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International Center for Materials Nanoarchitectonics (MANA)

Nano Revolution for the Future

Leader's Voice

Asking The Question, "WHAT NEXT?"

Prof. Jean-Marie Lehn was interviewd by Mitsuhiro Ebara

Asking the Researcher

Yusuke Yamauchi

Crystalline Inorganic Porous Materials

– A New Frontier for Nanoscience –

Asking the Researcher

Principal Investigator,
MANA Nano-Materials Field
Group Leader,
Mesoscale Materials Chemistry Group

Yusuke Yamauchi

PROFILE

Ph.D. (Engineering). Completed the doctoral course at the Graduate School of Science & Engineering, Waseda University in 2007, and entered NIMS as an International Center for Young Scientists (ICYS) Researcher. Became a MANA Independent Scientist in 2007 and MANA Principal Investigator and Professor of the University of Wollongong (Australia) in 2016. Dr. Yamauchi also holds concurrent positions as Visiting Professor at Tianjin University (China), King Saud University (Saudi Arabia), Waseda University, etc.

Crystalline Inorganic Porous Materials

–A New Frontier for Nanoscience–

Porous materials are substances which contain uniformly-distributed small holes, or pores. As Dr. Yusuke Yamauchi explains, “When porous materials are fabricated from metals or metal oxides, which are crystalline materials, we discover physical properties which are completely different from those of the bulk. This is a new frontier for materials science.”

Interviewer: Akio Etori, Science Journalist

Creating porous materials from metals

"Porous material" means a substance which contains countless small holes called "pores." Zeolite is a well-known porous material that exists in nature. Because its surface area reaches several 100 m^2 per gram, zeolite has been used in adsorbents, catalysts and similar applications. Research with the aim of creating porous structures artificially from various substances has a long history. One representative example is silica (silicon dioxide, SiO_2). This material, which is called mesoporous silica, is already produced commercially. However, the compositions of conventional porous materials are extremely limited, and cannot conduct electricity in general.

Dr. Yusuke Yamauchi has taken on the challenge of extending the concept of porous materials and creating new materials whose compositions have not existed until now by utilizing various chemical techniques. "Originally, the fact that I'm always interested in energy problems is the backbone of my research. For that reason, I initially wanted to do research on electrochemistry, but because I lost at drawing lots when I was a student, I entered an inorganic chemistry laboratory. However, the result was fortunate, since I focused on porous materials as revolutionary substances that can be applied as energy materials." "What should we do to realize electrical conductivity in porous materials? The answer is obvious: Metals, or metal oxides. That's the only solution." "For example, if graphene is produced as a porous material, its surface area increases to as much as 500 to 1000 m^2/g. Why create porous graphene? Graphene, which is an electrical conductor, can be used in large-capacity capacitor applications by increasing its surface area. This is precisely because it can be applied as an energy material."

In porous materials, the unknown region is expanding

Dr. Yamauchi's research on the creation of porous materials from metals and metal oxides for the development of new energy materials is original, one-of-a-kind work. In 2013, he succeeded in fabricating mesoporous platinum nanorods with the scarce metal platinum. The surface area of this material is around 80 m^2/g. "Although conventional platinum catalysts are made from platinum nanoparticles, the thermal stability of these nanoparticles is low, so they immediately cohere into large particles, which reduces their catalytic activity. In contrast, mesoporous platinum is also thermally stable. Thus, this development realized a new platinum nanomaterial which displays sustained high catalytic activity."

Dr. Yamauchi says that a new science is emerging as a result of the synthesis of metal and metal oxide porous materials and enhancement of the crystallinity of their skeleton. "When we create pores in a metal, physical properties which are completely different from those of the exposed surface in the ordinary bulk state appear at the surface of those pores. For example, this has the effect of increasing catalytic activity by as much as several times in comparison with the bulk. Why? Countless kinks and steps exist at the surface of the pores. When pores are made in a crystal, this happens, even if it's undesirable. These irregular features also formed in simulations of crystal structures. This may be the reason why porous crystal materials display physical properties which are different from the bulk crystal surface (Fig. 1)." "I also did a slightly different experiment in joint work with MANA Principal Investigator Osada. Even with the same compositions, we found that a large number of crystal distortions formed in the crystal structure in comparison with the bulk when fine pores were made in the crystal material, and the Curie point also changed significantly." "This 'completely different physical properties' is really interesting; it's the same as discovering a new material." "I don't think simply increasing the surface area of a material by creating pores is very interesting. Something extra is absolutely necessary for science: porous materials display a nature which is completely different from the existing substance. Our slogan is 'Make every metal and metal oxide a porous material'."

