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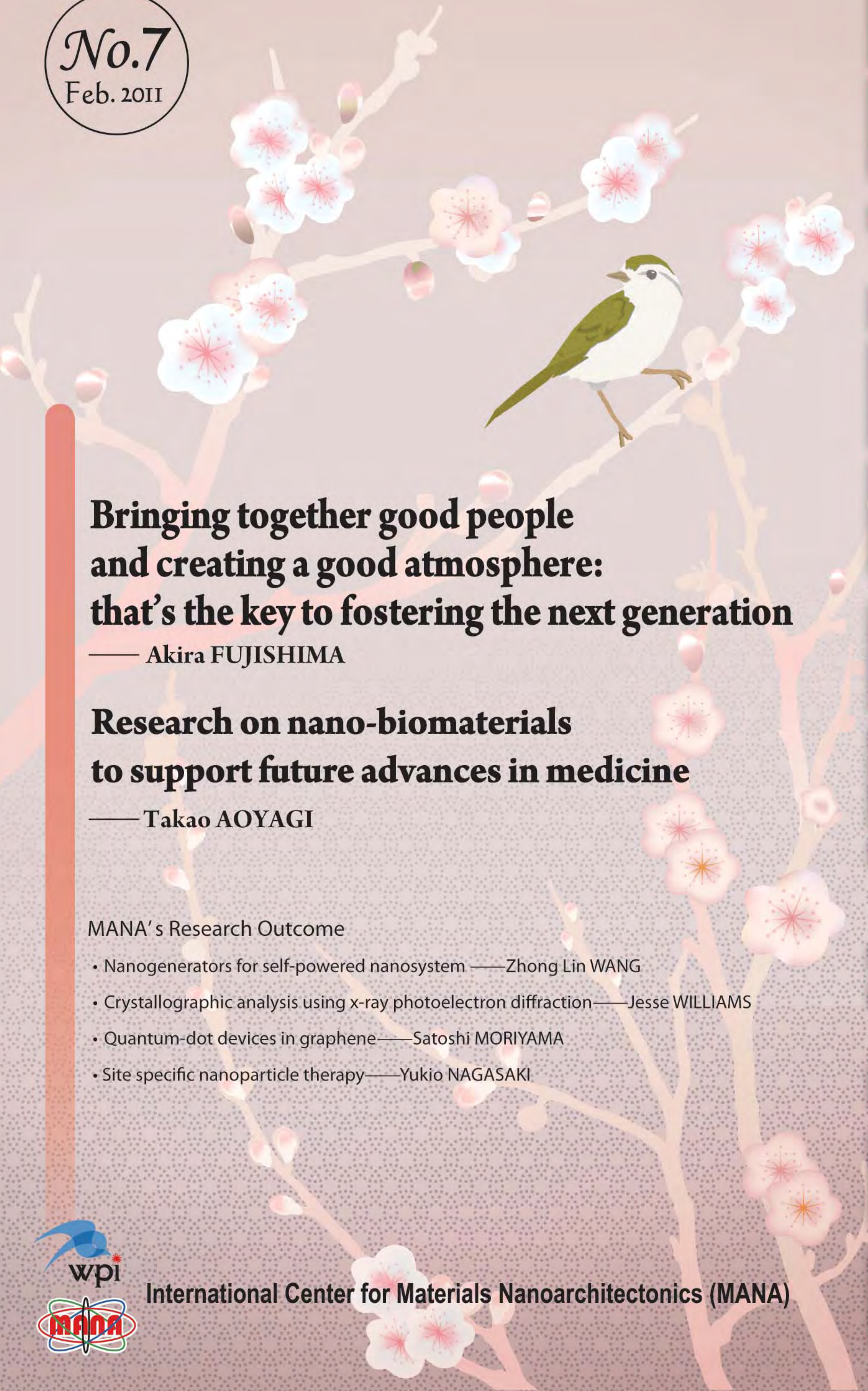

Bringing together good people and creating a good atmosphere: that's the key to fostering the next generation

—— Akira FUJISHIMA

Research on nano-biomaterials to support future advances in medicine

—— Takao AOYAGI

MANA's Research Outcome

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International Center for Materials Nanoarchitectonics (MANA)

Bringing together good people and creating a good atmosphere: that's the key to fostering the next generation

❖Interviewer: Akio ETORI, NIMS publishing adviser

Akira FUJISHIMA

Graduated from the Faculty of Engineering, Yokohama National University (1966), Ph.D. in Engineering, Graduate School of Engineering, University of Tokyo (1971), Assistant Professor, Faculty of Engineering, University of Tokyo (1975), Postdoctoral Fellow, University of Texas at Austin (1976–1977), Associate Professor, Faculty of Engineering, University of Tokyo (1978), Professor, Faculty of Engineering, University of Tokyo (1986), Professor, Graduate School of Engineering, University of Tokyo (1995), Chairman, Kanagawa Academy of Science and Technology (2003), Professor Emeritus, University of Tokyo (2003), Special University Professor Emeritus, University of Tokyo (2005), Member, Science Council of Japan (2005), President, Chemical Society of Japan (2006), President, Tokyo University of Science (2010).

