the negative electrode. Since substances with totally different natures are joined, barriers to ionic conduction appear at the interfaces between the electrolyte and the electrodes. In order to eliminate these obstacles, I developed a nanosized buffer layer which is inserted in the interface." In this way, Dr. Takada succeeded in realizing high output by inserting a new buffer layer between a sulfide solid electrolyte and an oxide electrode, and thus achieved a breakthrough toward practical application of all-solid-state lithium ion batteries (Fig. 1).

"Originally, I was told to use lithium cobalt oxide ($LiCoO_2$) in the oxide positive electrode in an all-solid-state lithium ion battery by my superior when I was in the company, but I didn't act on that advice immediately because I didn't think that a positive electrode which exhibits a potential of as high as 4 V would function with a sulfide solid electrolyte. However, a colleague tried assembling a battery and it worked well. Of course, the output was not high enough, but since it had been said solid-state batteries inherently have low output performance, I didn't pay it that much attention."

Although Dr. Takada's workplace at the time was searching for commercial products, he moved to NIMS while the problem of output performance was still unsolved. "After I moved to Tsukuba and built cells using various materials, I also found materials with high output performance, and conversely, it came to seem that the high resistance of the $LiCoO_2$ positive electrode was anomalous. I realized that, after all, thinking that an anomaly occurs at the interface between a high potential positive electrode and a sulfide solid electrolyte is more natural. In the end, it took me 10 years to come to that realization, but after that, it took a relatively short time to increase output."

As a result of the development of a buffer layer with a thickness of about 5 nm, which eliminated the barrier to ionic conduction at this interface, the output characteristics of all-solid-state lithium ion batteries became comparable to those of commercially-available lithium ion batteries (Fig. 2). Today, the Nano-System Computational Science Group at MANA is continuing research to elucidate the mechanism of this phenomenon.

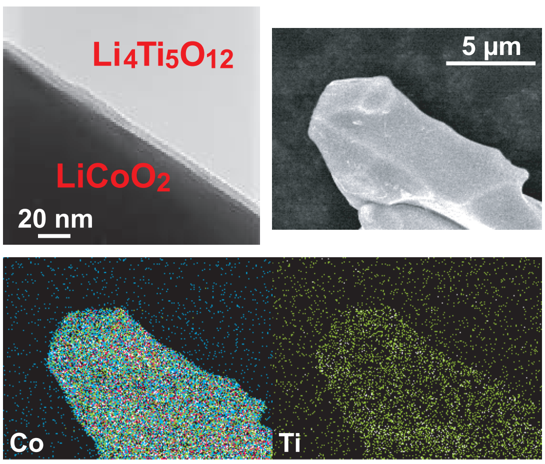


Fig. 1 Electron microscope images of the $LiCoO_2$ particles that formed the buffer layer. An enlarged view of the buffer layer region (upper left), and an image of a particle (upper right). The images at the bottom show the distributions of Co and Ti investigated by energy dispersive X-ray spectroscopy.

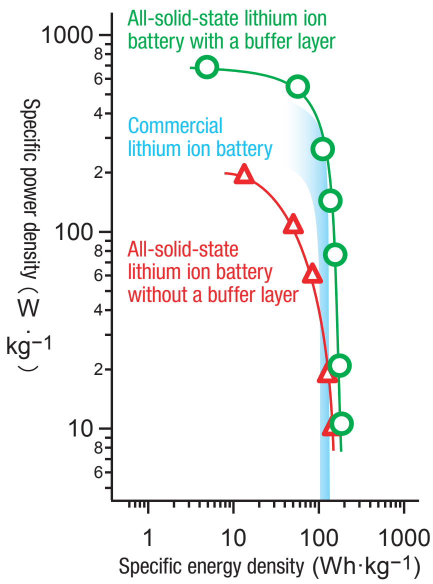


Fig. 2 Output characteristics of an all-solid-state lithium ion battery with a buffer layer.

Study of oxide electrolytes and nanoarchitectonics

Although sulfides are thought to be the only favorable substance in this type of solid electrolyte at present, many problems still remain to be overcome. These include process-related restrictions on the use of sulfides due to the fact that sulfides are extremely sensitive to the atmosphere and cannot be handled in air, as well as problems when a battery is damaged and the sulfide leaks out, among others.

