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Photovoltaic Materials Cluster

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Based on the Materials Science

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Chisato Niikura Hideomi Koinuma Masatomo Sumiya

With today’s intensive focus on global-scale environmental and energy problems, solar power has attracted great interest as one form of renewable energy. Many countries, including Germany and Spain in the EU, as well as China, India, and Russia, are rapidly increasing their investments in this field. In April, NIMS has launched the Photovoltaic Materials Cluster to develop new solar cells based on the materials science, and has begun research on crystalline silicon materials, thin film silicon solar cells, and solar cells using new materials. This special feature introduces the potential of materials in solar cells, the technical issues involved, and the future prospects for these technologies.

Materials Development Contributing to the Environment and Energy

Global warming, the recent rise in oil prices, the concern for the environment and resource/energy supplies are serious problems which face the world as a whole. In response to these problems, conversion to clean solar power, which uses natural energy and does not require fuel or emit CO_2, has been progressing. This is because solar power is expected to be the key to solve many environmental, resource, and energy problems if the cost-related problems of converting unlimited solar energy to electric energy can be cleared.

The types of solar cells can be widely classified as silicon-based, compound-based, and new material-based (see figure). Crystalline silicon solar cells have already been commercialized, but due to rapidly-increasing demand, the supply of silicon has become a problem. As a result, production of these solar cells in Japan has actually declined. Therefore, efforts to commercialize thin film silicon solar cells and compound solar cells such as CIGS ($CuInGaSe_2$) have been accelerating, and active R&D on solar cells using novel materials is also underway. However, in comparison with crystalline silicon solar cells, problems of conversion efficiency and cost remain to be solved with these solar cells.

In order to popularize solar cells worldwide, dramatic improvement in conversion efficiency and reduction in cost will be necessary. At the same time, it will also be extremely important to develop material resources which will enable mass power generation. Research which is not limited simply to improving efficiency, but also focuses on increasing scientific knowledge, is an area where NIMS can contribute.

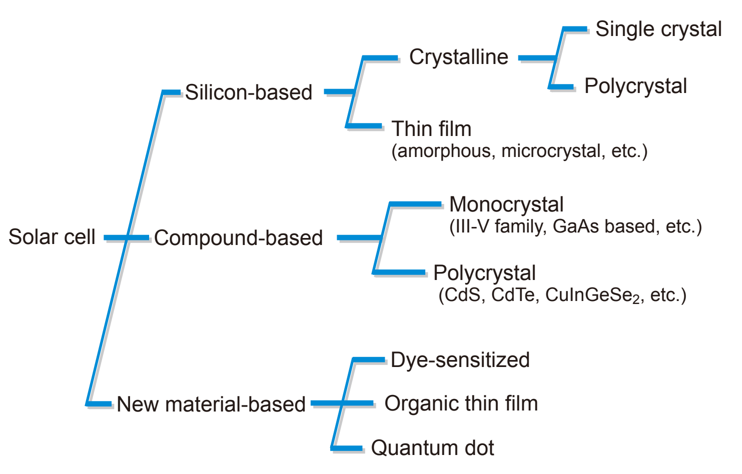
Collaboration between Different Material Fields

The NIMS Photovoltaic Materials Cluster was launched in April of 2008, bringing together researchers in the Advanced Electronic Materials Center, Sensor Materials Center, Quantum Dot Research Center, Organic Nanomaterials Center, and Composites and Coatings Center with the aim of promoting development of materials based on a fusion of fields. The Cluster is focusing on basic research of silicon, organic, and compound type solar cell materials, which are the semiconductor materials that directly determine conversion efficiency, as well as the mechanism and other aspects.

As one method of solving the raw material shortage affecting crystalline silicon, Cluster researchers are developing an innovative process that dramatically improves the reaction yield in material purification. As other approaches, research and development of thin film solar cells, which enables a substantial reduction in the amount of raw material silicon used, and the development of new materials and new substances such as III-V family nitride semiconductors, organic semiconductors, dye-sensitized materials, quantum dots, are also an important challenge.

This special feature introduces the six materials and concepts which are the main work by the Photovoltaic Materials Cluster.

Fig.



Classification of solar cells

Six PV Materials and Concepts

1 . Crystalline Silicon: Development of Innovative Manufacturing Process for Solar Grade Silicon

Prof. Hideomi Koinuma, NIMS Senior Advisor Emeritus

Crystalline silicon solar cells offer high conversion efficiency and reliability. However, demand for high purity silicon (Si), exceeds half (20,000 tons) of the world’s annual production. Faced with a serious shortage of Si, the technical strategies which will enable us to contribute to solving energy and environmental problems at the global scale are following.

○Development of innovative technologies for producing solar grade silicon with high efficiency/low cost.

○Improvement of thin film solar cells, which use only a small amount of semiconductor materials, and development of a mass production technology.

From the standpoint that “Silicon can be a stem material for saving the earth,” we, as a fundamental materials research center, are reviewing Si processes from their foundations and proposing methods of solution which anticipate the existence of important technical issues. Envisioning 100GW scale solar cells, which are expected to become a reality in the near future, we are focusing on the following concrete research on Si materials.