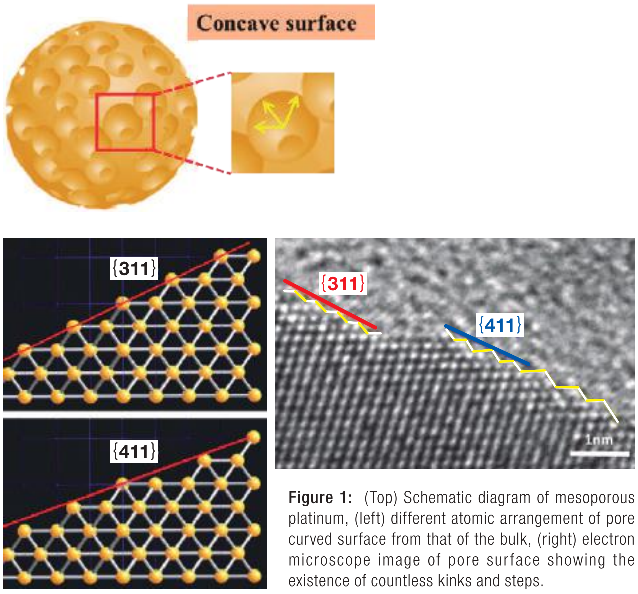


Figure 1: (Top) Schematic diagram of mesoporous platinum, (left) different atomic arrangement of pore curved surface from that of the bulk, (right) electron microscope image of pore surface showing the existence of countless kinks and steps.

How can metallic porous materials be created?

Let's look at the fabrication method of a metallic porous material, considering the example of a gold porous material which possesses a uniform, regular nanospace. This new material has attracted considerable interest since it was announced by Dr. Yamauchi in 2015. First, micelles of PS-b-PEO block copolymers, composed of polystyrene (PS) and polyethylene oxide (PEO), are prepared in an aqueous solution. Chloroauric acid ($HAuCl_4$), which is a compound that contains gold, is dissolved in this solution. At this point, the gold ions are thought to exist on the surface of the micelle due to interaction with the micelle surface. Because the gold ions are conjugated with the micelle, these ions also migrate to the electrode when gold is electrodeposited on a working electrode substrate by the electrolytic deposition method. This means the micelle can be made to function as a template for the structure of the porous material. When the micelle is removed by solvent extraction or some other method, a nanoporous structure corresponding to the size of the micelle can be obtained (Fig. 2).

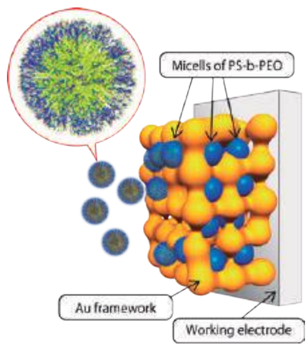


Figure 2: Synthesis process of gold nanoporous material
A porous structure is formed by utilizing the spherical micelle (blue) as a template, which are contained by gold .

Application to industry

Dr. Yamauchi also discusses future development. If it is possible to obtain new porous adsorbent materials which adsorb only a designated substance by verifying the material composition), the diameter and shape of the pores and various other parameters, the range of applications will be infinitely wide. “Since these are new materials which have not existed until now, they will have a large impact on industry. For example, it is interesting that there are mesoporous materials that selectively adsorb only the odor (formaldehyde) emitted when a new house is constructed and aromatic compounds that contain carcinogens. For instance, mesoporous carbon, which has a high graphitization degree, demonstrates an aromatic compound adsorption capacity that cannot be realized with conventional active carbon or silica. This suggests that use will not be limited to electrode catalysts, but may also include a variety of other industrial applications.”

When developing concrete applications for new materials, Dr. Yamauchi always carries out the developmental work after partnering with a company. This is because, for him, what is most important to pursue from the viewpoint of science is the research theme of “creation of new materials based on porous metal and metal oxide materials.” Since the applications of porous materials are considered to be unlimited, he believes that the focus of this theme may be blurred if he spreads himself too thin.

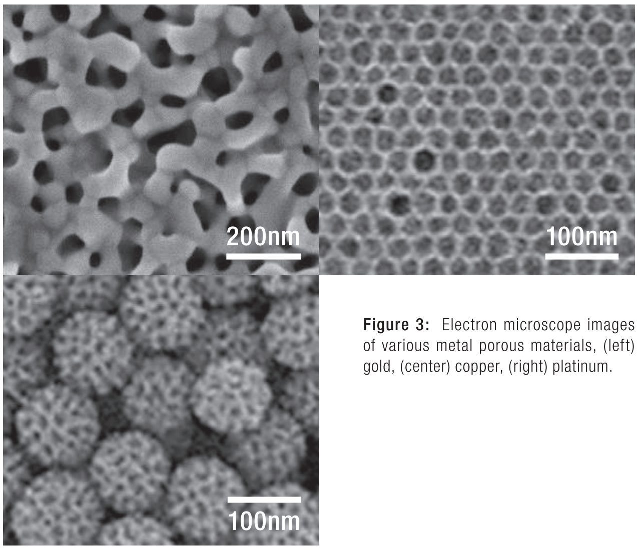


Figure 3: Electron microscope images of various metal porous materials, (left) gold, (center) copper, (right) platinum.