Therefore, advancing a step forward, Dr. Takada is now devoting the greatest effort to research aimed at using oxides as solid electrolytes. Based on their crystal structures, three oxides which are suitable for solid electrolytes are known. The NASICON type and perovskite type, which were already known in the 1990s, and the garnet type, which was discovered more recently, were studied. "The ionic conductivity in the crystal structures of all of these oxides is 10^{-3} S/cm, and there is no problem from the viewpoint of ion transport, but movement is poor due to their extremely high resistance at grain boundaries, or at the interface at points in contact with the electrolyte. We have to do something about that."

"For me, and for batteries, this interface is nanoarchitectonics. The space charge layer at the interface, which is said to have a thickness on the order of 10nm, this often controls ion transport in a battery. We have to focus our attention on that," Dr. Takada emphasizes (Fig. 3). Because the quantity of electricity that can be stored in electrode particles is proportional to the volume of the particles, use of large particles is advantage for storing energy. Although the volume of a particle is proportional to the third power of its diameter, the surface area through which ions can enter and leave a particle only increases by the second power of the particle diameter. Accordingly, as the size of the particles increases, it becomes increasingly important to create an interface through which ions can enter and leave at high speed. "Battery materials usually have a micrometer size, but what determines the transport phenomenon of ions entering and leaving the crystal structure is this nanosize region. I am now considering various ideas, for example, a new buffer material for oxides, in order to control this space charge layer. I want to overcome this problem and realize an electrolyte using an oxide."

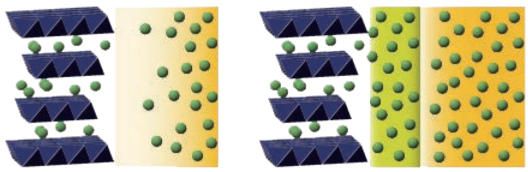


Fig. 3 The space charge layer of the interface which controls ion transport in a battery.

Novel techniques for material development began to turn toward batteries

In the development of batteries, various components, including the materials of the electrodes and the electrolyte, their structures, etc. are interrelated in complex ways. In this, Dr. Takada, who has constantly focused on solid electrolytes, says that the highest priority in that research is output. "What's more, this means increasing output as an essential material property. Although there is an apparent increase even when particles are reduced to the nanosize, I think they can only be adjusted for the first time when considering the application. Requirements are diverse, depending on the device, for example, ranging from the thin-film battery of an IC card to large-scale storage batteries for smart grids. If it is possible to increase performance by interfacial control of the battery materials, it will then become possible to design the particle size and structure, the electrode materials and other specifications suited to the application. For this reason, my primary aim is to develop battery materials with intrinsically high performance."

Dr. Takada is affiliated with a large number of organizations, including MANA, of course, and also the Battery Materials Unit in the Environment and Energy Materials Division at NIMS, the NIMS-Toyota Materials Center of Excellence for Sustainable Mobility, and the NIMS Open Innovation Center, among others. He has a real feeling that specialists in various areas of fundamental research have turned their attention toward batteries in recent years. "I feel that new techniques for material development for realizing next-generation batteries are appearing. For example, development of analytical techniques, and computational science are more closely related than in the past. Since energy problems are now influencing every field of research, research related to batteries is also increasing dramatically."

"I'm busy every day, but I play soccer to relieve the stress. I've been playing since I was in junior high school," Dr. Takada laughs.

Pioneering Mechanisms for High Performance in Thermoelectric Materials

Takao Mori
Group Leader
Nano-Materials Field

Importance of development of thermoelectric materials and related issues

The primary energy consumed by mankind includes oil, coal, gas, etc. Only about 1/3 of this energy is effectively utilized; most of the remainder is lost as waste heat. Although there are high expectations for solid-state thermoelectric material devices, which convert waste heat directly to useful electricity by utilizing the Seebeck effect, these devices still have not achieved widespread practical application. As one large reason for this, the performance of existing thermoelectric materials has not been good enough. In $Z = S^2\sigma/\kappa$, which is an index called the "figure of merit" that expresses the performance of a thermoelectric material (where, Z: figure of merit, S: Seebeck coefficient, σ: electrical conductance, κ: thermal conductivity), a conventional tradeoff relationship exists between S and σ. Meanwhile, the situation in which electricity needs to be conducted but heat should not be is paradoxical. These relationships make it difficult to straightforwardly realize high thermoelectric performance. Furthermore, in conventional high performance thermoelectric materials, the main components tended to be elements such as Bi, Te, Pb, Ag, Hf, etc. that are either toxic or scarce and expensive. In this research, we are pioneering mechanisms which make it possible to achieve high thermoelectric performance with compounds mainly composed of naturally-abundant elements, thereby contributing to wide-ranging practical application.

