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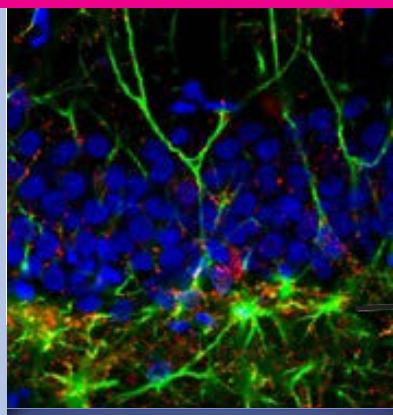
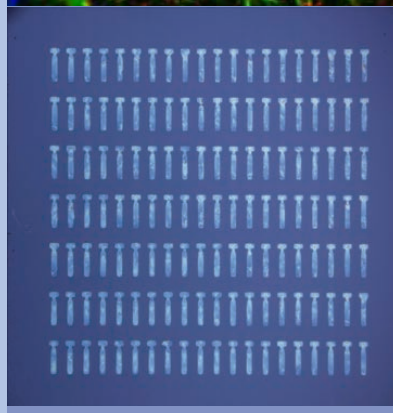




MESSAGE

President's Message
Scientific and Technological Innovation at AIST

FEATURE

AIST *Full Research* Supporting the Embedded System Industry
Open innovation based on industry-academia-government collaboration that makes best use of the strengths of the local community

Research Hotline
UPDATE FROM THE CUTTING EDGE（January–March 2012）

In Brief

Scientific and Technological Innovation at AIST

At the start of the new fiscal year

A year has passed since the Great East Japan Earthquake. Helped by everyone's warm and kind support, AIST has recovered its vitality. Although many issues still persist in the affected areas, as the president of AIST I have been greatly encouraged by the various forms of research activities carried out by our researchers in that will support the revitalization of the areas. The promotion of scientific and technological innovation policies is strongly emphasized in Japan's 4th Science and Technology Basic Plan, which was launched last year. I believe that these activities by our researchers are in line with the Basic Plan.

In the Basic Plan, "science, technology, and innovation" is defined as the "creation of intellectual/cultural values based on new knowledge obtained from scientific discovery, invention, etc., and the innovation to develop such knowledge into economic, social, or public value." AIST has, from the first day of its establishment, been conducting *Full Research* which puts emphasis on practical application while comprehensive and continuous R&B, from basic research to commercialization, is carried out. We will further promote it with confidence and responsibility.

At the AIST Advisory Board Meeting held in February, "the role of public research organizations in the era of globalization" was discussed with home and overseas board members. From this discussion, the following understandings were reached. Along with the growing intensification of global competition in innovation, worldwide issues such as the problem of global warming are also on the rise. For us to deal with these issues, it is indispensible to realize open innovation encompassing the industrial sector, academia such as universities, and public research organizations such as AIST. Public research organizations which are impartial and neutral should play the role of open innovation hubs. The scope of open innovation should not be confined within one country or region but should be extensive and global. Reflecting the high expectations being placed on the role of AIST, severe opinions were also voiced during the meeting. One example was the proposition that AIST should put more effort into revitalization of Japanese corporations, especially of manufacturing, the brand value of which seems to be declining in the world, and the creation of new industries combining software or services with hardware. We are now working to incorporate such outcomes into the promotion of scientific and technological innovation at AIST.

This year, the construction of the renewable energy research base will finally pick up speed. It will be constructed in an industrial park in Koriyama City and its effective site area is expected to be 50,000 m^2. The main research building will have four stories above ground and a total floor area of 8,000 m^2. The laboratory building is planned to be one story high with a total floor area of 4,000 m^2. The schedule calls for the design to be completed by the end of this year and for the construction to begin early next year. The facility is planned to house laboratories that can facilitate a wide variety of research, spaces that can be used for technical exchanges and human resource development, test beds for new technologies, etc. It will also be equipped with a photovoltaic power generation system, a geothermal air-conditioning system, natural lighting, and control technology that uses various sensors, and is intended to be a highly self-sustaining facility with a high energy-saving capacity. The themes of research to be carried out at this research base include solar energy, wind power, geothermal energy, energy management, and so on, and we are currently discussing how world-leading renewable energy research, development, and verification can be realized. Our goal is to create a research base that attracts a wide range of researchers and engineers from research institutions, universities, and corporations from both within Japan and abroad who wish to take up challenges in scientific and technological innovation in the field of renewable energy. We are especially interested in collaboration with the local community and thus, on February 16, we already concluded a partnership and cooperation agreement as well as a graduate school collaboration agreement with Fukushima University.

Evolving collaboration

In *AIST TODAY* 2012-1, I expressed my strong feelings at the time of the event entitled "AIST Open Lab 2011 – Let's keep on looking! The seeds of innovation for energizing Japan" held

at AIST Tsukuba last October, and stated that we have now entered a new era of industry-academia-government collaboration; in other words, an era of open innovation in which various players cooperate synergistically and complementarily to reach wide-ranging goals. In this issue, I would like to talk about the "*Full Research* Workshops" held at our regional research bases.

Last fiscal year was the third year since we transformed the workshops into events that are open to everyone. As the years progress, we have been seeing growing numbers of participants from local industrial sectors, universities, and governments. At the same time, the range of programs that are being offered to promote collaboration also seems to be evolving. The theme of the workshop selected by each regional center is listed below.

Hokkaido : Comprehensive utilization of biomass in Hokkaido – A proposal from AIST

Tohoku : Reconstruction of the Tohoku Region after the Great East Japan Earthquake and promotion of industry

Chubu : AIST's challenge for next-generation vehicles

Kansai : Scenario for a sustainable low-carbon society – To pass down a prosperous Japan of 2050 to younger generations

Chugoku : Challenges of the full-scale introduction of renewable energy and our plans for the future

Shikoku : Creating new industries to become a healthy 100-year-old

Kyushu : Current status and future development of AIST's support of regional corporations

Included were a few highly ambitious themes that had me worried as the president of AIST, but with the assistance of lecturers and panelists from outside AIST, all of the workshops were a success. The participants from outside of AIST had various backgrounds. From academia there were professors, associate professors, executive directors, and vice presidents of universities. From the industrial sector we had the heads of planning sections of service industries and trading companies; as well as heads of technology development at large- medium- and small-sized manufacturers and from primary materials industries such as metals, chemicals, and biotechnology; and from financial institutions there were heads of corporate finance. The participants from government comprised directors of the Ministry of Economy, Trade and Industry and executives of prefectural governments and public research institutes. In some regions, we were also honored by the attendance of, and an opening speech by, the prefectural governor, the chair of the local economic federation, or the director-general of the regional bureau of economy, trade and industry.

The displayed panels have also become more informative. In the beginning, the panels presented an introduction of the activities of the regional research base concerned, but now the display style has greatly evolved and from all AIST activities, the activities best suited to that particular region are selected and displayed. In addition, the number of display panels by local governments, corporations, and public research institutes has also increased and the workshops are functioning as a venue for mutual interactions. The quality of collaboration between innovation coordinators and technological advisors of AIST and the members of corporations and the local community seems to have also greatly improved.

It was also an opportunity for us to receive valuable opinions. Included were expectations for AIST's full and determined involvement in the revitalization of industry in each region; expectations for AIST to engage in pioneering research not only with short-term goals but from the medium- and long-term perspectives; expectations for AIST's effective support of the industrial sector, which is in the midst of global competition; and expectations for AIST's support in the field of human resource development, especially from small- and medium-sized companies that are facing difficulties in achieving this on their own. We are searching for ways in which we can incorporate these opinions into our future efforts for the development of research and into the further enhancement of collaborative activities.

Closing

The Japanese industrial sector is currently burdened by the "six intense sufferings" (see *AIST TODAY* 2012-1) beginning with the historically strong yen. However, among the members of the industrial sector that I have met in each region, the enthusiasm for managerial reform and technological innovation seems not to have diminished but to have increased. It appears that Japan has grown out of the "catch up and surpass" era and is currently tackling the much harder task of creating a new industrial nation. By sharing the same awareness of the issues with members of the industrial sector, AIST is committed to making contributions to the promotion of scientific and technological innovation.

Tamotsu NOMAKUCHI
President
National Institute of Advanced Industrial Science and Technology

AIST *Full Research* Supporting the Embedded System Industry

– Open innovation based on industry-academia-government collaboration that makes best use of the strengths of the local community –

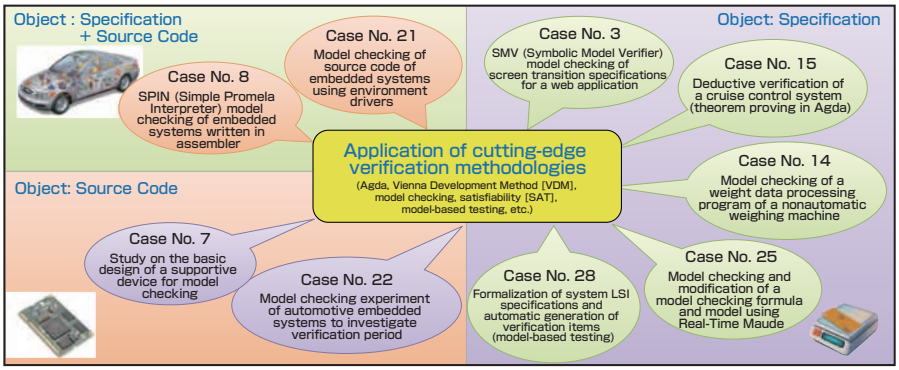
Activities of the Collaborative Research Team for Verification and Specification: An Introduction

Software has made its way into our daily environment in various forms. The roles of software are numerous, for example, of enabling human communication, transporting people and goods, and of supporting a comfortable living environment. For people to live in safety, stable systems that can support society over the long term are crucial.

Most software in everyday life is installed in electronic devices called embedded systems. An embedded system is a system composed of a device (hardware) and a program (software). Until recently, such systems were exclusively designed for specific functions, but with the progress in integrated circuit microfabrication technology, the number of large-scale multipurpose embedded systems is increasing. For example, about 100 embedded devices are used in a modern automobile and is said that programs of more than 10 million lines in total are required to actuate these devices.

However, correctly written software is not enough for these embedded systems to maintain stable operation. These systems must be able to prevent malfunctions and provide notifications of any abnormality if their internal data are altered by static electricity, cosmic rays, etc. Yet, no matter how carefully an embedded system might be constructed, it can never be considered to be lastingly perfect due to the possibility of an oversight in the design, an error in programming, an accident due to unanticipated use, and so on.