Involved in training of young people as a young researcher

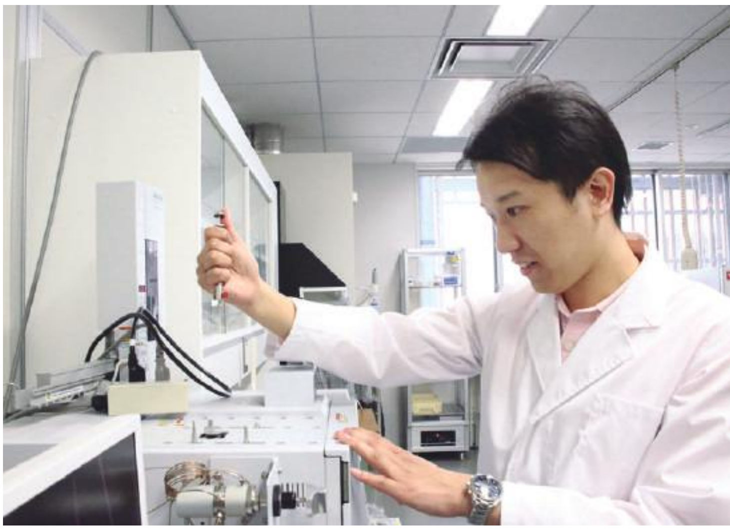
Dr. Yamauchi began working at the National Institute for Materials Science (NIMS) immediately after completing graduate school. This April, in his ninth year with NIMS, he became the youngest person to become a MANA Principal Investigator (PI). Thanks to training in the international environment at MANA, he says that his English conversation, which was difficult for him in his student days, has improved to the point that he can engage in even nitpicking discussions in English. He also has words of praise for MANA, which has a complete support system for researchers, beginning with its technical support team, saying that it is a suitable place to extend his talents. These days, when he has a real feeling of the weight of responsibility, he is leading his research life with an awareness that he is a bridge between young researchers and veterans. Moreover, he is also a Professor in the Waseda University-NIMS Joint Graduate Program, and is in a position to advise 10 graduate students. “For research in materials science, it is important absolutely not to waste failures and accidents. When you do something new, there is a fairly high percentage of failures. Mistakes in the conditions or changes in the composition often lead to an unexpected result. This tend to occur easily because students who are engaged in research while constantly rushing about. I help by skillfully picking that up and summarizing it in the form of research results. The unexpected result also deepens understanding.”

In addition, Dr. Yamauchi is taking up a teaching post at the University of Wollongong in Australia in May of 2016. This is an example of the new system being promoted by NIMS, which makes it possible to hold official positions at multiple research institutions. “Of course, the content of my research will center on metal and metal oxide porous materials, as it has until now. This should encourage more active exchanges between our laboratory and the laboratory in Australia. I’m looking forward to it.”

Dreams for the future

“If I’m asked about hobbies in my private life, I answer by saying that I can’t name any one thing.” He is a Ph.D. who enjoys snowboarding and scuba diving (he has a license), but he is full of curiosity and too interested in many things. When he thinks about what he really wants to do, ultimately, the answer is research. “After all, it’s really moving when I see a beautiful material with an electron microscope. Recently, friends have told me that I look ambitious,” Dr. Yamauchi says with a wry smile.

Dr. Yamauchi, who aims to pioneer a new research field with a tremendously energetic research motivation, says this: “In the first place, the division between organic chemistry and inorganic chemistry is strange. Materials chemistry handles all types of materials.” “Eventually, I’d like to skillfully incorporate organic synthesis reactions with inorganic compositions, and synthesize organic-inorganic hybrids elegantly.” When Dr. Yamauchi talks about his dream: “The more other people think that synthesis of a composition is difficult, the more I want to try it.” “Something that can be done simply isn’t interesting. Succeed in synthesis through repeated hard work, and the world will praise you!”



Research Outcome 1

Creating Nanoionic Devices with Diverse New Functions

― Development of Low Power Consumption Spintronic Devices Enabling High Integration ―

Kazuya Terabe
MANA Principal Investigator
Nano-System Field

Importance of next-generation nanodevices

Many electronic devices, the majority of which are semiconductor-based, are used in familiar information and communications equipment. Although semiconductor devices continue to achieve astonishing progress, supported by technical developments in miniaturization and integration, there are fears that this progress may slow in the near future. To ensure sustained progress toward an advanced, next-generation information society, we must actively create devices which operate on principles different from those of conventional semiconductor devices, and thereby realize new functions and higher performance. At MANA, we are focused on the development of nanoionic devices for these new devices.

Nanoarchitectonics utilizing ion transport

One distinctive feature of nanoionic devices, which differentiates them from conventional semiconductor devices, is that they control/utilize the transport of ions, which form crystal lattices, on the atomic to nano scales. Ion transport in crystals reconstructs their crystalline structure, interfacial structure, and other parameters, enabling nano architecture, that is, "nanoarchitectonics," in materials. Use of this nanoarchitectonics gives nanoionic devices plasticity and enables functional and structural changes where necessary.

Development of new spintronic devices

By utilizing nanoarchitectonics, we have created nanoionic devices with diverse new functions. For example, we have succeeded in developing new spintronic devices that are aimed at application to high density, large capacity memory, etc. (Fig. 1) Conventional spintronic devices, which utilize electron charges and spins to store information, have complex structures that make it difficult for them to realize higher integration. Some problems have been pointed out in these devices, such as that they require large write currents. By inserting lithium ions into and removing them from Fe_3O_4 magnetic material, using a solid electrolyte that allows lithium ion transport between electrodes, our new technology changes the electronic carrier density and electronic structure of Fe_3O_4. This enables the control of magnetic properties such as magnetoresistance and magnetization. (Fig.2)

This novel control technology, which utilizes ion transport, allows magnetism to be controlled at lower currents compared to conventional electron transport spintronic devices, and also makes it possible to realize higher integration owing to its simple structure. Moreover, as the spintronic devices are all-solid-state devices, they do not suffer from problems such as liquid leakage. Development of low power consumption/high-performance memory is expected to become possible using conventional semiconductor processes. We plan to develop microfabrication techniques for higher integration, etc., and to conduct demonstration experiments aimed at application of the technology to high-density, large capacity storage devices and other electronics devices.