Nanostructural control

One popular method to achieve high thermoelectric performance, based on the fact that the mean free paths of phonons and the charge carriers are different, is suppressing thermal conductivity by building nanostructures into the material which scatter phonons more selectively. Although mechanical methods employing ballmilling or the like are widely used to introduce these nanostructures, we succeeded in synthesizing nanosheets of thermoelectric materials, and obtained enhanced thermoelectric performance. This is a simple technique which consumes low energy. As the next stage, if this technique can be applied to wider classes of thermoelectric materials, and high-order structures designed by nanoarchitectonics can be built up by stacking the nanosheets, additional dramatic improvements in performance are expected (Fig. 1).

The search for new concepts

As described above, nanostructuring is a powerful method for reducing thermal conduction with little loss of electrical conduction. Nevertheless, it is also extremely important to discover new concepts which increase the numerator $S^2\sigma$ (= power factor) of the above-mentioned figure of merit. We previously obtained a high thermoelectric power factor at around room temperature with a $CuFeS_2$ system, which is a magnetic semiconductor. In contrast to the champion room-temperature thermoelectric Bi_2Te_3–type materials, toxicity is not an issue with Cu, Fe and S, and these elements also exist in abundance in nature in the form of chalcopyrite. As the mechanism by which magnetism enhances thermoelectric performance, we recently clarified the importance of the interaction of the charge carriers and magnons (quasiparticles related to the oscillation of the magnetic moment in magnetic materials), as is shown in an image in Fig. 2, and are now attempting to use this for the design of materials with even higher performance.

In other research, ultra-high temperature thermoelectric materials are required for the ultra-high temperature topping cycle, which can improve the output of thermal power plants. We discovered that SmB_{66} displays a figure of merit 40 times higher than the other rare earth phases, and we are now engaged in research to elucidate the origin of that phenomenon.

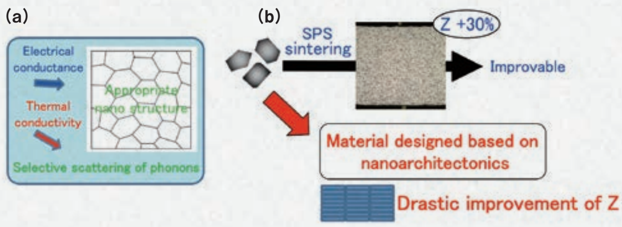
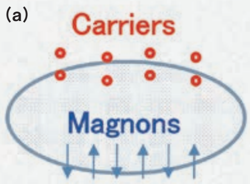


Fig. 1 (a) Image of selective scattering of phonons.
(b) Creation and potential of nanosheets of thermoelectric materials.



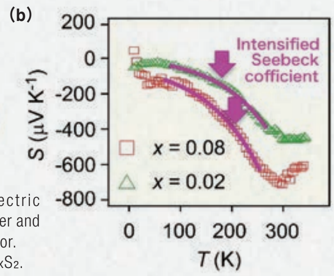


Fig. 2 (a) Image of thermoelectric enhancement effect (coupling of carrier and magnons) in a magnetic semiconductor.
(b) Seebeck coefficient of $Cu_{1+x}Fe_{1-x}S_2$.

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A conversation with Prof. Yasuhiko Arakawa

Interviewer: Akio Etori, Science Journalist

Create your own path in life, without fearing change

An approach to the central issue of research

—— You're a pioneer in quantum dot research. How did you become involved in that work?

In graduate school, I was involved in research on communication theory, especially in optical communication theory, but when I became a lecturer at the University of Tokyo in 1980 I changed my specialization to device development and set semiconductor lasers as my research theme. While I made that change at the request of the university, I had also wanted to do experimental work, and not just theoretical work after seeing the limits of communication theory. At the Institute of Industrial Science where I was working, Prof. Hiroyuki Sakaki, an up and coming associate professor at that time, was doing research mainly on electronic devices using quantum effects. Around that time, active research began in the US on thin film laser - that is, the quantum well laser - incorporating developments of Dr. Leo Esaki's work on semiconductor superlattices. That area seemed interesting to me. Then I decided to focus on lasers accompanied by quantum effects. In a quantum well, electrons behave two-dimensionally, but I wondered what would happen if their degree of freedom were changed. This led me to write my paper published in 1982 which proposed the application of the quantum dot and laser.