We at the Collaborative Research Team for Verification and Specification are conducting research on the industrial application of software and hardware analysis, design, and verification technologies based on mathematical principles, which are known as formal methods. Formal methods are composed of a collection of various techniques, and individual people will imagine different techniques upon hearing this term. The role we expect from formal methods is to become the foundation for the techniques used in software to minimize errors (high-reliability techniques) and find errors (system verification techniques).



More than 20 case studies on system verification

In integral-type development, which is a proud feature of Japan's manufacturing culture, a detailed specification tends not to be emphasized. The requirement for a detailed specification is not to use a large number of words, but to write the specification so that it is consistent, comprehensive, and unambiguous. In our research project, we have selected products in various industrial fields, from devices to real machines and products (systems), conducted modeling experiments on specifications, and developed techniques that can be used to prevent the introduction of erroneous factors.

AIST has been conducting case studies of model checking techniques used for finding errors in a system since 2003, and published a Japanese textbook on model checking in June 2006. Model checking is included in the industry-academia-government collaboration program for training advanced embedded software engineers (Kumikomi-Tekijuku), a regional program offered in collaboration with the Embedded System Industry Promotion Organization, which is a practical course allowing participants to acquire hands-on experience.

AIST Kansai, the base of this Collaborative Research Team, has strong connections with the business community in Kansai and is active in the utilization of technologies and human resource development. Formal methods have begun to attract the attention of the industrial community and an increasing number of companies are thinking about introducing them, but not infrequently, concerns over the difficulty of grasping them and the difficulty of obtaining information on their cost effectiveness are voiced. In the following feature articles, under the theme of "utilization of technologies,"

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collaborative research on software test design technologies and front-loading technologies based on formal methods is introduced. Additionally, a collaborative research case involving railroad systems and functional safety standards is introduced as a new technological trend.

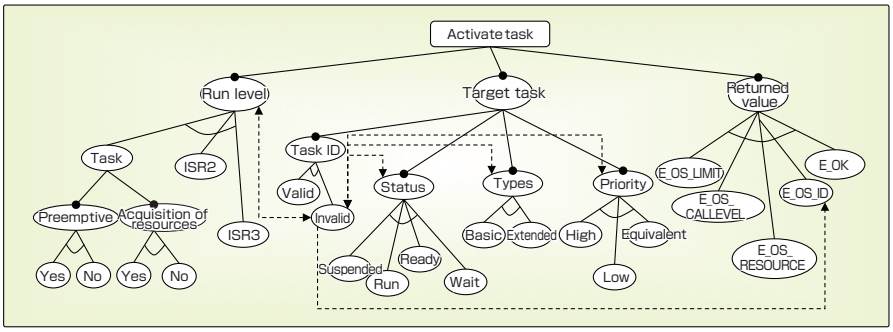
Under the theme of "human resources development," regional collaboration efforts with the Embedded System Industry Promotion Organization will be introduced with a special focus on Kumikomi-Tekijuku and verification service. Lastly, we will round-up by elucidating the strategic importance of embedded systems research in the regional innovation strategy of AIST Kansai.

Deputy Leader,
Collaborative Research Team for
Verification and Specification
Hitoshi OHSAKI

Example of Collaborative Research: Use of Formal Methods in the Development of a Test Design Technology for Highly Reliable Software

The front-runner in formal methods

The study of formal methods that began in the 1970s initially set as its ultimate goal the systematic development of software by verifying its correctness at each phase of development.* However, it must be admitted that we have still not reached this goal. Although one reason was technological, this situation was due more to the more fundamental problem of "what is correct software?" Nevertheless, apart from the attainment of this goal, formal methods are beginning to be used in software development in various ways from engineering standpoints. One such example is their fusion with software testing techniques. Formal methods and testing are software verification techniques, but each has different strengths. By devising the fusion of both techniques, effective verification techniques can be developed.



Example of test design for AUTOSAR using the FOT technique

FOT technique (Feature Oriented Testing)

We are developing a software testing method that incorporates several aspects of formal methods called Feature Oriented Testing (FOT) in collaboration with Toshiba Semiconductor & Storage Prodcuts Company. FOT provides a test-specification language based on an extended variant of an and-or logic tree with which developers analyse software requirements specifications and describe test designs. A set of test cases is mechanically constructed from the test designs. Then the software under test (SUT) is verified for its correctness by applying the set of test-cases to the SUT, which, as a result, confirms the conformance between SUT and its requirements specifications.

Included in FOT are several functions to practically support introduction to industry. The analysis method with graphical diagrams based on an and-or logic tree makes analysis intuitive and hence easy to handle, allowing developers to concentrate on problem analysis, and also lowering the barriers to introduction into industry. Additionally, its graphical representation visualizes the analysis and test-case designs, facilitating the review of analysis and designs among developers to check their correctness. Moreover, the automatic test-case construction from the test designs not only lowers costs for testing, but can also guarantee the correctness of the set of test cases (such as it is free from omissions, duplications and errors) by mathematically proving it.

We have conducted a case study of applying the technique to AUTOSAR (AUTomotive Open System ARchitecture), the next generation standard for automotive

systems. The figure shows a test-case design for "activateTask", an API-function of AUTOSAR. The case study demonstrates that test-cases are effectively analyzed and designed with the diagram of an extended and-or logic tree. And 721 test cases were automatically constructed from this diagram model. The case study has demonstrated the effectiveness of the technique. We are planning to apply this technique to various types of software in various domains that require high reliability.

As the often quoted phase, "there is no silver bullet** in software development," expresses, a single almighty solution to software development does not exist. And FOT, like other techniques, is not a dream technique that can get rid of all defects. However, it can tell us many things regarding defects and reliability around requirement specifications, which are a main basis of the question, "what is correct software?" Although there is no silver bullet in software development, different effective technologies and techniques can be combined to develop better methods. The Collaborative Research Team for Verification and Specification is conducting the research and development of techniques and methods that can be used to improve software reliability such as FOT.

Glossary

*: This approach is called Correct by Construction (CxC).

**: In folklore, the silver bullet is the only one kind of magic bullet that can finish off demons and monsters in a single blow. Derived from this, it means a simple guaranteed solution for a difficult or intractable problem.

Collaborative Research Team for Verification and Specification

Takashi KITAMURA

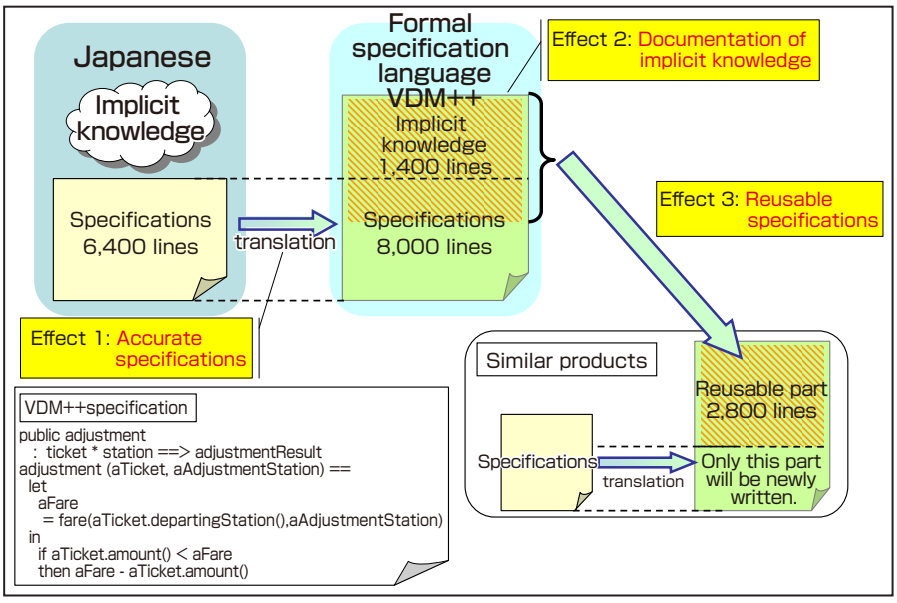
Example of Collaborative Research: Technology Development for Large-scale Upstream Process Tests — Front-loading of Embedded Systems Development —

Outline of research

This is a collaborative research project with Omron Social Solutions Co., Ltd. The railroad networks in Japan's urban areas are extremely large with more than 3,000 stations in the Tokyo metropolitan area alone, and with increased interconnection services between different railroad companies and the introduction of IC cards, the operation of station service equipment (ticket vending machines, fare adjustment machines, etc.) is becoming more complex. Meanwhile, station service equipment is expected to perform with high reliability as part of the public system. In this research, we focused on automatic fare adjustment software and constructed a highly reliable development method by resolving problems that existed in the upstream development process.

Writing accurate specifications

In current automatic fare adjustment software development, there is a problem that defects originating from specifications are increasing. This is because specifications are written in Japanese and thus have a tendency to be incomplete due to the vagueness of the language. It is also due to the existence of unwritten knowledge (implicit knowledge) that comes from the assumption of common knowledge. Incomplete descriptions and implicit knowledge lead to misunderstanding of specifications by developers and the occurrence of defects.



Effects of formal description of specification

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To resolve this problem, the present Japanese specifications were translated into the formal specification language VDM++ (formal description) and the effect of this was examined. A formal specification language is a structured language that is based on mathematics; by adopting a formal description, many incomplete descriptions can be eliminated.

The following three results were achieved as a result of this formal description (see figure):

1. accurately written specifications
2. documentation of implicit knowledge and elimination of dependency on individual skills
3. secured reusability of specifications.

Large-scale test environment for upstream process

When Japanese specifications are translated into VDM++, the specifications become testable (= executable). Testing of specifications makes it possible to check whether the specifications are written as intended and to provide specification test results to the test process as test cases. To put this into practice, an environment in which VDM++ specifications can be executed at high speed is indispensable.

In addition to specifications, an enormous amount of data is necessary to run automatic fare adjustment software. If all of these data are written in VDM++, the total amounts to about 800,000 lines. This gives rise to the shortcoming that a large-capacity memory is required as well as a long time is needed for specification test execution. To overcome this problem, a test environment was constructed in which the VDM++ specification and C++ software could be run in unison and data that were not essential to the specifications were processed by the existing software written in C++. Using this test environment, 850,000 test cases were executed. The results confirmed that a large-capacity memory was not necessary to run the software, the run time could be greatly reduced, and the system was practical.