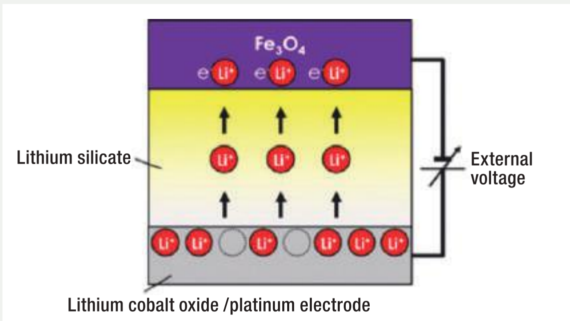


Figure 1: Schematic diagram of novel magnetism control technology utilizing solid-state ion transport. Magnetoresistance and magnetization are controlled by inserting/removing lithium ions into/from a magnetic material (Fe_3O_4) by applying an external voltage.

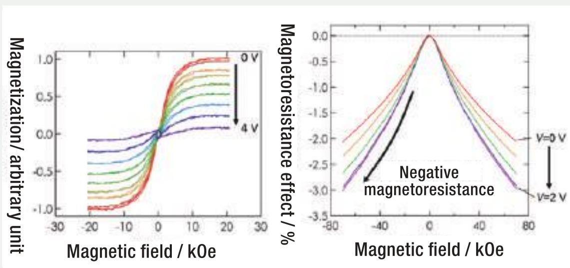


Figure 2: Magnetization-magnetic field loops **(left)** and magnetoresistance-magnetic field curves **(right)** of the device tuned in situ by lithium ion insertion into Fe_3O_4. The amount of lithium ion insertion is controlled by an external voltage (V).

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Leader's Voice

Asking The Question, "WHAT NEXT?"

Prof. Jean-Marie Lehn

was interviewd by

Mitsuhiro Ebara

Concepts of Supramolecular Chemistry

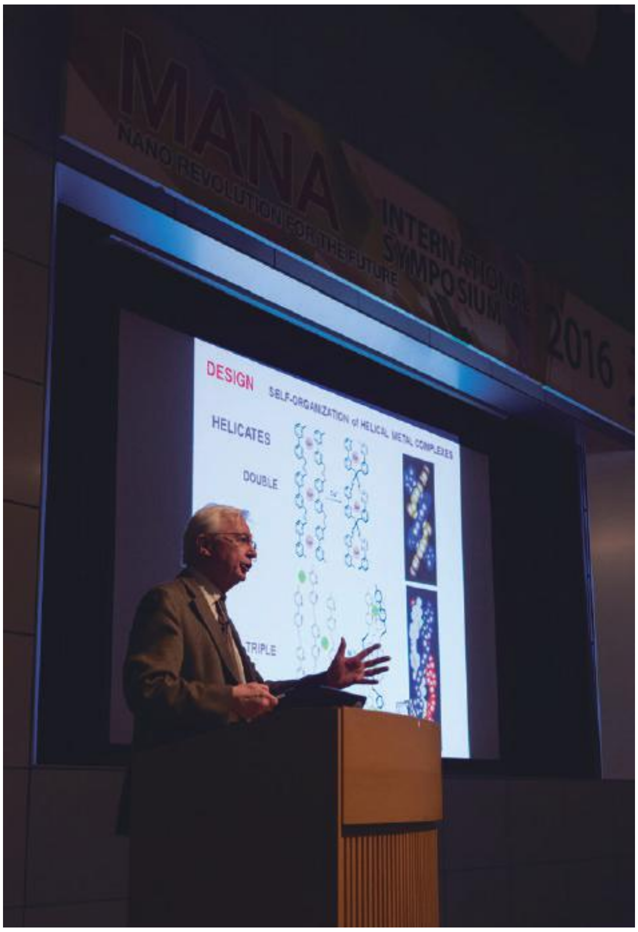
Dr. Ebara: Thank you very much for coming to MANA.
Prof. Lehn: My pleasure.
Dr. Ebara: First, I would like to ask you how the concepts of supramolecular chemistry were disseminated. Were the concepts easily accepted?
Prof. Lehn: It took some time. I first used the term “Supramolecular Chemistry” in two papers in 1978. Although it was not criticized, it took time for the term to come into regular usage. The idea of molecular recognition was a bit more difficult because biologists considered molecular recognition a biological phenomenon, though it is in fact a molecular phenomenon, biological or not. In fact, the basis of biology is chemistry –molecules. We are all made up of molecules. So, molecular recognition concerns the living as well as the non-living world.
Dr. Ebara: What kind of personality or characteristics did you have when you were young? Were you curious about a multitude of things or were you focused on just one thing?
Prof. Lehn: To begin with, I was not at all a scientist. I was studying classics, Latin and Greek, and philosophy, but not much science in high school, except in the last year. In university, I wanted to study philosophy but in France it was a requirement to take an exam in science in order to study philosophy. I started by taking the exam in science, which made me interested in chemistry, so I continued chemistry and quit philosophy.
Dr. Ebara: You have published many papers. Which would you choose as the most memorable?
Prof. Lehn: For historical reasons, I would choose our paper in Tetrahedron Letters, published in French in 1969, which started our work that led to supramolecular chemistry. But much more important in terms of concepts and perspectives is my book “Supramolecular Chemistry” of 1995.
Dr. Ebara: The book is very famous in Japan actually. It has been translated into Japanese and all students in chemistry use it as a base.