—— Your research became particularly well-known overseas.

For two years beginning in 1984, I joined the laboratory of Prof. Amnon Yariv at the California Institute of Technology. While pursuing theoretical research, we also performed various experiments on quantum well devices. The opportunities to create actual devices in the laboratory was a valuable experience for me. The first paper that I jointly authored with Prof. Yariv in 1984 had an important impact on the world.

Actually, my paper on quantum dot lasers from 1982 was too ahead of its time to attract much attention. Even though people might call it "interesting," they really meant to say that it "wasn't mainstream enough of a topic." However, in the paper that I authored with Prof. Yariv, we were able to introduce new ideas which I had cultivated about quantum effects to central issues in laser research at that time, including modulation characteristics and spectrum characteristics. Even though it was the same topic, the fact that we came to grips precisely with this central issue was important.

—— After all, how one understands the key issue is critical when selecting a research topic, right?

While something may be a key issue, it also has to be new. In my case, I think that it was good that I could show the practical impact of quantum effects. If something is a key issue, then many researchers are already doing it. However, we were able to make a breakthrough by introducing a new aspect into that.

Toward practical applications of "quantum mechanics"

—— What are you currently putting particular effort into in your own research? And what is the outlook for its practical aspects?

A silicon interposer incorporating a quantum dot laser was announced in 2014 in the FIRST program [FIRST: Funding Program for World-Leading Innovative R&D on Science and Technology]. This realizes optical information transmission in an optical wiring integrated circuit in a 5-mm square of silicon. The threshold current of the quantum dot laser displays little temperature dependency, and the threshold current is almost unchanged even at high temperatures. It is not affected by the heat generated by the integrated circuit. We confirmed very high speed operation of the circuit at temperatures as high as 125°C, which is impossible with conventional semiconductor lasers.

Up to now, the object was long distance communication, but quantum dot lasers are now being applied practically even to this kind of ultra-short distance. There is virtually no doubt that quantum dot lasers will be applied in computing technology in the near future. Of the three fundamental elements of computers, -namely storage, logic, and wiring - storage and logic may continue to use electricity, but in wiring, the changeover from electricity to light is only a matter of time. This means the optical communication technology is introduced to the LSI/computer industry with a large market. Silicon photonics utilizing quantum dot lasers play an important role in this paradigm shift of the market.

In fields other than optical communication, high expectations are also placed on quantum dot lasers in a variety of applications, which include ultra-high power lasers, ultra-compact lasers, ultra-low power consumption lasers, optical detection and so on. The quantum dot laser in particular can play an active role as a nanolaser in a variety of areas in the future, including so-called "IoT." I am extremely happy as an engi-

A conversation with

Prof. Yasuhiko Arakawa

neering researcher that it is possible to bring one essential property of quantum mechanics, namely the complete discretization of energy, to fruition in this kind of practical quantum dot laser device.

The importance of the mobility of human resources

── What are your thoughts on the WPI program?

I feel that the program is further developing the good points of each center, without forcing linkages with industry. This also has the aspect of strengthening the organization to which the WPI center originally belongs, which in the case of MANA means NIMS. For society as a whole, this increases the organizations which are strengthened in that manner, which benefits Japan as a whole.

── And expanding opportunities in Japan as a whole is also important from the viewpoint of developing young researchers?

I feel that it is important to increase mobility in society and create an atmosphere in which people can take advantage of moving to other organizations. If every researcher who joins a certain organization continues to work in the same place through their entire career, this is questionable from the viewpoint of activation of that organization and society as a whole. Personal growth can be encouraged by changing affiliations and objectives of research.

── You also changed your specialization.

As to why I was able to change my specialization when I found a job in the University of Tokyo, the fact that I had been hired with a permanent contract and managed my own laboratory from the beginning were important. Otherwise, it would have been difficult to change specializations. If the pressure to write a paper in two years is too intense, people will choose the easy way and won't be able to act boldly. That's a delicate balance. Also, even though the number of researchers required for one research area is almost unchanged, the number of young researchers entering has increased dramatically because of postdoctoral recruitment programs and such. Both the policy side and the young researchers themselves must be conscious of that risk. If you don't achieve results within a certain period of time, it is also necessary to have the mentality to transform yourself, for example, by approaching industrial aspects, or by resolutely going abroad, or by changing fields of specialization. Even looking at the US, Germany and other countries, a large number of young people don't join a research organization after finishing their Ph.D., but, for example, become consultants, or find employment in companies, or grapple with other work. Researchers, with diverse values, must search for their own path in life.

