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CONVERGENCE

Breaking organizational taboos

—— Hideo HOSONO

Struggling to survive in a global research environment

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Fostering new human resources

— MANA Independent Scientists

International Center for Materials Nanoarchitectonics (MANA)

Hideo HOSONO 細野 秀雄

Completed the doctoral course at Engineering of Tokyo Metropolitan University in 1982. Has served as a professor at Tokyo Institute of Technology since 1999 and also at the Frontier Research Center of the university since 2004. Currently the general manager of the JST ERATO-SORST project on functional oxides (2004 to 2010). His paper on iron-based high-temperature superconductors was the most cited paper in the world in 2008. Specializes in inorganic materials science, transparent semiconducting oxides, and magnetic resonance.

Breaking organizational taboos

Impacts of MANA are on forerunning reforms and experimental systems.

Prof. Hideo Hosono has published ground-breaking results many times, including the creation of amorphous materials such as transparent semiconducting oxides, electrically conductive concrete, and the discovery of new iron-based high-temperature superconductors, and attracts worldwide attention as a result. We asked him what he expects from MANA and what its roles are. He replied by making an incisive analysis of the present state of materials sciences.

❖Interviewer: Akio Etori, NIMS publishing adviser

Superconducting iron is no mystery.

——Professor, have you enjoyed science since your childhood? Were you interested in any special field?

Even at home I made simple devices myself and did experiments. I found the electrolysis of water particularly fascinating – I was astonished to see that gas was generated from a liquid by passing electricity through water. What's more, hydrogen burns. I never expected that something generated from water could burn, as water is used to extinguish fire. It opened my eyes, and is the most impressive experiment ever.

——Did the lesson learned from the experiment with water lead to your works in later years?

I found that it is not surprising that water and hydrogen, or simply, a compound and its constituent elements, have completely different properties. This is a most interesting aspect of materials. For example, iron is attracted to a magnet and does not become a superconductor. And yet iron compounds do not inherit the properties of iron in principle, and so have the potential to become superconductors. In fact, the iron-based superconductors we developed are not magnetic. Today, iron-based superconductors are attracting global attention, but I was not surprised at all and have never thought it was an amazing study.

I was far more impressed when I saw electricity flowing through cement — in fact, the excitement was incomparable. Electricity flowing through a mixture of calcium oxide, lime, and alumina, imagine! The astonishment is even bigger to people who understand materials better.

——Still, the world is excited over iron-based superconductors. Do you think that's because they are anticipating the applications?

No. It's because they have never thought that iron-based superconductors could possibly exist. It is certainly interesting that they exhibit superconductivity at higher temperature. But more than that, the responses of people are similar to those when the world suddenly hyped up "nano" even though nanotechnologies have been around and studied for a long time. The excitement led to higher budgets for nanotechnology studies and has promoted research, so it is significant that it became a science and technology policy.

Modern technology without profit is a pastime of the elite.

——Was it necessary to declare "Nanotechnology research is a national project?"

It was crucial. Free-thinking scientists are absolutely necessary, but without such a declaration, studies on modern technologies diverge too randomly and do not converge. As long as studies are funded by taxes, policies are needed to respond to social needs.

Another point is, do people really want a technology that cannot solve any of today's social issues? No. We should not pursue merely profit; technologies should be useful somewhere, and particularly materials. Otherwise, modern research is merely the pastime of a lucky few. Such games may be necessary, but should not consume large taxes.

——Emphasis in NIMS has been switching from basic studies to benefiting society.

It is difficult to see how a study might be useful. For example, in mathematics and particle physics, things that were thought to be completely useless led to the development of nuclear power, so the issue is not clear-cut. Declaring "studies that are useless for the time being" is good, but they should be conducted by distinguished people. Basic studies should be entrusted to particularly capable scientists who can perform outstanding work, otherwise it will be a waste of taxes.

In universities, education and research are inseparable. Universities can somehow fulfill their roles without conducting research but cannot do so without education. Pioneering people are cultivated via pioneering research. The ultimate value of universities is education. And to educate people, pioneering research is absolutely essential.