While a graduate student at the University of Tokyo, Akira Fujishima discovered that photocatalysis occurred when titanium oxide in an aqueous solution was exposed to strong light, the "Honda-Fujishima effect." Photocatalysis has since been applied in a variety of fields, such as environmental cleanup.

Initial encounter with photocatalysis and its widening field of applications

— Dr. Fujishima, you are world-renowned as a researcher on photocatalysis and have been publically honored for your cultural contributions. How did you first become involved in research on photocatalysis?

Photocatalysis involves a substances called titanium oxide. I first encountered titanium oxide in monocrystal form when I was in the first year of a master's program at the University of Tokyo. This was around the time that photocopiers first came onto the market. I was working in in a photographic chemistry lab and some of our research dealt with materials used in photography. Work related to light was just getting started, with labs in America and Germany leading the way, and I wondered what would happen if the effects of light were incorporated into work on electrolysis. I was looking for a material that no one had used—something other than silicon or zinc oxide, which were already being employed—and I discovered that Nakazumi Crystal in Kobe was producing monocrystal titanium oxide. I wrote a letter to Yoshihide Nakazumi, the president of the company, asking him to let me use this material, and he agreed. When I did experiments using the titanium oxide, it reacted in ways that were clearly different from the behavior of other materials as reported in research papers. All the previous papers reported that the materials they were testing "melted" when they reacted to light. But the titanium oxide did not melt. When exposed to light there was a reaction and gas was produced. When I collected the gas and analyzed it, I discovered that it was pure oxygen. When exposed to light the titanium oxide caused oxygen to be extracted from water. This was similar to the photosynthesis that occurs on the surface of a leaf, and I was very excited. Unfortunately, no one believed me when I presented my findings at academic conferences. The process of breaking down water molecules by electrolysis requires a voltage to be applied, and I was claiming it could be done by applying light.

Later I submitted an article to Nature in which I stated that water could be decomposed using sunlight, and that oxygen was generated at the surface of the titanium oxide and hydrogen at a counter-electrode made of platinum. The year after the article appeared the first oil crisis occurred. So the fact that a Japanese scientist had published an article in Nature saying that a clean energy source such as hydrogen could be produced from water using sunlight brought me favorable recognition. My discovery was featured as the top page-one story in the Asahi Shimbun newspaper on New Year's Day 1974, which was quite an epoch-making event for me.

— Research on more efficient ways to extract hydrogen continues all over the world even today. I hear that you are now working on applications for photocatalysis outside the field of energy conversion. Why this change of focus?

Initially, photocatalysis was particularly highly evaluated as a way to extract hydrogen from water. But it is difficult to produce enough hydrogen for use as an energy source in this way. I started to wonder if the power of photocatalysis to decompose water might be useful for something other than energy conversion. I discussed my thinking with Kazuhito Hashimoto, who was then an associate professor, and Toshiya Watanabe, a researcher at TOTO Ltd. We thought that photocatalysis could be used to break down bacteria inside restrooms, so we started out by applying a clear coating of titanium oxide to restroom tiles. We put a variety of bacteria on the tiles and shined light on them, and sure enough the germs were killed off right away. We also found that a clear coating of titanium oxide applied to a mirror would prevent it from fogging up. When exposed to ultraviolet rays the titanium oxide produces a strong oxidizing power that decomposes whatever is on the surface, causing it to become more attractive to water and preventing the surface from fogging up. It occurred to me that these two effects might be applied to environmental problems.

I presently am also serving as head of the research lab of Central Japan Railway Company. Three years ago a smoking ban was put in place on the Nozomi N700 trains of the Tokaido Shinkansen. There are still four designated smoking areas in the sections between the seating compartments, and photocatalysis is used to clean the substances associated with cigarette odors from the air. I'm also working on the development of air cleaners that eliminate viruses. But the field with the broadest range of possible applications is exterior building materials. These were used extensively in the Japan pavilion at the Shanghai Expo. Also, the building in Minatomirai where the APEC summit was held employed photocatalytic materials. The market for products using photocatalysis is now worth 80 billion yen in Japan and 20 billion yen overseas.