── What are your expectations for MANA in the future?

In particular, I think that MANA has succeeded in good human resources development for young researchers. Not only the results of today's research, but also the fact that their experience at MANA provides good sustenance for researchers who return to their own countries 5 years or 10 years from now, is also important. They will return to their own countries or go on to their next position with successful experiences and good memories of Japan. That will create something that can be called a MANA network, they will send their own students to Japan, and this will expand and deepen the network with other countries. In the broad sense, this will result in mobility of human resources. That kind of development can be expected.

PROFILE

Prof. Arakawa completed his Ph.D. specializing in electrical engineering at the University of Tokyo in 1980, became Lecturer and later Associate Professor at the Institute of Industrial Science, the University of Tokyo in the same year, and in 1993, was appointed as Professor at the institute. From 1984 to 1986, he was a Visiting Researcher at the California Institute of Technology. He is presently Director of the Institute for Nano Quantum Information Electronics, Professor / Center Director of the Center for Photonics Electronics Convergence, the Institute of Industrial Science, all units of the University of Tokyo. Among his many awards, he received the Leo Esaki Award in 2004, the Medal with Purple Ribbon in 2009, the Heinrich Welker Award in 2011. He has been President of the International Commission for Optics (ICO) since 2014.

Atomic Step Josephson Junctions Revealed by Scanning Tunneling Microscope

Takashi Uchihashi
MANA Scientist,
Nano-System Field

Discovery of metal atomic-layer superconductor

Two-dimensional materials with atomic-level thicknesses have attracted great interest in recent years, and their application to a variety of nanodevices is expected. A representative example of these materials is graphene, which is made of carbon atoms. Metal atoms can also be used to create two-dimensional materials that are different from their bulk counterparts, when assembled on a semiconductor surface. Recently, we discovered that indium atomic layers grown on a silicon surface exhibit superconductivity at low temperatures. This was surprising, since it had long been thought that atomic-layer materials never become superconducting. It is expected that surface superconductors consisting of metal atomic-layers will be applied to ultra-high speed, ultra-low energy consumption logic operation devices.

Atomic step as a Josephson Junction

Josephson junctions, which control the flow of a supercurrent, are necessary in order to fabricate superconducting devices. Without a Josephson junction, a superconductor is nothing more than a material with zero resistance. A Josephson junction is a junction where two superconductors are coupled through a thin insulator or the like and superconducting electrons can flow by tunneling through the barrier. While microfabrication techniques are generally necessary to create Josephson junctions, it was assumed that Josephson junctions were naturally formed at so-called atomic steps, which exist on semiconductor surface in a large number. However, no direct evidence for this has been found so far.

Observation of anomalous superconducting quantum vortices at atomic steps

We have successfully found clear evidence that atomic steps work as Josephson junctions using scanning tunneling microscope (STM), which is widely used to observe atomic images of material surfaces. When magnetic field is applied to superconducting indium atomic layers on a silicon substrate, quantum vortices of supercurrents are generated (Fig. 1). We also discovered that, when a superconducting quantum vortex is trapped by an atomic step, the vortex is elongated along the step and the "strength" of the vortex decreases (Fig. 2). This means that the supercurrent is regulated at the atomic step; namely, the atomic step works as a Josephson junction. This anomalous behavior was observed using STM for the first time. This present result is a great step toward realization of superconducting devices based on metal atomic-layer materials.

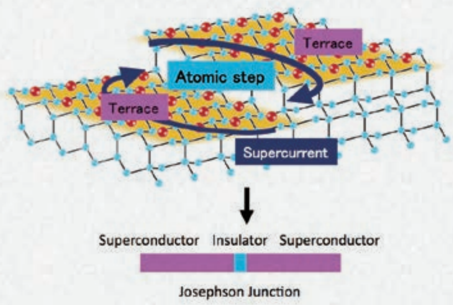

Fig. 1 Schematic diagram of an atomic-layer superconductor and an atomic step. A Josephson junction is formed at the atomic step that separates terraces (flat regions) in the superconducting state. The arrows show that a vortex is formed by supercurrents flowing over the step.