1) Chemical analysis of problems in the existing Siemens method* and proposal of innovative technologies

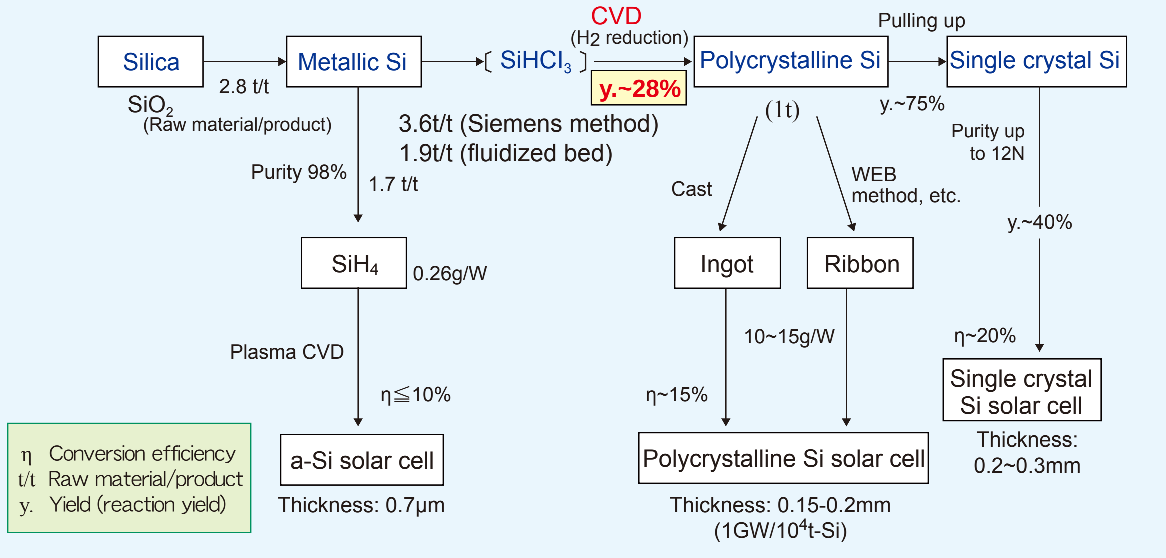
Siemens developed a high purity Si synthesis method by chemical vapor deposition (CVD) of chlorosilane gas for use with semiconductors, in which ultra-high purity of 10 nines (10N) or higher (impurity level of 0.1ppb or less) and single crystals are necessary. However, the weaknesses of this method are its low reaction rate and low reaction yield (y). A new high speed, high yield manufacturing technology would undoubtedly contribute to progress in Si solar cells. At present, one priority theme at NIMS is ambitious research aiming at low cost mass production of Si which can also be used in semiconductor devices with no sacrifice of Si purity. NIMS has proposed a new chemical process for dramatically improving reaction yield (28% → >75%) verified by thermodynamic calculations, and will verify this method through joint research by the NIMS Plasma Group, the University of Tokyo, and others.

2) Development of upgrade (purity up to 6N) metallic silicon manufacturing technology by carbon reduction of silica sand

A preliminary stage in the above-mentioned Siemens process involves a reaction to produce metallic Si of approximately 98% purity by carbon reduction of lumpy silica stone. If the problem of removing gas during the reaction can be solved and solar grade Si material can be produced metallurgically by carbon reduction of sandy silica (SiO_2), which is an abundant resource, a revolutionary reduction in cost can be expected. From this viewpoint, deserts can be considered a “treasure house” of energy resources, offering not only strong sunlight but also high purity silica as a raw material for Si. As a first step in the (Sahara) Solar Breeder (SSB) project to produce Si solar cells in the desert, NIMS is planning joint research with Hirosaki University. The SSB project is a far-reaching concept in which even larger solar cells will be produced progressively using the power generated by desert solar power plants (Si farms), and if possible, these will be linked to consumers worldwide using superconducting cables.

*Siemens method: Method of producing crystalline silicon with the highest purity possible at present.

Flow from Silicon Raw Material to Si Solar Cell



2. Thin Film Si: Control of Photo-Induced Degradation of Amorphous Silicon Thin Film Materials

Chisato Niikura, Advanced Device Materials Group, Advanced Electronic Materials Center

Thin film Si-based solar cells attract much attention as the coming generation particularly because of their advantages of material-saving and reduced environment loads: The amount of Si raw material required for them is two orders of magnitude less than that required for bulk crystalline Si solar cells. Furthermore, their energy payback time as well as CO_2 payback time is shorter.

There is a requirement to increase further their conversion efficiency, for which “Controlling photo-induced degradation of amorphous Si (Staebler-Wronski effect)” is one of the key technical issues.

In order to reduce photo-induced degradation of amorphous Si, it is considered important to reduce the adverse effect of the contribution of higher silane-related reactive species including Si_4H_9 toward film growth. However, under deposition conditions which satisfy this condition, film growth rate is extremely low. Then, faster deposition is required for industrial application.

Therefore, for realization of high-rate growth of high-quality amorphous Si with excellent photostability, we are working on controlling film growth process through development of a novel deposition technique, namely, “gas flow-controlled multi-hollow plasma CVD (see **figure**: patent pending)”.

We control gas flow under multi-hollow discharge conditions where numerous plasma spots, which are effective for gas dissociation, are produced stably at multi-hollow sites on cathode surface. By means of this technique, higher silane-related reactive species which have high-mass can be annihilated preferentially by gas flow and also by gas phase reactions. Then, low-mass SiH_3 radicals with long lifetime in SiH_4/H_2 atmosphere can survive and can be selectively transported to substrate, which enables high-rate growth of highly stable, high-quality amorphous Si films.

