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NIMS Project

NIMS Projects and Recent Achievements

Sensor Materials Center

- Research on Sensor Function Using Surface Plasmon Resonance Method

Research Highlights

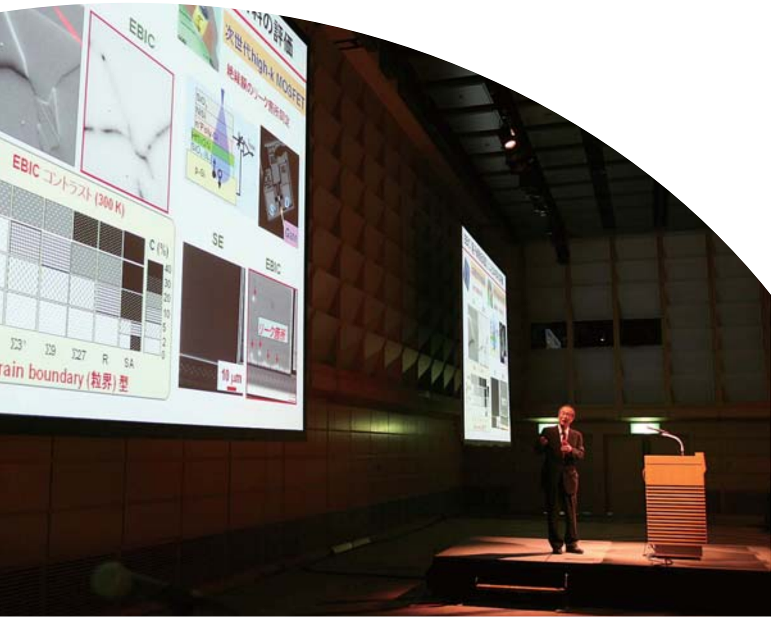
- Success in Development of 1500MPa Class Low Alloy Steel with High Impact Strength
- Polarized Organic Light-emitting Diodes Fabricated by Using Very Thin Photoaligned Films