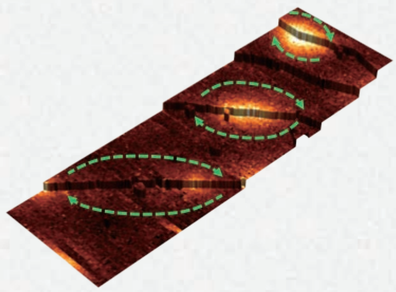

Fig. 2 Three-dimensional representation of the atomic-layer superconductor observed by scanning tunneling microscope. The bright regions correspond to the centers of superconducting vortices. The arrow shows a schematic illustration of supercurrent flows, indicating that the vortices are elongated along the steps as the Josephson coupling becomes weaker.

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Progress of MANA

MANA – A Commitment of Support for Students

Social contribution through human resources development

One form of social contribution by MANA/NIMS is development of young human resources and support for students. Here, we introduce various systems and activities which MANA and NIMS have actively implemented in order to train researchers who can spread their wings around the world.

1 Joint Graduate School Program

Developing talent and potential as specialists with higher research competencies

In the Joint Graduate School Program, NIMS researchers managing independent specialties or affiliated with existing specialties in graduate schools which have concluded cooperation agreements with NIMS, advise doctoral course students as teachers. Because the students enrolled in the graduate school with this program can get the degrees by the research achievement carried out in NIMS, they are expected to achieve higher research competencies. The program also provides financial support to brilliant graduate students under the "NIMS Graduate Researcher Assistantship" program. As of 2015, 41 students including 37 non-Japanese students are engaged in research to get the degrees at MANA under the Joint Graduate School Program, and realizing an extremely international Joint Graduate School Program.

2 Cooperative Graduate School/ International Cooperative Graduate Program

Obtaining degrees under the guidance of MANA researchers

Under the Cooperative Graduate Program, NIMS researchers are entrusted to serve as Visiting Professors of graduate schools which have cooperative agreements with NIMS, and advise graduate students until they receive their academic degrees through advanced research in NIMS. NIMS has concluded cooperative agreements with 32 graduate schools in Japan, and to date, 39 students have received guidance at MANA.

In addition, NIMS receives students in the second half of the doctoral program in cooperation with 19 international leading universities. During the period, NIMS researchers provide research guidance as Visiting Professors. Research done at NIMS is recognized as the part of achievement in academic course work, and the results of research are included in the student's doctoral dissertation. Five foreign students are currently engaged in research at MANA under this program.

3 NIMS Internship Program

Providing opportunities to experience cutting-edge research

The NIMS Internship Program gives students in universities, graduate schools and technical colleges in Japan and other countries opportunities to experience research at NIMS for up to 90 days. Each year approximately 150 students are received in this program. Especially at MANA, a globally open research center, the possibility of creating wide-reaching human networks is an important merit for students. NIMS also offers financial support in the forms of a daily allowance and accommodation expenses to students who are recognized as particularly outstanding. As another purpose, the Internship Program allows students to become acquainted with the respective Joint Graduate school Program / Cooperative Graduate Program.

Nanotechnology Students' Summer School

Lecture by Principal Investigator James K. Gimzewski and students.

MANA holds a "Nanotechnology Students' Summer School" with universities and research institutes in other countries to enhance the qualities of students as future researchers. Through intensive discussions which go beyond the framework of their own specialties, participating nanotechnology students from Japan and other countries learn practical research know-how in a fusion of different fields. The participants, who are divided into teams make presentations about their ingenious research plans. This Summer School is also to promote scientific exchanges among universities and institutes.

I strongly recommend higher education at MANA to students who aspire to research careers!

Yasuhiro Nakagawa
(NIMS Junior Researcher)

There are 3 reasons why I wanted to do research at MANA: "I can study under Japan's top-class researchers," "It's possible to study in a laboratory with a strong international flavor," and "Financial support is available." At MANA, students can receive guidance from researchers who are involved in front-line research in Japan and other countries in an international environment. Consequently, high quality work is always expected. I am confident that this MANA "sense of professionalism" will also contribute to my own improvement. I am also making several dozen new acquaintances every year, both in Japan and internationally. Considering this as well, I am very happy that I came to MANA. The fact that I could also receive financial support by utilizing the Joint Graduate School Program also became a powerful driving force for going on to doctoral studies. Every day at MANA is rich and rewarding. There's no better environment for students!

NEWS & TOPICS

EVENTS

MANA Holds Nanotechnology Students' Summer School

MANA held the Nanotechnology Students' Summer School over a 5 day period from June 29 to July 3, 2015. A total of 25 students in the first half or second half of their doctoral courses participated from Japan, Canada, the United States, Australia and France. In each group, the participants proposed and presented nanotechnology contributing to modern society based on "nanoarchitectonics." This was a very substantial summer School, in which participants practiced group tasks and learned the fundamentals and mental attitudes of research through a fusion of different fields, going beyond the barriers of different backgrounds and cultures.

