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Feature

The 5th AIST Advisory Board Meeting

Feature

Global Warming

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Research Hotline

UPDATE FROM THE CUTTING EDGE (January-March 2008)

In Brief

The 5th AIST Advisory Board Meeting

AIST intends to contribute to social development, enhancing Japan's industrial technology to realize a sustainable society. Consequently, the AIST Advisory Board comprehensively discusses about more appropriate AIST strategies to promote research activities and the management, and obtains advices to accomplish our achievement by board members made up of leading domestic and overseas experts from various fields, with external viewpoint.

A total of three meetings were held during the first term of four years. In the second term, the meeting schedule was previously determined to be held biennially; the fourth meeting has held in the first year (2005) of the second term, accordingly the next meeting was expected to be held in this year (2007) ,which was the term's midway point. Thereby, the fifth meeting was held on November 28 and 29, 2007 in the network conference room at the AIST Tsukuba Headquarters.

For this meeting, members of the Advisory Board discussed focusing on a subject entitled "Past Achievements and the Evolution of Research Promotion Management" to ascertain how AIST strategy should be progressing for the second term. Being divided into five groups, the members also conducted an inspection of the laboratories and exchanged views with researchers on site. The following descriptions provide an outline of the meeting and the main comments from each member of the Advisory Board.

Table 1 List of AIST Advisory Board Members

Hiroshi Komiyama (Chairman)	President, The University of Tokyo
Wataru Aso	Governor, Fukuoka Prefecture
Takeshi Isayama	Chairman, Carlyle Japan LLC
Katsuhiro Utada	Senior Corporate Adviser, Ajinomoto Co., Inc.
Isao Uchigasaki	Advisor to the Board, Hitachi Chemical Co., Ltd.
Tomoko M. Nakanishi	Professor, Graduate School of Agricultural and Life Sciences, The University of Tokyo
Tomoyo Nonaka	Director, Association for the Promotion of Financial Literacy
Lord Broers*	President, Royal Academy of Engineering, UK
Hans-Jörg Bullinger**	President, Fraunhofer-Gesellschaft, Germany
Geoff Garrett*	Chief Executive, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Binglin Gu*	President, Tsinghua University, China
Richard K. Lester	Professor, Nuclear Science and Engineering, Massachusetts Institute of Technology (MIT) and Founding Director, MIT Industrial Performance Center, USA
Sakarindr Bhumiratana	President, National Science and Technology Development Agency (NSTDA), Thailand
Hratch G. Semerjian	President and Executive Director, The Council for Chemical Research, USA

(*: Absent, **: Had visited on November 8 and held discussions in advance)

Table 2 Schedule

Day 1: Wednesday, November 28, 2007

9:30 Opening / Welcome address (H. Yoshikawa, President, AIST)

9:50 Major achievements and assessments to date and future initiatives (H. Yoshikawa, President, AIST)

10:10 AIST's research promotion management and research content (S. Wakimoto, Vice-President, AIST)

10:20 Contribution to the regional deployment of industrial policy (H. Kato, Vice-President, AIST)

10:45 Exchange of views

12:00 Lunch

13:00 Laboratory Tour: Meeting with AIST research scientists

14:40 Achievements of AIST's initiatives to date and the future evolution of research promotion management (Vice-Presidents in charge of Innovation Promotion)

・Innovation strategy at AIST (J. Itoh, Vice-President, AIST)

・How to realize the potential of the hub function in the early stages of industries' development—Case study of organizational initiatives in the nanotechnology field—(S. Ichimura, Vice-President, AIST)

・Realizing the potential of the innovation hub function for promotion of energy research (M. Yamazaki, Vice-President, AIST)

16:30 Exchange of views

19:00 Banquet

Day 2: Thursday, November 29, 2007

9:30 Thorough compliance and risk management (S. Koga, Vice-President, AIST)

9:50 Exchange of views

10:50 General discussion

12:00 Closing address (H. Yoshikawa, President, AIST)

Table 3 Discussion Points at the 5th AIST Advisory Board Meeting

● Major achievements and assessments to date and future initiatives
(H. Yoshikawa, President, AIST)

1. Major achievements and assessments to date
2. How to assess of an independent administrative institution for research and development
3. Human resource development in industrial technology
4. Future direction of AIST's role

● AIST's research promotion management and research content
(S. Wakimoto, Vice-President, AIST)

1. Validity of management to strategically allocate research resources
2. Important viewpoints for future research promotion
3. Policies on R&D, application of the results to society, and on AIST's leadership in regard to the government policy objectives of promoting "Cool Earth 50" and ecological innovation

● Contribution to the regional deployment of industrial policy
(H. Kato, Vice-President, AIST)

1. Balancing the two roles and functions that the regional research bases have
2. Validity of the direction of focused R&D at each regional research bases

● Achievements of AIST's initiatives to date and the future evolution of research promotion management
(J. Itoh, S. Ichimura, and M. Yamazaki, Vice-Presidents, AIST)

I. Innovation strategy at AIST
(J. Itoh, Vice-President, AIST)

1. The innovation hub strategy
2. System for the promotion of innovation

II. How to realize the potential of the hub function in the early stages of industries' development
—Case study of organizational initiatives in the nanotechnology field—
(S. Ichimura, Vice-President, AIST)

AIST's role in industrialization of nanotechnology

1. R&D for carbon, organic, and other nanotubes
2. Promotion of R&D for risk assessment
3. Domestic and overseas initiatives to facilitate standardization

III. Realizing the potential of the innovation hub function for promotion of energy research
(M. Yamazaki, Vice-President, AIST)

Individual research project initiatives as well as assessments of initiatives for the promotion of energy research, including standardization, assessment, and improvement of the materials database.

1. Establishment of industrial infrastructure including standardization and assessment studies : Solar cells
2. Formation of international networks : Biomass
3. Conducting basic research for innovative energy development: Fuel cells

● Thorough compliance and risk management
(S. Koga, Vice-President, AIST)

1. Inadequacies in AIST efforts, and their improvement
2. Need for each scientist to diligently follow research ethics and the spirit of compliance

Outline of the AIST Advisory Board Meeting

The 5th AIST Advisory Board meeting is regarded as the second meeting in the second term. The seven domestic board members were from domestic universities, business organizations, and local governments and other three from foreign universities and national research organizations; total ten external board members were invited. (see Table 1). Including the President, those Vice-Presidents of AIST presented their viewpoints which are described in Table 3, and then each board member remarked his perspective.

The meeting took place for a day and a half schedule. (see Table 2). In the morning of the first day, AIST President Hiroyuki Yoshikawa notified major current achievements and assessments of AIST and future approaches. The followings were presentations "How AIST approaches to promote researches" and "The regional deployment" by AIST Vice Presidents; Shinya Wakimoto and Hirokazu Kato. In the afternoon, the board members set out on a laboratory tour (for details, see the article on p. 9). After the tour, Vice-Presidents; Junji Itoh, Shingo Ichimura, and Masakazu Yamazaki described "Innovation Hub Strategy at AIST", introducing some basic strategies and examining case studies of nanotechnology and energy research issues. On the second day, the first program was a presentation by Vice-President Shigeaki Koga on compliance and risk management. At the end of the meeting, each member concluded to provide a comment and an advice for more appropriate research activities and management, based on what has been discussed over these two days.

Prof. Hiroshi Komiyama(Chairman)

I believe that determining what is needed not only in Japan but also in the rest of the world and playing a role in linking AIST's basic research to the industrial world are Full Research and will serve as the working model will lead to the vitalization of AIST. I saw the mass synthesis of carbon nanotubes at the Research Center for Advanced Carbon Materials and the nanometer standard at the National Metrology Institute of Japan, and I was very impressed with them. These results were borne out of the Type 1 Basic Research and of the background necessary to carry out the Type 2 Basic Research in Japan. However, an even greater factor behind these excellent results was, I believe, that

we had the concept of Full Research.

At the University of Tokyo, we have been promoting two working models: Autonomous and Decentralized Cooperative Systems, and Structuring of Knowledge. It is, however, difficult to introduce a new form of organization. The operational management method at the time of organizational change (change management) is one of our current challenges and I thought AIST is still on its way to adopting change management. I also thought that for AIST to actually build the newly proposed three-dimensional collaboration with external organizations will be challenging. The strong will of the executives and good manpower will be essential if this is to be realized.

Research on energy technology is extremely important and more policy-oriented than driven by research based on technological seeds. Such research is linked to all six fields that AIST is involved in. At present, many researchers around the world are studying energy and I believe how AIST allocates its human resources is of importance to the future of energy research. Although I feel the need to consider the future direction of some of AIST's policies such as the biomass, most of its policies are, I think, proceeding in the right direction. AIST should now exercise caution in how it addresses these policies. In other words, it is important for AIST to decide at what level each policy should be addressed: should AIST staff actually visit an external organization to engage in policy planning, for example?

Meanwhile, I think that the AIST School of Innovation, a college for postdoctoral researchers, could be an excellent place for human resource development. We have a similar setup at the University of Tokyo and we make no distinction between teachers and students because research will lag behind ten years if time is spent in preparing a curriculum and establishing a department for a new initiative. Without an available curriculum, we believe that it is important to promote initiatives by seeking mutual learning with no distinction made between teachers and students.

Mr. Wataru Aso

In Fukuoka Prefecture, we are promoting research on LSI, biotechnology, and hydrogen energy, as a part of our cluster policies. On hydrogen energy, AIST has adopted a new approach under which AIST built a research facility on the campus of Kyushu University, trying to upgrade the core R&D in the hydrogen projects to global standards. This has laid the foundation for our area to become one of the most important regions in the establishment of a global hydrogen energy hub, and AIST should thus focus more attention on the development of this type of initiative.

AIST is now not only playing a role in handling regional resources but is also clearly handling all tasks in the comprehensive strategy. This indicates that researches conducted at AIST regional research bases have now reached a high standard and are on the way to becoming the world's most advanced. It is extremely important to carry out advanced research for a specific field. In terms of regional development, I don't believe that regional communities will achieve prosperity without industries that can compete in the global economy. If they are to do so, it is absolutely essential to apply and put to use the most advanced R&D. Therefore, I would like to see each regional research base serve as a representative of AIST that returns some of the considerable fruits of its R&D to the region. The concept that each research base returns its own R&D results to its own region should be abandoned. For example, although the AIST Kyushu does not conduct research in all the areas of research that Fukuoka prefecture has an interest in as part of our various cluster policies, since AIST as a whole conducts a wide range of research, I would like the AIST Kyushu to act as a representative of AIST that provides support for our regional activities, enhancing our partnerships in the relevant fields.

Mr. Takeshi Isayama

I see a lot of similarities between the reform being undertaken by AIST and that being undertaken by Nissan. However, I honestly feel that, although at Nissan, we always quantify our goals so as to deliver easily understandable messages to society, AIST makes little contribution to society, especially to the industry. Since AIST has achieved important results in various fields, I think AIST needs to sufficiently communicate these to society. There are two stages to reform. The first stage is reform to achieve greater efficiency; that is to say, rationalization. There are two types of rationalization: objective and subjective. What is important for objective rationalization is how to enhance competitiveness. In that sense, I see that AIST has a comprehensive ability that Nissan does not have. Unfortunately, I don’t know how great this ability is, so I would like AIST to make this information available. In doing so, I think AIST would be able to narrow the gap with the industrial world. Subjective rationalization, on the other hand, is how you enhance competitiveness that cannot be quantified. Some examples of subjective rationalization are motivation and the turnover rate of researchers. These factors can be changed by the constituent members, so I would like you to let us know how you go about improving these factors.

The second stage is reform to achieve sustainable growth based on the first stage. Simply put, this is a distinctive role. The second stage of reform is, I think, how you turn an ability to realize something different from others into reality. You should, however, always strengthen the first stage, before advancing to the second stage. AIST conducts research in some fundamental matters that business enterprises are incapable of, which they are unable to verify even if they think the research is valuable. So please show us the actual results of your reform by making the information available. I believe that if you have a good track record of success, the results will take care of themselves.

Mr. Katsuhiro Utada

In the previous meeting, I felt that AIST’s researchers and laboratories were focusing on autonomy–conscious management or governance. It has been said at this meeting that AIST has moved from the dream stage to the nightmare stage, but I think the mission and strategic aspects of AIST’s Full Research have now become clear. I can see that AIST is particularly committed to the strategic aspects of its research, including innovation, partnerships, assessment, and ventures, for example.

However, I cannot see, from a business perspective, how AIST sees the public and how much AIST understands the public. I think AIST should further pursue policies of partnership, communication, and personnel exchanges. Although AIST has been conducting personnel exchanges with colleges and administrative organs, it has hardly ever tried this with business enterprises. That is why AIST needs to enhance its collaboration with industry in terms of, for example, collaborative research. It may be a little rude of me to say this, but AIST still has a bureaucrat-dominated atmosphere, and from a business perspective, it seems hard for outsiders to express their opinions. In addition, it would be of great benefit to the public if AIST could make a greater effort to nurture venture companies.

The role AIST plays as an independent public research institute should differ from that of a university. Of course basic research is important, but I think AIST should further highlight the strategic aspect of its research. To achieve this, AIST’s strategic research should be aimed at issues including energy, food, issues related to life and health, and environmental concerns such as global warming. Furthermore, AIST’s activities should be conducted for the benefit of the industrial world, the public, and general consumers, rather than for the benefit of the Ministry of Economy, Trade and Industry.

Finally, let me mention a few words about the AIST Kyushu. Research tends to be vertically divided, but I believe that fusion among units is equally important and that collaboration with the laboratories of other government ministries is required. The AIST Kyushu is a perfect example of this ideal system. Since clusters play an important role in the commercialization and industrialization of advanced technologies, I would like AIST to play a leading role in the cluster of each region.

Mr. Isao Uchigasaki

AIST is currently managed according to the midterm plan for the second term determined by the Ministry of Economy, Trade and Industry and I strongly believe that AIST has a central role to play in achieving the Innovation Super-Highway concept. To achieve this, AIST should link the regional research bases to the Super-Highway concept to further reinforce the research subject. The challenge of revitalizing regional communities—that is to say, how to activate the public organizations that are dotted all over Japan—is a nationwide one. I think AIST is the only organization that can take the lead with this issue. I expect AIST to conduct an organizational operation in which AIST plays a central role in the Super-Highway concept by actively recommending promising strategies for other organizations and divisions.