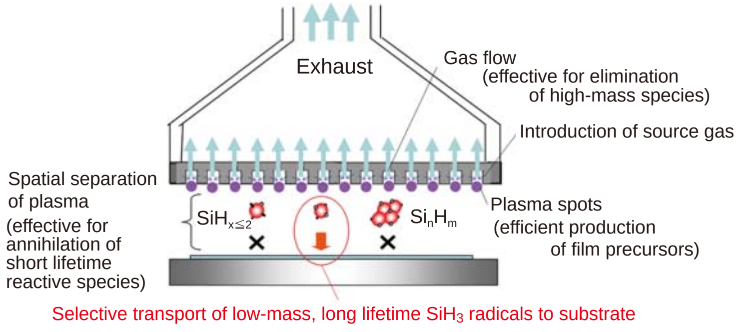


Fig. Schematic diagram of gas flow-controlled multi-hollow plasma CVD

3. New Materials (Semiconductors): Toward High Efficiency in III-V Nitride Thin Film Materials

Masatomo Sumiya, Optical Sensor Group, Sensor Materials Center

The basis of the materials used in solar cells is generation of carriers (electrons and holes) by absorption of light, separation of electrons and holes and removal of those carriers from the system as electrical energy. The physical property which determines the wavelengths (energy) in the solar spectrum is the bandgap in semiconductors. As shown in the figure, expanding the range of solar wavelengths which can be used by combining materials with different bandgaps, in other words, increasing sunlight utilization efficiency, is one effective means of increasing the conversion efficiency of solar cells.

The III-V nitride semiconductors have the function of emitting blue light like that which can be seen in Christmas tree lights and traffic lights. Since recent research has revealed that these substances also have the functions of receiving light as ultraviolet sensor, and the photocatalysis effect as seen in splitting water, they are also considered to have high potential of converting light to electrical energy for development of solar cells.

From the viewpoint of materials development, NIMS is engaged in research with the first target of producing solar cells using III-V nitride semiconductor thin films with conversion efficiency exceeding 10%, based on research on a high-In contented InGaN thin film material process. Because crystalline Si materials, which are the mainstream in solar cells, generate electricity mainly using light in the red region, our second target is to improve conversion efficiency by combining a nitride solar cell, which generates electricity by absorbing light in the UV and blue-green regions, with an Si solar cell. In this system, the nitride solar cell is arranged on the side of the cell irradiated by sunlight, as illustrated in the accompanying figure.

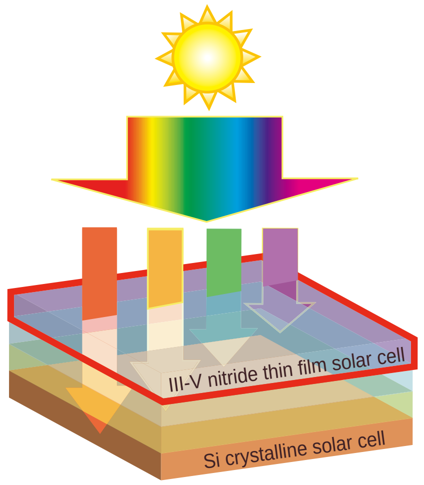


Fig. Image of a solar cell which improves conversion efficiency by absorbing sunlight in multiple tandem structure

4. New Materials (Semiconductors): Basic Research on Quantum Dot Solar Cells

Takeshi Noda, Exploratory Devices Research Group, Quantum Dot Research Center

Various ideas for achieving high efficient solar cells have been proposed. As one such idea, it is expected to improve efficiency if a current can be obtained using light with lower energy than the bandgap. Theoretically, the conversion efficiency of this type of solar cell is predicted to exceed 60%. Quantum dot is a candidate to create this kind of structure because states in the bandgap of the host material.

Although quantum dot solar cells have great potential, many problems also must be solved. For example, it is necessary to clarify whether it is actually possible to obtain an electric current with light having energy smaller than the bandgap, as predicted theoretically. In order to obtain adequate absorption, high quality and high density quantum dots are required. We are tackling with the fabrication of stacked quantum dots using the droplet epitaxy method, which is one technique for self-assembly of quantum dots and is a NIMS original technology. Using this technique, quantum dots are self-assembly fabricated, even in lattice-matched system. The figure shows an atomic force microscope image of GaAs quantum dots grown by this method. The individual particles capture electrons, and thus function as quantum dots. Since at least several tens of layers of quantum dots are necessary in solar cell application, crystal quality of stacked quantum dots, grown by self-assembled technique using strain, usually deteriorates as the number of stacked layers increases. Therefore, a lattice-matched (strain-free) quantum dot system is advantageous for creating multilayer structures.

Quantum dot solar cells are a challenging problem. In cooperation with crystal growth, optical and transport groups, we are doing research on quantum dot solar cells to aim for high efficiency solar cells.

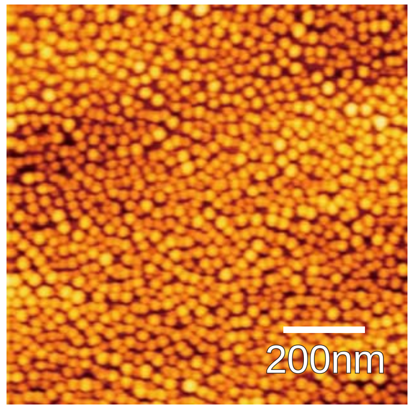


Fig. Atomic force microscope image of GaAs quantum dots fabricated by the droplet epitaxy method.

5. New Materials (Organic Materials): Development of π-Conjugated Organic Materials and a Hierarchical Alignment Method

Masayuki Takeuchi, Macromolecules Group, Organic Nanomaterials Center

The key to the development of organic thin film solar cells is considered to be the design and organization of organic compounds (π-conjugated organic materials). In addition to tuning of the optical/electrochemical physical properties and functions of molecules and among molecules, the development of crystalline materials, which display high electron and hole mobility, is desirable, regardless of whether the material is a p-type or an n-type organic semiconductor. In organic thin film solar cells, the formation of a photoelectric conversion interface with a structure controlled in 3-dimensions at the nanometer order, and efficient transfer of the generated charge, are necessary. For this, the development of a technique for arranging heterogeneous organic semiconductors at the nanometer order is desirable.