MANA Holds the International Symposium on Nanoarchitectonics for Mechanobiology

The "International Symposium on Nanoarchitectonics for Mechanobiology" was held during 2 days from July 29 to 30, 2015. The symposium featured three plenary lectures from Dr. Viola Vogel (ETH), Dr. Toshihiro Akaike (Foundation for Advancement of International Science, FAIS) and Dr. Yasuhiro Sawada (National Rehabilitation Center for Persons with Disabilities), invited talks by 11 distinguished scientists from Japan and other countries, 9 MANA research presentations and 37 poster presentations. The spirited discussions and exchanges of ideas at this symposium strongly highlighted the importance of the interdisciplinary fields of materials science and mechanobiology.

NEWS

Trainees from Qatar Complete Training at MANA

On May 28, 2015, NIMS held a ceremony marking the completion of training by trainees from Qatar, who had attended training at NIMS since December 2014 and recently completed the 6 month training period. NIMS received technical trainees from the Qatar Environment & Energy Research Institute (QEERI) based on a comprehensive cooperation agreement which was concluded between the Qatar Foundation (QF) and NIMS in April 2014. Among seven trainees, MANA received Mr. Ghanim Al-Kubaisi and Mr. Rakan Al-Marri, who studied the operation of analysis, measurement and observation devices and other topics. Exchanges between the two organizations are expected to contribute to friendship between Qatar and Japan.

Left: Mr. Ghanim Al-Kubaisi, Right: Mr. Rakan Al-Marri

AWARDS

Yoshitaka Tateyama, Group Leader
"Gottfried Wagener Prize" (July 2015)

Katsuhiko Ariga, Principal Investigator
"Japan Society of Coordination Chemistry Contribution Award" (July 2015)

NEW FACES

ICYS-MANA Researcher
Shunsuke Yoshizawa

Emerging MANA Researcher

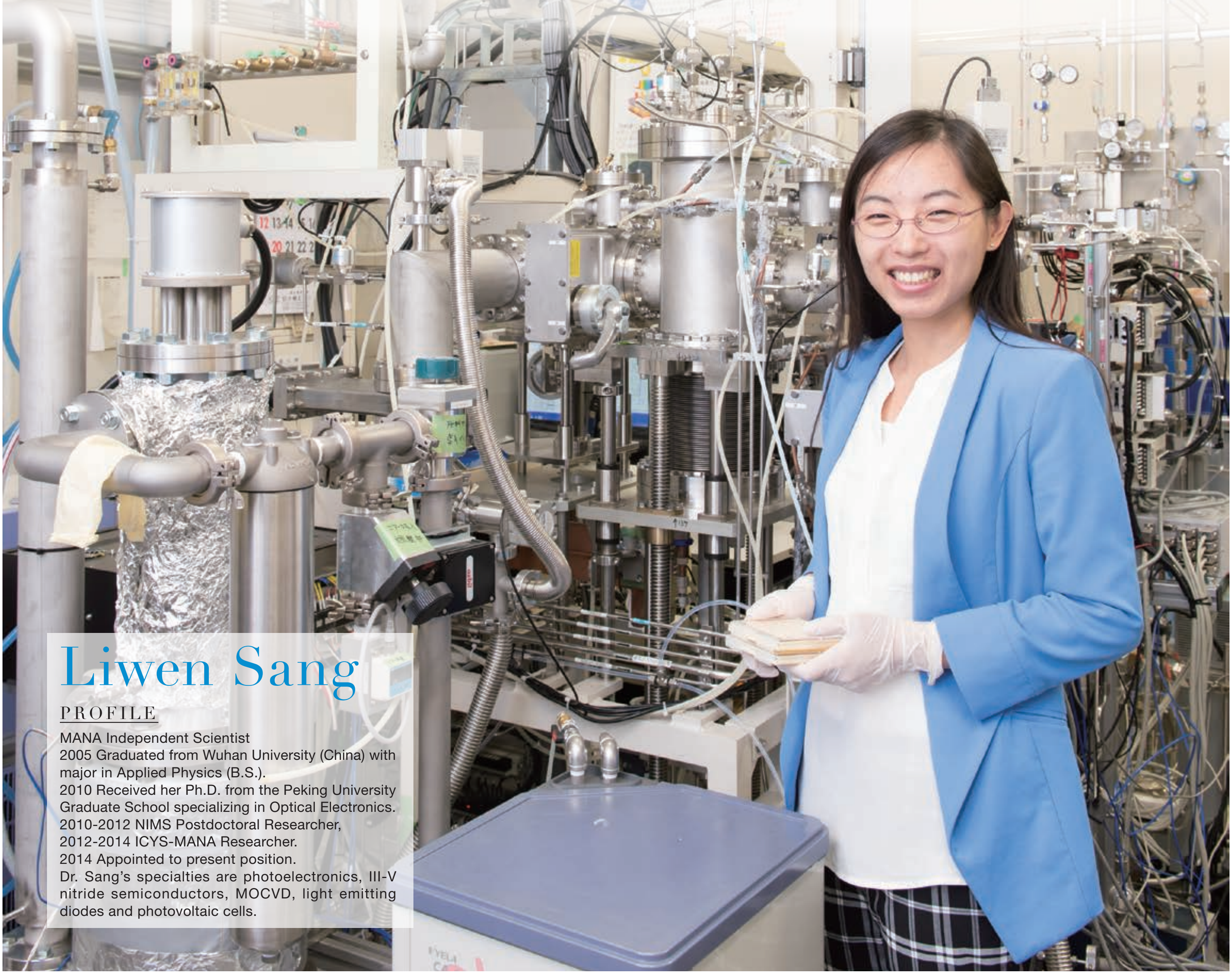
Interviewers: Yasuhiro Nakagawa, University of Tsukuba graduate student D1,
Yuma Kumisawa, University of Tsukuba undergraduate student B2