— So you are doing research on applications useful in our daily lives.

Photocatalysis is like a poster boy for nanotech, and I'm often asked to speak on its practical uses at nanotech symposiums. Titanium oxide is a common material. Particles of titanium oxide a few micrometers in size are used as a principal ingredient in some types of write paint, for example. It is hard and stable, and is even used in toothpaste. When the particles are reduced in size to 10 or 20 nanometers in diameter they are no longer white and become transparent. Photocatalysis uses nano-size titanium oxide in coatings that do not peel off. This is why it can be regarded as an example of nanotechnology.

Deriving excitement from basic science

— You are also passionate about education and are trying to prevent young people from losing interest in science. What do you think is particularly worthy of attention in this regard?

I think that "excitement" is the most important thing. To teach young people the importance of getting excited about science I go to many different venues to give lectures, in addition to the Tokyo University of Science, where I serve as president. I speak at elementary schools and kindergartens in addition to high schools and junior high schools. I ask things like "Do you know when dandelions bloom?" or "Do you know when morning glories bloom?" And when I then tell them that "morning glories don't bloom early in the morning; they bloom ten hours after it gets dark," I've caught their interest.

—So you tell your audiences that they should be interested in the familiar things all around them and that a sense of excitement will be important in the future.

Yes, that's right. That's the basic idea. I also tell them stories about Einstein, for example. GPS navigation systems used to have a margin for error of about 100 meters, and now their margin for error less than ten meters. How was their accuracy improved? The error is the result of a slight time lag affecting the three satellites that are used to pinpoint the location. Einstein's theory of relativity tells us that time moves more slowly for something travelling at great speed. Based on this theory, a fourth satellite is now used to compensate for the time lag, resulting in improved accuracy.

Einstein's theories may be difficult to understand, but all of us benefit from them. That's why it's exciting when we come to understand the essence of science, I tell them.

A good atmosphere leads to good research

— So a sense of excitement also helps a researcher to grow. What do you think is required for researchers to produce good results?

I think that "people" are essential to producing good results. It is very important to have a good "atmosphere" created by the coming together of many people. Without a good atmosphere it is impossible to produce good research and good results.

In my lectures I often point to the Renaissance as an example. The Medici family greatly valued the environment and culture, and they turned Florence into a cultural center. Leonardo da Vinci was born there, as were the famous sculptor Michelangelo and the celebrated painter Raphael a little later. All three were active in the same place, Florence, during the same period. Renoir, Monet, van Gogh, and Gauguin all lived and worked in Paris. They were all painting during the same period. What about Japan? Why did so many great figures suddenly emerge simultaneously at the time of the Meiji restoration? The common factor in all three of these cases is that there were exceptional people gathered together in the same place at the same time.

The same is true for research. To produce something exceptional it is important to bring together good people in a good atmosphere. In my own case, I found the atmosphere my colleagues and I enjoyed in the lab where I did my first work on photocatalysis to be something really extraordinary. When you have a good atmosphere results will follow: you'll find something interesting, you'll focus on what your working on, and you'll discover something new.

— What should we pay attention to if we want MANA to become a world-class center for research?

MANA already has sufficient equipment and personnel. People like Teruo Kishi, the first President of NIMS, and Sukekatsu Ushioda, the current President, have done a marvelous job of creating a good atmosphere. I am sure that under such leadership many impressive research results will be produced. And I think that even better results will come about when the researchers in each lab work together to enhance the atmosphere. I hope that MANA will become a model facility that is truly world-class.

— Thank you for talking to us today.

Research on nano-biomaterials to support future advances in medicine

Takao AOYAGI

- Principal Investigator
- Nano-Bio Field

Different approaches to research in industry, government, and academia

——Dr. Aoyagi, your career thus far has spanned industry, government and academia, including work at private enterprises, universities, and independent government-sponsored institutes. How would you compare their approaches?

Some universities specialize in research, but I was a professor at a regional institution where the role of the university was largely seen as educating students. We were told to devote our full attention to our classes.