Our group is developing a new π-conjugated organic material, and also developing a method of arraying and organizing the material by a new solution process, with the aim of contributing to high efficiency in organic thin film solar cells. Recently, we developed a new method of aligning conjugated polymers* using a crosslinking reaction. In this method, a one-dimensional conjugated polymer and molecular crosslinker (“aligner”) having 2 or more parts which are capable of interaction with the conjugated polymer are simply mixed in a solution. The molecular crosslinkes act as clips, bundling the polymer, and as a result, it is possible to obtain a two-dimensional sheet structure (see **figure**). At present, we are developing this technique to alternating arrays of conjugated polymers.

*Conjugated polymer: Polymer in which a double bond or triple bond is alternately linked with a single bond.

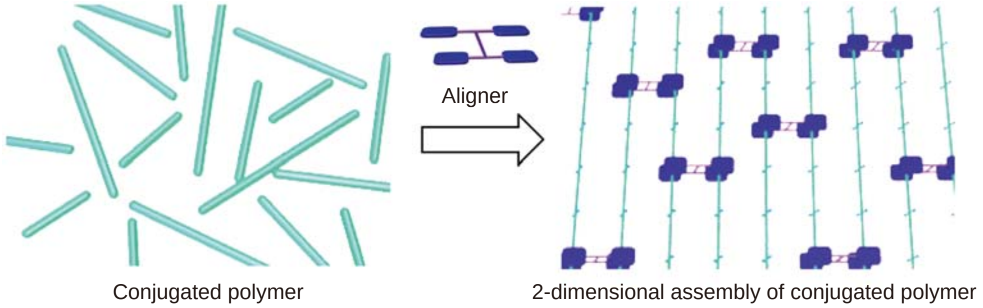


Fig. Bundling of conjugated polymer by molecular crosslinkes (“aligners”) and growth to a 2-dimensional assembly. The aligned conjugated polymers are fixed to the spacing of the aligners (several nm). As a result, it is possible to obtain a crystalline 2-dimensional assembly.

6. New Materials (Organic): Development of Dye-Sensitized Solar Cell

Jin Kawakita, Coating Materials Group, Composites and Coatings Center

Dye-sensitized solar cells (DSSC) are a type of solar cell in which an organic dye is used to obtain photo-voltaic function (photo-voltage). Figure shows a schematic structure of DSSC, which is one of the photo-chemical cells and characteristics of occurrence of the oxidation-reduction reactions in addition to the photoelectric conversion function. Furthermore, the cost of DSSC is comparatively low because it does not need to have the semiconductor manufacturing equipment essential for Si solar cells and gets along with relatively small energy in production. Various types of dye are selectable, making it possible to produce colored or transparent and flexible cells because of an aggregate of fine particles as the photo-electric conversion material.

The theoretical conversion efficiency of DSSC is considered to be around 30% while the observed value is currently 11% in maximum. To date, research for DSSC has focused mainly on investigation of superior dyes and modification of the morphology of titanium oxide (TiO_2) particles. In recent years, however, progress has stagnated. Although progress has been made in understanding the losses in conversion efficiency attributable to the respective component parts of cells, the reason for the losses including their mechanisms still remain unclear. Moreover, for practical application, it is also important to carry out research for contributing to establish reliability and long-term stability of the cell.

The ultimate aim of the research is dramatically improving conversion efficiency of DSSC. The objective of the current research is to elucidate the mechanism of charge transfer in the photo-electrode from the electrochemical viewpoint, focusing on photoelectric conversion materials with a controlled orientation of TiO_2 crystal plane. Thereby, design guidelines for the optimization of photoelectric conversion materials are expected to be offered. Considering electric power supply during periods of no sunlight, it is also studied whether it is possible to impart an electric storage function to photo-electrodes by utilizing ions in the electrolyte.

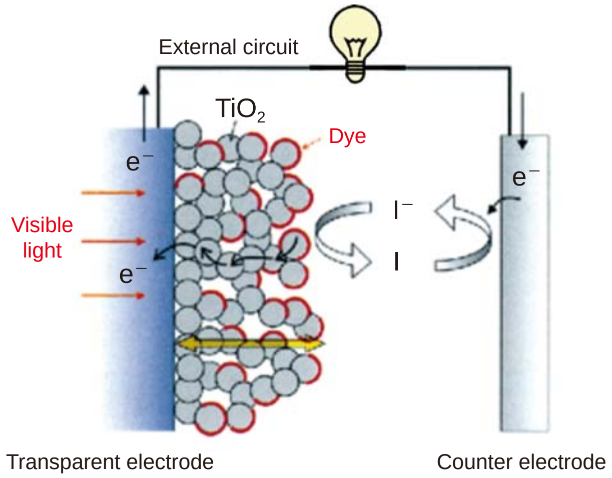


Fig. Operation mechanism of a dye-sensitized solar cell.

When light strikes the transparent electrode (photoelectrode), the dye in the cell is excited and electrons (e^-) are discharged. e^- reach the transparent electrode via the titanium oxide (TiO_2) and flow to the outside. On the other hand, the shortage of e^- resulting from this discharge is supplied to the dye from iodine ions (I^-) in the electrolyte. At this time, I^- are changed into iodine (I) (oxidation), but revert to I^- when they receive e^- supplied from the counter electrode (reduction).

Outlook for the Future

For a dramatic expansion in the use of solar cells, it will not be sufficient simply to improve energy conversion efficiency. Extending the life of solar cells will also be an important challenge for the future. For example, the polymers used in sealing materials and other parts deteriorate easily in comparison with semiconductors. Therefore, one key target of the Photovoltaic Materials Cluster is to improve the durability of polymer materials for solar cells.