——When you teach students, does pioneering mean being original?

First, I think about educational guidance, but try not to be too conscious about it. University professors have much to learn from their students. Unlike professors who are busy outside the laboratory, students are always in the laboratory and have energy. Professors and students keep discussing the same themes. This constant exchange of place between professors and students leads to education.

In any university, laboratories that produce excellent results have excellent students without exception. Good results cannot come without excellent students, even if the professor is excellent. This is a basic fact.

——Was there any professor who greatly influenced you?

Yes, there were many, including Professor Hiroshi Kawazoe (Tokyo Institute of Technology in later years), who was my advisor when I was a student, and Professor Yoshihiro Abe, who was a professor when I first became an assistant professor at the Nagoya Institute of Technology. Today, transparent amorphous oxide semiconductors are enjoying a boom, following that of amorphous silicon, and full-scale development of displays has started. I was inspired by a speech of Dr. Kazunobu Tanaka (then a member of the National Institute of Advanced Industrial Science and Technology, which I heard when I was a student. I still clearly remember his passionate speech on amorphous semiconductors, and I was highly impressed because I was young and impressionable. All professors were very original in their studies, and key ideas came spilling out in just a few words. I am very grateful to them.

The need to alter the system dramatically

——What do you think the roles of MANA are?

It is good to have a core institute for materials like MANA in Japan. Japan has led the world in materials sciences in the last 10 years or so but is being caught up by China and other countries in some fields. Overall, Japan is still leading, but its top groups are not. Because it is impossible to strengthen all institutes in Japan, the prominent ones should drive the research forward. And one of those is MANA, so MANA should not be satisfied merely with being the top institute in Japan.

The important point is whether MANA can attract excellent researchers from around the world or not, and the fact is, it is not attracting many. Responsibility does not lie with MANA alone but also with the system in Japan. When an overseas researcher seeks his or her next position, there is no position, or particularly permanent position, available in Japan, so they have no incentive to learn Japanese. For them, Japan is merely a stepping stone before going to the US.

In the US, researchers can expect to gain tenure by working on a tenure track for less than 5 years. Japan has no such system. Overseas researchers will not stay in Japan if there are no such criteria. This problem of MANA is a problem of Japanese society, and cannot be resolved by a single institute.

——How about the problem of language? MANA is trying to use English as the common language.

Put it this way. For example in Taiwan, there are no Taiwanese technical words related to superconductors. On the other hand, people cannot create new ideas without reading original textbooks in their native language. That means they have to be bilingual in English and Taiwanese. Also in Japan, Japanese textbooks are indispensable, and thus we need two languages.

This photograph was taken with Prof. Kawazoe at a meeting of the Chemical Society of Japan at Kinki University, which Prof. Hosono attended to present a graduation study.

However, language is not a big problem when writing papers and communicating. As I explained, overseas researchers are not attracted to Japan not because of the language but because of the lack of positions, which is a serious issue.

——What do you expect from MANA?

MANA has many researchers who are invited to international conferences as speakers. But MANA should have more researchers who can give plenary speeches. There should be not only those who score 4 in the 5 grade system but also those who score 10 in the 10 grade system. Instead of being an institute in which everybody is equal, it should be a highly flexible institute in which everything changes when a project ends. Universities cannot easily be overhauled completely because they have to educate, but MANA is a core research center. I hope it will create a system that cannot be mimicked by other organizations. I want it to clarify what areas it will attempt, and then challenge them with courage. It is not easy to do.

——Do you mean cultivating top stars by testing such a system?

Cultivating top stars may not be a major goal of MANA. But, creating such a system is absolutely vital. For example, it could suddenly triple pay. This is a vulgar example, but MANA should challenge issues that are deemed taboo in Japan. We are monitoring what taboos MANA takes on.

——Please watch us! Thank you very much.