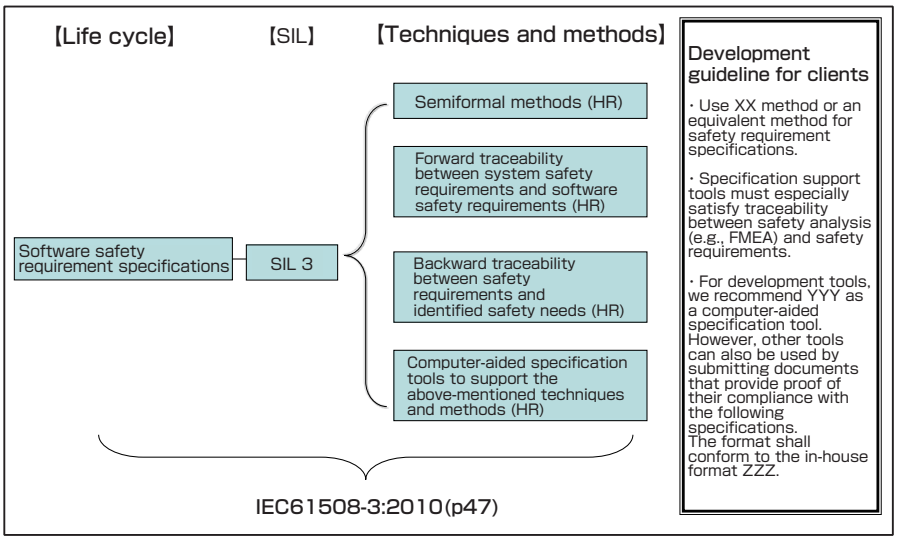
Omron Social Solutions Co., Ltd.
Goro HATAYAMA

Collaborative Research Team for Verification and Specification
Daisuke SOUMA

New Trends in Research: Functional Safety Standards and Social Systems

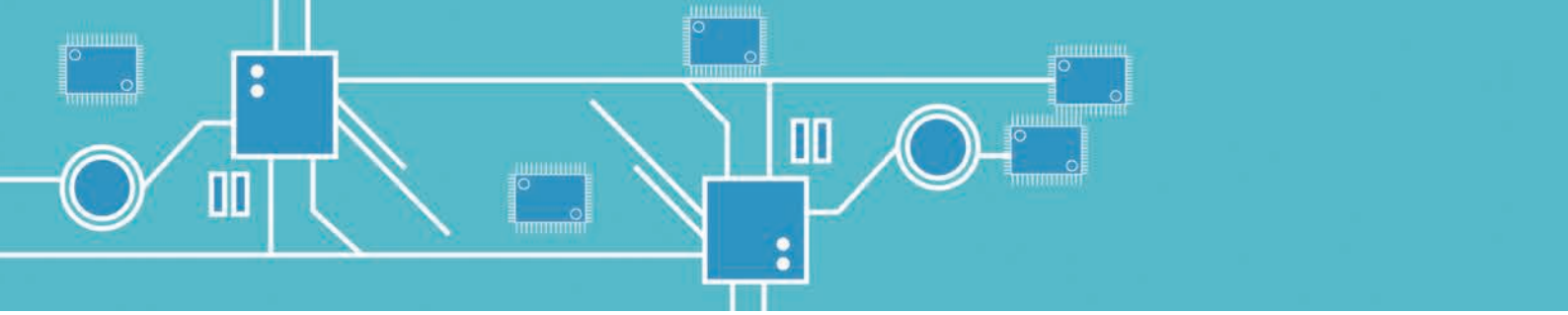
Circumstances surrounding the railway system

The Japanese railway system is proud of its railway technology with its exceptionally high standards even from a global prospective, and is developing and operating high-speed railway networks such as the Shinkansen (“Bullet Trains”) while maintaining high safety and reliability. In recent years, it has also been expected to play its vital part in Japan’s economic development strategy in the area of social infrastructure exports. However, there is still only a small track record in railway system export, and this is a major problem.



Example of client-side development guideline

Although there is unwavering trust in the safety of the railway system in Japan, there are several hindrances when it is to be exported overseas. One such hindrance is the functional safety certification conforming to international standards.



International functional safety standard applicable to railways

Nowadays, the term *functional safety* has great significance in various industrial fields. Functional safety is not intended to eliminate every cause of risk to a system, but to cope with risk to the allowed extent by the functioning of the system. The IEC 61508 standard is considered to be the basic standard for functional safety and is specified for electrical and electronic components, but similar standards have been issued for various other industrial fields as well. In the field of robotics, ISO 13482 is currently in the process of finalization, and in the medical device field there is the IEC 62304 standard.

EN 50126/IEC 62278, referred to as the RAMS standard, serves as a functional safety standard in the field of railways. This standard examines whether the system satisfies Reliability, Availability, Maintainability, and Safety, the four crucial non-functional requirements for a railway system. Reliability is related to the failure rate. When the failure rate is low, reliability becomes higher. A relationship exists such that even when things do go wrong, if the maintainability is high, the time for repair work will be short, and trains can be operated longer, therefore their availability will be higher. As described here, RAMS focuses on characteristics that are especially important to the system.

There is a series of standards for railway systems including the above standard and when exporting railway systems overseas, it is common for overseas clients to demand conformity with these standards.

The efforts of the research group

To respond to these trends in the industrial sector, our research group has been providing collaborative research and technical consultations on functional safety standards and guidelines for various industrial fields from the perspective of research on development methodologies for highly reliable systems. As for our achievements, we have adopted the processes from safety analysis to the definition of functional safety requirements with the aim of ensuring safety by applying the safety analysis process described in ISO 26262, which is the standard for embedded automotive systems, to hazard analysis and risk assessment of a railway system.

As shown above, beginning with investigations and research on standards in various industrial fields, we have been conducting research on safety analysis methods and research and development of certification support development guidelines from the perspective of clients such as railway companies and certification support processes based on safety cases. These research activities, on one hand, provide direct technical support to the industrial sector for more efficient and effective acquisition of certification. On the other hand, they also comprise of research and development to guarantee high reliability and high safety of a system. We are planning to further pursue these research activities, since we are firmly convinced that they will be a part of integral core technologies for Japan's future industrial sector.

Collaborative Research Team for
Verification and Specification
Kenji TAGUCHI

Path Leading to the Establishment of the Embedded System Industry Promotion Organization (ESIP)

In June 2006, the Kansai Association of Corporate Executives founded the Software Industry Promotion Committee (Chair: Shinichi OTAKE, the current President of Nippon Telegraph and Telephone West Corporation) to discuss promotion of the software industry in the Kansai area. Active debates unfolded with a total of 15 participants from both industry and academia including representative Japanese household electric appliance manufacturers such as Sharp Corporation, Daikin Industries, Ltd., and Panasonic Corporation; software houses; and vocational schools. Professor Makoto IMASE of the Graduate School of Information Science and Technology of Osaka University joined as an advisor. In March 2007, the Committee set "Osaka and Kansai, a major center for embedded software industries!" as a goal and advocated the importance of creating a platform that would serve as a driving force to realize this goal. In response, in August 2007, the Embedded Software Industry Promotion Council (Chair: Hideo MIYAHARA, President of the National Institute of Information and Communications Technology [NICT]), the predecessor of the Embedded System

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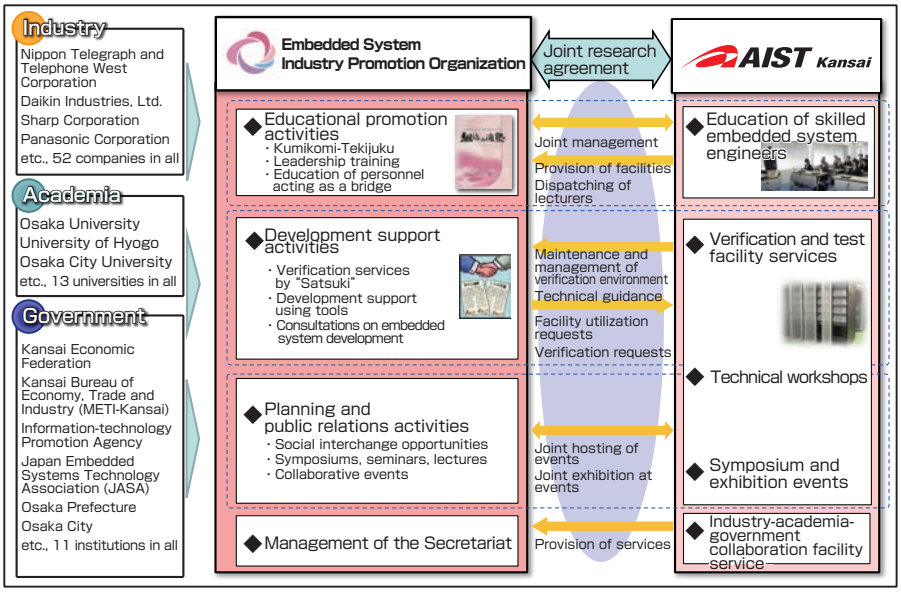
Industry Promotion Organization, was established as an organization within the Kansai Economic Federation.

Lively discussions were held among many members at the Promotion Council to explore the feasibility of businesses and services necessary for the vitalization of industries in the Kansai area based on the following five issues: education of skilled embedded software engineers, expansion of basic- and mid-level engineers, collaboration with Asian countries, quality improvement in software development, and increasing business transactions. As a result, for functions concerning education such as Kumikomi-Tekijuku,an agreement was reached on the necessity of expanding educational programs. Measures include programs to educate personnel who could act as a bridge, by creating a system for securing lecturers and a stable enrollment of students. The need for continued discussions was agreed for issues related to the expansion of development support services that directly contribute to quality improvement in embedded software development. Other goals include matching companies to facilitate business transactions. In light of these needs, the Promotion Council reached the conclusion that it should continue its activities to further deepen and augment the results so far, and to bring the provision of practical services to fruition. The "Embedded Software" part of the official name of the Promotion Council was changed to "Embedded System" due to the necessity of expanding its sphere of activities to encompass not only the embedded software industry, but also hardware industrial fields such as information home appliances, environment and energy equipment, medical instruments, factory automation control equipment, automobiles, etc. The original Japanese word for promotion was also changed to highlight the determination to vitalize the industry. In June 2010, the tasks of the Promotion Council were transferred to the Embedded System Industry Promotion Organization (Chair: Hideo MIYAHARA, President of NICT).