Another significant role for AIST to perform is the execution of a long-term strategy for human resource development. Of the AIST School of Innovation concept, including President Yoshikawa's graduate school concept and innovator education issue, I would like to express my appreciation for AIST's efforts. Although it is about time business enterprises too reevaluated the role postdoctoral researchers should play, measures to deal with this issue have yet to result in any substantial progress. I really hope to see the AIST School of Innovation concept realized.

I believe that, for researchers, the nightmare stage is an opportunity to advance technology and is thus something you enjoy overcoming. For example, I noticed on the laboratory tour that researchers have overcome problems with the development of spintronics and mass production of carbon nanotubes. I feel that AIST will establish a new business model by accumulating these successful models. However, it will be extremely difficult for AIST to act as the final bridge between technologies and markets if the number of innovation architects and research coordinators remains the same. In order to accumulate these business models, you will need to employ ten times as many people as those currently employed in the organizational operation. I think the human resources suited to these positions are private workers with excellent character, sufficient experience, and a wealth of knowledge.

I also feel that AIST should make its research and development more accessible. One way to do this would be to periodically hold AIST harvest festivals and invite the public to the festival. Small- and medium-sized companies are hungry for technology and information, especially in regional areas. With regard to the issue of personnel exchange, AIST should be aware of revitalization with private enterprises and build up a network of contacts. I would like the nine corporate Vice-Presidents to willingly participate in private sector activities and develop various routes in order to make use of these activities in next-generation management.

Prof. Tomoko Nakanishi

With respect to AIST's current position on innovation creation, industry can not carry out innovation without basing it on existing technologies. Universities are places to sow the seeds for next-generation innovation. AIST plays an extremely important role, by acting as a bridge between universities and industry, selecting and nurturing budding technologies that it believes may blossom into industries. For example, although a great deal of time has passed since people began discussing nanotechnology promotion, no distinct technologies appear to have come into practical use, despite the number of projects that have been promoted. I think this is because there has been insufficient research conducted for practical application in industry. There are, of course, many difficulties associated with putting new technologies to practical use. I think AIST should engage in a careful examination of what technologies should be practically realized. In other words, an important role for AIST to play is in building up new technologies so that the industry can take advantage of them.

I don't believe there is any other research institute that has researchers in as wide a variety of different fields as AIST does. With many companies splitting up into smaller companies and the number of fields requiring a comprehensive ability as that of the environment is increasing, our expectations of AIST will continue to grow and grow. As subjects of research are also being investigated by other laboratories, AIST should judge how best to promote the subject. Should AIST carry out the research independently, for example, or should they undertake joint research? In light of this, I would like AIST to take a step further in positioning each subject.

In Japan, people tend to associate the word "standard" only with standard reagents and the Japanese Industrial Standards (JIS), but I believe what sustains Japanese technological capabilities is the "standard technologies" of various fields. The United States knows the importance of standard technology, and that is why they have a laboratory exclusively for standard technology (NIST). This field is unspectacular and never ostentatious, but since AIST is the only organization that formulates the nation's standard technologies, I would like it to provide robust support for Japan's standard technologies.

Because AIST has no students, it has to either develop human resources in its laboratories itself or employ personnel that already possess the prerequisite skills from outside. I believe, however, that AIST should create a system to develop human resources to a certain level in its own laboratories. It would be a good idea to have some off-the-job training on the curriculum, such as teaching research project theory, follow-up methods, and how to make a presentation. Some organizational theories including the theory of management and methodology for R&D may also be needed. I hope AIST will build up a solid curriculum for management systems to carry out training or educational programs, including, for example, how to lead a team, how to live within an organization, how to deal with society, and financial matters such as how best to make use of research expenses.

Ms. Tomoyo Nonaka

When 15 different research institutes under the former Agency of Industrial Science and Technology, each with its own cultures, were merged in 2001 to form AIST, a public research organization, some missions for the new AIST were declared. Those missions included that each industry should take advantage of research conducted by AIST to improve its productivity, that AIST should conduct peer reviews for each research unit, and that AIST should create a method to properly assess the social impacts of its research. I think AIST has now cleared the first phase of these. In the second phase, AIST needs to acquire a sense of urgency; it no longer has the liberty to only deal with management of the human resources of the former organization's 15 institutes and with accountability to taxpayers. Japan now faces a significant challenge in how it should handle the changing social structure caused by the decline in population and aging of the population. What role should AIST actually play in the global competition of the 21st century? Japan lacks domestic raw materials and its food self-sufficiency ratio is now below 40%. In today's world, AIST's missions will be how to promote collaboration with, support for, and dialogue with all types of enterprises, including large companies, small- and medium-sized companies, and venture companies. AIST should also consider how Japan can exercise the leadership it needs to exert to survive in today's world and to put this into practice. However, we don't have time to discuss these needs and the AIST management system that would satisfy them. AIST is the largest independent public research institution in Japan and the world's leading research institute, responsible for not only important cutting-edge science and technology but also basic science and technology. That is why AIST needs to be more aggressive in carrying out its missions. To achieve this, AIST must overcome the challenge of realizing a form of management that allows both a regional viewpoint and a global or macroscopic viewpoint at the same time. I would like AIST to adopt the perspective that if it acts as a catalyst for development of a regional industry to establish companies in the region, it will eventually lead to the global development of the industry. In the second phase, AIST, as a public institution, should not be securing equality using common denominator assessments for each mission. I would like AIST to stop using evaluation logic that is shortsighted or old-fashioned Kasumigaseki-style. Instead, by setting technological fields in which Japan is on the cutting edge as its priority and highlighting AIST's originality, I would like AIST to exercise active management as a world player. That is, I believe, the best way to achieve accountability to taxpayers.

Prof. Richard K. Lester

An important consideration for AIST's senior management is the issue of strategic differentiation and the need to draw attention to the distinctive roles played by AIST. One distinctive mission is to carry out research with the objective of contributing to sustainability in industry. Another, very different way of differentiating the organization is by insisting on excellence and quality in everything it does. This is equally important but is not a mission-based distinction.

These ways of differentiating AIST have important implications for human resource development, and I want to comment on this specifically as it relates to the role of the innovation architect. The innovation architect has a very important role at AIST, although of course this is not equally important in every situation. There are some situations and laboratories, such as the spintronics lab, where the role of the information architect may be somewhat less important. The results achieved by this laboratory are very impressive, and there is a road map which identifies the difficult objectives still to be achieved. In that case, the objectives of the innovation process are relatively clear, and there is not really a great deal of uncertainty about what those objectives are. But in other situations where the goals of innovation are not so clear, it seems to me that the role of the innovation architect is extraordinarily important, because what that role entails is bringing together the perspectives from the basic scientific community, the perspectives of industry where the technology will be applied, and the perspectives of the users of the innovation. We must not underestimate the increasing importance of consumers as drivers of innovation, especially in advanced economies. And one of the roles of the innovation architect is to bring the consumer perspective into the innovation process at a very early stage. So the architect requires a set of skills which are in a quite different category from the skills that are involved in successfully managing a project with well-defined scientific goals. AIST has recognized the importance of the innovation architect function and it will now be important to develop these skills. I think it is a distinctive role and it needs to be proactively developed, nurtured, rewarded and evaluated within the organization.

On the other hand, AIST has a role not only as an actor in innovation systems -- that is, as a participant -- but also as a *designer* of the systems that lead to the deployment of new technology in our society. These systems are to some extent self-organizing. But in some cases they need to be actively designed, along with the technology itself. And in order to be a successful system designer, it is very important for AIST to develop the capability to understand the working of these innovation systems. Therefore, AIST should know how such systems operate, and this requires a set of capabilities, and a set of analytical skills. And again I would recommend approaching the development of these skills in a proactive way and acquiring the necessary skills if they are not already present in the organization.

AIST really is a jewel. Its purpose, which is the generation of fundamental knowledge and the application of the knowledge to real problems in society, is a role of enormous value, and there are very few places in the world that can claim to be doing that effectively across a broad range of fields. It is a diamond of an organization, and our role here is merely to polish the diamond, not to try to convert it into some other kind of lesser mineral.

Prof. Sakarindr Bhumiratana

I noted the great success, the high capacity and the technological excellence in AIST and I greatly admire AIST in extending more of her resources to foster the S&T development of other developing countries.

The ideas of Professor Yoshikawa regarding the setting up of innovation school as a post doctoral training of full research site is a great way of utilizing AIST suitability as a place for the training of the young postdoctoral people. These young researchers, attached to AIST, can create a lot of outcomes and many impacts not only to Japan but also to others. Certainly the innovation school would be a great benefit to any country. I cannot say how much the school would mean to Japan, but it certainly would mean a world to Thailand.

When you talked so much about Valley of Death or the nightmare period, but having visited the two very impressive labs (Humanoid Research Group, Intelligent Systems Research Institute and Nanocarbon Material Team, Research Center for Advanced Carbon Materials]), they appear to have been very successful in overcoming the nightmares. I don't know exactly what the successful rates in 56 other research units of AIST are, but I would guess that there are probably more than 10 labs like these two, and a testament of an excellent success.

I can foresee that Professor Yoshikawa's new type of publication, the "Synthesiology", will be an important ground to show case the second type of basic research in the future and will contribute significantly as a measure for the researchers. We have tried to use many types of measurements including the publication and patents to facilitate greater socio-economic impact of the R&D results, and I don't have any additional good suggestions for measurement tools, but perhaps counting spin-offs and direct benefits of recipient of developed technologies can be added. R&D results should also in the future be counted for their contribution for reducing the use of world resources and for helping closing the society gaps.

In the last session, we talked quite a bit about communications. For the ethical and the risk management, whether the best model for communications is being practiced or not in your culture, it is not quite clear. But I feel a lot of things have been carried out with excellent success. These successes are very important to communicate to the researchers, especially when it comes to try to commercialize the innovations intellectual properties.

Dr. Hratch G. Semerjian

My impression is that, over the last couple of years, there have been significant changes organizationally in AIST. I think AIST has matured a great deal. Certainly, the technical work of AIST is of the highest level of excellence. Now since AIST is clearly a national jewel, and a critical resource for Japan's economic well being and for global leadership, AIST should declare a clearer and more visible mission.

I think the president's emphasis on open innovation and providing the proper environment to encourage free thinking is admirable and well placed. I am adding just some words of caution; please make sure that the balance between encouraging free thinking and too much management has the proper balance. I hope that the guidance provided by management is strategic in nature and not micromanagement. I think the AIST work obviously has to be driven by strategic guidance, driven by national priorities, and that is up to you to decide. Accordingly, I don't have a good feel for the roles of the vice presidents, coordinators, etc.

Innovation can certainly not be over-managed. You can manage based on outcomes. I think you cannot help but make that judgment through a subjective process to judge the outcomes and impact of your work.

We hope that from Japanese industrial perspective, AIST is the place to go when you have a scientific issue or a research issue. Certainly closer collaboration with industry is very important for the future of the institution. We certainly recognize the accomplishment of recognition by Japanese industry is also very important.

In the international arena, while we are all competing with each other, we have to make collaboration and competition run together to achieve good results. There are many ways to strive for excellence, while competing with each other. For example, working on pre-competitive issues associated with standards do not let competitiveness get in the way of developing new technologies.

I very much appreciate the emphasis on HR (human resources) issues, especially recruitment of postdoctoral fellows. I think the AIST School of Innovation is a very good program that is of benefit for both AIST and the graduate students or the postdoctoral fellows who go through the program. Furthermore, these types of programs are very important for preparing the future cadre of research scientists and engineers that will contribute to the economy and the well being of the society. However, AIST has especially the prestige within Japan as well as in the international arena, I note that please do not understate the value of what the AIST provides for postdoctoral fellows, or for their careers.

And just one more observation --- when I look around this room, I see only one female sitting over there. For the future of the country, I am sure you are concerned about diversity; you need to take advantage of all talents that you have available and there is just as much talent in the female gender; I hope that you make efforts to take advantage of all resources available in Japan.

Thank you for your kind hospitality and sharing your thoughts and plans with us.

Dr. Hiroyuki Yoshikawa, President, AIST

I would like to thank you for taking time out of your busy schedules and sharing your concerns with us today. I have realized, for example, that a lot of management issues remain unresolved. Our need to further clarify the significance of the existence of AIST as a public entity was identified as a problem by several guests. This means that AIST is not yet functioning as an integrated organization and it has made me realize that AIST needs to be more open. In other words, it is about time we organized and put what we have accumulated to date into a more accessible form so as to make it available to the public. Of course, we cannot limit our actions to only this; one of our most important obligations to society is to help society derive some positive benefits from our accumulated knowledge. I am firmly resolved to move forward with our new projects, which include the foundation of the AIST School of Innovation and the publication of our new journal (Synthesiology).

Laboratory Tours by three groups of board members

Development of user-oriented robot architecture

Innovative mass synthesis of carbon nanotube

Development of the world's most advanced spintronics

Investigation of active faults

Provision of nanometer standards

AIST has been reformed in order to realize an industrial innovation on December 1, 2006. As a result of this reform, the profession of “Innovation Architects”, “the Research and Innovation Promotion Office”, and three Vice-Presidents have been assigned to promote “innovation” in management.

The purposes of those laboratory tours for board members was to view how AIST accordingly facilitates the innovation hub function to approach researches on the site, and concurrently to enable them to engage in active discussions with AIST scientists on the line.

Board members visited five locations : the Spintronics Group, Nanoelectronics Research Institute, which is developing the world’s most advanced spintronics; the Humanoid Robotics Group, Intelligent Systems Research Institute, which is developing user-oriented robot architecture; the Active Fault Research Center and Geo information Center, which are investigating active faults (geological investigation and research are for the future infrastructure of a secure and safe society); the Nanocarbon Materials Team, Research Center for Advanced Carbon Materials, which is developing innovative mass synthesis method of carbon nanotubes; and the Dimension Standards section, Lengths and Dimensions Division, Metrology Institute of Japan, which provides nanometer standards.