Challenges Faced by Young People in Developing Creativity

Prof. Lehn: I would also like to insist on the fact that this first paper was in Tetrahedron Letters and in French. It indicates that you do not need a high impact journal and you do not need English. That is important for young people, because nowadays there is too much pressure on these issues which do not mean much to me. It is the work that makes the quality of the journal, not the journal that makes the quality of the work.
Dr. Ebara: What counts is not some high-impact journal or the language - that is a very good message to young researchers. On the other hand, what do you think of evaluation?
Prof. Lehn: If you want to hire somebody new, the best way is –-of course you have to make a gross selection first, but then-- to talk with the people. You need to invite them for an interview in order to get to know them better.
Dr. Ebara: MANA is pursuing a melting pot environment where the fusion of different fields and cultures enhances creative research. We believe that a rich international research environment makes challenging research possible. What do you consider important for helping young people develop their creativity?
Prof. Lehn: There is no national science, as science itself is fully international. I do not like it when people say that the Nobel laureate is Japanese, French or American. It is just science and it does not have to be nationalistic. To a certain extent, it is a way to give some information about the level of science on average at a national level. It is important that in order to produce high-quality work, we need to have good infrastructure, education, and an efficient administration in each country. However, we should not make science a nationalistic issue.

I usually tell young people that the scientific profession is very exciting also because it is international. You have colleagues and friends everywhere in the world.

You also mentioned an international research environment, and yes, this is very important. International but also multidisciplinary, which are two things often linked together.
Dr. Ebara: Are there any words that have influenced you? I was impressed by your words in your presentation at the 2016 MANA International Symposium, specifically “there’s even more room at the top”. It was contrasted with “there’s plenty of room at the bottom” by Richard Feynman, describing nanotechnology as an important field. Beyond nanoscience and nanotechnology, you advocate that the goal is complexity. Now we are looking for elucidating complex systems in



Special lecture by Prof. Lehn at MANA International Symposium 2016

nanoscale. That was very nice.

Prof. Lehn: That was partly tongue-in-cheek. Although I wanted to make clear that it is not so much size that counts, but complexity. As for words, there are several I find important, reason, truth, knowledge, etc.... Human beings should behave rationally and so the scientific spirit is something that influences me.

Application of Supramolecular Chemistry in Different Fields

Dr. Ebara: Supramolecular chemistry has been applied to many fields now, but are there any unexpected fields where it has not been applied yet?

Prof. Lehn: Supramolecular chemistry is an important step, but chemistry does not stop there, of course. It is always important to ask the question "what next?".

For me, what is next is adaptive chemistry where developments in chemical systems are dynamic and change their constitution as a function of different factors such as environment, physical stimulus, or a chemical entity which acts on it. It is on the way towards complex matter, with emergence of novel features as complexity increases. Brain science is a most important and exciting field, and is just at the start considering the questions it addresses. What we are doing in brain science is very simple compared to the brain itself. Computers can do things which a brain cannot do as fast, but the brain is a much more complex machine than a computer. So, trying to simulate brain function with computers is only one aspect. Most important is to unravel how the brain works. I think one has to combine the two.

Then, we come across the question of storing information. Molecular recognition concerns the storage and processing of information in specific chemical entities. On the other hand dynamic systems open the possibility to store information in a distribution of chemical entities. If you have dynamic systems which have many components, you can generate all the combinations of these components. And if you add something to these dynamically connected combinations, the proportions will change. So, the information is not stored in a molecule or a pattern but stored in a distribution that is characteristic of the agent added. One might think of implementing this approach to encrypt information in dynamic sets, an idea that can possibly be explored.

Making biomaterials reversible and creating artificial cells are also very interesting and challenging fields.

Dr. Ebara: I am also working in the field of biomaterials and work is being undertaken on stimuli responsive polymers, not supramolecular ones, but just set polymer, like a temperature responsive polymer or pH responsive point. I am very interested in the dynamic systems because our body is always dynamic but biomaterial is mostly static. I also feel that creating artificial cells is a very challenging field.

Prof. Lehn: You are right. But polymers can be made dynamic. For instance, you can make millions of proteins out of one protein by cleaving and recombining the component aminoacids. Trying to make biomaterials reversible is really a very interesting field.

Dr. Ebara: That will be very interesting. I would like to say a very sincere thank you for taking time to speak with us.

Jean-Marie Lehn

Chemist Jean-Marie Lehn is currently the Director of the Laboratory of Supramolecular Chemistry, at the Institut de Science et d'Ingénierie Supramoléculaires, the University of Strasbourg France. Prof. Lehn was born in 1939 in Rosheim, France, and educated at the University of Strasbourg. He obtained his Ph.D. in organic chemistry in 1963, which was followed by a postdoctoral year at Harvard University. He returned to the University of Strasbourg, where he became a full professor in 1970. He received the Nobel Prize for Chemistry in 1987 along with Donald Cram and Charles Pedersen for their development and use of molecules with structure-specific interactions of high selectivity.