The industry-academia-government cooperative platform

The pillars of the activities of the Promotion Organization are education, development support, and planning and public relations. It is also engaged in new services that aim to materialize the discussions that took place at the Promotion Council so as to further vitalize the embedded system industry. In addition to improving the current educational activities such as the Kumikomi-Tekijuku (the best known activity of the Promotion Organization), the organization is also conducting other activities together with member corporations. These activities include offering "Satsuki" facility and verification services in cooperation with AIST, organizing exhibitions to match companies according to their business needs, providing development support activities such as support for overseas expansion, seeking the best industrial promotion measures for vitalizing industries, and planning and public relations activities such as social interchange opportunities or exhibitions.

The Embedded System Industry Promotion Organization is determined to continue to act as a platform for industry-academia-government cooperation (see figure) and to engage in activities that contribute to the vitalization of the embedded system industry. We will further enhance our services and programs based on the collaboration with AIST Kansai that has continued since the initial establishment of the Promotion Council.

Senior Executive Vice President
Nippon Telegraph and Telephone West Corporation
Noriaki ITO

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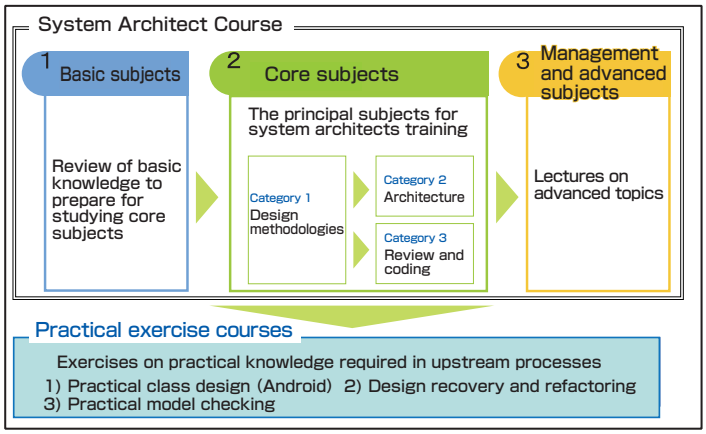
Developing the Advanced embedded software Industry-academia-government collaboration program

Introduction

Subcommittee 1 of the Embedded Software Industry Promotion Conference, responsible for higher education for embedded software engineers, developed the Advanced embedded software Industry-academia-government collaboration program. With the program Subcommittee 1 has been fostering system architects, who create new concepts for products and systems that use embedded software, who decide the optimal architectures for hardware and software, and who take responsibility for the basic design of embedded software. Stimulating discussions on the vision of educating skilled engineers were held at several working groups within the subcommittee, in which corporations, universities, AIST, and the Information-technology Promotion Agency (IPA) participate. Those activities result in the establishment of a unique training program for advanced engineers. The program is named "Kumikomi-Tekijuku" to embody the spirit of "Tekijuku", a noted early school established by Kōan OGATA (1810-1863), who made his name in Osaka. Kumikomi-Tekijuku was launched in July 2008, and the fifth lectures will be held in 2012.

Concepts behind system architect fostering

- Clearly define the system architects to be fostered and the principles and characteristics of the training program, and clarify the knowledge and skills necessary for the program.



Overview of Kumikomi-Tekijuku curriculum

- Research currently available training programs in detail and learn from their management and issues arising from such programs.
- Encourage learning not only by lectures but also by exercises and report making, in order to acquire practical skills that can be used in actual system development immediately.
- After the program, evaluate the results and improve the curriculum.

Basic policies of program curriculum and management

1) Systematic curriculum based on software engineering techniques

- Typical techniques on software design such as structured design, object-oriented design, and Unified Modeling Language
- Designs specific to embedded software such as state transitions systems, time-driven systems, and parallel processing
- Implementation techniques with high reliability and maintainability, quality management including reviews, and the ability to understand source codes
- The ability to follow modern knowledge related to embedded software

2) Teaching world-leading skills on solving actual problems

- The knowledge useful in solving problems which software engineers face
- Consideration of international standards
- Formalization of know-how accumulated at actual software development, and incorporation of it into the curriculum
- Offering practical exercise courses in addition to lectures for relating the knowledge to actual software development

3) First-class faculty

- The matter from cutting-edge research done at universities, and know-how about system development in industry
- Experiences learned from actual projects introduced by the companies concerned
- A place for self-improvement through mutual efforts between the faculty and students, and between the students themselves

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An efficient collaboration of industry, academia, and government

Industry:Corporate members of the subcommittee made contributions to formulate the program; they gave many lectures, and incorporated the needs of industry into the training program.

Academia: The training program was aligned with highly advanced educational programs such as the IT Specialist Program Initiative for Reality-based Advanced Learning (IT Spiral), a program led by Osaka University and offered by nine universities with courses on information systems in the Kansai area.

Government: AIST has been a joint partner in pursuit of this project. It has provided not only AIST Kansai's educational facilities and equipment but also the verification support service using the "Satsuki", the collaborative verification facility.

Future development of Kumikomi-Tekijuku

The Education Subcommittee of the Embedded System Industry Promotion Organization that succeeded the Embedded Software Industry Promotion Conference is making every effort to further educate embedded software engineers as follows:

- Development of an embedded systems developer's career plan, which shows career paths for software engineers and their required skills, and standardization of the career plan in collaboration with IPA.
- Development of a training program for bridge SE, who will perform an important role as a bridge in expanding activities to overseas or offshore development for software companies.

Director,
Embedded System Industry
Promotion Organization
Kiyoshi NINOMIYA

Fostering of Human Resources for Model Checking

Development of model checking training materials

In the early 2000s, AIST conducted joint research with a company on the application of model checking. One of the goals of this research was to introduce model checking into an actual development site and to realize this, technical training materials had to be developed.

To apply model checking, the model to be tested must be written in a special language. The characteristics that are to be tested must also be written using a logical system called temporal logic. Temporal logic itself is an abstract concept that is not normally used in system development, and it therefore takes time just to understand it.

The development of the technical training materials was implemented based on the following basic principles: The overall structure was to be based on exercises and explanations were to be broken down and presented in detail. All exercises were to follow the checking process sequence from

Fig.1 Model checking training textbooks

Fig.2 Lecture scene at Kumikomi-Tekijuku

understanding of problems, modeling, and checking through to analysis of the results, and constructed to facilitate understanding of the meaning of each procedure within the whole checking process. Meanwhile, explanations of matters such as background theory and the checking of algorithms not directly linked to model checking were omitted.

The formulated materials were used in the joint research and proved to be useful in a short-term (five-day) introductory training in model checking. However, textbooks on model checking at the time were mostly in English and opportunities for technical training were limited. For these reasons, the above materials were revised and a training environment including textbooks was organized (Fig. 1). In addition, the Model Checking Training Course was held and direct training was offered. The attendees of the course totaled about 100 engineers, mainly in the field of embedded systems development.

Practical model checking

In 2007, when Kumikomi-Tekijuku was being planned, formal verification techniques such as model checking and formal methods were beginning to receive considerable attention as a means for improving the quality of software design. At a working group for the planning of Kumikomi-Tekijuku, the need for knowledge of verification was also discussed and a decision was made to hold a program named the Model Checking Course. In the following year, a practical exercise program called the Practical Model Checking Course was inaugurated. This course includes illustrative cases and explanations of verification processes, comprising knowledge that is directly connected to actual development sites in addition to the contents of the Model Checking Training Course, and is constructed as a highly intensive exercise course (Fig. 2).

In the current trend of increased interest in formal verification techniques, the Practical Model Checking Course has gained popularity as one of the few regularly held model checking training courses in Japan. We believe that this is due to the cooperative efforts of especially the attendees of the course and the industrial sector that began right from the initial stage of training materials development.

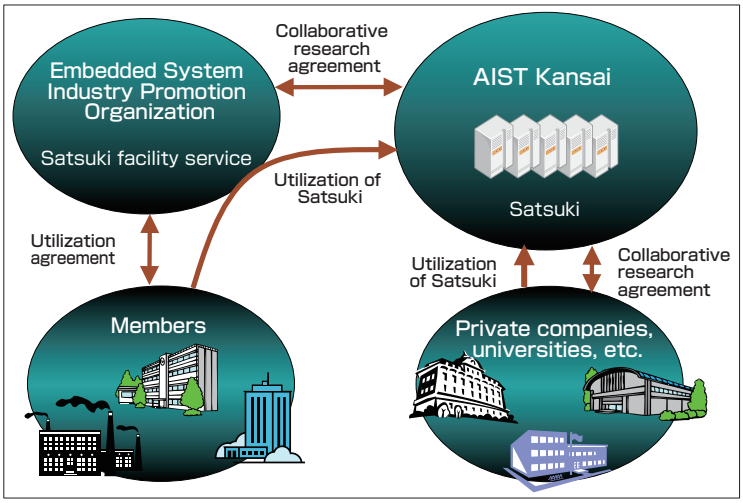
Collaborative Research Team for
Verification and Specification
Hideaki NISHIHARA

"Satsuki" Cluster for Verification

The launch of Satsuki

In October 2007, many automatic ticket gates in the metropolitan area stopped functioning, affecting a large number of people. Not only this, but many other embedded systems also frequently malfunctioned at the time. The Ministry of Economy, Trade and Industry (METI) decided that urgent measures must be taken to improve system reliability and began to study the creation of verification test facilities for embedded systems.

The Research Center for Verification and Semantics, the predecessor of our collaborative research team, had a long history of research on embedded systems verification. In addition, the Kansai area was a production center for embedded devices that were closely connected to people's daily lives. For these reasons, METI asked the Research Center for Verification and Semantics to consider the establishment of a verification test facility, and a decision was made to incorporate the creation of a verification facility in AIST Kansai into the FY2007 supplementary budget. Prior to its establishment, the opinions of the industrial sector, academic institutions, and public



Flow of Satsuki use

For inquiries about this article : Collaborative Research Team for Verification and Specification http://cfv.jp/cvs/index.html

agencies were collected and the scheme of the facility was studied. In the end, it was decided that the facility would be based on a cluster system, and it was completed at the end of March 2009.

Characteristics of Satsuki

The configuration of Satsuki emphasizes two factors that are crucial to the verification of an embedded system.