Struggling to survive in a global research environment

Kazuhito TSUKAGOSHI

- Principal investigator, MANA
  (Leader of the Pi-Electron Electronics Group, Nano-Systems Field)
- Specialty: Nanoelectronics
- Academic degree: Ph.D., Osaka University (1995)

Cultivating a relationship with colleagues in foreign countries

——Dr. Tsukagoshi, you are the youngest principal investigator at MANA. You' re only 42 years old, but have achieved a number of excellent results. What is the secret to your success?

I have diverse experience working in private companies and research institutes in and outside Japan. If I am any different from others my age, it is probably due to this experience. Also, I adopted a positive attitude when faced with several extremely difficult challenges, which definitely changed me.

For example, I had taken a position at Hitachi Laboratory because I wanted to know how semiconductors could be useful to people. However, the research group that was I scheduled to join was dissolved when the bubble economy burst. So, I resigned and returned to graduate school, but in the second year, the Hanshin Awaji Earthquake struck, and our experimental systems were destroyed. I took it as an opportunity to review the data collected thus far and organized it into a doctoral thesis. Afterwards, I was invited by a researcher at the Cavendish Laboratory of the University of Cambridge, whom I had met at a conference, and I worked feverishly in the UK for three and a half years, constantly aware that there would be no place to go if I did not produce results there. I was a postdoctoral fellow, with no money, no position in Japan, and basically, no roots. The only thing I could do was to absorb myself in experiments day and night. I even worked on Christmas, which invited more than a few frowns. However, as I continued to work diligently, there was a gradual shift in the response from others. By the third year, I was recognized not merely as a visitor but as a colleague able to participate in collaborative work and deep discussions.

Then I found a position at the Hitachi Cambridge Laboratory, but could not continue with experiments at ultra-low temperatures due to the slowdown in the semiconductor industry. As a last resort, I started studying nanomaterials. It was a big turnabout of study topics, but I found a new development by fusing my old studies with new materials.

I have always felt driven to produce results, but my research success is the fruit of challenging struggles made as a researcher to respond to every type of situation.

——What studies are you planning to undertake at MANA? Will they be an extension of your former studies, or something new?

First, I must do my best to develop "high-speed organic transistors by means of nanointerfaces and control of electrical conditions," which was adopted as a CREST project*.

Also, I'll be studying whether or not field-effect transistors that far exceed the conventional semiconductor transistors can be actualized by using the electrical conditions of single- or double-layer graphene film, which is a nanocarbon material. I want to know how we can incorporate new materials into electronics in 20 or 30 years. For me, all my themes are on the same line. I have encountered them naturally by digesting what I've studied, observing the relationship with society, and investigating the direction of development.

Basic studies contributing to society are requisites

——What sense of purpose or mission do you have as a researcher?

In any form, research must contribute to society. Then it can contribute to the development of Japanese industry and culture. What I can do is to reveal, among the many unknown physical phenomena in electronics, why organic transistors work, why electricity flows, and so on. Studies, even those on phenomena that cannot be understood by today's concepts, will be advanced by elucidating such mechanisms. The significance of conducting basic studies at NIMS, MANA and Japan lies there.

I am not a genius. I do not have the power to do extraordinary work. As a person of ordinary ability, I have persistently combined daily experiments, thinking deeply and thoroughly until I am convinced, and then I have accomplished what everyone believed to be impossible. For that, I use every ounce of energy and time, which I believe is the most honest way for me to do my research.

——How would you express your wishes as a promising young principal investigator?

The point is how to promote the study results. If there is someone who highly evaluates the studies and invites us to give lectures, the opportunities to present the studies will increase. But, we should also expand discussions through mutual exchange by visiting laboratories and holding seminars. When I was in Cambridge, people were rushing about having discussions and acquiring skills for promoting themselves. MANA encourages us to venture outside.