GLOBAL WARMING

Mitigation Technology and its Assessment

In 2007, Intergovernmental Panel on Climate Change (IPCC) released the Fourth Assessment Report (AR4) composed of Working Group Ⅰ Report (Physical Science Basis), Working Group Ⅱ Report (Impacts, Adaptation and Vulnerability), Working Group Ⅲ Report (Mitigation of Climate Change), and the Synthesis Report providing an integrated view of climate change as the final part of the AR4. The AR4 states that warming is occurring in the climate system of the earth, very likely due to the increase in anthropogenic greenhouse gas concentrations. It also strongly states that many options for reducing global greenhouse gas emissions exist. We, at AIST, aim to give constructive proposals in supporting policy planning and execution concerning global warming measures, and have stated in the Second Period Research Strategy (Environment & Energy), formulated in April 2005, that our strategic goal is to contribute to global warming prevention and assessment. Over a wide variety of research fields, we have been engaged in developing mitigation technologies and assessment methods for their environmental impacts. In this brochure, we will first review the discussions on global warming mitigation plan in an international framework and on the present situation, by introducing the IPCC AR4 and the two IPCC Special Reports in which researchers at AIST played major roles in writing. As mitigation technologies in various fields are presented and put to practical use, there is a demand for an appropriate assessment of these technologies and their environmental effects. Here we would like to introduce the researches of AIST on carbon dioxide capture and storage technologies anticipated as promising mitigation options, the utilization technologies of the clean and renewable energy sources already put to use, and also environmental assessments for the mitigation technologies.

Edited by
Masayuki Kamimoto Research Coordinator for Environment & Energy
Masahiro Suzumura Research Institute for Environmental Management Technology
Taizo Sano Research and Innovation Promotion Office

Climate Change Mitigation in a Sustainable World

–Findings of the IPCC 4th Assessment Report–

Dr. Bert Metz (of Netherlands Environmental Assessment Agency), co-chairman of IPCC Working Group Ⅲ, gave a lecture on IPCC Fourth Assessment Report at "AIST Environment and Energy Symposium Series Special Lecture: The activities of IPCC Working Group Ⅲ and the summary of Fourth Assessment Report" held in October, 2007. Here is the summary of the lecture.

Dr. Bert Metz who gave the lecture

Does climate change threaten sustainable development?

The present global mean temperature is already about 0.7 ℃ higher than it was before the industrial revolution. Precipitation patterns have changed, glaciers are retreating, and the arctic ice cap and the Greenland ice sheet are melting. Ecosystems are reacting to these changes showing notable impact such as the coral reefs being at the edge of extinction. Extreme weather events as heat waves and droughts are more frequent, and the intensity of tropical storms is escalating. The cause of the temperature increase and the changes that follow has now been established with a very high likelihood (of 90 % or more) to be the sharply increased greenhouse gas (GHG) emissions as a result of human activities.

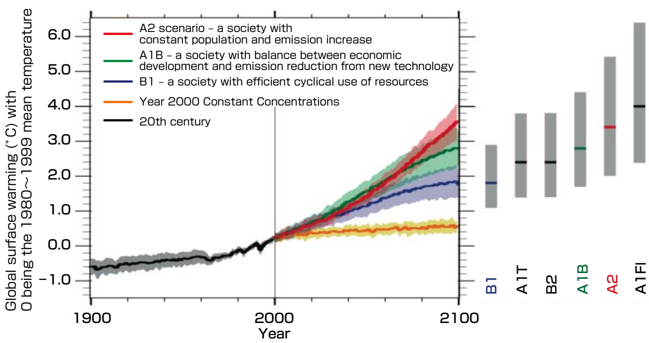


Fig.1 Projection of future temperature increases for different scenarios

As a range of scenarios of our future society, global mean temperatures are projected to increase 1.1 to 6.4 °C by 2100, compared to 1980~1999 (Fig.1). Impacts of climate changes could be serious and could overwhelm the coping capacity of human beings. With several degrees warming, food production of tropical areas will decline, many people will be faced with drought and flooding, ecosystems will be endangered and diseases will spread. These impacts pose a serious threat to sustainable development, and in monetary terms, could wipe out up to 5 % of GDP.

Can technologies for reduction of greenhouse gas emissions limit climate change sufficiently to allow for a sustainable future?

There are technologies available today to reduce GHG emissions and to increase the absorption of CO_2 by the biosphere. These are efficient lamps, cars, low-carbon electricity generation technologies, such as wind, biomass, nuclear, geothermal and solar, clean industrial processes that avoid methane and nitrogen oxide emissions, avoiding deforestation and forest deterioration, management technology of agricultural soils and forests. Other technologies are under development, such as fuel cells for cars, affordable photovoltaic cells, advanced energy saving and tidal and wave energy. Based on the scenario of these innovative technologies, the GHG concentration in the atmosphere is thought to be able to be stabilized at 450 ppmv (CO_2-equivalent, presently at 380 ppmv).

As bringing in new technology takes time socially and economically, a stabilization level at 450 ppmv CO_2 eq. is probably the highest (the lowest number) that can be achieved. In order to achieve this, global emissions need to be decreased to 50 % by 2050, and great efforts need to begin right away.

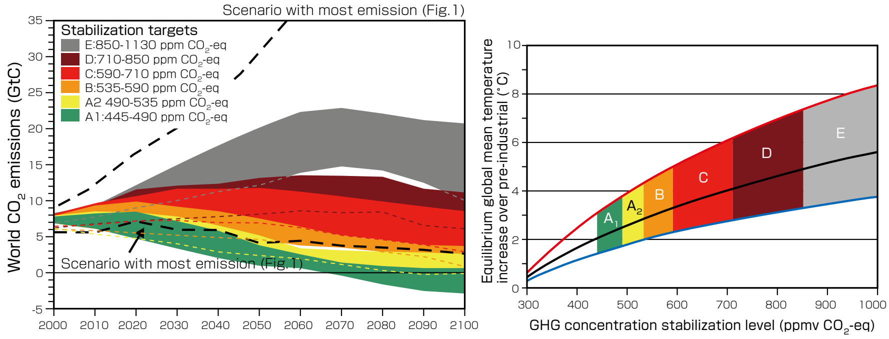


Fig.2 Global CO_2 emissions and corresponding relationship with stabilization level

However, even with stabilization at 450 ppmv, the global mean temperature will be about 2 °C higher (Fig.2), and a certain amount of impact is apprehended. Several countries and environmental NGOs are stating that global mean temperature increase must be kept below 2 degrees level to allow countries to develop in a sustainable manner. With implementation of effective strategies, this reduction scenario will only cause a few tenth of a percentage reduction in annual economic growth rate. However, on the other hand, some believe that emission reduction strategies will cause great setback of growth, and therefore, realization of such scenarios is a great challenge.

What is required for sustainable development to happen?

Thus, it is very doubtful if a pure climate oriented policy is sufficient. Fortunately, there are many ways to lower GHG emissions without sacrificing development of each country. The examples are listed here:

- **Macro-economic policies: design of taxes, subsidies, other fiscal policies, structural adjustment**
- **Trade policies: removing barriers for low-carbon products, promoting domestic energy sources**
- **Energy security policies: efficient energy use, domestic energy sources**
- **Policies to enhance replacement to modern energy: bioenergy, poverty tariffs**
- **Air quality policies: clean fuel, non fossil fuels**
- **Bank lending policies: lending for efficiency/renewables, avoid lock-in into old technologies in developing countries**
- **Insurance policy: differentiated premiums, liability insurance exclusion, improved conditions for green products**

Moreover, in reducing vulnerability to climate change, well designed infrastructure, agricultural and coastal development and other policies can be pursued.

Strategies using these various methods are required to realize a truly sustainable development of the world that avoids the risk of climate change. Climate change cannot be solved with climate policies alone.

Research Institute for Environmental Management Technology
Koh Harada

The 2005 IPCC/TEAP Special Report on the Ozone Layer and the Global Climate System

Preparation of the Special Report [1]

The Montreal Protocol adopted in 1987 mandates the stepwise phase-out of ozone depleting substances (ODSs [2]) to the Parties that ratified the Protocol. In the pre-Montreal period, the worldwide production of ODSs exceeded 1,800,000 metric tonnes per annum, but it was decreased down to approximately 90,000 metric tonnes in 2005 by the successful implementation of the Montreal Protocol mainly in the developed countries since 1996. What played important roles in the phase-out of ODSs have been the two fluorinated alternatives, that is, HCFCs (hydrochlorofluorocarbons) and HFCs (hydrofluorocarbons) as well as the introduction of not in kind (non-fluorine) alternative technologies. Above all, HFC-134a (CF_3CH_2F) has been rapidly introduced in replacement of CFC-12 (CCl_2F_2) as a refrigerant in the mobile air-conditioning application. Meanwhile, the HFC compounds along with PFC (perfluorocarbon) and SF_6 (sulfur hexafluoride) have been listed as greenhouse gasses and are targeted for reduction under the Kyoto Protocol in 1997. The relevant industries are looking seriously for the solution to meet the requirement of the two Protocols in treating HFCs.

In 2002, the Parties to the United Nations Framework Convention on Climate Change as well as the Montreal Protocol decided to request the Intergovernmental Panel on Climate Change (IPCC) and the Technology & Economic Assessment Panel (TEAP) under the United Nations Environment Programme (UNEP) to produce a special report on“ *Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons”*. With this request, both organizations (IPCC and TEAP) nominated 140 lead authors from academia and industries worldwide, and published the Special Report in the fall of 2005.

Summary of the Special Report

This report consists of Part A : Ozone depletion and the climate system, Part B : Options for reducing greenhouse gas (GHG) emissions from ODS replacements, Part C : Future estimation and availability of HFCs and PFCs. However, its content focuses on emission behaviors of CFCs, HFCs, and HCFCs which affect global warming as potential GHG, and the mitigation to reduce those GHG emissions.

(1) Part A : Ozone depletion and the climate system

Figure 1 shows the extent of the global ozone depletion against the years and the simulation of recovery of the ozone layer, optimistically predicting recovery by around 2050. However, at the 19th Meeting of the Parties to the Montreal Protocol in 2007, the recovery was feared to be delayed to around 2065 due to the rapid increase of HCFC emissions in developing countries and the uncertainty of the effect of climate change on the ozone layer. Figure 2 shows fluorocarbon (CFC, HCFC and HFC) emissions expressed by CO_2 equivalent tonnes against the years, and compared them to total CO_2 emissions from fossil fuel burning. The fluorocarbon emissions that were 7.5 giga tonnes (Gt) in 1990 (approximately 33 % of CO_2 emissions derived from fossil fuel) were reduced

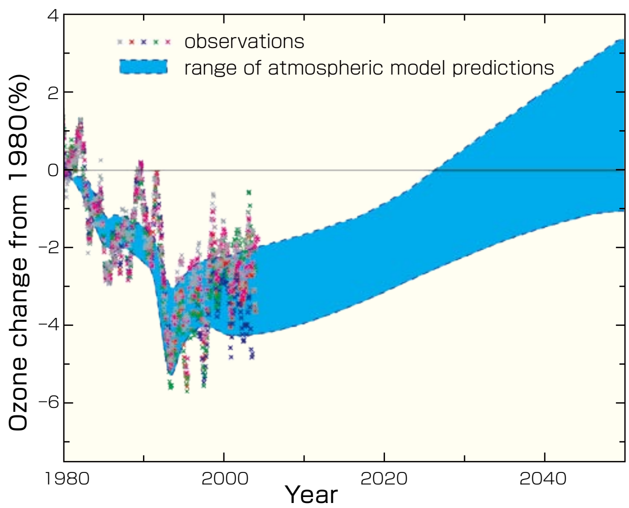


Fig.1 The ozone depletion and recovery

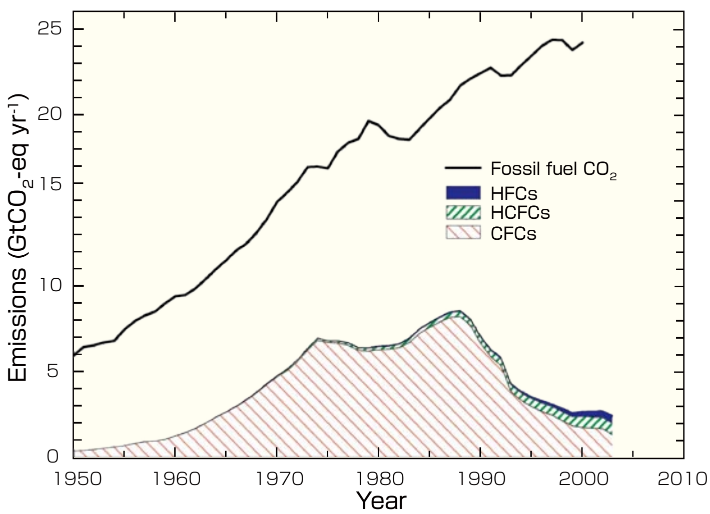


Fig.2 Halocarbon emissions

Table Emission reduction effects of halocarbons

Emissions ($GtCO_2$-eq yr^{-1})	2002	2015 business-as-usual (BAU)	2015 with mitigation measures
CFC/HCFC/HFC	2.5	2.4	1.2
CFC/HCFC	2.1	1.2	0.7
CFC	1.6	0.3	0.2
HCFC	0.5	0.9	0.5
HFC	0.4	1.2	0.5

From G8 agenda for global growth and stability in G8 summit 2007 at Heiligendamm

59. We will also endeavour under the Montreal Protocol to ensure the recovery of the ozone layer by accelerating the phase-out of HCFCs in a way that supports energy efficiency and climate change objectives. In working together toward our shared goal of speeding ozone recovery, we recognize that the Clean Development Mechanism impacts emissions of ozone-depleting substances.

This declaration adopted in the G8 agenda clearly supports the decision by the “Montreal Adjustment” to accelerate phaseout of HCFCs.

greatly to 2.5 Gt in 2000 (approximately 10 % of CO_2 emissions from fossil fuel). This clearly indicates that CFC is not only an ODS but also a strong greenhouse gas, and its phase-out is contributing greatly to the prevention of global warming as well as to the recovery of the ozone layer.

(2) Part B, C: Fluorocarbon emissions and reduction measures

The CFC, HCFC and HFC emissions between 2002 and 2015 were estimated. In addition to these gasses being emitted at the production, transport and usage stages, the amount of HCFCs and HFCs preserved for long periods in devices or equipments as future banks[3] is especially increasing. Therefore, the importance of bank treatment at the end of their lives has been pointed out. The table shows in contrast the actual emissions in 2002 bearing in mind the bank load, the business-as-usual (BAU) estimation in 2015, and the expected estimation with the possible mitigation for reductions. In the BAU cases, the emissions of HFC in 2015 will be three times larger than those in 2002, the emission of HCFC and CFC will be twice and about one fifth respectively, and, in total, it will result in about the same as 2002; however, if any mitigation is taken, it is estimated to be possible to halve the emissions. This report concludes that the total phase-out of ODS and the significant emission reductions of HCFC and HFC can be achieved by: 1) improvement of containment technology, 2) recovery, recycling and destruction, 3) use of not-in-kind or alternative substances with low global warming potential (GWP), and 4) introduction of innovative technology.