Mitsuhiro Ebara

Dr. Mitsuhiro Ebara is an Associate Principal Investigator, Mechanobiology Group, MANA, NIMS. He was born in 1975 in Tokyo, and obtained his PhD in Chemical Engineering from Waseda University. His specialties are smart materials, biomaterials, and medical devices.

Functional Nanosheets of Layered Double Hydroxides

Renzhi Ma
MANA Associate Principal Investigator
Nano-Materials Field

Multifunctional layered double hydroxides

As an important class of clay-like materials, layered double hydroxides (LDHs) comprise alternately stacked positively charged layers and weakly bound exchangeable charge-balancing anions. A wide variety of inorganic, organic anions and even complex biomolecules including DNA may be intercalated by LDHs. In this aspect, LDHs are unique as a great majority of materials have negatively charged layers and cations in the interlayer spaces.

Mixed magnesium-aluminum hydroxide carbonate (Mg-Al-CO_3) is the longest-known naturally occurring (i.e., mineralogical) example of a LDH phase. In general, LDH materials are considered benign to the environment and human body. This has led to an intense interest in the use of LDHs for advanced applications such as adsorbents, polymer additives or drug delivery systems. To endow this traditional clay mineral with more versatile functions, we have developed a range of synthetic methods to produce brand new LDHs incorporating various mixed transition metal cations, such as Mn, Fe, Co, Ni, and Zn. The successful and controllable introduction of transition metal compositions has initiated new attractive prospects for exploring electronic, magnetic, electrochemical and catalytic properties in LDHs.

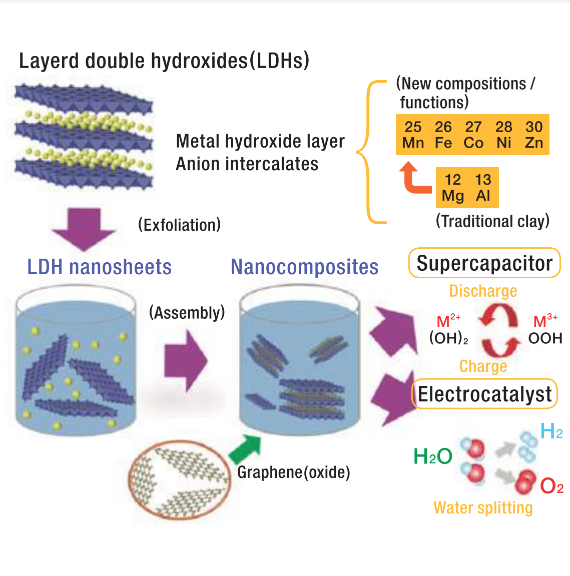


Figure: Brand new LDHs with mixed transition metal compositions (Mn, Fe, Co, Ni, Zn) have been successfully prepared. After exfoliation into nanosheets, they can be assembled with other building blocks, e.g., graphene (oxide), to produce multifunctional nanocomposites.

Versatile functionality exploration using nanosheet architectonics

Like other layered materials, LDHs can be substantially expanded normal to the layer stacking directions through some soft chemical treatment. Under an extreme situation, known as exfoliation or delamination, the layers fall apart, yielding molecularly thin nanosheets. The ultimate two-dimensional anisotropic feature of nanosheets can radically increase the accessible surface area, and enhance the chemical and physical reactivity.

Utilizing an electrostatic charge-driven assembling process, the positively charged LDH nanosheets can be alternately stacked or sandwiched with oppositely charged building blocks, e.g., graphene (oxide). Similar to a LEGO game, we have successfully fabricated nanocomposites of transition metal LDH nanosheets and graphene. The nanocomposites, with both high reactivity and high conductivity, have shown great potential to develop hybrid supercapacitors capable of storing or releasing huge energy in very short time, i.e., seconds. They have also been tested as promising catalysts for efficient water splitting: electrochemical decomposition of water (H_2O) into oxygen (O_2) and hydrogen (H_2) with as little as 1.5 Volts. These successes can be regarded as typical examples of nanoarchitectonics.

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A new and improved MANA!

The fourth mid-to-long term plan for NIMS, the host institute of MANA, has been active since April 2016. As it celebrates its 10th year, MANA continues supporting cultivation of innovative new technologies and promotion of challenging research in these next seven years as the "International Center for Materials Nanoarchitectonics (MANA)". MANA has been reorganized to be more active and attractive.

The foundation of "Nano-Theory Field"

We have established a 5th new research field, the "Nano-Theory Field", led by MANA's Principal Investigator Taizo Sasaki as the field coordinator, which follows Nano-Material, Nano-Systems, Nano-Power and Nano-Life Field.

Nanospace is a world in which common sense does not apply, where extremely small atoms are in motion, and electrons fly about in an even smaller space. Key activities in the field of Nano-Theory include building fundamental theories behind this strange and novel behavior by incorporating quantum mechanics and statistical mechanics, thus achieving an understanding of the myriad of phenomena that emerges in nanospace, as well as incorporating our supercomputing facilities to obtain quantitative numerical predictions, along with the developing of new and efficient calculation methods. Besides providing interpretations of results obtained in other fields, we aim to invoke the outcome of our research to predict as-yet unearthed phenomena and to propose new materials featuring novel properties.

New MANA Principal Investigators (PIs)

Eight members, including young researchers, have been appointed as MANA Principal Investigators.