There is another important point. As long as technology is human action, we must earn people's trust not only in our technical skills and knowledge but also in our personal qualities. In order to publish technological accomplishments produced in Japan to the rest of the world, it is indispensable to deepen personal communication. From my experience in Cambridge, it takes about three years to build a trusting relationship that allows us to express our true feelings and engage in thorough discussions. This time is necessary for learning the history of the researcher's success, and we should expand the opportunities for conducting studies on an international scale, promote our skills to the international world, and make wise use of our time.

*CREST project: Team-based study project for producing seeds of innovation that have a large impact toward achieving a strategic goal presented by the national government.

Fostering new human resources
—MANA Independent Scientists

Discovering young, capable researchers and fostering their development is vital for MANA's goal of becoming a core global research center. The MANA Independent Scientists system provides the optimum environment for this purpose.

Providing opportunities to step out into a wider world

One of the most stimulating experiences for promising researchers is meeting world-leading scientists and hearing their stories first-hand. If the experience is personal, the impact is even more profound. For Japanese researchers, who tend to stay in their own small world, it is essential to actively communicate with people from other countries and fields, broaden the range of vision, and gain insight into not only research matters but personal matters as well.

What are MANA Independent Scientists?

Most MANA Independent Scientists are young researchers in their thirties. Diverse recruiting strategies are used to secure excellent researchers, the majority of which have been involved in PRESTO programs** of the Japan Science and Technology Agency.

There are currently 13 independent scientists, including 3 from abroad. They are full-time researchers at NIMS but are engaged in independent studies at MANA.

Distinctive 3D system of MANA

Among the systems enjoyed by independent scientists, the most distinctive is the 3D system. "3D" stands for Double mentor, Double discipline and Double affiliation. The objective is to cultivate independence in research by allowing these scientists to obtain advice from two or more mentors, enhance interdisciplinary ability by requiring the study of two or more themes, and strengthen the spirit of independence by having them working at two or more organizations. Satellite institutes and overseas cooperating institutes are fully used for this purpose.

Cosmopolitan environment

MANA has made utmost effort to create a successful cosmopolitan environment worthy of a world-leading core research center. The majority of researchers (55%) are from abroad, and all matters, including administrative policies, can be communicated in English. During break times, researchers of diverse cultural and ethnic backgrounds enjoy lively discussions about their studies and home towns and ask the office staff about Japanese culture.

This environment is aptly referred to as a melting pot, and innovative results are expected from the mixing and melting together of a wide range of ideas and knowledge.

**PRESTO Program: PRESTO is a proposal-oriented research promotion program based on national strategic goals and aims at cultivating the seeds of future innovation. The mean age of researchers at assignment is 35.8 years.

Prof. Narayanamurti (left) and Dr. Nagao

Experience of Dr. Fukata

Naoki Fukata, a MANA Independent Scientist, is 38 years old and currently studying semiconductor nanostructures.

"It was fascinating to be able to visit one of the world's top scientists, a "courtier" for us. I was not acquainted with Prof. Zhong Lin Wang, but I submitted a proposal on energy conversion because I was interested in this topic. He accepted me immediately, and I spent five weeks in his laboratory. No one, including the Professor himself, went ahead with the work unless they were absolutely convinced of its validity. So we spent hours and hours discussing every aspect. Everyone had a strong sense of being a true professional. I learned much from the visit, including this point."

"Today, I conduct studies as an independent scientist with sole responsibility for the studies, including identifying the study themes, setting up the experimental devices, doing the experiments, advising the students from a joint research institute, and raising the necessary funds. My goal is to become a world-leading scientist whose name is the first one that comes to mind in this field of study."

Opinion of Dr. Nagao

Tadaaki Nagao, in his forties, is the oldest of the independent scientists. His specialty is nanoanalysis of surfaces, and he is confident that he is near the top in this field.

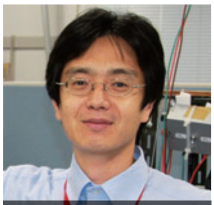
"I went to see Prof. Narayanamurti at Harvard University. While we talked, I discovered that we had much in common, and he helped me when I started new studies. Visiting with him did not produce direct results, but finding out that we had things in common had a strong impact. I feel that he is a colleague rather than a mentor.