The effect of the Special Report on the Montreal Protocol

In the Montreal Protocol, it has been decided that the developed countries must completely phase-out HCFC by 2020 and the developing countries by 2040. Here, the HCFCs include HCFC-22 ($CHClF_2$) as an important feedstock for fluorinated polymers or an effective refrigerant, and HCFC-14lb (CH_3CCl_2F) as a useful blowing agent and a cleaning solvent. Especially on the production of HCFC-22, a strong greenhouse gas, HFC-23 (CHF_3: GWP of 14,800) is produced as a by-product. If a destruction process of this HFC-23 is certified as a CDM (clean development mechanism) set in the Kyoto Protocol, a large amount of credit will arise making a high income possible. Actually a number of HCFC-22 manufacturing plants have been constructed in developing countries as China and more than ten of them have already received CDM certification. This Special Report expresses growing concern over such unnecessary production increase of HCFC-22. Triggered by this report, the necessity of the earlier phase-out of HCFC was aggressively discussed at the 19th Meeting of the Parties in its twentieth anniversary of the Montreal Protocol in September 2007. There, a revolutionary “Montreal Adjustment” was adopted which stated that the developing countries also must completely phase-out HCFC by 2030 via its stepwise reduction, a date brought forward by 10 years.

Research Coordinator for
Environment & Energy
Masaaki Yamabe

Related Information
[1] The author participated in the preparation of the Special Report as one of the coordinating lead authors.
[2] ODSs include CFCs, HCFCs, methyl chloroform, carbon tetrachloride, methyl bromide and halons.
[3] Bank is defined by the loaded ODSs in devices and equipment during their lifetime in use, for example the refrigerant in the mobile air-conditioning.

Summary of the Special Report on Carbon Dioxide Capture and Storage (SRCCS)

Introduction

Carbon dioxide (CO_2) capture and storage (CCS) is a process consisting of the separation of CO_2 emitted from thermal power plants and other industrial sources, transport to a geological or ocean storage location and long-term isolation from the atmosphere. Upon receiving advice from Conference of the Parties 7 (COP7) in 2001, the Special Report of Carbon Dioxide Capture and Storage (SRCCS) was issued in 2005, which is the first report from the Inter-governmental Panel on Climate Change (IPCC) to assess a specific “technology”. The report helped putting CCS into a policy agenda, and has influenced negotiations at United Nations Framework Convention on Climate Change (UNFCCC).

Contents of IPCC Special Report

The contents of SRCCS is shown in the table. Its summary is shown in the Summary for Policymakers (SPM) which is written in answer to the important points of issue in the eyes of the policymakers. The major points are as follows.

(1) What is CO_2 capture and storage technology and how could it contribute to mitigating climate change?

There is a need for a portfolio of mitigation measures for stabilization of atmospheric greenhouse gas concentrations, and CCS may reduce overall mitigation costs and increase flexibility in the measures that can be taken.

(2) What are the characteristics of CCS?

A power plant with CCS would need approximately 10 – 40 % more energy of which most is for capture.

(3)What is the current status of CCS technology?

Components of CCS are in various stages of development and there are few examples of integrated systems.

(4) What are the geographical relationship between the sources and the storage opportunities for CO_2?

Large point sources of CO_2 are concentrated in major industrial and urban areas and many are within 300 km of areas that potentially hold formations suitable for geological storage.

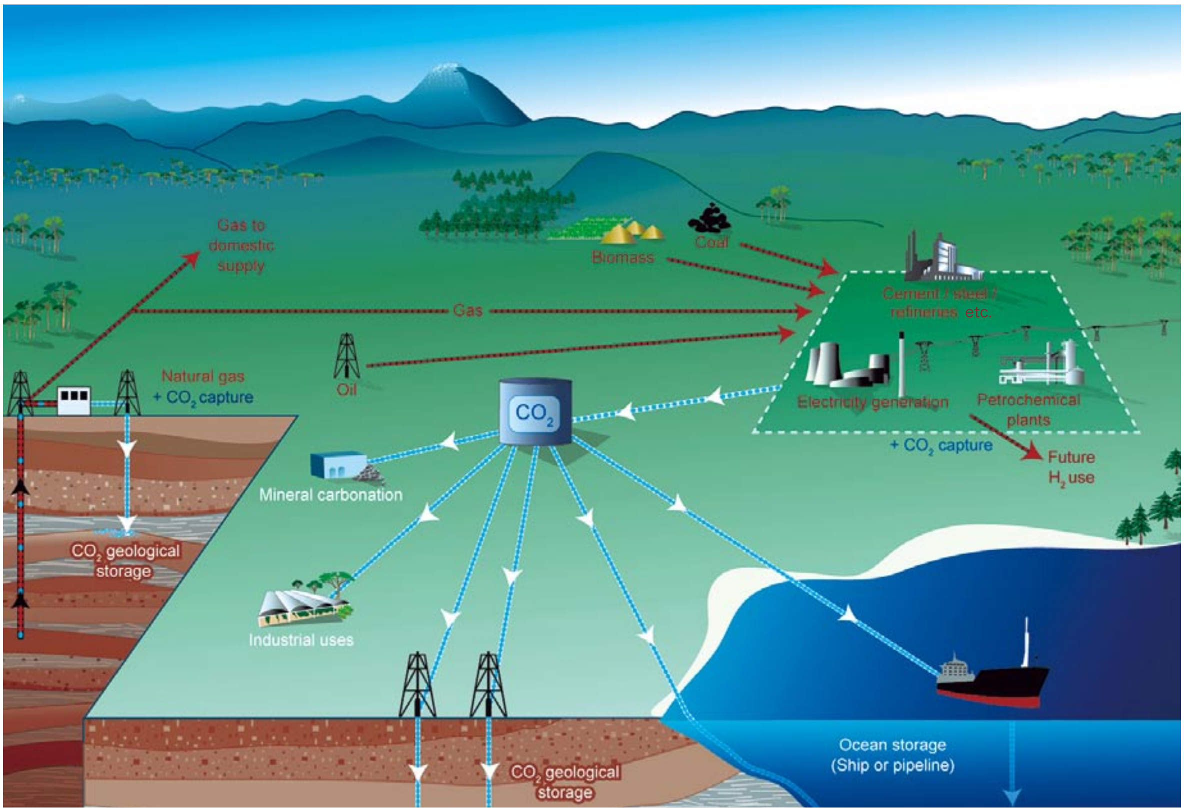


Fig. Schematic diagram of possible CCS systems (taken from IPCC SRCCS)

Contents of IPCC Special Report

Chapter 1	Introduction
Chapter 2	Sources of CO_2
Chapter 3	Capture of CO_2
Chapter 4	Transport of CO_2
Chapter 5	Underground geological storage
Chapter 6	Ocean storage
Chapter 7	Mineral carbonation and industrial uses of carbon dioxide
Chapter 8	Costs and economic potential
Chapter 9	Implications of carbon dioxide capture and storage for greenhouse gas inventories and accounting
Annexes	

(5) What are the costs for CCS and what is the technical and economic potential?

Application of CCS to electricity production system would increase generation costs by about 0.01 - 0.05 $/kWh which , in most cases, would be predominantly the cost of capture (and compression).

Worldwide, there is a technical potential of roughly 2,000 Gt CO_2 of storage capacity in geological formations at a probability of 66 - 90 %. In the ocean, the capacity could be thousands of Gt CO_2, depending on the stabilization level of CO_2 in the atmosphere.

In most scenarios for stabilization (of 450 to 750 ppm), the economic storage potential of CCS would be 220 - 2,200 Gt CO_2 (cumulatively from 2000 to 2100), which would mean a 15 - 55 % contribution to the mitigation efforts and a reduction of the costs of stabilization by 30 % or more.

(6) What are the local health, safety and environment risks of CCS?

With an appropriate site selection, a monitoring program, a regulatory system and an appropriate use of remediation methods to stop CO_2 releases if they arise, the risks of geological storage would be comparable to the risks of current activities such as natural gas storage, EOR (Enhanced Oil Recovery) and deep underground disposal of acid gas.

(7) Will physical leakage of stored CO_2 compromise CCS as a climate change mitigation option?

The fraction retained in appropriately selected and managed geological reservoirs is to exceed 99 % over 100 years at the probability of 90-99 %, and is likely to exceed 99 % over 1,000 years at the probability of 66-90 %. In the case of ocean storage, the fraction retained is 65-100 % after 100 years and 30 – 85 % after 500 years (a lower percentage for injection at a depth of 1,000 m [writer's note: 800 m to be correct], a higher percentage at 3,000 m).

(8) What are the legal and regulatory issues for implementing CO_2 storage?

Few countries have specifically developed legal or regulatory frameworks for long-term CO_2 storage. No interpretations so far have been agreed upon with respect to whether CO_2 injection into the geological sub-seabed or the ocean is compatible to specific international regulations.

(9) What are the implications of CCS for emission inventories and accounting?

The current [writer's note: when SRCCS was issued] 1996 IPCC Inventory Guidelines do not include methods associated with CCS. However, these are expected to be provided in the 2006 revised edition.

Conclusion

When I look back over the 20 years or so that I have been involved in CCS, the conditions surrounding CCS are poles apart, and CCS is now considered a policy issue in our country. However, for CCS to effectively function as a CO_2 mitigation process, there are many problems to be solved and technology is only one of them. Besides efficiency improvement through technological development and cost reduction, it is internationally common knowledge that there are mounting non-technological problems as the need to form regulatory and other systems, the application to Clean Developing Mechanism (CDM), or the consideration of a new international framework that could treat CCS properly and replace or complement CDM, the setup of incentives as economic support, and the gain of social acceptance. With this background in mind, if we are to choose CCS as a policy option in our country, we have come to a stage where not only technological research and development but the groundwork and the system structure for its realization should be considered and concrete policies should be made.

Energy Technology Research Institute
Makoto Akai

CCS Technology Development and Evaluation

Current situation of CO_2 geological storage and its perspectives

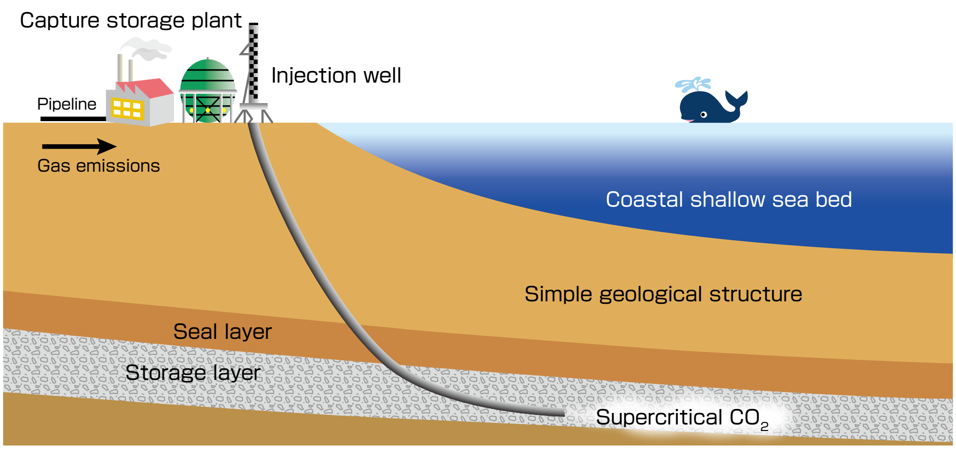
As no wait is allowed for global warming, there is a demand for speedy practical implementation of measures that cut the emissions of carbon dioxide (CO_2) which has quantitatively the most significant greenhouse effect. Carbon dioxide capture and storage (CCS) technology which captures and stores CO_2 emitted into the atmosphere from large scale emission sources is an important technology of atmospheric CO_2 reduction. For the final step of CCS, CO_2 storage in the water-filled geological strata (aquifer), or CO_2 geological storage, is drawing attention.

In our country, the large scale emission sources of CO_2 are located in the metropolitan areas along coastal plains, and the plains are mostly underlain by young geological strata of relatively simple structure. The underground strata are filled with groundwater (mostly saline water) which is stagnant for a long time and which can not be used as water resource. CO_2 geological storage technology attempts to store CO_2 by injecting it with physical characteristics between gas and liquid (supercritical CO_2 with low viscosity and small volume) into the underground strata. Such attempts are already underway in several countries, and in Norway, 1 million tons of CO_2 is stored a year. The 2005 total greenhouse gas emission of our country was 1.36 billion tons (certain value), and the possible CO_2 geological storage capacity (approximation) is estimated to be 146.1 billion tons; and it can be, therefore, said that there is ample storage capacity around our country.

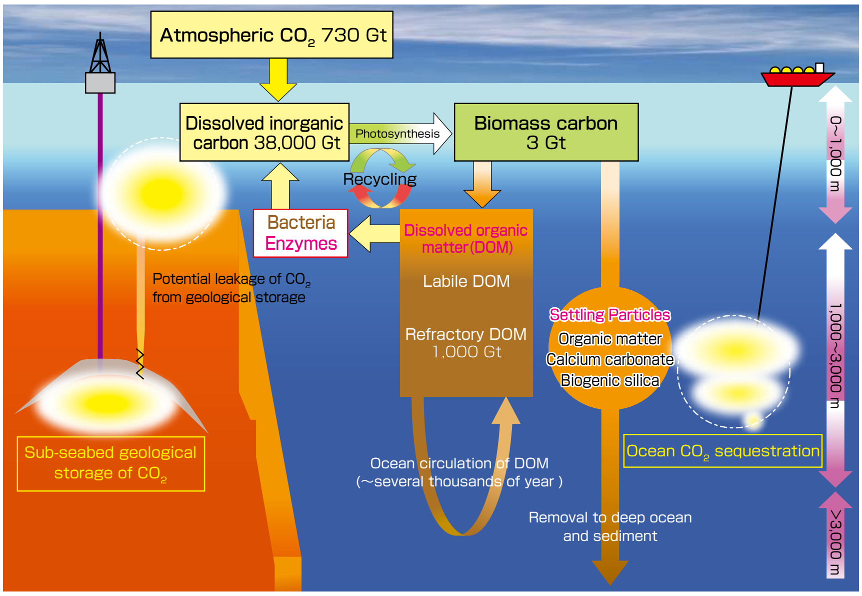
The technology of injecting fluid into deep geological strata is an extension of the accumulated technology of geological storage of natural gas and enhanced oil recovery (EOR). Moreover, we have a peculiar natural gas deposit called “dissolved-in-water type” that is commonly found in geologically young strata. The occurrence of this type of natural gas indicates that gases dissolving in fluid can be stored underground for long periods as hundreds of thousands of years, supporting the idea of CO_2 geological storage. However, for it to become operational, many problems still exist and the following need to be elucidated: 1) what is happening underground where CO_2 is injected (scientific understanding of the behavior), 2) how to keep CO_2 underground (storage mechanism), 3) how to monitor the injected CO_2 movement within the geological strata (monitoring). These issues all involve elucidation of the interaction of CO_2 fluid, underground rock strata, and deep groundwater. There is a demand for research and development of technology using various geoscientific methods as the collection of basic data from geochemical and rock mechanics experiments, the analysis of general groundwater flow based on well observation, numerical computer simulation, and the case studies on natural analogous phenomena.