In order to realize a fusion of the technical development capabilities, which we have cultivated in diverse fields and solar cell technologies developed outside of NIMS, active exchanges with experienced people from other research centers will be necessary. In the future, by further expanding our members and combining the wisdom of researchers specializing in different types of materials, we believe that it will be possible to enhance the functions of the individual materials, and at the same time, to achieve a remarkable improvement in total functions by combining these materials to take advantage of their respective properties. This will enable us to develop research on new solar cells with higher performance.

Our aim is to develop solar cells that contribute to society, based on new materials technologies focused on the science born from total capabilities which combine diverse areas of materials research.

Dye-sensitized solar cells have attracted attention as next-generation solar cells, but still have problems of low conversion efficiency and durability. Basic research to elucidate the principle and mechanism of power generation in this type of solar cell is key to improving their performance. At NIMS, Group Leader Liyuan Han of the Solar Cell Group, Nano Green field of MANA has taken on this challenge. We asked Dr. Han to describe the research he is doing at NIMS based on 10 years of experience in a private corporation.

Opening the Way to High Performance by Elucidation of the Principle and Mechanism

Liyuan Han, Group Leader
Solar Cell Group, Nano Green Field
International Center for
Materials Nanoarchitectonics (MANA)
Next-Generation Solar Cell Group
Innovative Materials Engineering Laboratory

First, how did you happen to come to NIMS from a private corporation?

For 10 years, I had been working on improved durability and conversion efficiency in dye-sensitized solar cells at a private corporation, aiming at practical application of this technology. I always felt that basic research to understand the principle and mechanism of this type of solar cell was necessary in order to obtain conversion efficiency and durability on the same level as in silicon solar cells. However, doing in-depth basic research is difficult in a private company because it doesn't make a direct contribution to the profit. Coming to NIMS was the perfect chance for me, because it meant that I would be able to realize this goal. After I moved to NIMS, I also received words of encouragement from acquaintances who were doing research on the same dye-sensitized solar cells. Some people said they hoped "I'd do my best to realize the practical application of a 'new solar cell' demanded by humankind." This was a great encouragement for me. Therefore To achieve that innovation, we have to begin from basic research.

How are you developing your research at NIMS?

In my research on dye-sensitized solar cells, I have already achieved the world's highest cell conversion efficiency, at 11.1%. However, considering the fact that the conversion efficiency of silicon solar cells exceeds 20%, I'm targeting conversion efficiency of around 20%, which is double the current efficiency, and lifetime of 20 years in my research. In order to achieve these targets, some revolutionary ideas, in other words, innovation, will be necessary, because we have found the limits to improvement with the existing technology.

What are the merits of doing research at NIMS?

It is possible to do free research with a wide perspective thoroughly, from a neutral standpoint, even though this kind of work takes considerable time. Because my current research on the mechanism of dye-sensitized solar cells will take 3 to 4 years, it would be extremely difficult to do in a private corporation. At NIMS, however, it is possible to return to the starting point and investigate the basics and principles. In addition, NIMS has a large number of outstanding materials researchers, and it is possible to create better devices through cooperation with these researchers. The synergistic effect of better ideas and hints can also be expected as a result of that kind of cooperation.

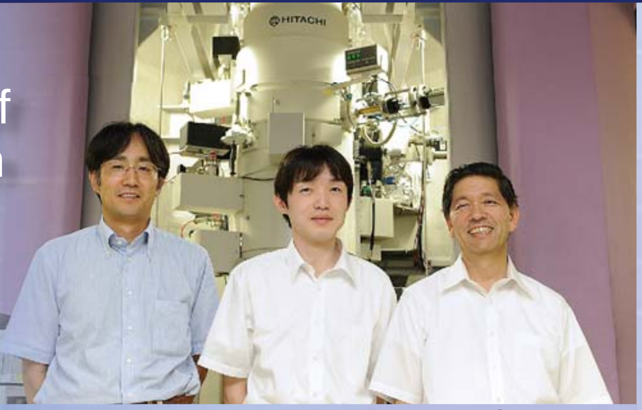
So, you're involved in quite basic research?

Various materials have been developed for dye-sensitized solar cells to date, but research to explain why one material is superior to another is still inadequate. We must propose guidelines for the development of better materials by elucidating this question. As another issue, completely unlike the silicon solar cells, there is interface with large specific surface area in this type of solar cell because nanoparticles are used. However, the mechanism of electron transfer at this interface has still not been adequately clarified. In my previous work, I was able to give a convenient explanation using the same theory as with silicon solar cells, but as my research progressed, various differences with silicon became apparent. I think that elucidation of these differences will lead to improvement in conversion efficiency. Thus, many questions still require investigation at the basic research level.

What about applied research?

Firstly, my mission is to investigate how to produce solar cells with higher performance by research from the basic level. I hope to propose solar cells with good performance by elucidating their principle and mechanism. In research at NIMS, we are ultimately aiming at improving the performance of dye-sensitized solar cells. Because Japanese companies have excellent product planning and development capabilities, if we can contribute to realizing dye-sensitized solar cells with high efficiency and long lifetime, any number of new applications are possible.

Electron Microscope Capable of Element-Selective Visualization of Atomic Arrangement



Advanced Electron Microscopy Group,
Advanced Nano Characterization Center

Group Leader
Koji Kimoto, Takuro Nagai, Yoshio Matsui

The excellent properties of materials are frequently determined by their microstructure in the nanometer region. Electron microscopy is an effective means of direct observation of the microstructure, and its resolution has already reached the atomic order. However, because electron microscope images are basically black-and-white images, in element analysis, it was difficult to distinguish the arrangement of atoms by coloring.