I am satisfied with the present research environment. I will be visiting Spain, Germany and the US and I intend to be a world-class scientist in my field."

We can expect that the world's top researchers will emerge from MANA Independent Scientists.

(Akio Etori)

Dr. Fukata (center) talking with Prof. Wang (right) at the Georgia Institute of Technology



Infrared plasmons in atom- and nano-scale one-dimensional objects

Tadaaki NAGAO
長尾 忠昭

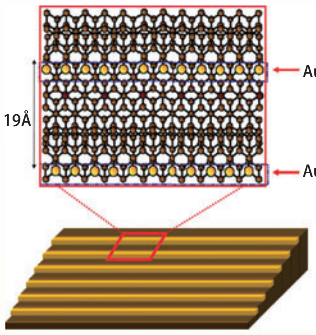
MANA
Independent Scintiest

The technology for amplifying, confining, and scattering the light in nanoscale objects is strongly desired as a key technology for future optical communication and sensing. By hybridizing the plasma oscillation with the electromagnetic field near the metal surface we can manipulate the light at a much shorter wavelength than that in free space. Such hybridized waves of contracted wavelength are called plasmon polaritons. Because the electromagnetic waves are strongly damped in metals, one has to avoid this damping effect, probably by minimizing the metal part in optical devices. For the first time in the world, we discovered that plasmon propagate through atomic wires and atomic sheets by low-energy electron scattering and we have systematically investigated their fundamental properties. For example, we found an infrared plasmon, which is similar to sound waves and is well-known as in the theory of Shin-ichiro Tomonaga. We also found a plasmon that disappears and reappears as a function of temperature, a plasmonic excitation in spin-polarized electrons in atom chains, and so on.

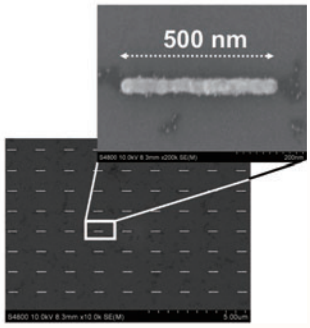
In metal nanomaterials, the average spacing between electrons is almost the size of an atom, and thus, the properties of plasmons change sharply with nanometric changes in shape and size. We are now conducting investigations to design the forms of metal nanorods and metal nanosheets and to control and use the properties of confined plasmons. Recently, we developed a material that emits infrared absorption signals at a level of sensitivity several thousand fold higher than that of a flat metal film surface and we are now investigating measuring methods that can detect a single molecule and attomoles (10^{-18}) of molecules.

Studies on infrared plasmons have just started, but have already attracted the attention of researchers abroad as a promising material development method that can extract the potential capacities of metal materials. In the research environment of MANA, where international cooperation and support are readily available, I plan to develop our studies on physical properties into the full-scale application of materials, possibly in concert with researchers in Europe, North America, China and other countries.

Atomic-scale structure of a self-assembled one-dimensional atom chain



SEM image of nanoscale one-dimensional nanoantenna of gold prepared by electron lithography (SEM photo)



Plasmons of the infrared region are generated in both the one-dimensional atom chain and one-dimensional nanoantenna.

Atom probe tomography of insulator ceramics using ultraviolet laser pulses

Kazuhiro HONO
宝野 和博

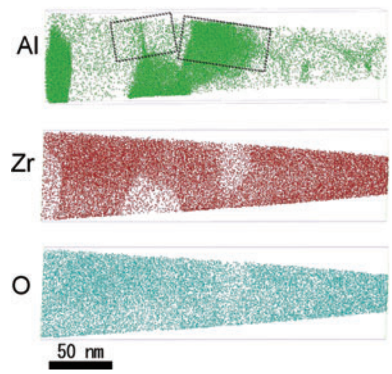
MANA
Principal Investigator (PI)
Nano-Materials Field

Contrary to the popular belief that bulk insulators cannot be analyzed by the atom probe technique, we have demonstrated that it is possible by using ultraviolet (UV) femtosecond pulse laser to assist field evaporation of atoms. 3D tomography of nano/micro-structures of materials can be easily obtained by transmission electron microscopy, but it has neither atomic spatial resolution nor atomic sensitively. Unlike other tomography techniques, the atom probe tomography can map out 3D distributions of atoms with an atomic resolution. The limitation of the atom probe technique was its applicability to only electrical conductive materials. The present work has demonstrated that atom probe tomography can be obtained even from insulating ceramics by employing UV laser assisted 3D atom probe.