Climate change due to the increase of CO_2 concentration in the atmosphere is often considered as a problem of the atmosphere and the ocean. However, for CO_2 geological storage as a measure of climate change, the interaction of CO_2 in the earth interior becomes important. AIST Geological Survey of Japan, being the top geological research institute in our country, is contributing to solving the climate change problem by conducting researches on CO_2 geological storage based on the accumulated knowledge of geoscience.

Institute for Geo-Resources and Environment
Toshiyuki Tosha
Yasuko Okuyama



Geological storage



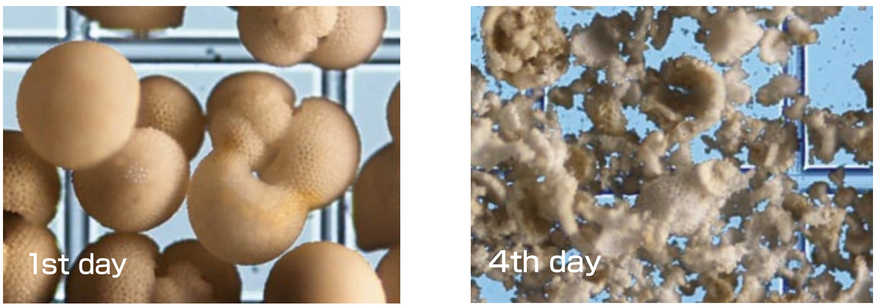
Schematic view of CCS technologies and carbon cycling in the ocean.

Environmental assessment for ocean CO_2 sequestration

The ocean covers 70 % of the earth's surface and contains roughly 50 times more CO_2 than in the atmosphere. Moreover, the ocean has absorbed and stored about 30 % of human-generated CO_2 emissions into the atmosphere. Ocean CO_2 sequestration (injection to and storage in the bathypelagic layer of 1,000~3,000 m) is a technology that actively utilizes the potential of the ocean to dissolve extremely large amounts of CO_2. While geological storage is the option to entrap CO_2 in confined space, ocean sequestration is a technology utilizing the open space of the ocean to curb the rapid increase of atmospheric CO_2 concentration by the long-term retention potential. Because of the direct usage of the open environment, more rigorous and cautious assessments of the potential impacts on the marine environment are needed.

With ocean sequestration, CO_2 is widely and thinly dissolved as to keep the impact on the marine environment at the minimum. However, in considering a long-term, large-scale operation, an appropriate evaluation of the long-term effect on the marine ecosystem which supports the carbon storage potential of the ocean is essential. It was considered that bathypelagic is a zone with very little life. However, now it has become known that various microbial communities including bacteria exist and play important roles in marine carbon cycle through the degradation of labile organic matter and the formation of refractory organic matter. Bathypelagic layer is also important as the site where settling particles dissolve. In order to assess the effects of the increase of CO_2 concentration and the decrease in pH with CO_2 injection on the marine biogeochemical cycling, we are executing laboratory experiments under high CO_2 and low pH conditions by using bathypelagic seawater samples and special high pressure apparatus which simulates the ambient environment of the deep sea.

In November 2007, in the international convention for conservation of marine environment (the London Protocol 1996), assessment guideline was adopted for the implementation of CO_2 storage in sub-seabed geological formations. In the guideline, it is stated that environmental impact assessment will be done in regard to the potential leakage of CO_2 into the marine environments. The results obtained from our research will not only provide important knowledge for the ocean CO_2 sequestration but also will be pioneering research of environmental assessments for sub-seabed geological storage.



High pressure dissolution experiment of calcium carbonate settling particles (foraminiferal shell)
The spheric shells are rapidly dissolved in sea water of high concentration of CO_2.

Research Institute for Environmental Management Technology
Masahiro Suzumura

Life Cycle Assessment (LCA) of Photovoltaic Power Generation

Increasing installation of photovoltaic power generation system

There is a growing expectation for clean and inexhaustible solar energy as a renewable energy source indispensable for sustainable society and for preventing global warming. Photovoltaic power generation above all is a system which converts solar energy directly to electricity and, as it has no moving part like a turbine, its maintenance is easy and it can be applied in various scales and forms from pocket calculators to large-scale power plants.

Ever since the Sunshine Project which started in 1974 as a long-term national project after the first oil crisis, research and development efforts through industry-government-academia cooperation and governmental promotion policies effectively resulted in reducing the cost, and there has been rapid increase in production and installation in recent years. As can be seen in Fig. 1, our country is the largest producing country of solar cells in the world.

Life cycle assessment

Although photovoltaic power generation system is an effective energy source in preventing global warming, a certain amount of energy is needed in manufacturing system components like photovoltaic cells and inverters, and naturally carbon dioxide (CO_2) is emitted in the process. The time needed to recover input energy and to reduce CO_2 emission during production is called energy payback time (EPT), and CO_2 payback time (CO_2PT) respectively. If these payback times are not sufficiently short compared to the life time of the system, it does not make sense at all as an energy producing technology. Life cycle assessment (LCA) which analyzes and evaluates these payback times are indispensably important in assessing the energy technology.

In fig.2 is shown the production process of polycrystalline silicon solar cells. In order to make accurate assessment of the input energy and the CO_2 emission in production, it is necessary to thoroughly investigate the input materials and to sum up the energy needed for fabrication at each process.

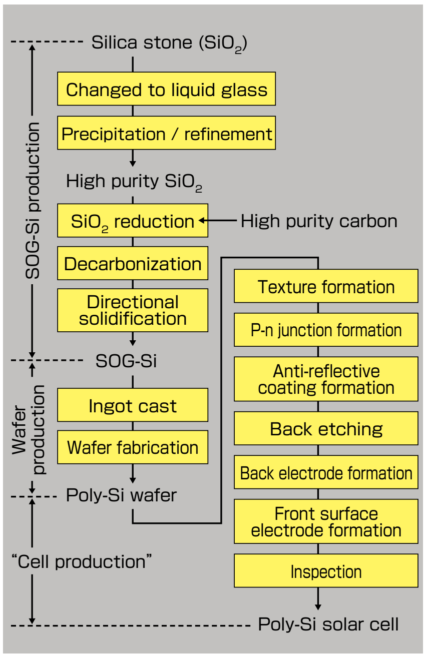


Fig. 2 Production processes of polycrystalline silicon solar cell

The payback time of photovoltaic power generation system is calculated from the ratio of the production energy and CO_2 emission at production of all system components like solar cells, and the annual electricity production and CO_2 reduction. As the former gradually decreases through development of new solar cells, improvement of production technology and expansion of production scale, and the latter increases along with improvement in conversion efficiency and efficient usage of the system, the payback time of photovoltaic power generation system, which is still in the middle of technological innovation, is rapidly shortening year by year. However, as the recent payback time value is not sufficiently known to the public, even now it is sometimes incorrectly stated that the payback time of photovoltaic

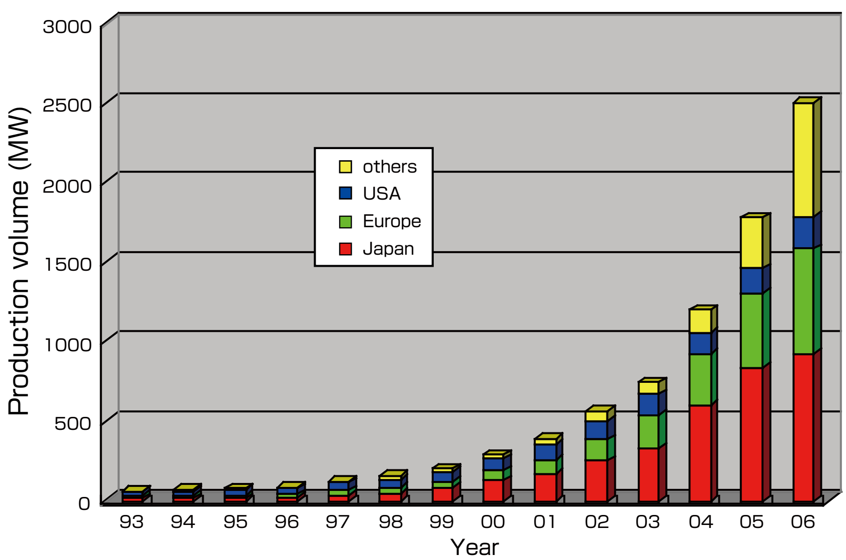


Fig. 1 Progress in world solar cell production

power generation system is more than 10 years based on old data of over ten years ago.

The most recent EPT data published in our country (in the case of residential roof-top installations) states that EPT of polycrystalline silicon is 1.5 year, for amorphous silicon is 1.1 year, for compound thin film (CIS) is 0.9 year and CO_2PTs are 2.4, 1.5 and 1.4 year respectively[2]. Please note, however, that with crystalline silicon, the above calculation was done with the new silicon manufacturing method presently being developed, and if calculated with the current method, the EPT is 2.0 years and CO_2PT is 2.7 years (Fig.2). Similar figures have been reported in Europe and the US. As the life time of solar cells is considered to be at least 20 to 30 years, both the EPT and CO_2PT based on the most recent data is sufficiently short, and a photovoltaic system is a good power generating system from the view point of LCA.

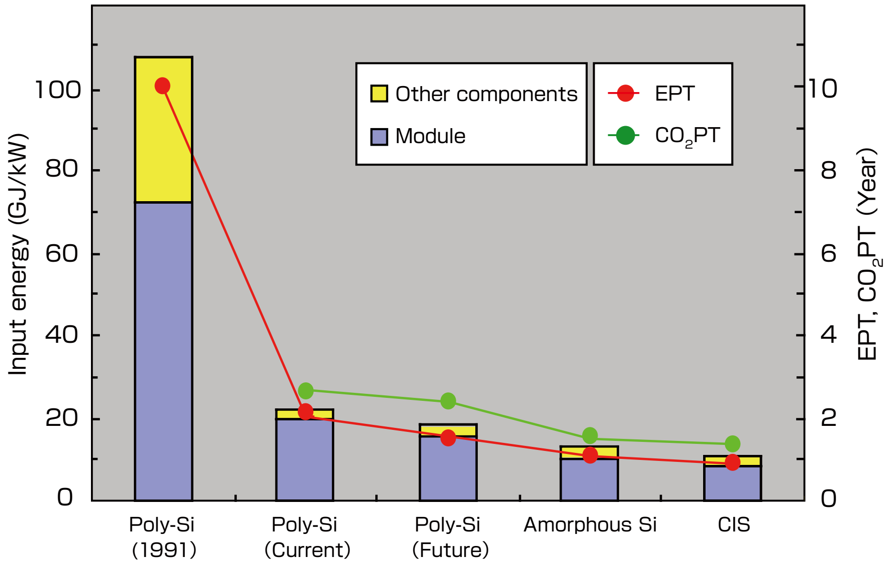


Fig. 3 Input energy for production and payback times of photovoltaic power generation systems
Assumptions:
PolySi (1991): ground installation 1 MW, production capacity = unknown, operational energy = 1 %
Others: residential 3 kW system, production capacity = 100 MW/year, operational energy = neglected
Current data of poly-Si is recalculated based on the document [2]

Toward a sustainable society

In the "New Energy Innovation Plan", which is one of the 4 pillars of the "New National Energy Strategy" made in May 2006 as the basic policy of the energy measures of our country, it is clearly stated that the cost of photovoltaic power generation will aim for a reduction to the level of conventional thermal power generation by 2030. In the long-term road map of research and development concerning photovoltaic power generation (PV2030) made in 2004, it is assumed that by 2030 the cumulative installation will be 100 GW (100 million kW) which will cover 10 % of the total electricity need.

In order to achieve these installation goals, it is indispensable to do research and development for further efficiency improvement of solar cells, cost reduction, and introduction of new system concepts that would allow expansion of application areas and installation sites. It is also important that, with the assessment of environmental effects with LCA introduced here, the latest information is constantly provided by continually investigating the results of new production technology introduction based on advancement in research and development and from expansion of production scale, in order to gain public understanding of photovoltaic power generation as a new energy technology.

Research Center for Photovoltaics
Koichi Sakuta

References
[1] Uchiyama, *et al.* Central Research Institute of Electric Power Industry Research Report Y90015 (1991.1.11)
[2] NEDO Report, “Research Study of Photovoltaic Generation Evaluation”, Association of photovoltaic generation technology research, (2001.3)

Life Cycle Assessment (LCA) of Biomass Utilization

What is life cycle assessment (LCA)?

LCA is a method to quantitatively assess the influence of a product to the environment. It is one of the tools that is expected to contribute to establishing an environmentally-friendly society by, for example, inspecting the manufacturing and transport of necessary materials and energy for a product, and checking and assessing its impact on environment through the product's life cycle from production, distribution, consumption, disposal and recycling. Presently its use is spreading mainly in the manufacturing industry and we are at a stage where consumers may use LCA results as one of the factors in decision making.

Application of LCA to biomass utilization

With biomass, it is widely accepted that CO_2 is fixed during the growing period and that CO_2 emitted at combustion is balanced out. Therefore, the utilization of biomass is anticipated to be environment-friendly from the view point of greenhouse gas (GHG) emission control worldwide. There is a need to quantitatively assess it by using LCA and to clarify the necessary efforts for its utilization with even lower impact on the environment.

At Research Center for Life Cycle Assessment of AIST, we have promoted development of a method to locally assess the effective use of one kind of biomass, organic waste (livestock excretion, kitchen refuse, food industry leftovers, construction debris *etc.*), and have developed and made public a method for local optimization called "RCACAO".[1] In collaboration with researchers of Asian countries, LCA assessment of large-scale biomass utilization is being done, and are conducting studies of sustainable biomass utilization. From these results, here is presented an example of LCA assessment of a large-scale plantation.