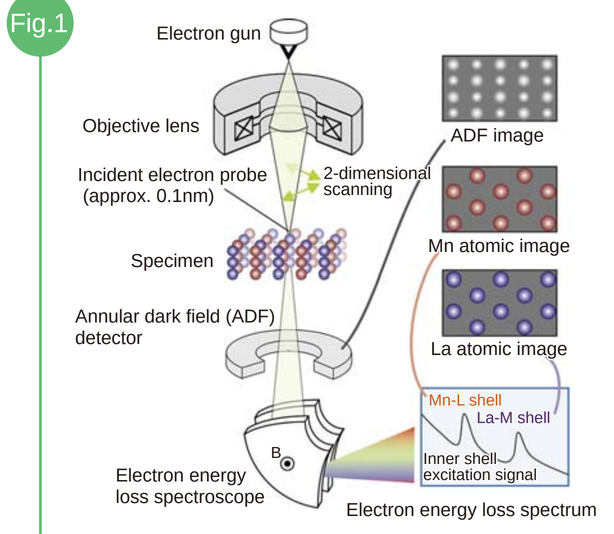
In this research, a technique which combines the scanning transmission electron microscope (STEM) and electron energy loss spectroscopy (EELS) was used, as shown schematically in **Fig. 1**. The basic principle is simple, in that a tightly converged electron beam is scanned on the specimen, and the energy of the transmitted electrons is measured. Because the characteristic inner shell excitation signals of the individual elements are observed in the energy loss spectrum created by the transmitted electrons, element-selective visualization of the atomic arrangement is possible.

Then, is it sufficient simply to use a small electron beam? With advanced instruments, it is possible to converge an atomic order electron beam on specimens, but for high resolution analysis, the following physical conditions must also be satisfied. Therefore, we focused on these conditions.

First, there is the problem of reduced resolution due to scattering of the incident electrons in the specimen. Simulations have shown that incident electrons may deviate from the position of convergence and be propagated, depending on the crystal structure and orientation. In principle, visualization of the atomic arrangement is not possible in such cases. Furthermore, when the incident electrons excite the inner shell electrons of the specimen, there are differences in the degree of non-locality (so-called “delocalization”), depending on the energy exchanged. Accurate measurement of the positions of atoms is only possible by realizing more localized scattering of the incident electrons by the inner shell electrons. NIMS is engaged in ongoing work on advanced electron microscopy technologies, and is also continuing to study the above-mentioned physical conditions. This work, in combination with steady technical development for improvement of the mechanical electrical stability of instruments, made it possible to obtain the world’s first element distribution images (**Fig. 2**) in which the arrangement of the atoms can be distinguished. Part of this research was performed by the Nanotechnology Network of Japan’s Ministry of Education, Culture, Sports, Science and Technology (MEXT). For details, please see the following URL.

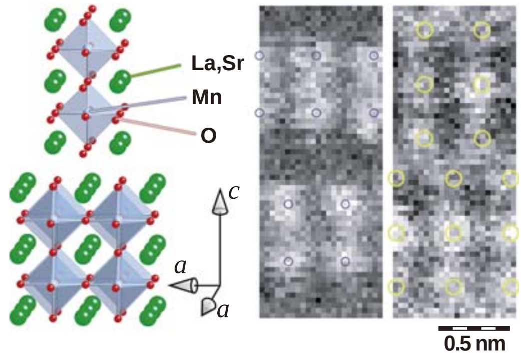
http://dx.doi.org/10.1038/nature06352

Fig.1



Schematic diagram showing the principle of visualization of the atom arrangement using a scanning transmission electron microscope (STEM) and electron energy loss spectroscopy (EELS).

Fig.2



(a) Crystal structure model (b) Manganese (c) Lanthanum

Element distribution images with atomic-resolution observed in this research. The atomic arrangement of manganese and lanthanum atoms can be distinguished.

Prediction of Microstructure Morphology of Practical Ni-base Superalloy

High Temperature Materials Group,
High Temperature Materials Center

Managing Director
Tomonori Kitashima, Hiroshi Harada

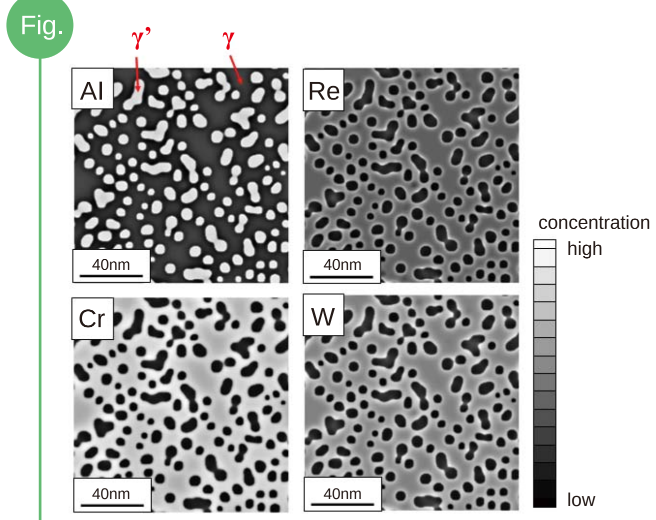
Ni-base superalloys with high strength at elevated temperatures are used as materials for turbine blades in aircraft engines and gas turbines. Higher performance of these Ni-base superalloys is strongly desired in order to improve the thermal efficiency of heat engines, thus, contributing to lower fuel consumption and reduced CO_2 emissions.

Practical Ni-base superalloys contain about 10 elements. In order to design the high performance alloy, it is necessary to know the effect of the content of each element on the microstructure and properties of the alloy. But, its experimental research is expensive and labor-intensive. Our Center has achieved successful results in predicting the microstructure and properties of superalloys using empirical formulae based on abundant experimental data. However, with this technique, it is still only possible to predict parameters for part of the microstructure morphology. Predicting the microstructure morphology itself would enable higher efficiency in the design of alloys. Therefore, we have developed a simulation for the microstructure morphology of practical Ni-base superalloys using a theoretical calculation technique called the phase-field method.