In the atom probe technique, atoms are ionized by applying a high electrical field of 10^{10} V/m to a needle-like specimen. In this research, a needle-like specimen with a tip radius of approximately 50 nm was prepared from an yttoria-stabilized t-ZO_2-$MgAl_2O_4$ nano-composite using the focused ion beam (FIB) technique, which was then put onto a tungsten needle. A high voltage was applied to the ceramic tip on the tungsten needle, and the tip was irradiated with femtosecond laser pulses with a wavelength of 330 nm. The ionization of atoms was confirmed to occur in synchronization with the laser pulses. Using this laser assisted field evaporation phenomenon, the positions of the individual atoms and their time-of-flights were measured, and 3D atom tomography was successfully reconstructed.

In the past, the 3DAP technique has been believed to be applicable to only electrical conductive materials like metals and semiconductors. Unlike the conventional belief, the work has demonstrated that the 3D atom probe technique can be employed to obtain 3D atom tomography of even *bulk* insulating ceramics. This work will expand the application areas of the 3DAP technique in nanoscale analyses of a wider variety of inorganic materials.

http://www.nims.go.jp/apfim/exhibition/ZrOMgAlO.html



Atom probe tomography of aluminum, zirconium and oxygen atoms in an yttoria-stabilized tetragonal-ZrO_2/$MgAl_2O_4$ nano-composite ceramics. Individual dots correspond to atoms.

Tough nanotube circuits using metal clamps

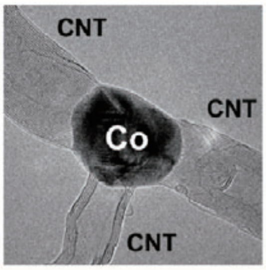
Dmitri GOLBERG
ドミトリ・ゴルバーグ
MANA
Principal Investigator (PI)
Nano-Materials Field

Joining the nanotubes in circuits is an essential process as far as their real electrical/mechanical applications are concerned. The reliable technique to weld the nanotubes has not been available till recently. We found that carbon nanotubes can be tightly soldered using Co nanoparticles as ultimate clamps.

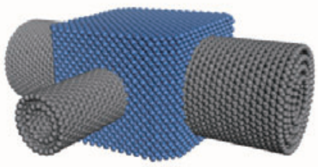
Under 300 kV TEM electron irradiation of cobalt-filled carbon nanotubes along with their Joule heating in a dedicated Scanning Electron Microscope (STM)- Transmission Electron Microscope (TEM) holder we achieved a unique structural rearrangement; that is Co/C intra-diffusion resulted in reliable welding the tubes through cobalt particles.

It is suggested that strong covalent bonding between a metal and carbon (in a manner peculiar to metal carbides) is behind the observed phenomenon.

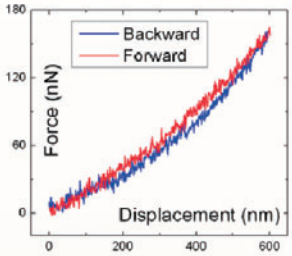
The formation process involves a current flow and electron irradiation of tube areas where a metal particle is located at the overlapping region of two C nanotubes. *In situ* TEM measurements show that the junctions are electrically conductive and have low resistances of only several 10 kΩ. After the junctions were formed using the STM-TEM setup they were gently transferred to a holder of an Atomic Force Microscope (AFM) and TEM for direct tensile testing. And they were found to be mechanically robust. An ultimately high tensile strength of 0.6-1.4 GPa was measured. This value is comparable to the ultimate strength of stainless steel 0.8 GPa, spider silk 1.2 GPa, or tungsten 1.5 GPa. The extension of this technique towards creating more complicated circuits, such as junctions with more terminals or with branches spanning in many directions, is straightforward and only requires a positioning of the starting C tubes in a pre-defined network.