Private enterprises have different metric than universities or government-sponsored institutes. When I joined a private company we were asked by the executive in charge of training new employees, “what do you consider your responsibilities to be?” We new hires gave answers like “pursuing profit” or “contributing to society,” but the correct answer was “achieving efficiency.” I will never forget that question and its answer. For example, if it takes me one hour to wash 100 vials that were used in experiments but buying 100 new vials costs less than my hourly salary, buying 100 new vials would clearly be more beneficial for the company. This cost consciousness made an impression on me. The job is to do things as efficiently as possible, and the private sector measures the value of research in terms of the profit it makes.

In contrast, independent government-sponsored institutes view their mission as accomplishing government policy. Most of the researchers have PhDs, and their main goal is to achieve results through their research. So I think that this is a fundamentally different type of stage on which to work than a private company or a university where one's teaching and research are focused on education. The purpose of a government-sponsored institute is to implement state policy. That's why I'm always thinking about awareness of costs and doing outreach to show the taxpayers how our work benefits society.

Materials therapy —using materials to treat disease

——Japan's Fourth Basic Plan for Science and Technology identifies the nano-bio field as an area to be focused on, and this means that you will be playing an important role in the work of NIMS and MANA. What aspects of nano-bio are you thinking of exploring moving forward?

Polymer chemistry has long been my specialty, and my work has involved designing new materials, using them in actual applications, and evaluating their performance. So my future research in the nano-bio field will be have materials as its basis, and I think this approach will give me a lot of freedom. I am considering materials-centered nano-bio work that exploits the special characteristics of organic materials, which provide an especially high degree of freedom. Research in fields such as tissue engineering and regenerative medicine are presently very active, but these treatment methods remain very expensive and they are not a solution to everything. When I discussed the possibilities of using materials in medical treatment with people at the Biomaterials Center, the consensus was that once we reach the limits of regenerative medicine the next step will be to explore the use of artificial materials in treating the body and disease. The term “materials therapy” was coined to refer to the use in treatment of materials that positively act on tissues. This term was newly created in the context of discussing such treatments. As a government-sponsored facility, I hope we can look ahead and use “materials therapy” as a catchphrase to publicize our work on the creation of systems for treating disease with materials.

——What specific targets do you have as your work moves forward?

I have several. For example, I'd like to develop a material to control inflammation that could be used to treat myocardial infarction without the need for drugs. Another would be materials that would enable us to eliminate from the body substances that cause disease, early on while their concentration remains low. Some examples would be a material to eliminate from the body beta amyloid, a protein that forms hard plaques in the brain and is thought to be a cause of Alzheimer's disease, or materials to eliminate substances associated with metabolic syndrome. Antibiotic medicine is presently very active as a research field, but I want to find ways to treat disease with materials rather than drugs. I also want to consider “preventative medicine” that eliminates the causes before sickness can develop. Drugs or new proteins always have side effects. That's why I want to exploit the freedom provided by organic materials to combine desired functions into systems that are extremely safe for the human body but also very effective.

Also, though it is important to increase the variety of materials available, I think, speaking as a provider of materials, that we need to put the emphasis on biological knowledge and conduct lots of research on how medicine and the human body work, on the mechanisms through which disease originates, and so on. By collaborating with people with this kind of knowledge we can make up for our own deficiencies and achieve real benefits for society in our materials research. We are developing materials to be used in the human body, so unlike industrial materials or other materials developed by NIMS and MANA, more time and money will be required for animal experiments and the like. Nevertheless, medical materials are gradually beginning to appear on the market, and commercially viable medical devices with really excellent performance are on the horizon. So I'm confident that the materials research we have been doing all this time will eventually emerge in a prominent way.

——What is your future vision for MANA?

As a matter of fact, there is a particular person I really hope will come to work at MANA. I can't say who it is because negotiations are still underway, but I think everyone doing polymer research in Japan is familiar with this person's name. She has a worldwide reputation, her papers are often cited, and her techniques are widely referenced. When I saw her recently and said that we would really like her to consider working at MANA as a Principal Investigator, she gave me a very positive-sounding reply. I think it is important for MANA to actively recruit Principal Investigators overseas in order to expand and strengthen our work in the nano-bio area.

MANA as an Opportunity for Career Advancement

For young researchers the most important thing is to make steady progress in the advancement of their own careers. Against this background, they endeavor to produce excellent research results and to grow as scholars and scientists. We are always strongly aware of the importance of MANA as a place where young researchers can advance their careers. In particular, we endeavor to satisfy the demands of researchers from overseas as far as possible, and we see MANA as a place where they can gain career experience that will enable them to make a more valuable contribution at their next place of employment. To ensure that researchers can focus on their work and produce results, we put maximum effort into maintaining all aspects of the research environment at MANA, including provision of necessary equipment, elimination of language barriers, improvement of human relations, and simplification of paperwork. The results of this approach are attested by the active roles played at institutions all over the world by young researchers after leaving MANA. Here we introduce the actual testimony of four such young researchers.