A case study of bioethanol

Thailand is the fourth largest producer of sugarcane after Brazil, India, and China, and is expected to produce and utilize ethanol in a large scale. We have done trial calculations of GHG emission of sugarcane life cycle, supposing that sugarcane is made into ethanol in Thailand, transported to Japan, upgraded in purity and mixed directly with gasoline.

With this utilization system there are many uncertainties as fluctuation of yield depending on the location and weather, variation of fertilizers, difference of transportation path depending on producing district, difference of generating efficiency using bagasse, the dregs after squeezing the raw material of ethanol. In order to quantitatively grasp these effects, we have made assessment by analyzing or supposing the distribution. We calculated the GHG emission of a life cycle which makes and uses absolute ethanol of 1 MJ. Fig. 1 shows results from using the Monte Carlo method which simulates by repeatedly using random values for uncertain data. According to these results, there is about 44 g to 78 g emission within the 95 % confidence interval. Here is reflected the uncertainty arising from the difference in yield and fertilizer usage, and as a result, there is a wide distribution.

The emission breakdown of the median value is shown in Fig.2, and the emission at the cultivation stage is large. This is due to the large influence of fertilizer production and dinitrogen monoxide (said to have 300 times as much greenhouse effect as CO_2) emissions from fields, as well as fuel consumption of machines used for cultivation. Next, the emission of transportation and dehydration processes is large. The GHG emission reduction effect (shown as negative value in Fig.2) from electric generation using bagasse left from ethanol production is also large, and with the improvement of generating efficiency and ethanol production efficiency, there may be possibilities for further increase in the amount of reduction.

According to our calculations, the GHG emission of 1 MJ gasoline from oil production, transportation, refinement is approximately 70 g/MJ. When comparing the two, even with biomass

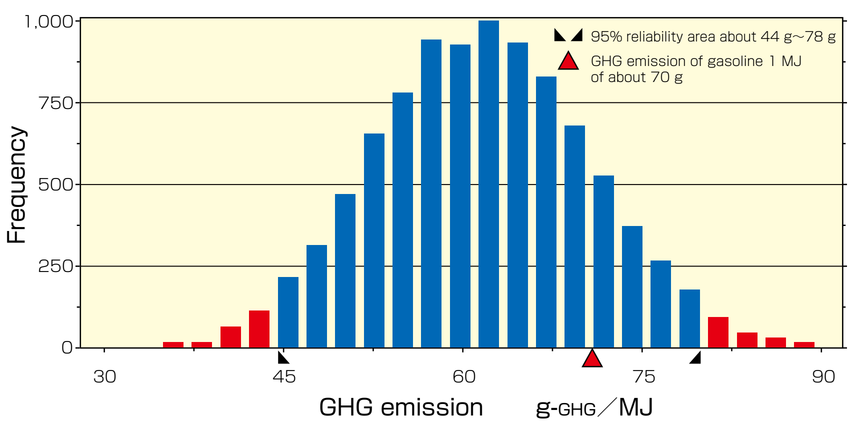


Fig.1 Life cycle GHG emission and emersion frequency of bioethanol

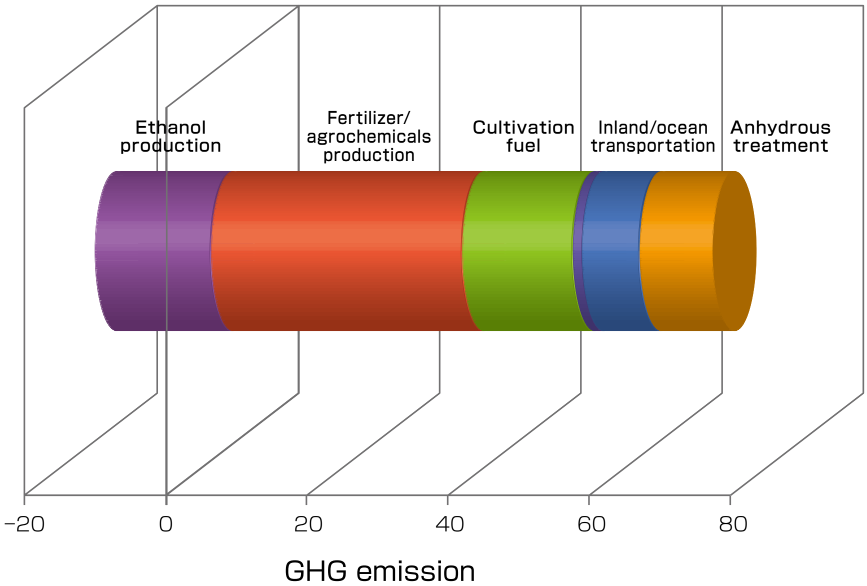


Fig.2 Breakdown of GHG emission

Sugarcane brought into the sugar factory in Thailand

Sugarcane just before harvest

origin ethanol, the GHG emission surpassing that of fossil fuel is suggested to be possible if the cultivating conditions are bad and the utilization efficiency is low.

The direction and future of biomass utilization from the LCA results

With biomass ethanol, GHG emission will be in the decline with the development of more efficient ethanol conversion technology and anhydrous technology, the development of technological and management methods such as appropriate fertilizer control, production management, and ways of consumption. It is, therefore, important that these developments are to be advanced.

Moreover, for the LCA results to be used in decision making, it is necessary to lead to certain conclusions. By collecting and analyzing data on the location where biomass is actually to be made and used, the application process, and the consumption pattern, the emission distribution indicated here can be reduced, and therefore can lead to definite conclusions.

Presently at Research Center for Life Cycle Assessment, we are proceeding with examinations of fertilizer origin GHG emission data, additional uncertainty data of ethanol production process, in order to improve the accuracy of the results. We are also promoting assessment studies to clarify the course for GHG emission reduction by evaluating biodiesel, and by examining combinations of utilization processes and systemization of usage within a district. Furthermore, along with other Asian countries, we are promoting assessment of environmental impact of land use other than GHG emission, and also research that includes social development of biomass producing areas as an assessment factor, and are acting as a leader of this area.

Research Center for Life Cycle Assessment
Masayuki Sagisaka

Reference
[1] Shimizu, Yang, Ihara, Genchi, “Design Method of Intraregional Livestock Excretion Treatment in View of Life Cycle”, Collection of Environmental System Papers., vol.33, pp241-248 (2005)

Assessment of Biomass Utilization System

Biomass (bio resources) utilization is drawing attention as global warming measure and rural vitalization method. We view the whole utilization system in terms of process planning and are doing research and development of economical and environmental assessment technology.

Simplified economy simulation

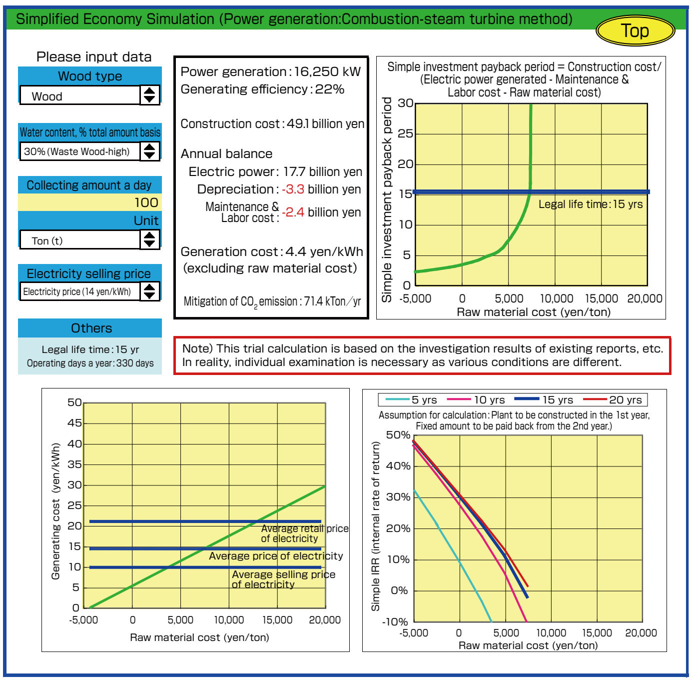
In order to promote popularization of biomass utilization, a supporting technology to simply assess the economy and the environment is needed. Based on biomass database we made separately, we have released on a website a simple economy simulator of three current biomass utilization methods: combustion heat utilization, combustion power utilization, and methane fermentation utilization[1]. The economy is expressed in relation to raw material cost, product price, payback years of investment (construction cost). We have made improvements as adding internal rate of return (IRR) based on comments from users. With this, it is possible to compare possible locations at the introduction of biomass utilization, and to make economy comparison of newly developed technology with current or past technology.

The economy assessment of bioethanol production in Japan

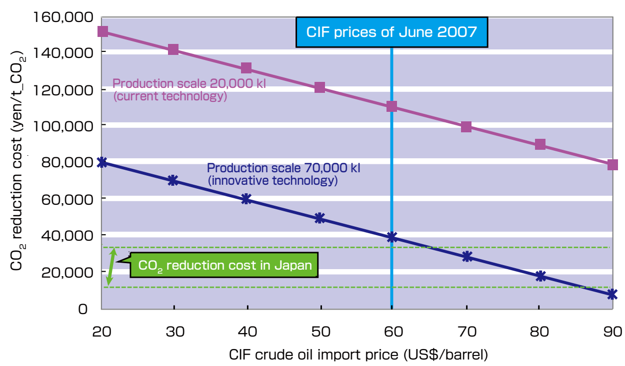
Recently, although ethanol (bioethanol) made from sugarcane and grain (corn, rice *etc.*) is drawing attention as a gasoline substitute, we, at Biomass Technology Research Center of AIST, are predominantly doing research and development of ethanol production from cellulose type biomass as wood and straw, not to compete with food supply. Ethanol made from cellulose is said to be second generation ethanol and research development is making progress all over the world. We have analyzed the production cost and carbon dioxide (CO_2) reduction cost if we produce this second generation ethanol in Japan. In the case where ethanol is produced with biomass collected within a 50 km radius, 20, 000 kl can be produced annually with the present technology, and as a method of CO_2 reduction, it becomes relatively expensive. However, with technological innovation, annual production of 70,000 kl becomes possible, and if the cost of oil exceeds $70/barrel, the cost will be the same as the energy conservation methods as other CO_2 reduction methods.

This report is released as a discussion paper[2] and all comments are welcome.

Biomass Technology Research Center
Tomoaki Minowa



Simplified Economy Simulation on display



Analysis of CO_2 reduction cost of domestically produced cellulose type biomass

Related information (in Japanese)

[1] http://unit.aist.go.jp/btrc/ci/simulation/systemteam_gaiyou

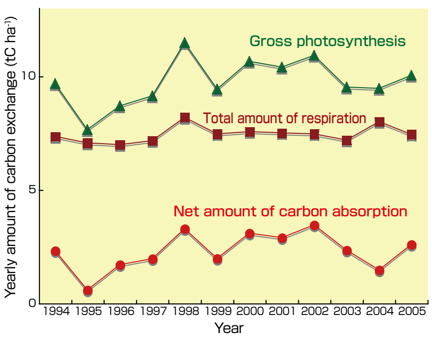
[2] http://unit.aist.go.jp/btrc/ci/research_result/documents/DISCUSSIONPAPER.pdf

Assessment of Forest CO_2 Absorption

CO_2 absorption ability of forests

Forests, when receiving sunlight, absorb carbon dioxide (CO_2) from the atmosphere by photosynthesis. At the same time, CO_2 is continually released into the atmosphere by the activities of microorganisms within the soil and the respiration of plants. The speed of forest CO_2 exchange greatly influences the atmospheric CO_2 concentration as it constantly fluctuates with the influence of weather conditions as amount of sunlight and temperature, and as large amounts of CO_2 is released in a short period of time when there is a disturbance as forest cutting and fire. The technology to accurately measure CO_2 absorption capacity of a changing forest is vital in order for future estimation of atmospheric CO_2 concentration and for a precise estimation of CO_2 emission reduction effect.

Measuring equipment of CO_2 concentration fluctuation



Change over the years of yearly gross photosynthesis of 1 ha deciduous broad-leaved forest observed in Gifu prefecture, total amount of respiration and net amount of carbon absorption (=net photosynthesis − total amount of respiration)

Observation tower in a forest

Observation network of CO_2 absorption capacity in the terrestrial ecosystem of Asia

Presently, there is established a worldwide long-term observation network of CO_2 exchange capacity in terrestrial ecosystem based on micrometeorological technique (calculating method of CO_2 absorption from the fluctuation of atmospheric CO_2 concentration and wind velocity, eddy correlation method), and the Asian network (AsiaFlux) has started its activities in 1999.

Our group, coordinating with other research institutes from home and abroad, has obtained long-term CO_2 absorption of forests in over 10 locations in Asia with eddy correlation method, and has clarified the characteristics of the topographic distribution and the change over the years. As a result, we have found that the net photosynthesis of tropical forests is 2 to 3 times that of Japan, but because the total amount of respiration is large, the net amount of absorption differs greatly by location and condition. We also found that over evergreen forests in Japan absorb 3~5 t of carbon per ha every year, and the larch forests which grow at mid to high latitudes show significantly high absorption speed only in the short summer periods.

The spread of CO_2 absorption measurement technology to Asia

Eddy correlation method requires technology in sophisticated meteorological observation and in large amounts of data processing. Therefore, in Asia, personnel training of these technologies are only done in certain research institutions of Japan and Korea. With this in mind, our group having experience so far in improving CO_2 absorption assessment technology in various ecosystems, is engaged in spreading the technology in Asian countries by organizing training courses every year.

These educational and diffusion activities of observation technology not only promote accumulation of organized observation data of CO_2 absorption in Asia and the improvement of data quality, but also are expected to contribute to strengthening coalition amongst Asian researchers and policy makers.

Research Institute for Environmental Management Technology
Nobuko Saigusa

Research Hotline

UPDATE FROM THE CUTTING EDGE

Jan.-Mar. 2008

The abstracts of the recent research information appearing in Vol.8 No.1-3 of "AIST TODAY" are introduced here, classified by research area.
For inquiry about the full article, please contact the author via e-mail.