The predictions using the phase-field method have only been previously reported for up to ternary systems, even though practical Ni-base superalloys incorporate a multi-component system of about 10 elements. One reason for this is the difficulty of describing the free energy surface which determines the path of microstructure changes as a function of the concentrations of individual elements in a multi-component system. Therefore, we proposed a new phase-field method linking with the computational technique called the CALPHAD (calculation of phase diagrams) method, which calculates the free energy and equilibrium phase diagrams of multi-component materials. The occupation ratio of elements in the structural lattice, which is used as a variable in the free energy function of the γ’ phase in the CALPHAD method, was expressed using a variable defining the state of a field called the order parameter of the Phase-field method. By applying this approach, the free energy function for multi-component systems of the CALPHAD method can be adopted in the phase-field method.

This method enabled the calculation of the microstructure morphology of the γ phase and γ’ phase of practical multi-component Ni-base superalloys, which has not been realized until now. The accompanying figure shows the simulated concentration distributions of Al, Cr, Re, and W in the initial stage of precipitation of the γ’ phase in the 8-element practical Ni-base superalloy TMS-75. The white areas are regions of high concentration of the respective elements, and black shows areas of low concentration. This is the world’s first time that the phase-field simulation predicts the changes in microstructure morphology during precipitation of the γ’ phase in an 8-element system at the practical level. In the future, this simulation method is expected to make an important contribution to the development of new alloys.

Fig.



Results of a simulation of the concentration distributions of Al, Cr, Re, and W in the initial stage of precipitation of the γ’ phase in the 8-element practical Ni-base superalloy TMS-75. White and black areas show, respectively, the regions of high and low concentration of the element concerned.

NIMS Fellow Dr. Yoshio Bando Receives the Title of Fellow from the American Ceramic Society

At the Award Ceremony: Prof. Emeritus L. D. Pye (Alfred University), President of the American Ceramic Society, and NIMS Fellow Dr. Y. Bando (right)

(Oct. 6, 2008) NIMS Fellow Dr. Yoshio Bando, who is currently Chief Operating Officer (COO) of the International Center for Materials Nanoarchitectonics (MANA), was recently selected as a Fellow of the American Ceramic Society. The Award Ceremony was held at the 110th Annual meeting of the American Ceramic Society held in Pittsburg on October 6, 2008.

The American Ceramic Society was founded in 1898. It is the largest society in the research field of ceramics, with the participation of a total of more than 6000 members from over 60 countries worldwide. Dr. Bando received a commemorative plaque recognizing his many outstanding contributions to the Society through his coutinuous activities of the ceramics science development.

Dr. Bando is the third Fellow of the American Ceramic Society at NIMS, joining NIMS's President, Prof. Teruo Kishi, and Prof. Yutaka Kagawa (Coordinating Director), who is also a Professor of the University of Tokyo.

NIMS Fellow Dr. Ushioda is Named President of the IUPAP

Dr. S. Ushioda delivering his remarks on assuming the position of President of IUPAP.

(Oct. 13-17, 2008) NIMS Fellow Dr. Sukekatsu Ushioda was named President of The International Union of Pure and Applied Physics (IUPAP) at the 26th General Assembly of IUPAP, which was held at the NIMS Sengen site over a 5 day period on October 13-17, 2008.

IUPAP is an organization of the world's physics societies which was established in 1922 by a group of 13 nations and now has a total of 59 countries and territories as members. In the world of physics, it plays a role analogous to that of the United Nations, as its announcements and activities have great influence on individual physics societies.

Dr. Ushioda, who is the second Japanese elected President of IUPAP, will serve a 3 year term beginning in October 2008 and is expected to demonstrate strong leadership in grappling with a variety of issues which face the world's physics societies, including promotion of international cooperation, formation of international agreements on physical constants, encouragement of free exchanges of scientists, and promotion of research and education in physics.

Because the IUPAP General Assembly was held at NIMS, more than 100 researchers from physics societies around the world had an excellent opportunity to deepen their understanding of NIMS through exchanges with NIMS researchers, lab tours, and other activities.

NIMS Signs an MOU with the IGM of Russia

(Sep. 25, 2008) – The NIMS Optronic Materials Center signed a memorandum of understanding (MOU) on research cooperation with the Institute of Geology and Mineralogy (IGM) of the Siberian Branch of the Russian Academy of Sciences. The IGM is one of the Russia's core research institutes in the field of bulk single crystal growth. To date, the two sides have cooperated in work on single crystal materials, centering on fluorides, including exchanges of researchers. The signing of this MOU will strengthen the system of research cooperation in the field of optical single crystals through closer exchanges of research information, researchers, and expansion of the topics of joint research.

From left: Dr. K. Shimamura, NIMS Group Leader, Prof. L. I. Isaenko of IGM, and Dr. G. Villora, NIMS Senior Researcher

The Sixth Asian Meeting on Electroceramics (AMEC-6)

(Oct. 22-24, 2008) The Sixth Asian Meeting on Electroceramics (AMEC-6) was held at the NIMS Sengen Site and the Tsukuba Center for Institutes under the joint sponsorship of the National Institute for Materials Science (NIMS) and the Ceramics Society of Japan/Electronics Division over a three day period from October 22 to 24, 2008. Approximately 300 persons participated, mainly from the Asian countries. Following the opening ceremony and a keynote address by Prof. Teruo Kishi, President of NIMS, 130 oral presentations and 80 poster presentations were given, featuring lively discussions in both cases.