I am currently holding faculty and group leader position in Singapore (at NTU). MANA and ICYS provided me unique opportunity to advance my career, I could for the first time freely follow my own ideas and as excellent equipment was abundant at MANA/NIMS, I took advantage of these two major ingredients and published over forty papers in high-impact journals. I made my name to be well recognized in the electrochemistry community. Without this unique opportunity, my career progress would be much slower. I will be forever grateful to MANA for this opportunity.

Dr. Martin Pumera

Following work as a Senior Researcher at Autonomous University of Barcelona, Spain, served from October 2008 to December 2009 as a MANA Scientist at the National Institute for Materials Science. Presently Professor at Nanyang Technological University, Singapore.

I was once an ICYS-MANA researcher from December 2008 to April 2010. As a foreign female researcher, I really hope I can be active in my research field. Before coming to Japan, I had heard about the different pay scale between women and men, extremely hesitant to accept foreign workers. However, MANA has provided a very good environment for foreign and female researchers. I received many supports from MANA and its administrative office, including language support, research fund, scientific advice, and technical assistance. Those valuable experiences in MANA will be a big influence in my future research career.

Dr. Jun Chen

Following work as a postdoctoral fellow at NIMS, served from December 2008 to March 2010 as an ICYS-MANA Researcher at the National Institute for Materials Science. Presently Researcher, Advanced Electronic Materials Center, National Institute for Materials Science.

I decided to choose ICYS-MANA because of the excellent environment for research in terms of facilities, experienced staff and scientific independence. Indeed, I am pretty sure that ICYS-MANA is the best showcase to get promoted in research as a young scientist. I knew from my previous experience that communication is easy (in English) in MANA, compared with other research places in Japan. So it means that my choice was not Japan itself, but ICYS-MANA.

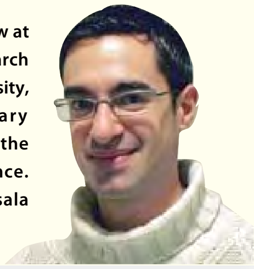
Dr. Samuel Sánchez Ordónêz

Following work as a Ph.D. student at Autonomous University of Barcelona, Spain, served from March 2009 to April 2010 as an ICYS-MANA Researcher at the National Institute for Materials Science. Presently Assistant Professor at Leibniz Institute for Solid State and Materials Research Dresden, Germany.

When I first decided to go to Japan I knew that it would be different. I did however, not know how different and to what extent the experience would affect my career and my life. Due to my experiences in Japan and my research proposal, I was one of the fortunate 11% selected from among over 500 applicants for a special government funded assistant professor position in a Swedish university of choice. I still have collaborations with NIMS and many other universities all over Japan and at this moment I am the host of Prof. Ryuji Tamura from Tokyo University of Science who is visiting our department at Uppsala University. My message to young researchers is that the opportunity lies in your hands, make the most of your time in MANA because it will change your life.

Dr. Cesar Pay Gómez

Following work as a postdoctoral fellow at the Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, served from March 2007 to February 2010 as an ICYS-MANA Researcher at the National Institute for Materials Science. Presently Assistant Professor at Uppsala University, Sweden.



Nanogenerators for self-powered nanosystem

Zhong Lin WANG
ゾン・リン・ワン
Principal Investigator (Satellite PI)
Nano-Material Field

Developing novel technologies for wireless nanodevices and nanosystems are of critical importance for sensing, medical science, defense technology and even personal electronics. It is highly desired for wireless devices and even required for nanodevices to be self-powered without using battery. It is essential to explore innovative nanotechnologies for converting mechanical energy, vibration energy, and hydraulic energy into electric energy, aiming at building self-powered nanosystems. We have invented a nanogenerator for converting such random energy into electric energy using piezoelectric zinc oxide nanowire arrays. The mechanism of the nanogenerator relies on the piezoelectric potential created in the nanowires by an external strain: a dynamic straining of the nanowire results in a transient flow of the electrons in the external load because of the driving force of the piezopotential. The advantage of using nanowires is that they can be triggered by tiny physical motions and the excitation frequency can be one Hz to thousands of Hz, which is ideal for harvesting random energy in the environment.