One factor is large-capacity memory. Large-capacity memory is vital for the verification of large-scale systems and for the comprehensive execution and analysis of a program. Satsuki has a large-capacity memory cluster centered around three computers, each with one terabyte of memory. It offers a total memory of 10 terabytes, thus allowing the verification of large-scale systems that was previously impossible. The other factor is an environment in which numerous computers necessary for analyzing the execution statuses of a large number of mutually communicating embedded devices are connected in a complex manner. The configuration of Satsuki emphasizes the number of connected computers more than their individual capacity, and the system is thus configured as a large-scale computation cluster. Taking advantage of the sheer number of computers, it is also well suited to distributed verification of enormous amounts of test data. For example, Satsuki proved to be effective in the verification of a fare adjustment system for the Tokyo metropolitan area, which is described as an example of collaborative research on page 6.

The characteristics of the style of use of Satsuki lie in exclusive utilization of each computer by individual users and long-term continuous utilization in units of a week. Continuous computation for more than six months has already produced results such as the solving of a previously unsolved optimization problem. Exclusive utilization also frees users from worries about interferences from other users.

A cluster open to everyone

In Satsuki, various model checking tools necessary for embedded system software verification can be used, including the Simple Promela Interpreter (SPIN), new symbolic model checker (NuSMV), Mini SATisfiability (MiniSAT), CVC3, Agda. In addition, to support not only software verification but verification in a wide range of other fields as well, fluid simulation software, structural analysis software, and others are also available for use.

Satsuki is a facility for everyone in industry, academia, and government. Utilization of Satsuki through the Satsuki facility service provided by the Embedded System Industry Promotion Organization requires a simple application procedure. For more detailed information on the cluster and its method of use, please access http://cfv.jp/cvs/service/.

Collaborative Research Team for Verification and Specification
Hayao NAKAHARA

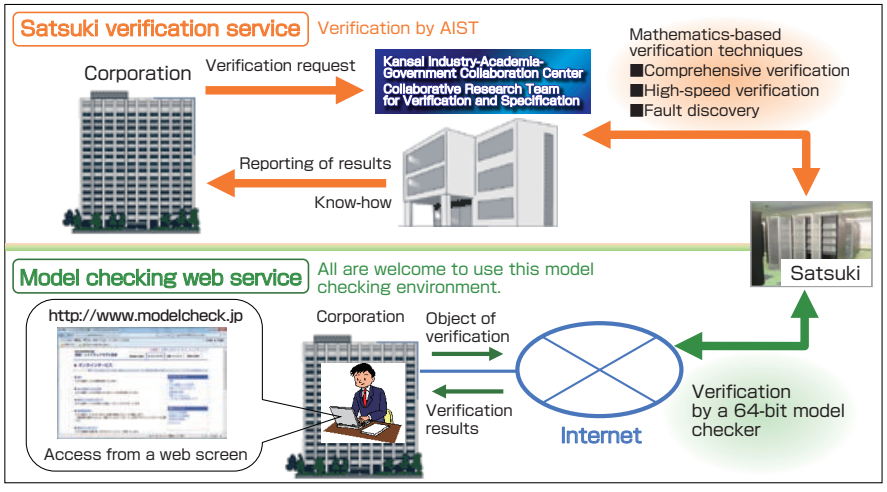
Verification Services

Introduction

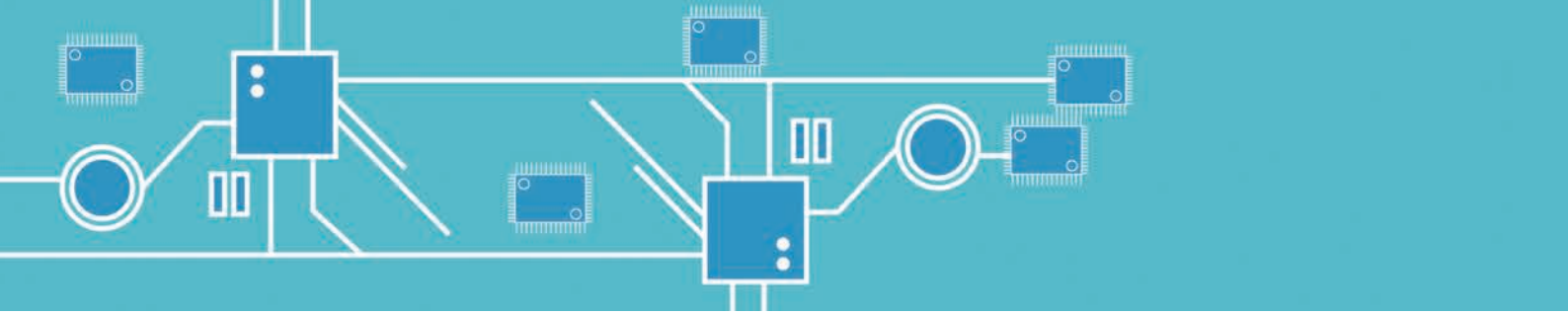
The following is an introduction to our two services. These two services are both offered through the collaboration among Satsuki, the Embedded System Industry Promotion Organization, and Kansai-based corporations and are an integral part of regional collaboration in the Kansai area.

Satsuki verification service

The ability to comprehensively verify the behavior and status of a system without much input in terms of human involvement



Satsuki verification service and model checking web service



and time has long been the dream of system engineers. The Satsuki verification service is a dream come true, made possible by cutting-edge mathematics-based techniques such as the model checking technique. In one case, it verified several ten trillions of statuses in several hours. To give an example of statuses, a traffic light has three possible statuses: red, yellow, and green. Using the conventional test method, even if one status was verified in a second, statuses of several ten trillions in number would take more than 300,000 years.

Through comprehensive verification, even the smallest of defects can be discovered. In the case of a frozen display of a game machine, one of the causes was that the system entered an unexpected state due to changes in the external environment. For corporate users, we offer the opportunity to acquire AIST's know-how in modeling after participating in the very first verification process. At present, two engineers are with us to learn the techniques. With our next target set as eliminating the expression "system failure" from TV news and newspapers, we are determined to continue our efforts in providing this verification service and technology transfers to the industrial sector.

Venture business inheriting the technology of AIST

Formal Tech Co., Ltd. was established in Kobe to promote the mathematics-based techniques acquired at AIST to the industrial sector and to support the verification services.

Collaborative Research Team for Verification and Specification
Formal Tech Co., Ltd.
Koji HAYAMIZU

Model checking web service using a 64-bit model checker

In this service, which is unique in the world, ordinary users can upload the model to be checked to the website and receive the model checking results on the same screen.

Looking back, a new, previously unheard-of technique called model checking was first introduced to us at the end of 2001, the year of AIST's establishment. Since then, for more than 10 years, we have been promoting its use as a technique indispensable for improving the quality of system development in collaboration with AIST. In the middle of the research period, we began to develop our original model checkers to replace overseas counterparts as our independent research. When we were about to complete the development of a 64-bit model checker with the kind help of Professor Hiromi HIRAISHI of Kyoto Sangyo University, the idea of turning it into a web service was introduced at a workshop. We approached AIST again for collaborative research and, since 2010, we have been offering a tentative free web service using Satsuki.

Since we do not keep system logs in consideration of security, we do not have details of the models and model checking results, but it is widely used by universities and private companies as a secure and easy-to-use model checking environment.

Power Engineering R&D Center,
Kansai Electric Power Co., Inc.
Koichi SHINOZAKI

Kansai Regional Innovation Strategy

AIST Kansai was born at the time of the founding of AIST in 2001 by incorporating the Osaka National Research Institute (ONRI) and branches of the Electrotechnical Laboratory, the National Research Laboratory of Metrology, and the Geological Survey of Japan. The parent body ONRI was established in 1918 in response to strong requests by the industrial sector in Osaka as a base for promoting manufacturing based on Japan-developed technologies. From the very beginning of its establishment, ONRI had a culture of enthusiastically promoting collaboration with and technology transfers to the industrial sector. Before World War II, for example, it contributed to the local industrial sector including the transfer of technology for dry plate photography to Konishiroku (which later became Konica Corporation). After the war, it invented carbon fiber, a transparent conductive film, and the nickel-hydrogen battery, contributing to the creation of world-leading industrial technologies including aircraft materials, liquid crystal displays, and hybrid cars.

AIST Kansai inherited this type of culture and, at the time of establishment

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AIST *Full Research* Supporting the Embedded System Industry

– Open innovation based on industry-academia-government collaboration that makes best use of the strengths of the local community –

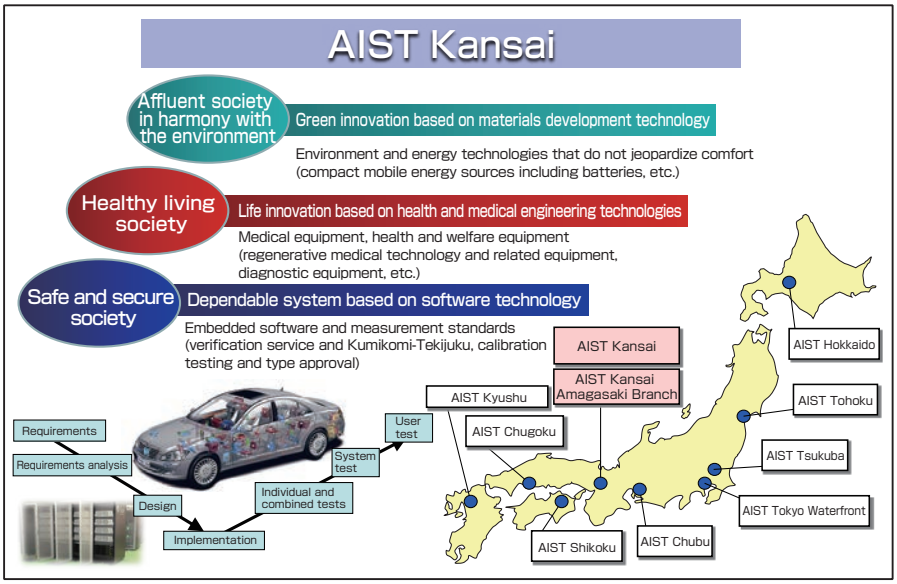
of AIST, the following were set up: the Special Division for Green Life Technology to promote green innovation, the Tissue Engineering Research Center, the Special Division for Human Life Technology, and the Life Electronics Laboratory to promote life innovation, and in anticipation of the advent of new industrial foundations, the Laboratory for Verification and Semantics.

In FY2010, AIST entered its third midium-term plan period and at AIST Kansai, we selected three priority fields and are strengthening collaboration with the industrial sector and academic societies mainly in the Kansai area. The three fields are green technology focusing on the battery technology, life technology focusing on the drug development-supporting technology and the medical and diagnostic equipment technology, and the embedded systems technology to strengthen the foundations of industry.