TEM image of a cobalt clamp.



Model of three branched C nanotubes using a cobalt clamp.



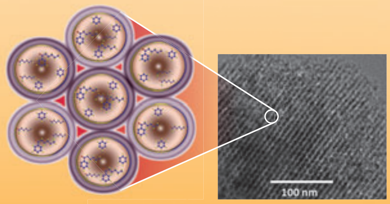
Force-displacement plot under pulling the junction apart inside the electron microscope.

Mesoporous carbon based materials and their multiple functions

Ajayan VINU
アジャヤン・ヴィヌ
MANA
Independent Scintiest

Silica molecular sieves are typically prepared using surfactant mediated self-assembly of suitable silica precursors. These materials exhibit very high specific surface area, specific pore volume, tunable pore size and controllable morphology which enable them to function as promising candidates for a large spectrum of applications including selective adsorption, separation and catalysis. Unfortunately, mesoporous materials with a silica wall structure possess poor water, thermal, and mechanical stability which limit their use for commercial applications. Thus, it is highly critical to explore the synthesis of mesoporous materials other than silica which must be highly stable both thermally and mechanically. As carbon is one of the interesting materials which possesses a high thermal and mechanical stability, we are exploring the synthesis of various mesoporous carbon materials with different structure and pore diameter by both the soft and hard templating approach in MANA. In the hard templating approach, well-ordered mesoporous silica with three dimensional structure is employed as the sacrificial template and sucrose as the carbon source. Mesoporous carbons such as carbon nanocage, carbon nanocoops, and glucocarbons have been successfully fabricated using the above approach. These materials possess a well ordered pore structure, a very high specific pore volume, a specific surface area and tunable pore diameter. They have also no charge on their surface and are highly tolerant in aqueous environment compared with silica materials and have successfully been employed as the catalytic support for the polymer electrolyte membrane fuel cells. The anodic performance of the platinum loaded mesoporous carbon materials fabricated in MANA is much higher as compared to that of the commercially available carbon black support.

The function of the mesoporous materials can also be tuned by altering the chemical composition of its wall structure with different elements. Carbon nitride (CN) is a well known and fascinating material that has attracted worldwide attention because the incorporation of nitrogen atoms in the carbon nanostructure can enhance the mechanical, conducting, field emission, and energy storage properties. Owing to its unique properties, CN is regarded as a promising material which could find potential applications in many fields. CN materials with no porous structure can be prepared either from molecular or chemical precursors at very high temperatures so far. By constructing CN materials with porous structure, many novel applications could emerge: from catalysis, to separation and adsorption of very bulky molecules, and to the fabrication of low dielectric devices. In MANA, we tried to explore the possibility of introducing the mesoporosity in the CN materials. We successfully fabricated the two dimensional mesoporous carbon nitride (MCN) with tunable pore diameters, using SBA-15 materials with different pore diameters as template through a simple polymerization reaction between ethylenediamine and carbon tetrachloride. The pore diameter of the MCN materials can be easily tuned from 4.2 to 6.4 nm by simply changing the pore diameter of the template. The catalytic activity of the materials has been tested in the Freidel-Crafts acylation of benzene using hexanoyl chloride as the acylating agent. The materials are highly active and show a high conversion and 100% selectivity to caprophenone.



Mesoporous carbon nitride for the synthesis of caprophenone via Freidel-Crafts acylation of benzene with hexanoyl chloride.

arch Outcome

News & Topics

6th Japan-UK-USA Nanotechnology Summer School

The 6th MANA-NSC-CNSI Nanotechnology Students' Summer School was held at the University of California, Los Angeles (UCLA), from July 27–31, 2009. The summer school was organized through the collaboration of the NIMS (Japan), the Nanoscience Center (University of Cambridge, UK), and the California NanoSystems Institute (UCLA, USA).