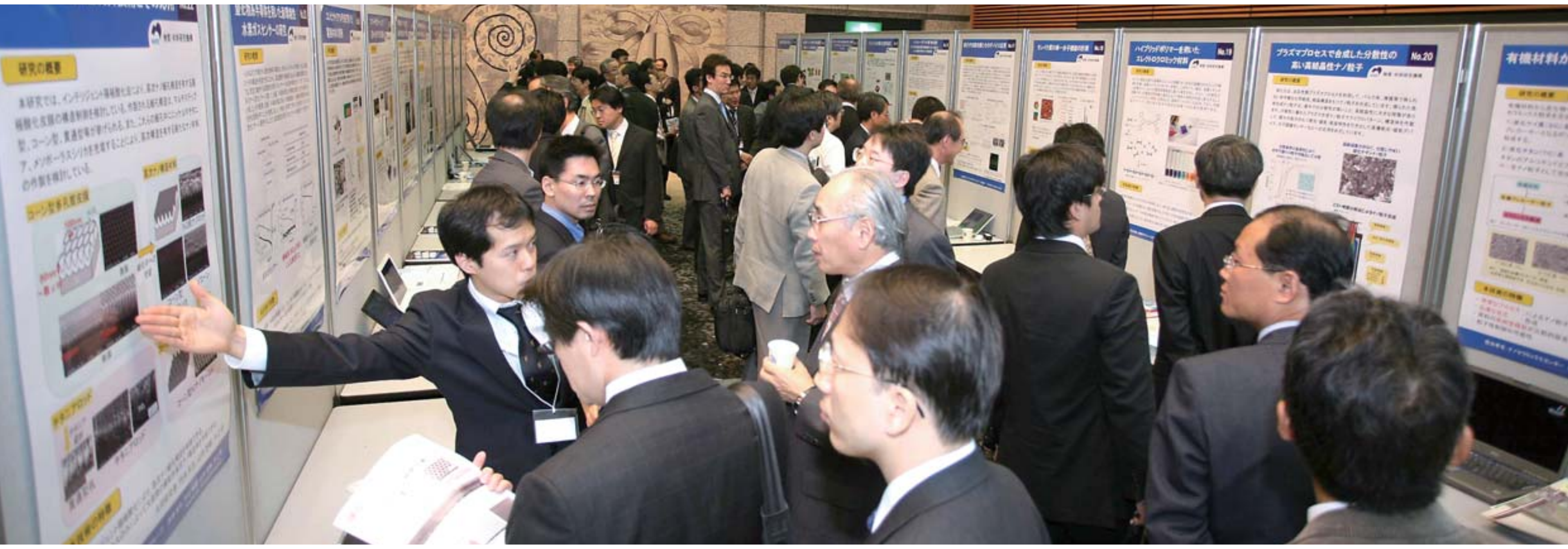
SPECIAL Interview

Prof. C.N.R. Rao

President, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), India

Passion and dedication to materials science for nearly half a century



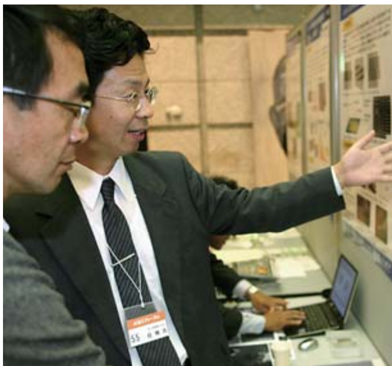



The Joint Graduate School Program at NIMS

Strategic Promotion of Student Education at NIMS

- Synergistic Effects on Research and Education -

FACE NIMS Professors in Joint & Linkage Program



The Joint Graduate School Program at NIMS

Strategic Promotion of Student Education at NIMS
– Synergistic Effects on Research and Education –

Professor, Former Chairman
Naoki Kishimoto

Development of outstanding human resources for research is extremely important in the idea of a “science and technology based nation.” Voices anxious about the future of Japan have been heard for a long time now, lamenting the growing tendency of young people to avoid science and mathematics, the decreasing number of students who desire to continue to their education in doctoral programs, and the decline in basic academic ability and specialized capabilities related to science and technology when students become company employees. Although Japan’s Ministry of Education, Culture, Sports, Science and Technology (MEXT) had promoted educational reforms, including the establishment of “graduate universities” and graduate schools programs using television and the internet, the lamentable conditions have not necessarily improved. Not only universities but we are sparing no efforts to overcome this critical situation, including drawing on the resources of all related institutions.

The main mission of NIMS is to conduct basic research and development, related to materials science and technology in a generic manner. Although this does not explicitly include “student education,” under the circumstances outlined above, NIMS has made graduate-level education one of its key policies and is actively promoting efforts in this direction.

With the young population in Japan declining, the fact that NIMS, which is an institution specializing in research, has embarked on a program in “education” also raised concern about conflict with universities, and debate was divided in the initial period of the joint graduate school program (late 1980s-early 1990s). Actually, in the conventional “joint” graduate school, the researchers who served as cooperating teaching staff supervised students based on their personal beliefs, in addition to performing their research work. However, since becoming an Independent Administrative Institution (IAI) under MEXT in 2001, NIMS has been pursuing the ideal paradigm for unique involvement in education, including the international joint graduate school programs, and has come to perceive graduate-level education as one important task. In particular, since fiscal year 2006, social demand for innovation and human resources development has become stronger. In response, NIMS has positioned these items as essential requirements for a core institute in materials science research.

NIMS believes that it can contribute to fostering/securing human resources from its original standpoint as an IAI. In FY2004, NIMS, together with the University of Tsukuba, jointly launched the “Linkage graduate school Program” (Doctoral Program in Materials Science and Engineering in the Graduate School of Pure and Applied Sciences) based on its advanced research infrastructure and advantageous location in Tsukuba, and also acquired a support system* as a management policy. NIMS is steadily continuing with its activities while stressing bold internationalization and nanotechnology/materials education, etc.

What is important for improving the current situation of graduate-level education is to enable young people to experience (peak experience) interesting, living research themes at a high level, in an international environment, free of worries about everyday necessities during the period when they are carrying out research as part of their education and to obtain a proud view of the future after graduation. We believe that the cooperation/fusion of education with the outstanding basic research activities which NIMS is proud of satisfies these conditions and is suitable for fostering research-type professional staff with fundamental capabilities and creativity. For NIMS, one important merit of the new “linkage” graduate school program is “rejuvenation of researchers.” Introduction of youthful, free thinking and use of world-class research facilities are requisite for maintaining and developing high-level research activities. The students in the linkage graduate school program are now indispensable human resources for NIMS. Of course, students should not simply be regarded as a supplementary labor force; the aim is to produce research of the highest level in Japan and the world by closely combining the young brains of universities and the NIMS research staff/infrastructure.