Life Science & Technology

Isolation of enzyme involving in activation of vitamin D

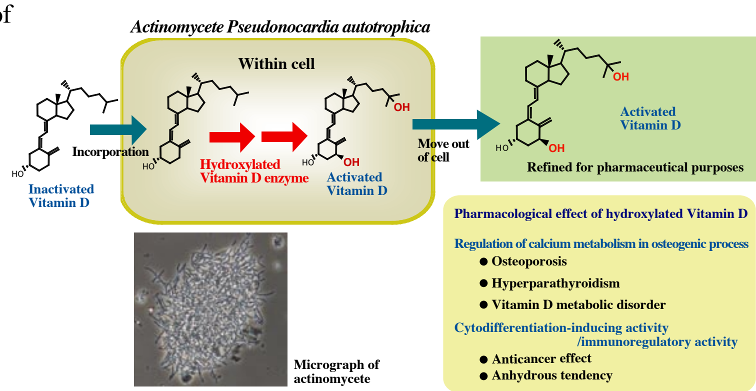
High-efficient production of hydroxylated vitamin D used for pharmaceutical purposes

It has been known that vitamin D_3 (VD3) is hydroxylated in liver and kidney by cytochrome P450 monooxygenases (CYPs) in animals, resulting in the formation of 1α, 25-dihydroxy VD3 (calcitriol) which modulates calcium metabolism. Calcitriol and its derivatives are used as pharmaceuticals for rickets, osteoporosis and parathyroidosis. About 20 processes are, however, required in chemical synthesis of calcitriol and its yield is very low. Alternate production of calcitriol is carried out by the use of an actinomycete *Pseudonocardia autotrophica* as a converter; the cell efficiently converts VD3 to calcitriol by endogenous CYP. We therefore isolated the CYP involved in the VD3 hydroxylation (VDH) and subsequently cloned the corresponding gene from *P. autotrophica*. Conversion of VD3 to calcitriol was observed using recombinant VDH and its redox partners in an *in vitro* reconstitution assay. We also confirmed that *Rhodococcus* cells expressing VDH and redox partner proteins were capable of the biotransformation of VD3. Mutational engineering of the *vdh* gene and genetic engineering of appropriate host cells will dramatically improve the productivity of hydroxylated VD3s in the near future.

*This is the result of a joint research with Mercian Corp. (Iwata, Japan).

Tomohiro Tamura
Research Institute of Genome-based Biofactory
t-tamura@aist.go.jp

AIST TODAY Vol.8, No.1 p.26 (2008)



Activation of vitamin D by actinomycete and pharmacological effect of hydroxylated vitamin D

Estimation technology of species composition of phytoplankton

Estimation method of species composition of phytoplankton based on *in-situ* measurement of excitation spectrum

Technologies for rapid measurement of phytoplankton community structure are required to monitor temporal dynamics and/or spatial distribution of phytoplankton. So far, several methods using multiple excitation wavelengths are distributed for the purpose of water quality assessment.

Taxonomic phytoplankton group has its own specific characteristics of excitation spectrum. While detecting fluorescence from chlorophyll a, we change the excitation wavelength. Then we can get an excitation spectrum in accordance with the community structure of phytoplankton. Analysis of the sampled water with HPLC can tell us the community structure based on pigment base. The estimated amount of chlorophyll a is an index of total phytoplankton, chlorophyll a is that of green algae, and fucoxanthin is that of diatom.

Based on empirical comparison between an excitation spectrum and HPLC data, we can get the conversion formula. Then we can know the community structure from the excitation spectrum.

Multiple wavelength fluorophotometer developed by us

Tatsuro Akiba
Research Institute for Cell Engineering
ta-akiba@aist.go.jp

AIST TODAY Vol.8, No.2 p.22 (2008)

Successful re-activation of human mesenchymal stem cells by transducing single gene

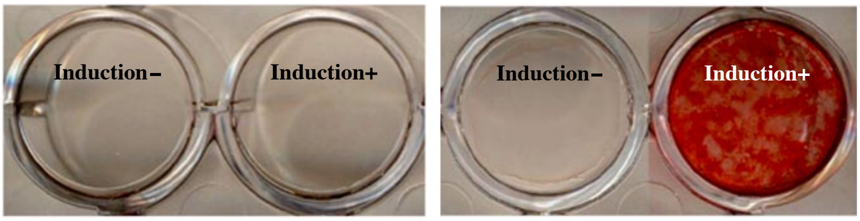
Leads to the spread of regenerative medicine using stem cells

Culture-expanded mesenchymal stem cells from the marrow of a patient are being used for regeneration medical therapy to his/her damaged tissues such as bone or cartilage. However, the clinical application of this technology is limited because the proliferation and differentiation abilities of these cells decline drastically within the culture after several weeks. We transduced a gene, *Nanog* or *Sox2*, which is expressed by embryonic stem cells, with the aid of a retrovirus into mesenchymal stem cells with reduced proliferation and differentiation abilities.

The proliferation and osteogenic differentiation abilities of the cells into which the *Nanog* gene was transduced were either restored to the normal levels or increased in comparison to their initial (right after the primary culture) levels. The proliferation and the differentiation abilities were not restored in the cells into which only the *Sox2* gene was transduced; however, they were restored when these cells were cultured with a protein named basic fibroblast growth factor (b-FGF).

Hajime Ohgushi
Research Institute for Cell Engineering
hajime-ohgushi@aist.go.jp

AIST TODAY Vol.8, No.3 p.26 (2008)



Controlled cell

Nanog gene transduced cell

Osteogenic differentiation of mesenchymal stem cells
(Dyed with red pigment that dyes bone cells only)

Universal design with robots

Making robots more adaptable to human living environment

AIST has developed several elements of universal design for household robots in particular, with the cooperation of Takasuke Sonoyama of T-D-F/Robot & Interaction Design. This research was jointly conducted by the University of Tokyo, Toshiba Corp. and GNSS Technologies, Inc. in the project organized by the Next-generation Robots Coordination Program, Council for Science and Technology Policy - Coordination Program of Science and Technology Projects.

In conventional robotic development, a robot is built for a specialized purpose because its hardware is designed for a specific environment, and it is required to execute only a predetermined task. In practice, it is very difficult to develop a robot that can handle all items found in a human living environment. To overcome this difficulty, AIST devised some methods, as part of the environmental platform for the easy adaptation of robots to the human living environment in which humans and robots can coexist. The methods include designing handles that are easily operable by robots and also by human, designing visual marks in order to provide the layouts and operating instructions of the handles, and building templates for the easy development of operation programs for robots. Introduction of robots in households is expected to be accelerated by the popularization of these methods.

Kohtaro Ohba
Intelligent Systems Research Institute
k.ohba@aist.go.jp

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This study was performed as one of the Coordination Program of Science and Technology Projects "Next Generation Robots," conducted by the Council for Science and Technology Policy (CSTP), Cabinet Office and funded by Special Coordination Fund for Promoting Science and Technology of Ministry of Education, Culture, Sports, Science and Technology.

Universal handle & CLUE (Coded Landmark for Ubiquitous Environments)

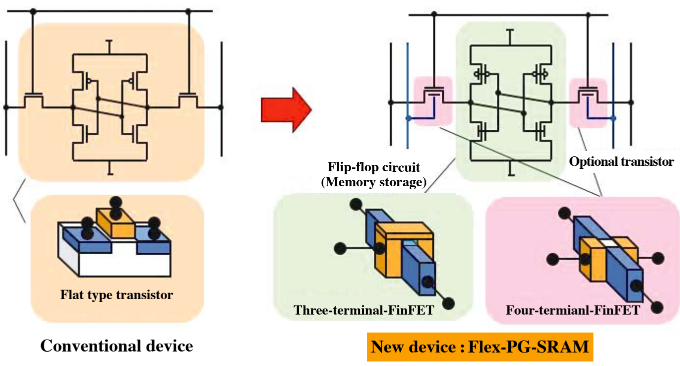
Novel SRAM circuit using double-gate-MOSFET devices

Promising solution for operational-stability enhancement in 22-nm generation

We have developed a fin-type-field-effect-transistor- (FinFET-) based SRAM to enhance noise margin during both read and write operations. In its cell, the flip-flop is composed of usual three-terminal- (3T-) FinFETs while the pass gates are composed of four-terminal- (4T-) FinFETs. The 4T-FinFETs allow dynamic threshold-voltage control in the pass gates. During the write operation, the threshold voltage of the pass gates is lowered to enhance the writing speed and stability. During the read operation, on the other hand, the threshold voltage is raised to enhance the static noise margin. This novel SRAM circuit is a promising solution to the chip-yield problem in 22-nm generation, which is caused by the shortage of the noise margin or the operational stability.

Shinichi Ouchi
Nanoelectronics Research Institute
shinichi.ouchi@aist.go.jp

AIST TODAY Vol.8, No.2 p.24 (2008)



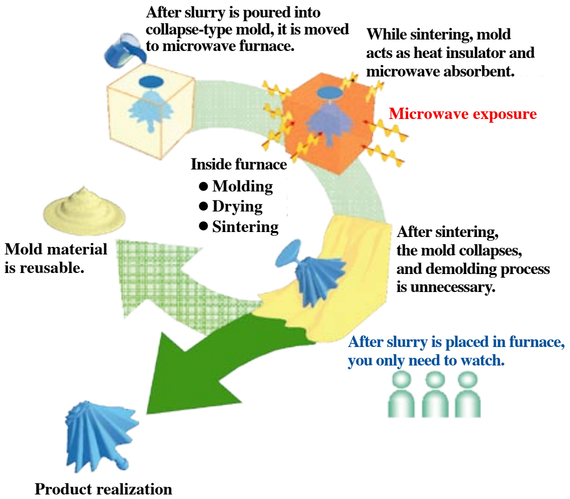
Comparison of circuit structure and device of conventional and new SRAM

Integration and simplification of ceramic manufacturing process

Reduces the manufacturing periods to less than half by using microwave

We have developed a new process that integrates and simplifies the ceramic manufacturing process by using microwave heating technique. This new process reducing the manufacturing periods of ceramics to less than half. It is a low environment load manufacturing process because it reduces the energy consumption during the process.

For the process, new collapse-type molding die was developed. It enabled the omission of the demolding and debinder processes. In this new process, a series of heating processes from drying to sintering are carried out inside a microwave furnace after ceramic slurry is poured into the collapse-type mold.



Compact process using collapse-type molding

Masaki Yasuoka
Advanced Manufacturing Research Institute
yasuoka-m@aist.go.jp

AIST TODAY Vol.8, No.2 p.25 (2008)

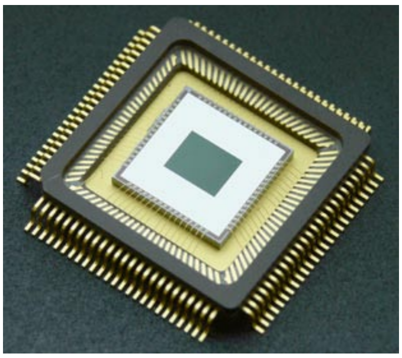
Highly sensitive and wide spectral range image sensor based upon the $CuInGaSe_2$ solar cell techniques

Image sensors with extended sensitivity in the near infrared region have large demands in consumer applications, such as night vision of automotive and security cameras. The sensitivity of typical crystalline silicon (c-Si) based image sensors rapidly decreases in the infrared wavelength range λ >1000 nm.

We have succeeded to fabricate a novel image sensor, for the first time, with a $CuInGaSe_2$ photodiode array fabricated on Si-LSI circuits. The developed image sensor consists of 352×288 pixels with each pixel size of 10 μm×10 μm. The sensitivity of wavelength range up to λ ~1200 nm was confirmed, and the integral sensitivities have been also extended by improving the aperture ratio and spectral response.

Shigeru Niki
Research Center for Photovoltaics
shigeru-niki@aist.go.jp

AIST TODAY Vol.8, No.1 p.27 (2008)


$CuInGaSe_2$-based image sensor (chip size: 7.5 mm×7.5 mm)


A night image taken by the $CuInGaSe_2$-based image sensor

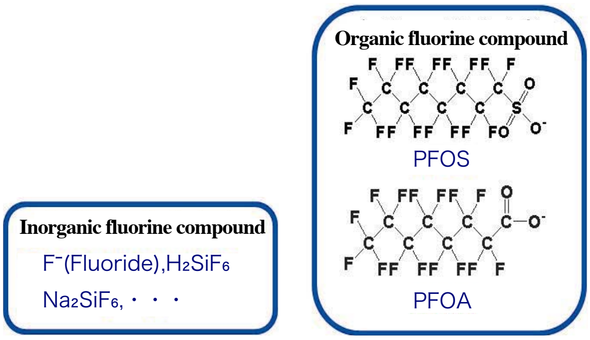
A total fluorine analyzer with an unprecedented high level of sensitivity as a conventional method

Easy and rapid analyses of PFOS and total fluorine in environmental samples and industrial products

We have developed a fully automatic total fluorine-analyzing system with an unprecedented high level of sensitivity. This analyzing system is based on the conventional halogen analyzer that uses combustion ion chromatography (CIC). A higher level of sensitivity was achieved by replacing the fluorine-containing materials in part of the equipment and in the gas-supply line, which have the potential for fluorine contamination, with non-fluoropolymer materials and by using gases of higher purity for the sample combustion. Our new system permits the quantitative analysis of absolute amounts of 0.6 ng fluorine. The analyzer allows easy, rapid, and sensitive analyses of the total fluorine and organic fluorine compounds that are present in various environmental samples and industrial products. It can also be used to analyze compounds that contain chlorine or bromine. Thus, it is suitable for ensuring compliance with the EU RoHS directive and with potential future regulations on fluorinated compounds, such as the EU's REACH legislation.

Nobuyoshi Yamashita
Research Institute for Environmental Management Technology
nob.yamashita@aist.go.jp

AIST TODAY Vol.8, No.1 p.28 (2008)



All fluorine compounds

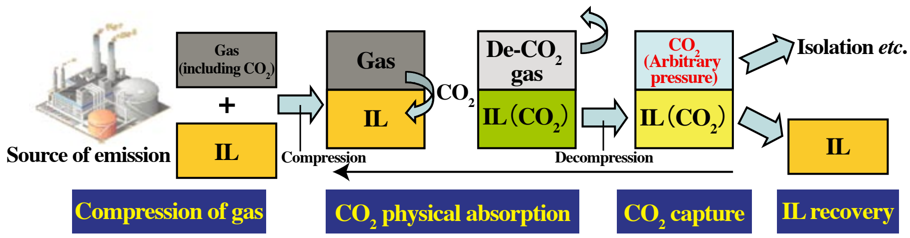
Development of new gas separation methods using ionic liquids

Technology for global warming with advantage of specific absorption phenomena of acidic gases

Ionic liquids are environmentally benign solvents because of their less volatile and nonflammable natures. Ionic liquids have very high and selective solubilities of acidic gases such as CO_2, SOx, and NOx. By means of X-ray diffraction measurements, we have revealed that CO_2 dissolved in an ionic liquid is preferentially solvated to anion species. This implies that there is the Lewis acid-base interaction between the positive carbon atoms of CO_2 and negative fluorine atoms of anion in the ionic liquids. In contrast, for lack of specific interaction site, nonpolar gases such as H_2 and N_2 do not generally dissolve in ionic liquids. The unique physical absorption property in ionic liquids should open doors for new gas separation methods.