Nano-Material Field

Minoru Osada
Functional Nanosheets Group

Yusuke Yamauchi
Mesoscale Materials Chemistry Group

Nano-System Field

Yoshihiko Takano*
Nano Frontier Superconducting Materials Group

Kazuya Terabe
Nanoionic Devices Group

Nano-Power Field

Takao Mori
Thermal Energy Materials Group

Nano-Theory Field

Taizo Sasaki*
Material Properties Theory Group

Tsuyoshi Miyazaki*
First-Principles Simulation Group

David Bowler
Satellite at UCL

*New to MANA

As we follow the concept of "Nanoarchitectonics",
MANA strives to lead the world in new materials research,
and we'd like to ask for the warm support of everyone involved.

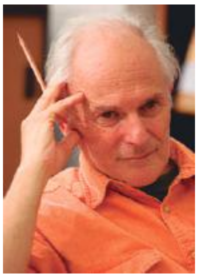
NEWS & TOPICS

EVENT REPORTS

MANA International Symposium 2016

The MANA International Symposium 2016 was held in Tsukuba City, Japan from the 9th to the 11th of March, 2016. This 2016 Symposium featured Greetings from Prof. Toshio Kuroki, Program Director of World Premier International Research Center Initiative program (WPI), Japan Society for the Promotion of Science and Special Lectures by Prof. Jean-Marie Lehn, Nobel Laureate in Chemistry 1987, France, Prof. Pedro Miguel Echenique, the President of Landiribar, Donostia International Physics Center, Spain, and Prof. Rainer Waser, Professor of Electronic Materials Research Center, Germany. Besides Invited Talks by 18 distinguished scientists from Japan and other countries, Research results at MANA were also announced in a total of 15 oral presentations and 102 poster presentations. The Symposium attracted 411 participants over the 3-day period, with lively question-and-answer sessions and exchanges of ideas.

Our deepest condolences on the passing of Sir Harold Walter Kroto



Sir Harold Walter Kroto (Nobel Laureate in Chemistry, 1996 / Professor, Florida State University), who was an Adviser to MANA, passed away on April 30th, 2016.

Sir Kroto had been an Executive Adviser of the International Center for Young Scientists (ICYS), the predecessor of MANA, since 2004, then subsequently made tremendous contributions to the development of MANA as an Adviser since our launch in 2007. He eagerly coached young scientists in MANA and periodically held science classes for children in Japan. His earnest encouragement enlightened all of us in MANA.

All of us at MANA sincerely pray that he may rest in peace. We would like to express our most heartfelt appreciation for his great contributions to us here at MANA, as we cherish the many wonderful memories we have of him. Thank you very much, Sir Kroto.

NEWS

G7 Science and Technology Ministers visit MANA

The G7 Science and Technology Ministers Meeting was held in Tsukuba from the 15th to the 17th of May 2016. During day two of the meeting, ministers from each country made a visit to MANA to get firsthand experience of Tsukuba's latest science technologies. They took a tour of the MANA facilities and visited the laboratories of the Nanoionic Devices Group, led by Principal Investigator Kazuya Terabe, and the Nanochemical Sensors Group, led by Group Leader Genki Yoshikawa. While there, they experienced cutting-edge nanotechnology studies and enjoyed relaxed conversations in the cafeteria with a variety of young MANA researchers from all over the world.

NEW FACES

Nano-Materials Field

Takashi Aizawa, Chief Researcher
Shinsuke Ishihara, Senior Researcher

Nano-System Field

Shigeki Kawai, Principal Researcher
Seiichi Kato, Senior Researcher
Takashi Tsuchiya, Senior Researcher
Takahide Yamaguchi, Senior Researcher
Toshikaze Kariyado, Researcher

Nano-Power Field

Yuichi Michiue, Chief Researcher
Mitsutake Oshikiri, Principal Researcher

Naohito Tsujii, Principal Researcher
Tetsuya Kako, Senior Researcher
Norifusa Satoh, Senior Researcher

Nano-Theory Field

Takahisa Ohno, Senior Scientist with Special Missions
Masao Arai, Chief Researcher
Wataru Hayami, Principal Researcher
Kazuaki Kobayashi, Principal Researcher
Masamichi Nishino, Principal Researcher
Yoshihiko Nonomura, Principal Researcher
Igor V Solovyev, Principal Researcher

Shigeru Suehara, Principal Researcher
Akihiro Tanaka, Principal Researcher
Junichi Inoue, Senior Researcher
Ayako Nakata, Senior Researcher
Jun Nara, Senior Researcher
Ryo Tamura, Researcher
Junya Shimizu, Principal Engineer

Nano-Life Field

Yoko Shirai, Principal Engineer
Naoto Umezawa, Independent Scientist
Ovidiu Cretu, ICYS-MANA Researcher

*Please see the left page for Principal Investigators.