"I really love my research field – From my heart, I want to contribute to the development of research on nitride semiconductors," Dr. Sang says with a smile. This frank young woman is grappling with the development of red LEDs and ultra-high efficiency photovoltaic cells using indium gallium nitride.

Last year, three Japanese scientists won the Nobel Prize in Physics for the development of the blue LED. However, a phosphor is necessary in order to obtain white light using only that blue LED, and this shortens the life of the LED. "The solution to this problem is a mixture of the three primary colors with the same material system. In other words, in addition to a blue LED, green and red LEDs are also necessary. However, emission of red light is particularly difficult. Although red LEDs are already produced using other materials, I want to realize a high efficiency red LED with a nitride system."

Even though high energy conversion efficiency is expected with nitride semiconductor photovoltaic cells, there are still no experimental data showing that they can withstand practical use. "Absorption of the long-wavelength light by thick InGaN layer in this system is the problem. However, it should be possible to overcome this by devising a device with a new structure, and also creating a new concept for accomplishing that."

After joining NIMS from China in 2010, Dr. Sang also received financial support from the Japan Science and Technology Agency "Sakigake" (PRESTO) program and, as a result of hard work, built a uniquely-designed high-pressure MOCVD equipment for the epitaxy of nitride semiconductors. "When I contact Japanese companies about purchasing the necessary materials and apparatuses, the English-language support of the MANA staff is very reassuring. MANA is an extremely comfortable environment for researchers from overseas."



Liwen Sang

PROFILE

MANA Independent Scientist
2005 Graduated from Wuhan University (China) with major in Applied Physics (B.S.).
2010 Received her Ph.D. from the Peking University Graduate School specializing in Optical Electronics.
2010-2012 NIMS Postdoctoral Researcher,
2012-2014 ICYS-MANA Researcher.
2014 Appointed to present position.
Dr. Sang's specialties are photoelectronics, III-V nitride semiconductors, MOCVD, light emitting diodes and photovoltaic cells.

MANA NEWS LETTER

CONVERGENCE

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Outreach team
International Center for
Materials Nanoarchitectonics (MANA)
c/o National Institute for Materials Science (NIMS)
1-1 Namiki, Tsukuba, Ibaraki, 305-0044 JAPAN
Phone: +81-29-860-4710
Facsimile: +81-29-860-4706
Email: mana-pr@ml.nims.go.jp
URL: http://www.nims.go.jp/mana/

"CONVERGENCE"
is the keyword used to symbolically describe the entire project of MANA, where outstanding researchers from around the world assemble and converge in the "melting pot" research environment to bring together key technologies into nanoarchitectonics for the creation and innovation of new functional materials.

COVER: MANA Principal Investigator, Kazunori Takada and young researchers

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