Mitsuhiro Kanakubo
Research Center for Compact Chemical Process
m-kanakubo@aist.go.jp

AIST TODAY Vol.8, No.3 p.27 (2008)

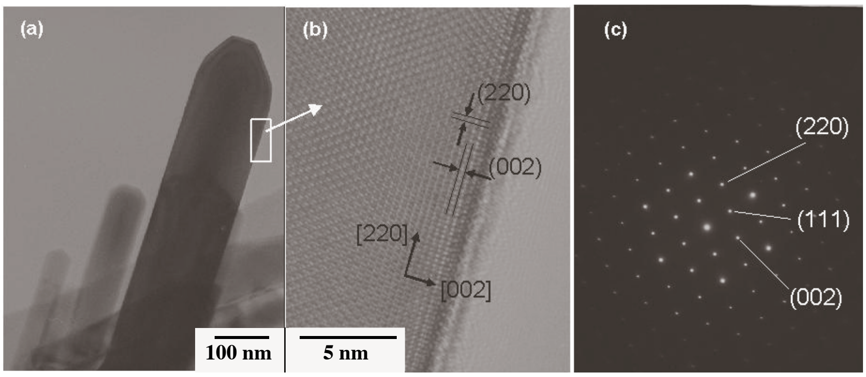


Outline of carbon dioxide (CO_2) physical absorption method by using ionic liquids (IL)

Synthesis of single crystalline spinel $LiMn_2O_4$ nanowires

Promising materials for the positive electrode of a high rate Li ion battery

How to improve the specific power density of the rechargeable lithium ion battery has recently become one of the most attractive topics of both scientific and industrial interests. The spinel $LiMn_2O_4$ is the most promising candidate as a cathode material because of its low cost and nontoxicity compared with commercial $LiCoO_2$. Moreover, nano-structured electrodes have been widely investigated to satisfy such industrial needs. Among all of the nano-structures, single crystalline nanowire is the most attractive morphology because the nonwoven fabric morphology constructed by the single crystalline nanowire suppresses the aggregation and grain growth at high temperature, and the potential barrier among the nanosize grains can be ignored. Here we first synthesized high quality single crystalline cubic spinel $LiMn_2O_4$ nanowires based on a novel reaction method using $Na_{0.44}MnO_2$ nanowires as self-template. These single crystalline spinel $LiMn_2O_4$ nanowires show excellent performance at high rate charge-discharge process such as 100C with both a relative flat charge-discharge plateau and excellent cycle stability.



Transmission electron microscope (TEM) image (a,b) of single crystalline spinel $LiMn_2O_4$ nanowire and electron diffraction pattern (c)

Eiji Hosono
e-hosono@aist.go.jp

Haoshen Zhou
hs.zhou@aist.go.jp

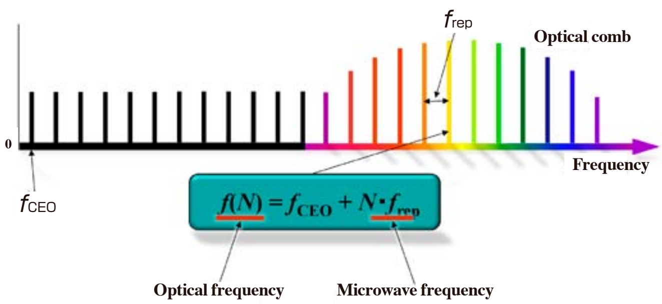
Energy Technology Research Institute

AIST TODAY Vol.8, No.3 p.28 (2008)

Octave-spanning optical frequency comb using mode-locked fiber laser

Fiber comb

Recent developments in fiber based frequency combs have made them the preferred link between optical and microwave frequencies. This is due to their robustness and cost-effectiveness. We have developed fiber based frequency combs at the National Metrology Institute of Japan and achieved long-term measurements of over 1 week. We are collaborating with a company and developing an "optical frequency counter". We believe this will be an important tool for optical communications and industries.



Optical frequency comb equally spaced on the frequency domain
The shaded lines are real modes of the comb, and the others are the virtually extended modes.

Hajime Inaba
Metrology Institute of Japan
h.inaba@aist.go.jp

AIST TODAY Vol.8, No.1 p.29 (2008)

DNA quantitation by isotope-dilution mass spectrometry

Development of method for accurate quantitation of DNA and the application to the development of DNA reference material

In recent years, the demand for quantitative measurement of DNA has been increased in the field beyond basic biology, such as food analysis and clinical diagnosis. Currently, real-time PCR, DNA microarray and UV absorption are utilized for the quantitation, however, the accurate quantitative measurement for DNA has not been established, because of the lack of well characterized reference materials. We have developed an accurate quantitative analysis of DNA using isotope-dilution mass spectrometry (ID-MS) for the development of DNA reference materials. In this study, 20-mer oligo DNA was used for the analyte, which was spiked with isotopically labeled nucleotides, and digested enzymatically. The resulted nucleotides and nucleosides mixtures were measured by LC-MS. The measured concentration of the analyte oligonucleotide was compared with other quantitation methods. The accuracy of this method has also been verified by the inter-laboratory comparison based on the CIPM/CCQM pilot study P54.1.

Tomoya Kinumi
t.kinumi@aist.go.jp

Shin-ichiro Fujii
s-fujii@aist.go.jp

Metrology Institute of Japan

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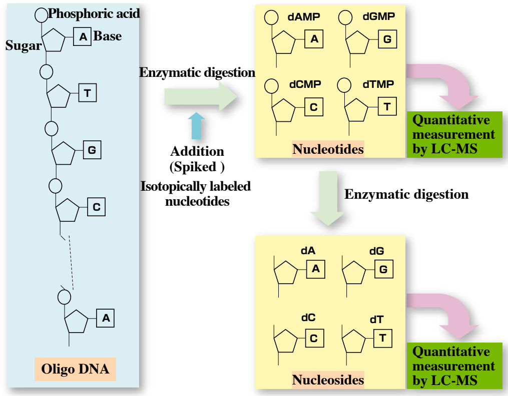

Quantitative measurement of oligo DNA by using ID-MS

In Brief

Fourth Biomass-Asia Workshop

The Fourth Biomass-Asia Workshop was held from November 20 to 22, 2007 at Shah Alam, Malaysia. The workshop was jointly organized by Malaysia and Japan. Malaysian organizers are Ministry of Energy, Water and Communications (MEWC), Ministry of Science, Technology, and Innovation (MOSTI), Ministry of Natural Resources and Environment (NRE), and Ministry of Plantation Industries and Commodities Malaysia (MPIC). Japanese organizers are Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Economy, Trade and Industry (METI), and Biomass-Asia Research Consortium.

Biomass-Asia Workshop, the first of which was held in Tokyo and Tsukuba in 2004, has been held annually in Thailand, Tokyo and in 2007, in Malaysia. Over 250 people participated from twelve countries including ten Asian countries.

Workshop site

Following opening remarks by Dr. Tatsuo Katsura, the then Senior Vice-President, AIST, and Mr. Kunio Oguri, Deputy Director General, Agriculture, Forestry and Fisheries Research Council Secretariat, special lectures were delivered by Prof. Kenji Iiyama, President, Japan International Research Center for Agricultural Sciences, and Mr. Lim Keng Yaik, Minister of MEWC. In the technical session, based on the result of study at the three prior workshops, there was active discussion on regionally adaptable model of sustainable biomass utilization technology in Asia. In the last session, a direction was charted for the development of utilization technology in three models, ASEAN island model, ASEAN continental model, and China model. The next workshop was agreed to be held in China, and the two day workshop came to a close. At the evening reception, there were speeches by MEWC Secretary-General and Mr. Masahiko Horie, Japanese Ambassador to Malaysia. On the last day, there were separate technical tours to palm oil mill facility and to power generating facility from waste paper.

CAS-AIST-NEDO Workshop on Fuel Cells and Hydrogen

CAS-AIST-NEDO Workshop on Fuel Cells and Hydrogen was held from November 11 to 13, 2007 at Dalian Institute of Chemical Physics (DICP) of Chinese Academy of Sciences(CAS). This was the fourth of a series of workshops held to find specific collaborative tasks under the Comprehensive MOU concluded between AIST and CAS in May, 2004. The themes are all related to environment and energy because these fields are considered extremely important in constructing a sustainable recycling society which is an urgent global issue. New Energy and Industrial Technology Development Organization (NEDO), which has much to do with these themes, has also joined the other two organizations and has co-hosted the workshops.

At the workshop, on various technological issues concerning different types of fuel cells and hydrogen energy, overall activities, projects and topics were introduced; by research institutes affiliated to CAS, mainly DICP, on the Chinese side, and by AIST, NEDO, and universities on the Japanese side; and active discussions were held. On the last day, there was a lab tour of DICP, and much information on the Chinese situation concerning the relevant areas was obtained.

Participants from both countries that attended the workshop

AIST Contribution to Rare Metal Diplomacy with Southern Africa
-Accompanying Mr. Akira Amari, Minister of Economy, Trade and Industry to the Republic of South Africa and the Republic of Botswana-

In order to develop friendly relations with African countries and to promote resource related diplomacy of the Japanese government, Minister Amari, Ministry of Economy, Trade and Industry (METI) visited the Republic of South Africa and the Republic of Botswana from November 14 to 17, 2007, held talks with the presidents and ministers of both countries, and returned to Japan successfully concluding the trip.

The then Senior Vice-President Tatsuro Katsura, Vice-President Masakazu Yamazaki, and Research Coordinator Eikichi Tsukuda of AIST traveled with the Minister. Honored with the presence of Minister Buyelwa Sonjica of Ministry of Minerals and Energy of South Africa and Minister Amari, AIST, Japan Oil, Gas and Metals National Corporation (JOGMEC) and Council for Geoscience of South Africa concluded a Comprehensive MOU on November 16 at the Department of Minerals and Energy in Pretoria. South Africa has abundant resource reserves of rare metal, also called “vitamin of industries”, which is vital for high-tech products, and the MOU was concluded with an eye on securing rare metal supply. Specifically, what is being considered is conducting cooperative geological survey based on new technology of rare metal centering on rare earth. AIST is going to cooperate with the geological survey mainly by scientifically clarifying and grasping the components and nature of mineral deposits which is the basis of exploration technology. Presently, discussions have begun among the three organizations concerning specific research cooperation along the outline of the MOU.

On November 16, a MOU was concluded between JOGMEC and Geological Survey of Botswana at the Republic of Botswana. This is to strengthen relationships with this country which has the headquarters of Southern African Development Community (SADC) made of 14 countries. As the observation data of resource exploration satellite information of Japan (ASTER and PALSAR) will be used for the benefit of the 14 member nations of SADC, AIST is asked by JOGMEC for cooperation with such technology as GEO Grid.

On November 17, the party moved to South Africa, and Minister Amari exchanged views with the CEOs of Anglo Platinum. Then the party toured the platinum mine of Lonmin company, where the then Senior Vice-President Katsura and Research Coordinator Tsukuda grasped the situation of mineral related companies of South Africa from expert viewpoints.

This visit to South Africa and Botswana by Minister Amari was accompanied by people related to the government, private companies, AIST, and JOGMEC, and demonstrated their high level of interest in South Africa.

Presentation of GEO Grid at Fourth Earth Observation Summit

The Fourth Earth Observation Summit, sponsored by Group on Earth Observations (GEO), was held from November 28 to 30, 2007 at Cape Town. Representatives of over 100 member governments and international organizations discussed climate change by global warming as well as the construction of an international monitoring system against natural disasters, and Cape Town Declaration which advocates strengthening of international cooperation was adopted. The Japanese government organized a delegation with Minister Kisaburo Tokai, Ministry of Education, Culture, Sports, Science and Technology (MEXT) as the head (secretariat: Ocean and Earth Division, Research and Development Bureau, MEXT), and the then Director Satoshi Sekiguchi of AIST Grid Technology Research Center (GTRC) participated as a member of the delegation. At the attached exhibition, state of progress of the formulation of Global Earth Observation System of Systems (GEOSS), and the contributions of each organization were exhibited. From AIST, GEO Grid (Earth Observation Grid), chosen as one of the first 100 steps to GEOSS (published in a document of the same name), was presented with demonstrations. Geo Grid is an IT framework which promotes information sharing of data concerning cross-border earth observation and cooperation, and it attracted interest of many participants.

Then GTRC Director Sekiguchi explaining GEO Grid to MEXT Minister Tokai

MOU Follow-up Workshop between Department of Biotechnology, Ministry of Science and Technology of India and AIST

MOU follow-up workshop / symposium / bilateral meeting between Department of Biotechnology (DBT), Ministry of Science and Technology of India and AIST were held from January 22 to 23. This is based on the Comprehensive MOU concluded in February 2007 which advocates research cooperation in three topics: glycoengineering, cell engineering, and bioinformatics.

As the first cooperative project, an international symposium related to cell engineering was also held, and over 70 researchers from 8 countries including India participated.

At the bilateral meeting with DBT, three research units and International Affairs Department of AIST participated, and discussions were held in view of specific research cooperation. As a result, the structural difference between DBT, a government ministry, and AIST, a research institution, was confirmed, and specific collaborative research themes related to bioinformatics were also suggested. Hereafter, it was agreed, interaction among researchers will be promoted and individual collaborative research themes will be launched under the MOU.

Lecture by DBT Joint Secretary N.S. Samant

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AIST NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

Publication Office, Public Relations Department
National Institute of Advanced Industrial Science and Technology (AIST)

AIST Tsukuba Central 2, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan
TEL: +81-29-862-6217 FAX: +81-29-862-6212 Email: prpub@m.aist.go.jp URL: http://www.aist.go.jp/