We have developed a simple and effective approach, named scalable sweeping-printing-method, for fabricating flexible high-output nanogenerator (HONG) that can effectively harvesting mechanical energy for driving a small commercial electronic component. The HONG consists of two main steps. In the first step, the vertically-aligned ZnO nanowires (NWs) are transferred to a receiving substrate to form horizontally-aligned arrays. Then, parallel stripe type of electrodes are deposited to connect all of the NWs together. Using a single layer of Hong structure, an open-circuit voltage of up to 2.03 *V* and a peak output power density of ~11 mW/cm^3 have been achieved. The generated electric energy was effectively stored by utilizing capacitors, and it was successfully used to light up a commercial light-emitting diode (LED), which is a landmark progress toward building self-powered devices by harvesting energy from the environment. Furthermore, by optimizing the density of the NWs on the substrate and with the use of multi-layer integration, a peak output power density of ~0.44 mW/cm^2 and volume density of 1.1 W/cm^3 are predicted. This research opens up the path for practical applications of nanowire based piezoelectric nanogeneragtors for self-powered nanosystems.

Reference
Z.L. Wang *et al.*, "*Lateral nanowire/nanobelt based nanogenerators, piezotronics and piezo-phototronics*", Mater. Sci. and Engi. Reports., 2010, **R70** (No. 3-6), 320-329.

Figure1. SEM image of ZnO nanowire arrays bonded by Au electrodes. Inset: demonstration of an as-fabricated nanogenerator.

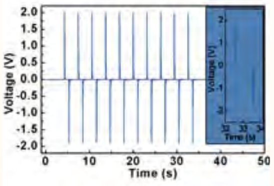


Figure2. Open circuit voltage measurement of the nanogenerator. The output charges have been stored by a capacitor, and later be used for driving a LED.

Crystallographic analysis using x-ray photoelectron diffraction

Jesse WILLIAMS
ジェシー・ウィリアムズ
ICYS-MANA Scientist

ZnO is a promising wide band gap semiconductor that has the wurtzite, and along its c-axis, (0001), there is a spontaneous polarization. It is known that properties such as chemical strength, impurity concentration and band bending are strongly depend on the specific polarity. Although ZnO thin-films tend to grow along the c-direction, it is difficult to control whether the polarity is (0001) or (000$\bar{1}$). Furthermore, there in no good technique for measuring the polarity non-destructively.

Currently, we are developing a non-destructive technique for c-axis polarity determination of the wurtzite structure by using x-ray photoelectron diffraction (XPD), which is an extension of x-ray photoelectron spectroscopy (XPS). While XPS measures the spectral response collected over a fixed detector angle, XPD measured the angular response over a fixed spectral window, which means the diffraction from a specific emitter can be measured. For example, by measuring the Zn $2p_{3/2}$ and O 1s *XPD* individually separately measure the diffraction from the Zn emitters and the O emitters.

The observed XPD patterns are unique for the (0001) and (000$\bar{1}$) polarities, which indicates that this is an effective method for polarity determination. Furthermore, multiple scattering and kinematic simulations have corroborated the individual patterns, and it is found that diffraction maxima are a result of strong forward scattering from the emitters nearest neighbors. Single-crystals samples produce spot patterns, while textured polycrystalline thin-films produce ring patterns, and polarity determination is possible from both types of materials.

Although synchrotron radiation was initially used to establish well defined diffraction patterns, the idea was to make these measurement on a laboratory size system. Subsequently, distinct patterns have been measured using a specially designed laboratory system that utilizing Cr *Ka* radiation. Now we are evaluating the viability of XPD on a commercially available Al *Ka* angular-resolved XPS system (located in the MANA Foundry).

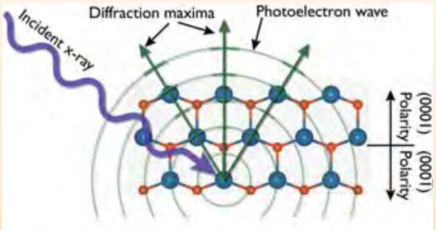


Figure 1: An incident x-ray excites a photoelectron wave which interacts with the lattice to form characteristic diffraction vectors. With the indicated polarity, Zn-cations are blue and O-anions are orange.

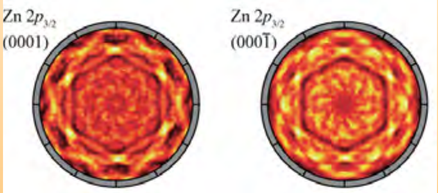


Figure2: XPD patterns from a ZnO single-crystal using synchrotron radiation.