The 29 participating students from Japan, the UK and the USA cultivated friendships and enjoyed cultural exchange through Japan-UK-USA beach volleyball games, and a festival sponsored by UCLA students.

The 7th summer school will be held at the Nanoscience Center, University of Cambridge, in the summer of 2010.

At the California NanoSystems Institute (UCLA)

Viisit by US government delegation

Japan-US research collaboration on renewable energy technology

A team from the US Department of Energy (DOD) and Department of Defense(DOD) visited MANA on July 14, 2009 to investigate the possibility of Japan-US collaborative research on renewable energy technology.

The investigation team from the US and members of MANA

MOU with University of Cologne, Germany

On May 28, 2009, MANA signed a memorandum of understanding (MOU) with the Institute of Inorganic Chemistry, University of Cologne, Germany, for research on the fabrication and application of advanced nanomaterials.

Signing ceremony (from left to right): Prof. Schmalz (Universitiy of Cologne), Prof. Mathur (University of Cologne), and Prof. Bando (MANA COO)

Joint workshop with University of Cambridge

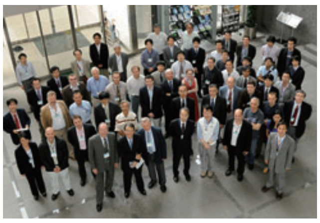
Research collaboration with MANA satellite institute

The 1st MANA-NSC Joint Workshop was held on July 3, 2009 at the University of Cambridge. The University of Cambridge is one of the overseas satellite institutes of MANA.

Participants in joint workshop with University of Cambridge

Past and upcoming events

Feb 25–27, 2009	MANA International Symposium 2009
May 28, 2009	MOU with University of Cologne, Germany
Jun 15–17, 2009	Japan-France Workshop on Nanomaterials
Jul 3, 2009	Joint workshop with University of Cambridge
Jul 14, 2009	Visit by US government delegation
Jul 27–31, 2009	Japan-UK-USA nanotechnology summer school
Sep 20–22, 2009	Joint workshop with Xi'an Jiaotong University
Oct 9, 2009	Nobel laureate Prof. Kroto visits MANA
Oct 13, 2009	Joint workshop at University of Rome Tor Vergata
Oct 13–14, 2009	Joint workshop with CEMES, CNRS (France)
Oct 23, 2009	Symposium on Frontiers in Nanotechnology and Materials
Nov 12–13, 2009	Joint workshop between NIMS, WUT (Poland), and EMPA (Switzerland)
Dec 10, 2009	Joint workshop with Osaka University
Jan 14, 2010	Joint workshop with Waseda University
Mar 3– 5, 2010	MANA International Symposium 2010



Japan-France Workshop on Nanomaterials

Prof. Kroto

Foreign researchers take up the challenge of Japanese culture

MANA has various programs aimed at helping foreign researchers enjoy Japanese culture. This summer, researchers took up the challenge of summer kimono and Japanese traditional drums.

MANA International Symposium 2010

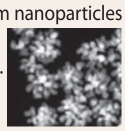
The MANA International Symposium 2010 will be held from March 3–5, 2010 at Epochal Tsukuba, Japan.

Press Release

Dr. Ajayan Vinu appeared in an article on the MANA environment for foreign researchers.
—*Yomiuri Shimbun*, April 12, 2009

Two principal investigators at MANA, Dr. Liyuan Han and Dr. Jinhua Ye, were featured in a report on the lives of researchers.
—*Asahi Shimbun*, April 15, 2009

A study by MANA Independent Scientist Dr. Yusuke Yamauchi and colleagues on platinum nanoparticles with an ultra-fine candy-ball-like structure was featured in two reports.
—*Asahi Shimbun*, June 24, 2009
—*Kagaku Shinbun* ,July 10, 2009



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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.