Emerging MANA Researcher

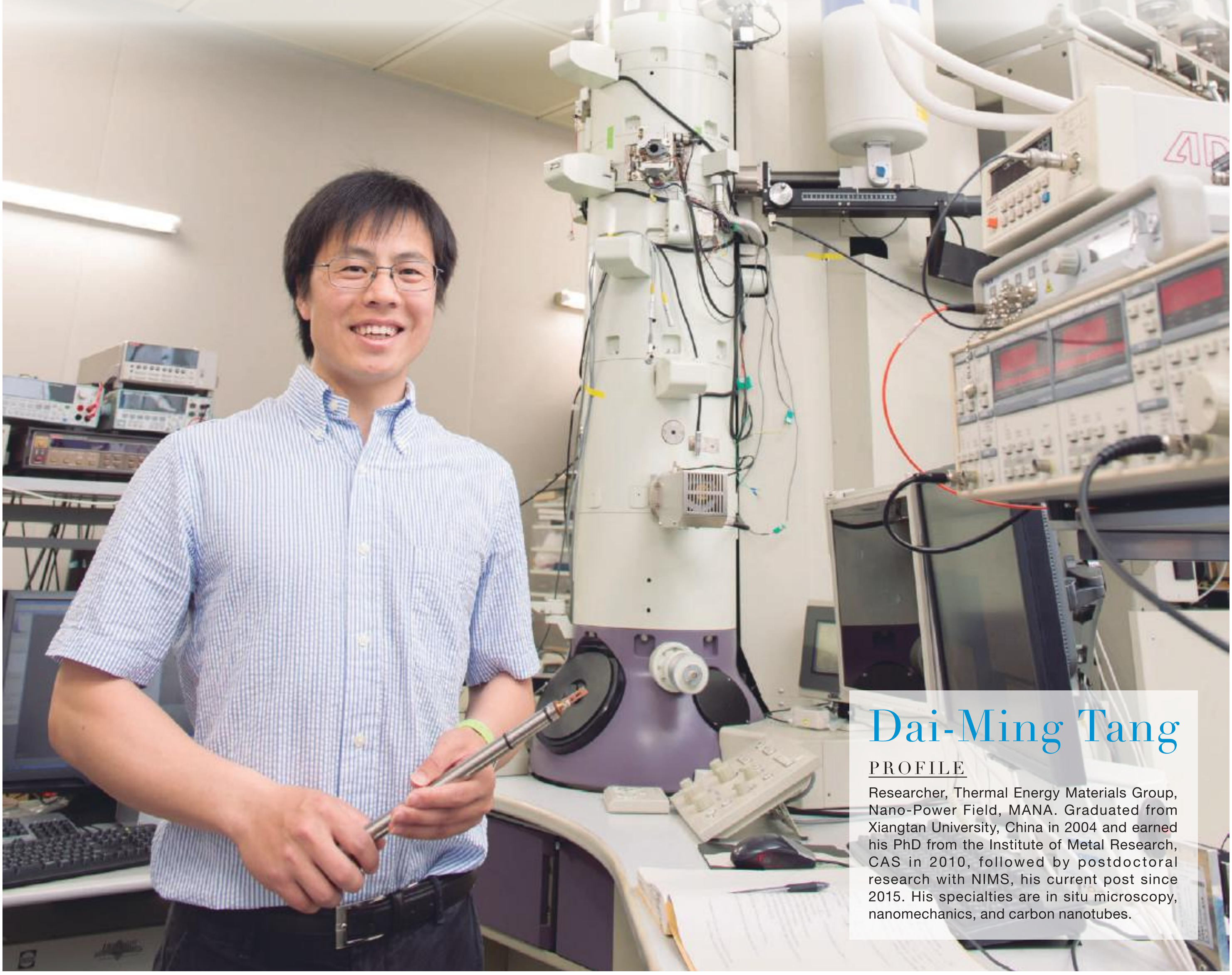
Interviewer and writer: Eri Niiyama, University of Tsukuba graduate student D1

Dr. Tang came to Japan in 2010 after his graduation from the Institute of Metal Research, Chinese Academy of Sciences (CAS) where he studied properties of metal inside carbon nanotubes, including phase transition. He joined MANA as a Postdoctoral Researcher, and then ICYS-MANA (International Center for Young Scientist-MANA) in 2012.

Since then, Dr. Tang has focused on in situ transmission electron microscopy. He is engaged in research to visualize not only the structure, but also the processes and properties of nanotubes/nanowires that are approaching their physical limit. It is important to understand the mechanisms behind these nanoscale materials in terms of their practical applications as well as basic research. Thus, he is eagerly interested in what is possible with such tiny materials, and in how we can design novel devices with them. For instance, he is working on minimum transistors using nanowires. While smaller transistors lead to lower performance in general, he believes that it is possible in the future to have new devices under 10 nanometers work more efficiently and with higher performance if we thoroughly understand the fundamental properties of the material.

In 2015, Dr. Tang was promoted to a permanent staff member at NIMS as a MANA Scientist. Asked about researching in Japan, he replies "Life is to experience. Experiencing different cultures and knowledge ties in with creative, significant research." His words show his sincerity and strong will for science.

Dr. Tang also treasures time with his family. Together with his wife, they find ways every day to develop the individuality and curiosity of their two young daughters, who were both born in Tsukuba. "My older daughter's first English word was 'atom'," he tells us with a big smile.



Dai-Ming Tang

PROFILE

Researcher, Thermal Energy Materials Group, Nano-Power Field, MANA. Graduated from Xiangtan University, China in 2004 and earned his PhD from the Institute of Metal Research, CAS in 2010, followed by postdoctoral research with NIMS, his current post since 2015. His specialties are in situ microscopy, nanomechanics, and carbon nanotubes.

MANA NEWS LETTER

CONVERGENCE

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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 nanoarchitectonics for the creation and innovation of new functional materials.

COVER: MANA Principal Investigator
Yusuke Yamauchi and young researchers

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