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Quantum-dot devices in graphene

Satoshi MORIYAMA
森山 悟士
MANA Independent Scientist

Quantum dots are referred as an artificial atom in a sense that the electrons are confined in a small space, and they could be applied to the novel quantum devices such as single-electron devices and quantum computing devices. Although atom-like physics has been studied through their interaction with light, artificial atoms can also be used to measure and control electronic properties in solid state systems. Therefore, quantum dots are expected for future electric devices that can control the single-electron charge and spin. Based on the above background, we explore novel quantum devices that have different functions with conventional transistor devices.

Recently, we have developed quantum nanodevices in graphene, consisting of an isolated single atomic layer of graphite, as unrolled carbon nanotubes. The recent discovery of novel electron-transport characteristics in graphene demonstrates that they are attractive two-dimensional conducting materials, not only as a new subject in low-dimensional physics but also as building blocks of novel quantum nanodevices.

Graphene nanostructures can be fabricated by carving out of the graphene sheet. By using high-resolution electron-beam lithography, we patterned a thin resist coated on graphene that protected chosen areas during oxygen plasma etching and allowed us to carve graphene into a desired geometry. We have demonstrated a double quantum dot device in a graphene-based two-dimensional semimetal, which exhibits single-electron transport in two lateral quantum dots coupled in series. Low temperature transport results revealed that the device acts as single-electron transistors in which the electrons through the quantum dots flow one by one. Furthermore, we also confirmed that the strength of coupling between the two quantum dots can be controlled by the gate voltage, and thus succeeded in demonstrating operation as a coupled quantum dot device.

The research has shown the possibility of developing integrated nanodevices using graphene, it is expected to contribute to progress in single electron electronics, and the development of novel functional nanoelectronics, so-called "Beyond CMOS" including quantum information processing.

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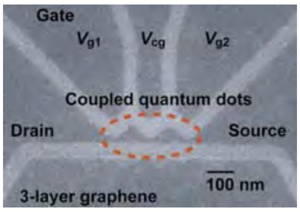

Figure 1. Scanning electron microscope image of the fabricated device. Bright areas show etched triple-layer graphene.

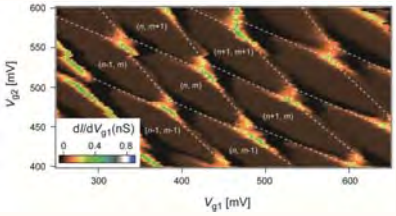

Figure 2. Experimental charge stability diagram in graphene-based double quantum dot system. Honeycomb structures in this mapping, which are characteristic of coupled quantum dots, are clearly observed.

Site specific nanoparticle therapy

Yukio NAGASAKI
長崎　幸夫
Principal Investigator (Satellite PI)
Nano-Bio Field

Reactive oxygen species (ROS) are known to play versatile roles on the occasion of many important events *in vivo*. However, excessive production of ROS causes significant adverse effect to living body. Such oxidative stress must be controlled appropriately. For example, ischemia reperfusion injury is one of the most famous damages by ROS, which are produced after a long ischemic period and can increase the area of damage. Therefore, the protection of organs affected by ROS must be considered in order to minimize the area of damage associated with ischemia-reperfusion. We have recently designed core-shell type nanoparticle, possessing nitroxyl radicals in the core (nitroxyl radical containing nanopartielcs; **RNP**), *viz.*, an amphiphilic block copolymer possessing 2,2,6,6-tetramethylpiperidinyloxys (TEMPO) moiety as a side chain of hydrophobic segment, which is self-assembled in aqueous media to form core-shell-type polymeric micelle: the cumulant average diameter of the nanoparticles was ca. 40 nm, and the nanoparticles emitted intense electron paramagnetic resonance (EPR) signals. The TEMPO radicals in the core of the nanoparticles showed reduction resistance even in the presence of 3.5 mM ascorbic acid. Due to the compartmentalization of nitroxyl radical in the core of the **RNP**, the blood circulation was extended. In vitro and in vivo toxicity were also reduced significantly. **RNP** tends to accumulate not only tumor area but also acidotic inflammation cites due to the pH-dependent disintegration of nanoparticle. Because a nitroxyl radical is known to scavenge ROS catalytically, it is confirmed that **RNP** shows protective effect to several types of ischemia reperfusion injuries such as brain, heart and kidney. Thus, **RNP** is promising as new nanomedicine for clinical applications in ischemia-reperfusion injury in ischemic heart and vascular diseases as well as ischemic stroke. Recently, we have also found that ROS damage on an aggregation of amyloid β, which is bereaved to cause a progressive neurodegenerative disorder, was recovered effectively by the **RNP** treatment (Figure 2). On the basis of these results, our developed nanoparticle is promising as new nanotherapeutic materials.