Based on AIST's motto of "Technology for Society," regional innovation plans are laid out for each and every regional research base. Included for AIST Kansai are nurturing of the storage battery industry, the biopharmaceutical industry, and the embedded systems technology-related industry, each corresponding to our three priority fields.

This feature article introduces activities aimed at the realization of the third regional innovation plan.

Embedded systems technology is indispensable for the accurate operation of embedded software in information appliances, but recently it has also become an essential technology for much larger mechanical systems. For example, recent automobiles have become a product of wide-ranging information control, railroad and airline networks require complex control, and power supplies will be controlled via smart grids. When all of these are considered, the importance of embedded systems technology is easily understood.



The three priority fields at AIST Kansai

At AIST Kansai, research on verification technology that utilizes mathematics and computer science is being undertaken in collaboration with the Information Technology Research Institute of AIST. At the same time, the Collaborative Research Team for Verification and Specification has been established and, based on collaboration with the Kansai Economic Federation, we are pursuing human resource development and verification services jointly with the Embedded System Industry Promotion Organization (ESIP), founded by the industrial sector.

Through these collaborations, we are strengthening technology exchanges with many ESIP member corporations. In addition, we are administering Kumikomi-Tekijuku based on a collaboration headed by Osaka University and researchers at other universities and corporations. The Collaborative Research Team for Verification and Specification is a perfect example of an Open Innovation Hub, one of the aims of AIST.

Embedded system technology is not just one technology within the field of information technology, but a fundamental manufacturing technology, and has the power to revolutionize the development process itself. AIST Kansai is strongly pursuing industry-academia-government collaboration based on the understanding that the establishment of this technology is essential to the development of the industrial sector. In addition to the present activities, we are planning to devote more efforts to standardization strategies and overseas collaboration activities.

Director, AIST Kansai
Team Leader,
Collaborative Research Team for
Verification and Specification
Takahisa TAGUCHI

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Research Hotline

UPDATE FROM THE CUTTING EDGE

Jan.-Mar. 2012

The abstracts of the recent research information appearing in Vol.12 No.1-3 of "AIST TODAY" are introduced here, classified by research areas.
For inquiry about the full article, please contact the author via e-mail.

Environment and Energy

New production technology for polycrystalline silicon solar cells

Surface texturing method of wafers sliced with fixed-abrasive wire

We have developed a new surface texturing method for polycrystalline silicon solar cells. Recently, a fixed-abrasive wire (diamond wire) where diamond grits are fixed on the surface of a piano wire is attracting much interest because of its advantages such as a higher slicing speed of Si ingots and a coolant without the slurry. However, the surface texture formation on diamond-wire-sawn wafers was difficult since the surface morphology of these wafers was mirror-smooth. A new method has thus been sought to form the texturing surface with low reflectance. In our new texturing method, the wafer is sandblasted to obtain desired asperity on its surface. Subsequently, the wafer is immersed in a newly developed acid-etching solution to form a uniform surface texture with low reflectance. The polycrystalline Si solar cells fabricated using this method have exhibited good performance. This method is inexpensive and suitable for industrial-scale production.

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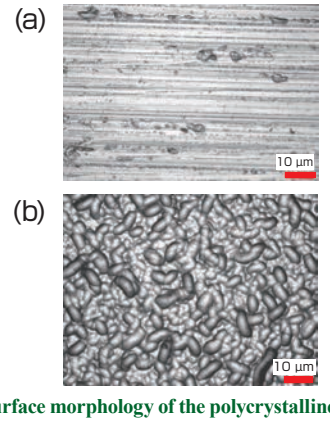
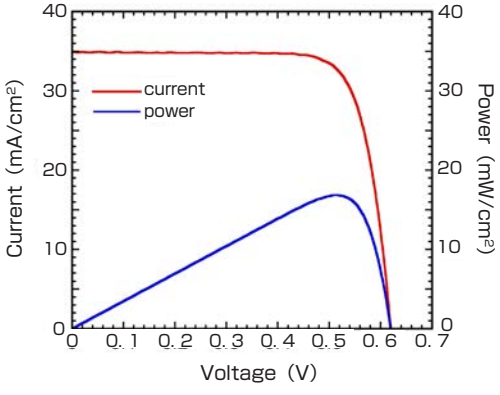
AIST TODAY Vol.12 No.1 p.16 (2012)



Surface morphology of the polycrystalline Si wafers
(a) The wafer sliced with a fixed-abrasive wire
(b) The surface structure textured with our method



Current-voltage characteristic of the solar cell

Development of diamond bipolar transistor

Low loss power device contributing to a sustainable society

We have developed a diamond bipolar transistor with a current amplification ratio of around 10 under the condition of the common-emitter configuration. The transistor consists of heavily phosphorus doped n-type and heavily boron doped p-type diamond layers in addition to well-controlled n-type and intrinsic diamond layers. This success has been achieved by the introduction of the low resistive n-type layer and the low contact resistance between metal and the n-type layer.

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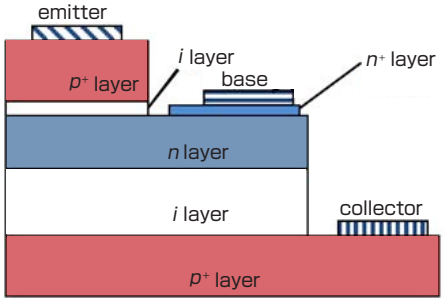
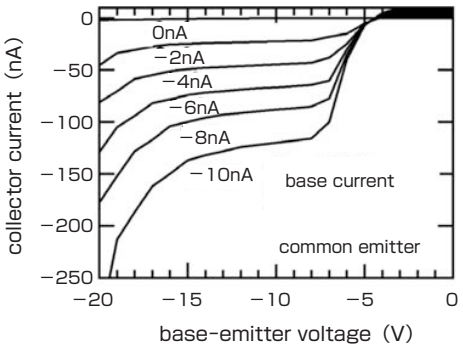
AIST TODAY Vol.12 No.2 p.14 (2012)



Structure of diamond bipolar transistor



Electrical transport properties of diamond power device
Collector current is amplified to around 10 times of base current.

Development of positive electrode materials for low-cost and high-performance rechargeable lithium-ion batteries

Co- and Ni-free and high capacity positive electrode materials

New oxide materials for the positive electrode consisting of lithium, iron, titanium, and manganese ($Li_{1+x}(Fe_{0.3}Mn_{0.7})_{1-x}O_2$ and $Li_{1+x}(Fe_{0.3}Mn_{0.5}Ti_{0.2})_{1-x}O_2$, $0<x<1/3$) are developed by a wet chemical method including carbothermal reduction process. These materials do not contain rare metals, cobalt and nickel, and have favorable battery characteristics (about 250 mAh/g of initial discharge capacity and above 80 % of initial cycle efficiency) in the same potential range (2.0-4.8 V) as that of conventional positive electrodes ($Li_{1.2}Co_{0.13}Ni_{0.13}Mn_{0.54}O_2$) . This development offers a high prospect for conserving resources and reducing the cost of rechargeable lithium-ion batteries used in electric vehicles by utilizing iron and titanium.

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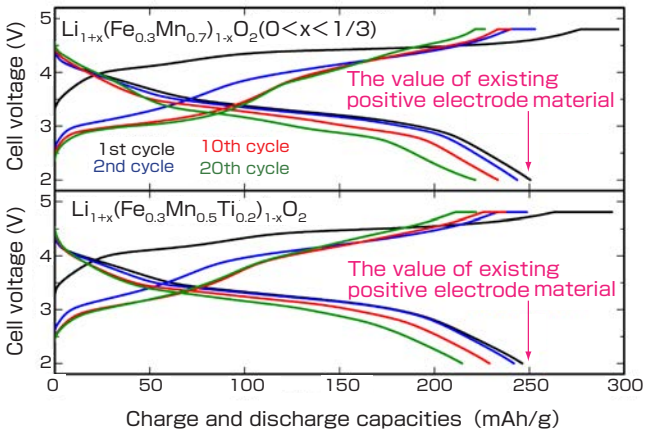
AIST TODAY Vol.12 No.3 p.12 (2012)



Comparison of charge and discharge cycle characteristics of two types of newly developed positive electrode material for up to 20 cycles at 30 ℃
Metallic lithium is used as the negative electrode material. (potential range: 2.0 V to 4.8 V)

Factor regulating the aging and rejuvenation of the brain

Discovery of an environmental factor for the activation of aged neural stem cells

We have discovered a factor that causes the impairment of neurogenesis in the aged brain. A mechanism has been identified by which stimuli including exercise re-activate the ability to generate newborn neurons that have declined due to aging. The discovery is expected to contribute to the prevention of diseases and the development of drugs and treatments, using a new target agent that controls neighborhood cells surrounding neural stem cells. We will further analyze the role of cells surrounding neural stem cells, which affect aging and various neurological disorders, to search for a new molecular marker detection method useful for diagnosis. We will develop industrial applications of the findings, including the development of drugs and new medical technology that promote the activation of stem cell-supporting cell populations without manipulating stem cells.

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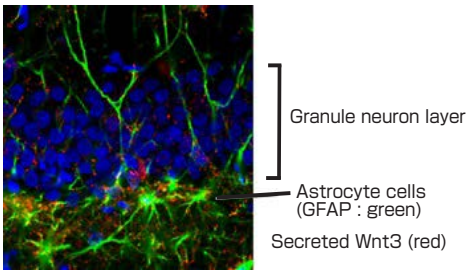
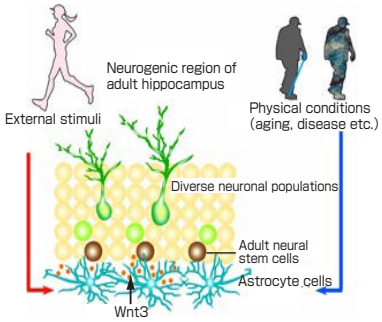
AIST TODAY Vol.12 No.2 p.15 (2012)



Wnt3 expression in adult hippocampus



The factor transmitting information on individuals to neural stem cells (Wnt3: orange)
The regulatory mechanism itself in neural stem cells responsible for the differentiation for the neuronal diversity remains unchanged, but the Wnt3 productivity of astrocytes is largely dependent on the condition of individuals.