All participants of AMEC-6

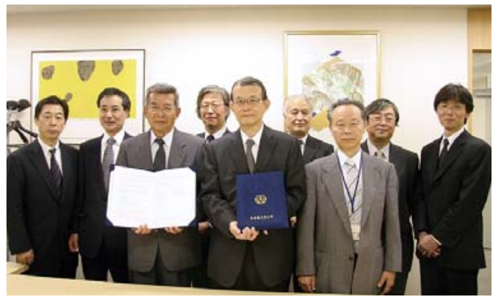
On October 22 and 23, an international symposium was held, commemorating the late Prof. Hiroaki Yanagida of the University of Tokyo, who also served as a member of the NIMS Advisory Board was held. Distinguished scientists who had deep friendships with Prof. Yanagida were invited as speakers and recalled his great achievements in electroceramics.

On October 24, the Okazaki International Symposium commemorating the late Prof. Kiyoshi Okazaki of Shonan Institute of Technology was held. Much research on environment-friendly lead-free piezoelectrics and efforts to incorporate nanopowders in processes were introduced, suggesting that technical development in these directions will also progress in industry in the future. As a distinctive feature of this event, industry researchers and engineers participated actively in giving presentations, which is unprecedented in similar conferences.

NIT and NIMS Conclude a Collaboration/Cooperation Agreement

(Oct. 24, 2008) Nagoya Institute of Technology (NIT) and NIMS concluded a "Basic Agreement on Promotion of Collaboration and Cooperation between NIT and NIMS", and agreement on a Joint Graduate School Program with the aim of encouraging learning and science and technology in Japan and internationally and contributing to the development of promising human resources by promoting collaboration and cooperation using the mutual research capabilities and human resources of the two institutions.

NIT and NIMS have long promoted joint research in fields related to ceramics, including, for example, the development of low environmental impact lighting and display materials which do not contain harmful substances (lead, cadmium, etc.), ultra-precise determination of the structures of materials, which is the basis for the development of ceramics, etc., and have cooperated in the creation of a world center for ceramics research and education.



The signing ceremony at NIMS Tokyo Conference Office

The conclusion of this agreement will further improve graduate school education at NIT by creating a Joint Graduate Program centering on the field of ceramics with the cooperation of NIMS researchers, who have numerous world-level achievements in this area, and is expected to make an important contribution to the development of learning and science and technology in Japan and internationally by further activating joint research in materials research related to energy, the environment, and biotechnology.

NIMS signs an MOU with ITRI, Taiwan

(Oct. 21, 2008) The Quantum Beam Center signed a Memorandum of Understanding (MOU) for research collaboration on the "nanotechnology-driven advanced materials metrology research, X-ray physics and its industrial metrology applications, nanoscale materials characterizations" with Center for Measurement Standards (CMS), Industrial Technology Research Institute (ITRI), Taiwan. The two institutions agreed to promote exchanges of researchers, information, publication of the results of the research and the implementation of cooperative research. Both sides are interested in developing and establishing novel advanced metrology as well as the international standardization in Asia-Pacific region.

Dr. K. Sakurai, NIMS Group Leader, gave an invited lecture on X-ray metrology for nanotechnologies at ITRI.

NIMS
NEWS

Two MANA Researchers Receive the Tsukuba Prize


From left: Governor M. Hashimoto, Dr. L. Esaki, Dr. T Sasaki and Dr. M. Osada

(Oct. 10, 2008) Dr. Takayoshi Sasaki, Coordinator of the Nanomaterials Field at the International Center for Materials Nanoarchitectonics (MANA), and Dr. Minoru Osada in the Soft Chemistry Group in the same MANA Nanomaterials Field, received the 19th Tsukuba Prize for their pioneering work on the new nanomaterial called “nanosheets”. The research recognized by the award was “Synthesis of inorganic nanosheets and their integration into functional materials.” The Tsukuba Prize, which is sponsored by The Science and Technology Promotion Foundation of Ibaraki, is given to researchers who achieve remarkable research accomplishments in science and technology in Ibaraki Prefecture with the aim of encouraging the creative research activities of researchers. In 2005, NIMS Fellow Dr. Yoshio Bando received the 16th Tsukuba Prize.

In the natural world, there exists a wide variety of layered compounds, such as graphite and mica, which are composed of stacked layers of two-dimensional atomic network. Nanosheets are produced by delaminating such compounds into the individual single layers by a soft-chemical reaction. The two recipients of the Tsukuba Prize have created various functional materials using these nanosheets as a building block.


From left: Dr. and Mrs. Osada and Dr. and Mrs. Sasaki .

The Award Ceremony was held at the International Congress Center Epochal Tsukuba on October 10, 2008. Following greetings by Dr. Leo Esaki, who is a Nobel Prize Laureate in Physics and President of the above-mentioned Foundation, the Leo Esaki Prize, Tsukuba Prize, and Tsukuba Encouragement Prize were bestowed on the respective recipients. At the Award Ceremony, laudatory comments were also given by Dr. Masatoshi Koshiba, who is also a Nobel Laureate in Physics, and Japanese astronaut Dr. Mamoru Mohri, among others.

Hello from NIMS

Davide Uglietti (Italy)
September 2007 to present
ICYS-IMAT


[Skiing in Niigata]

I arrived in Tsukuba in September 2007. I had visited Japan a few times in the past, so I knew a bit about what I was going to find.

There is superior equipment at the Tsukuba Magnet Laboratory of NIMS, which is one of the largest magnet facilities in the world. The Japanese classes I attended at NIMS were very useful, because I could learn some basic Japanese that helped me in communicating with the non-English speaking staff.


[At the Hybrid Magnet facility]

During weekends, I explored the Kanto area to watch *matsuri* (Japanese style festival) and visit towns. In the winter, I have great fun skiing, even if I have to drive 4-5 hours to get to beautiful mountain areas like Niigata or Nagano which have abundant snowfall. In the Kanto area, where I live, the weather was sunny and pleasant.

I am very looking forward to continuing my research for the next year.

National Institute for Materials Science

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