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Figure 1. Gastric phantom image by L-band electron paramagnetic resonance.

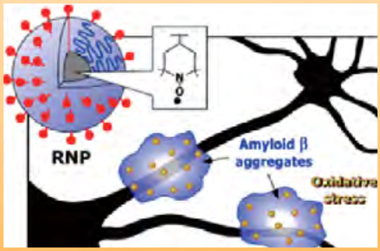

Figure 2. Scavenging effect of reactive oxygen species in amyloid-*β* aggregate in neuron cells by **RNP**.

MANA international Symposium 2011

The WPI center for Material Nanoarchitectonics of MANA announces that it will hold an international symposium 2011 on Nanotechnology and Material Sciences for 3days from March 2(Wed) -4(Fri), 2011. We'll invite many distinguished guests from around the world to discuss the research activities and future directions of MANA. About 40 oral presentations including 9 invited lectures and about 100 poster presentations will be presented for 3 days. Everybody is welcome to attend (and admission is free).

Date: March 2 (Wed) to 4 (Fri), 2011
Place: Tsukuba International Congress Center, Tsukuba Epochal, Tsukuba, Japan
For details, please visit the official website at:
http://www.nims.go.jp/mana_2011/

New MOU with Two Research Organizations

MANA has signed a Memorandum of Understanding (MOU) with Multidisciplinary Center for Development of Ceramic Materials (MCDCM), Brazil, for scientific collaboration on "Research and development of nanostructured materials for alternative energy and sensor devices". (Oct 26, 2010)

From left: Prof. Jose Varela (UNESP/Araraquara), Prof. Elson Longo (MCDCM Director), Prof. Traversa (MANA PI) and Prof. Reginald Muccillo (MCDCM PI)

MANA has signed a Memorandum of Understanding (MOU) with Anhui Key Laboratory of Nanomaterials and Nanostructures, Institute of Solid State Physics, Chinese Academy of Sciences, Anhui, China, for scientific collaboration on "Low dimensional Nanostructures" (Oct 6, 2010).

From left: Prof. Bando (Chief Operating Officer, MANA) and Prof. Li (Director of Anhui Key Laboratory of Nanomaterials and Nanostructures)

Awards

2010 Foresight Institute Feynman Prizes in Nanotechnology

Dr. Masakazu Aono, MANA Director-General, received 2010 Feynman Prizes for Experimental work by Foresight Institute. This prestigious prizes was established in honor of Nobel Prize winner Richard Feynman, two prizes are awarded in two categories, theory and experiment, to recognize researchers whose recent work has most advanced the field toward the achievement of Feynman's vision for nanotechnology: molecular manufacturing, the construction of atomically-precise products through the use of molecular machine systems. Dr. Aono was appraised in recognition of his pioneering and continuing work, including research into the manipulation of atoms, the multiprobe STM and AFM, the atomic switch, and single-molecule-level chemical control including ultradense molecular data storage and molecular wiring; and his inspiration of an entire generation of researchers who have made their own ground-breaking contributions to nanotechnology (December 21, 2010).

NISTEP Award 2010

Dr. Katsuhiko Ariga, MANA PI, received NISTEP Award 2010 as one of thirteen winners of "Remarkable contributions to science and technology 2010" from the National Institute of Science and Technology Policy (NISTEP). This award was established by NISTEP in 2005. NISTEP highly appraised Dr. Ariga's research in supramolecular functional materials, which is attracting the worldwide attention. At the award ceremony, Mr. Yoshiaki Takagi, Minister of Education, Culture, Sports, Science and Technology, paid a courtesy visit to the winners (January 17, 2011).

Dr. Katsuhiro Ariga (right)

Friedrich Wilhelm Bessel Research Award From Alexander von Humboldt Foundation

Dr. Ajayan Vinu, MANA Independent Scientist, received the prestigious 2010 Friedrich Wilhelm Bessel Research Award given by the Alexander von Humboldt Foundation. The foundation grants 25 of these awards annually to young, high level researchers around the world. Award winners are honored for their outstanding research and invited to spend a period of up to one year cooperating on a research project at a research institution in Germany. Dr. Vinu was selected in recognition of his outstanding research accomplishments in the field of nanoporous materials (December 11, 2010).

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"**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 nanoarchitechtonics for the creation and innovation of new functional materials.