Manufacturing technology for single-crystal thin films of organic semiconductors

Highest-performance printed thin-film transistors have been realized

We have developed a manufacturing technology for single-crystal thin films of organic semiconductors at arbitrary positions on the surface of sheets using a novel inkjet printing technique. The technique uses alternating print deposition of microliquid droplets both of ink composed of a dissolved organic semiconductor and of another ink that prompts crystallization of the organic semiconductor. The technology allows producing single-crystal thin films of an organic semiconductor, C_8-BTBT, with molecularly flat surfaces, and thereby improving performance of thin-film transistors (TFTs) that are indispensable building blocks for large-area electronics products such as flat displays. The performance of the device is 100 times as high as that of TFTs fabricated by conventional printing methods. It is expected that the technology would greatly accelerate the research and development of flexible electronic devices.

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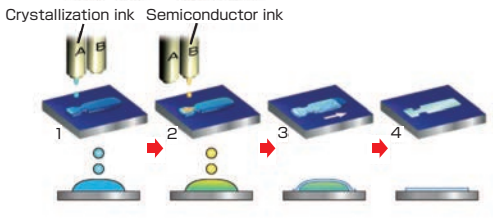
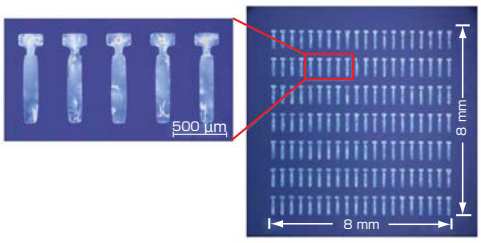
Flexible Electronics Research Center

AIST TODAY Vol.12 No.1 p.17 (2012)



Schematic of semiconductor single-crystal thin film production by the double-shot inkjet printing technique



Single-crystal thin films of organic semiconductors formed at respective positions by a new inkjet printing technique

Position control of a transistor source–drain junction with sub-nanometer accuracy

Expected to be a new junction technology for the MOS transistors of 16-nm generation and beyond

We have developed a new metal source-drain junction technology that can be applied to the transistors of 16-nm generation and beyond. In the very small metal-oxide-semiconductor (MOS) transistors of 16-nm generation and beyond, the parasitic resistance of the source-drain junction will become a big issue because it would ruin the improvement of the transistor performance. In addition, it is a big challenge to fabricate a source-drain junction accurately in transistors with a gate length in the order of 10 nm. The developed technology allows us to control the position of a very low-resistive metal source-drain junction at the sub-nanometer level. The control technology has been demonstrated to increase transistor performance significantly and should provide a solution to junction position control in the MOS transistors of 16-nm generation and beyond.

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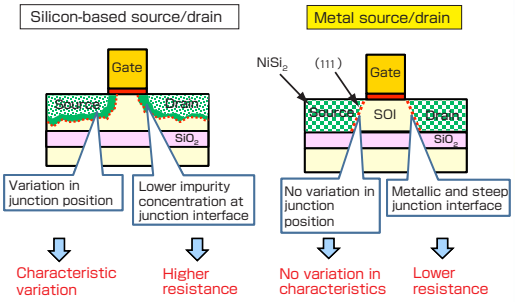
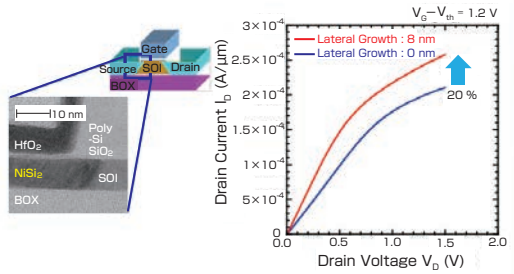
AIST TODAY Vol.12 No.1 p.18 (2012)



Comparison between the silicon-based source–drain junction and the metal source–drain junction



A thin SOI MOS transistor with the metal source–drain junction fabricated by using the developed technology, and its properties

Development of silicon nitride ceramic with high thermal conductivity

Expected as circuit boards for power devices

Applications of semiconductor power modules are rapidly expanding in a broad range of fields such as power generation systems and electric transportation systems. With increasing power supply and packing density of power devices, the ceramic boards are required to have high strength and high toughness as well as high thermal conductivity. Silicon nitride is an attractive candidate material because of its excellent mechanical properties combined with high intrinsic thermal conductivity over 200 $Wm^{-1}K^{-1}$. However, thermal conductivities of silicon nitride materials fabricated via the conventional sintering method are insufficient. This is because impurity oxygen dissolved in Si_3N_4 grains causes phonon scattering to lower their thermal conductivities. In order to decrease dissolved oxygen, high purity silicon powder was employed as a starting raw material. We have succeeded in preparing Si_3N_4 with a very high thermal conductivity of 177 $Wm^{-1}K^{-1}$ and good mechanical properties by nitriding a silicon powder compact followed by post-sintering.

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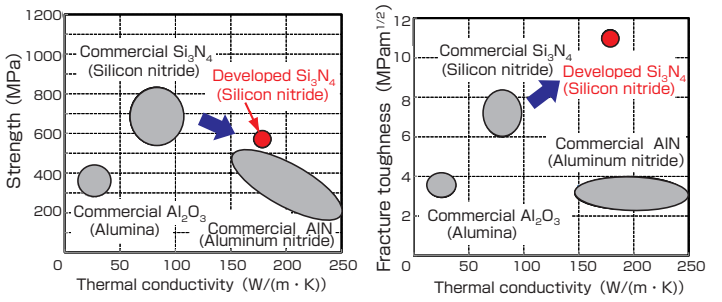
Advanced Manufacturing Research Institute

AIST TODAY Vol.12 No.2 p.16 (2012)



(a) Relation between strength and thermal conductivity

(b) Relation between fracture toughness and thermal conductivity

Mechanical and thermal properties of commercial ceramic boards and the developed silicon nitride board

Technique for reliable thermal diffusivity measurement

Approach for inherent thermal diffusivity of solid materials

We established the SI traceable and inherent thermal diffusivity measurement. The thermal diffusivity is a thermophysical property dependent on temperature and it is obtained as a function of specimen thickness and heat diffusion time determined by the laser flash method. The measurement system in AIST became traceable to length, time and temperature. Thermal diffusivity should not be independent of measurement conditions since it is unique for the material. However, thermal diffusivity measured by the laser flash method sometimes depends on the conditions. To solve this problem, we developed a procedure for the laser flash method. Apparent thermal diffusivity values are first measured by changing pulse heating energy at the same temperature. Then the inherent thermal diffusivity is determined by extrapolating these apparent values at the zero energy pulse heating. It was confirmed that the inherent thermal diffusivity obtained by the procedure is independent of measurement conditions. We verified the effect of the procedure from an international joint research between AIST and Laboratoire national de métrologie et d'essais.

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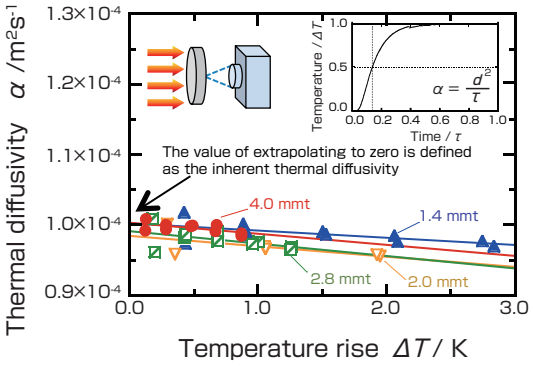
AIST TODAY Vol.12 No.1 p.19 (2012)



An example of inherent thermal diffusivity determination of isotropic graphite changing pulsed heating energy at room temperature

A certified reference material for thermal diffusivity measurement

For quantitative measurements of high and ultrahigh vacuum

Development of standard conductance element

A new element, named "standard conductance element (SCE)" , has been developed for in situ calibration of ionization gauges and quadrupole mass spectrometers. The SCE is a stainless-steel sintered filter with a pore size of less than 1 μm. Since the gas flow through the SCE satisfies the molecular flow condition even at the pressure up to 10^4 Pa, several useful characteristics of molecular flow are available: (1) calibration for various gas species only with this single leak element, (2) easy multi-point calibration, (3) calibration for mixture gases, (4) small and theoretical temperature dependence of flow rate. These advantages were experimentally demonstrated. The SCE is supplied to users with a calibration certificate describing its molecular conductance. Users can introduce arbitrary test gases with the known flow rate to their vacuum chamber through the SCE in their laboratories.

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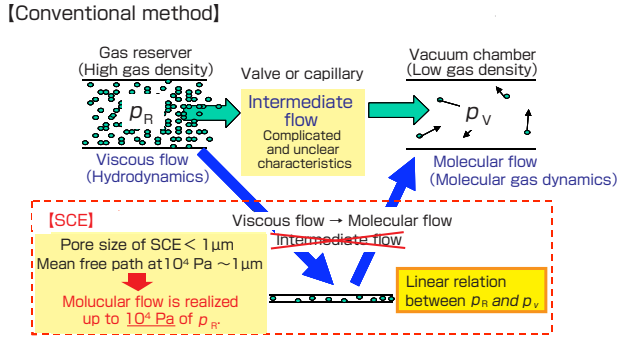
AIST TODAY Vol.12 No.2 p.17 (2012)



Principle of standard conductance element (SCE)

Photograph of standard conductance element (SCE)

Calibration technique for neutron dosimeters using pulsed white neutron sources

Open the door to obtaining the energy response curve of neutron dosimeters experimentally

Neutron dosimeters are important in various industrial applications such as at nuclear plants. The responses of neutron dosimeters are usually calibrated using monoenergetic neutrons of discretely limited energy points. We have developed a new calibration method to obtain a continuous response curve of a neutron dosimeter using pulsed white neutrons from 1 meV to 20 MeV all at once. The pulsed white neutrons are produced from the ^{7}Li (d,n) reaction or Ta (γ,n) reaction with a thick target. In the calibration method, the response curve is determined by two-dimensional measurements of pulse height and neutron time of flight. It is expected that the calibration method will broaden application to more precise neutron dose evaluation in various fields such as work places with inherent spectra.

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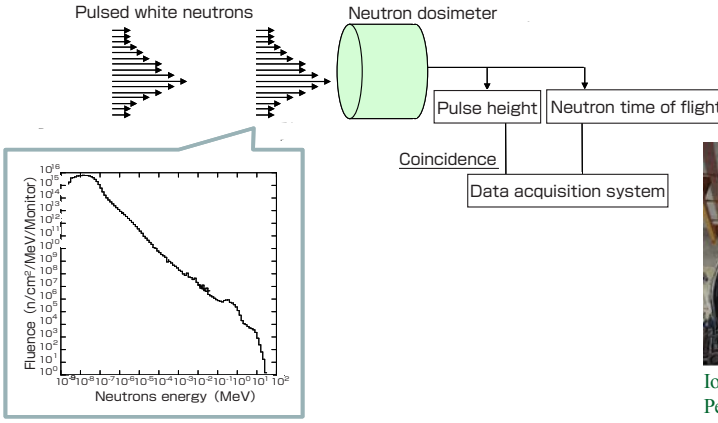
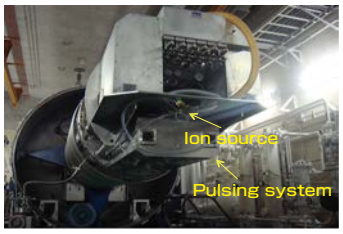
AIST TODAY Vol.12 No.3 p.13 (2012)





Ion beam pulsing system on the 4 MV Pelletron accelerator of AIST

Schematic view of the concept of the calibration method with pulsed white neutron sources
The calibration is performed by two-dimensional measurements using pulse height and neutron time of flight outputs obtained from the neutron dosimeter. The graph shows the white neutron spectrum produced by the Ta (γ,n) reaction and water moderation.

X-ray absorption fine structure spectroscopy of light elements for green chemistry

Opening a new era of materials analysis utilizing superconducting tunnel junction detector

X-ray absorption spectroscopy (XAS) in the soft X-ray region is important for materials analysis of compound semiconductors or catalysts, for which light elements are important to improve their performances. Superconducting tunnel junction (STJ) detector is promising for XAS in the soft X-ray region, because of its high sensitivity and high element selectivity compared to conventional spectrometers using semiconductor detectors or gratings. We constructed a soft X-ray spectrometer using a 100-pixel STJ array detector (Fig. 1, Fig. 2). To demonstrate the high sensitivity and high element selectivity of the STJ spectrometer, we observed the fluorescence of nitrogen from an SiC sample with nitrogen density of 300 ppm, for which it was impossible to detect the N-Kα line separating from the C-Kα line using conventional spectrometers. We successively observed the N-K edge XAS of the sample, separating the weak N-Kα line from the prominent C-Kα line (Fig. 3). The STJ spectrometer may be a powerful tool to improve performances of materials which require a low density light element dopant.

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AIST TODAY Vol.12 No.3 p.14 (2012)

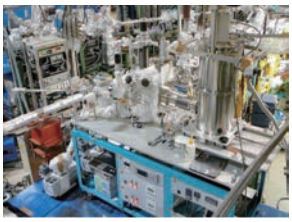

Fig.1 X-ray absorption fine structure spectrometer using 100-pixel superconducting tunnel junction array detector

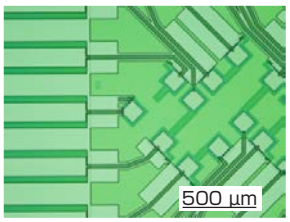

Fig.2 Microphotograph of superconducting tunnel junction array detector

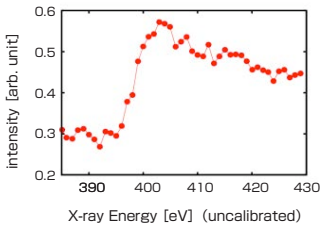

Fig.3 Nitrogen K edge spectrum in a silicon carbide sample with nitrogen density of 300 ppm

Report of "Electro-active polymer and Its Application", the Memorial Symposium for Collaboration between Fraunhofer IPA-AIST Kansai

Fraunhofer IPA (Fraunhofer Institute for Manufacturing Engineering and Automation) opened Fraunhofer OPER in March 2011 as a liaison office in Osaka where institutes for carbon nanotubes are gathered. AIST Kansai has 20 years experience in the research of electro-active polymer (EAP), and it is leading the world in the commercialization of ion conductive polymer actuators and the development of polymer actuators using carbon nanotubes.

Both institutions made an agreement on deepening their collaboration aiming at industrialization of EAP, and held a symposium on November 7, 2011, as one of the memorial projects to commemorate the anniversary of 150 years of Japan-German relations. At the symposium, Hans-Jörg Bullinger, President of the Fraunhofer-Gesellschaft, and AIST President Tamotsu Nomakuchi gave overviews of both institutions, and Yoshihito Osada, Leader of Molecular & Informative Life Science Unit of RIKEN gave a keynote speech titled "Artificial Muscles–Soft and Wet Engine of the Next Era–".

Lastly, Kinji Asaka, Leader of a group at the Health Research Institute, AIST, and Ivica Kolaric, Head of Department, Process Engineering of Functional Materials, Fraunhofer IPA, explained EAP research conducted at each institution. There were 134 participants at the symposium from not only industry but also from public research institutions and universities, and increased interest and expectations towards the research and development of EAP were shown.

AIST President Nomakuchi, and President Bullinger of the Fraunhofer-Gesellschaft

APMP 2011 Symposium

On December 6, 2011, APMP 2011 Symposium was held at the Kobe Convention Center. The Asia Pacific Metrology Programme (APMP) is a regional measurement organization in the Asia-Pacific region joined by 44 national metrology institutes and designated institutes from 29 economic blocks, acting to ensure international consistency of measurement standards.

This symposium was sponsored by the National Metrology Institute of Japan (NMIJ) of AIST and APMP with the support of the Ministry of Economy, Trade and Industry (METI), and 4 lectures were given on the theme of nanotechnology and material metrology .

At the beginning, Masayuki Yabuuchi, Director of the Intellectual Infrastructure Division, METI, Yukinobu Miki, Director of NMIJ, and Yu Yadong, Chairperson of APMP, gave opening remarks, which were followed by the lectures by Dr. Kamal Hossain of the National Physical Laboratory of the UK titled "Measurement Standards and Challenges and Strategy for Nanotechnology," and by Dr. Daisuke Fujita of the National Institute for Material Science of Japan titled "Measurements and Analysis of Nano Materials," in which they cross-sectionally gave future outlooks and present perspectives of this research field.

Later, Dr. Ren Lingling of the National Institute of Metrology of China gave a lecture titled "Development of the Thin Film Certified Reference Material and Single Wall Carbon Nanotube," and Dr. Kensei Ehara of NMIJ, AIST, gave a lecture titled " Development of Nanoparticle Standards: Current Status and Future Needs," and they introduced latest research results in China and Japan. Chaired by Toshiyuki Fujimoto, Deputy Director of NMIJ, AIST, there were many lively questions about each lecture from the participants, and the importance of measurement standards was recognized again as the intellectual infrastructure to support the research and development of nanotechnology and material metrology.

This symposium was held by taking the opportunity when measurement standards related people from Asia-Pacific region were visiting Japan to attend the APMP general meeting and related meetings (December 4-9, Kobe Convention Center). It was open widely to the public, and 190 people participated in the symposium.

Lecture of Dr. Kamal Hossain, National Physical Laboratory, UK

The 8th Biomass Asia Workshop

The Eighth Biomass-Asia Workshop jointly organized by Vietnam Academy of Science and Technology (VAST), AIST, the New Energy Foundation (NEF) of Japan, and the Biomass Asia Research Consortium was held in Hanoi, Vietnam from November 29 to December 1, 2011. There were presentations from 7 countries including Japan and 2 international organizations and around 200 people from more than 10 countries participated (more than 60 people from Japan including 18 from AIST). The last six workshops were supported by the Special Coordination Funds for Promoting Science and Technology of Japan. However, since the seventh in 2010, the workshop has been held under an operational structure where each member takes turns in hosting the workshop. These workshops have been building a biomass-Asia network composed of 12 East Asian countries as its members. This is the second time for the workshop to be held under the new operational structure.

The opening remarks were given by the hosts, Vice President Duong Ngoc Hai of VAST, Vice-President Masakazu Yamazaki of AIST, and Chairman Takahiko Kondo of NEF followed by remarks from the representatives of the Ministry of Science and Technology of Vietnam, Embassy of Japan in Hanoi and the Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry of Japan. Following these remarks, the outlooks for the utilization of biomass energy in East Asia were presented in the keynote speeches by representatives of the Ministry of Industry and Trade of Vietnam, New Energy and Industrial Technology Development Organization of Japan, the Asian Development Bank, the International Renewable Energy Agency, and VAST.

In addition, at 7 technical sessions and at the panel discussion, there were enthusiastic discussions concerning topics of biomass utilization technology focusing on fuel production, actual application of biomass utilization technology and the examples of the regional use of the technology in East Asian countries, fusion of the technology with environmental technology, and evaluation of sustainability of biomass use system with the project report of the Economic Research Institute for ASEAN and East Asia Project. At the panel discussion, future cooperative relations and the context of this workshop therein were also discussed.

On the last day, there was a technical tour, and the participants visited a cassava starch factory and one of the largest hydroelectric power plants in Vietnam (1 million and 92 thousand kw) in Hao Binh province, west of Hanoi. The next workshop will be held in the fall of 2012, in Japan.

Opening remarks of Vice-President Yamazaki

MOU Concluded between Geological Survey of Japan and U.S. Geological Survey

A memorandum of understanding (MOU) on research cooperation was signed by Director Tsukuda of the Geological Survey of Japan (GSJ), and Director Marcia McNutt of the U.S. Geological Survey (USGS) at the Marietta Hotel in San Francisco, USA, on December 5, 2011. The opportunity for signing the MOU was taken as the Fall Meeting of American Geophysical Union was held at a place near the hotel, and many of the geology related people from both Japan and US including Director McNutt were attending the meeting.

GSJ has been associating with USGS, and has been establishing a close collaborative relationship and exchanging personnel since the days of the former Agency of Industrial Science and Technology. From 1985 to 1999, collaborative researches of earthquakes, volcanoes, remote sensing, marine geology, and metallic ore deposits were implemented and many co-authored papers were published under a former MOU. After the establishment of AIST, an MOU was concluded in 2002 and the research collaborations continued. As that MOU expired in 2007, both parties discussed research collaborations in the future, and agreed to conclude a new MOU.

The pillars of the MOU concluded this time are the research collaborations concerning rare earth element deposits, earthquakes and volcanoes as they are currently crucial issues, and more results are expected in the future.

Having concluded the MOU, Director Tsukuda shaking hands with Director McNutt

Cover Photos
Above: Wnt3 expression in adult hippocampus (p. 18)
Below: Single-crystal thin film arrays of organic semiconductors formed at respective positions by a new inkjet printing technique (p. 18)

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