In the future, it is my ardent hope that we can expand the opportunities for active educational research, where young scientists from Japan and other countries can come together in a rich international environment, and create an atmosphere in which it is natural that many NIMS researchers wear two hats, as researchers and educators, and that NIMS can accomplish its fundamental mission at a higher level in harmony with this.

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*In the “Junior Researcher System,” salaries are paid to graduate students who possess outstanding research capabilities, allowing those students to devote themselves completely to research without worry about living expenses, etc.

Joint Graduate School System

The “joint” graduate school system (conventional-type joint graduate school system) is a system which assigned NIMS researcher to provide research guidance to graduate students at NIMS, based on agreements between NIMS and each university.

The aims of this system are to improve the quality of students by joint/cooperative guidance of students by NIMS and the graduate school, and to contribute to the academic progress and the development of science and technology by promotion of mutual research exchanges. As of November 2007, NIMS had concluded agreements with 20 universities in Japan and 10 institutions in 5 other countries.

Institutions with which NIMS has concluded International Joint Graduate School agreements	
Czech Republic	● Charles University
Australia	● University of Queensland ● University of Sydney ● University of Western Australia ● University of Melbourne ● University of New South Wales
Poland	● Warsaw University of Technology
India	● Anna University ● Jawaharlal Nehru Centre for Advanced Scientific Research
China	● Xi’an Jiaotong University

The Linkage Graduate School Program (new-type joint graduate school)

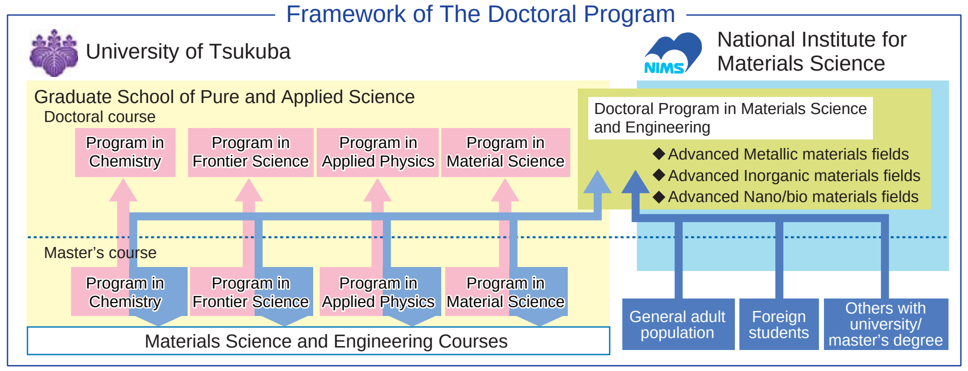
Professor, Chairman
Satoru Inoue

Outline

The “linkage ” graduate school program is a new system which is a further development of the conventional “joint” graduate school system. The conventional system is limited to receiving individual graduate students, but in contrast, in the new linkage graduate school program, NIMS researchers operate the actual doctoral program in the graduate school organization, and not only provide guidance to students, but are also responsible for the entire education including admissions to teaching and examination of credits.

The Doctoral Program in Materials Science and Engineering, Graduate School of Pure and Applied Sciences, University of Tsukuba was launched in April 2004 as the first linkage graduate school program in Japan. The program had a teaching staff of 27 as of September 2007, and to date has accepted a total of 65 graduate students (doctoral course: 34, master’s course: 31).

Although an independent program in Materials Science and Engineering is only available as a doctoral course, “Materials science and engineering courses” have been established in other four programs, including a Chemistry Program, Frontier Science Program, and others, as corresponding master’s courses, and the staff of the Materials Science and Engineering Program provides guidance to master’s course students.



*Authorized Number of Students Doctoral course : 9 persons/1year
Master’s course : 18 persons/1year

http://www.nims.go.jp/graduate/english

Aims

History of the Doctoral Program in Materials Science and Engineering

2003	May	Steering Committee for the Doctoral Program is established.
2004	February April August	Entrance examination held. Acceptance of students for establishment of the Doctoral Program begins. Acceptance of second-term students (foreign students with school years beginning in autumn). Number of students accepted in FY2004 Doctoral course: 6, master’s course: 3
2005	April	Acceptance of adult students begins. Lectures “Theory of Materials Engineering I–III” begin. Number of students accepted in FY2005 Doctoral course: 12, master’s course: 11
2006	October	Student research presentation meeting “Materials Engineering Seminar” held. Number of students accepted in FY2006 Doctoral course: 19, master’s course: 18
2007	May	Teaching staff is increased from 18 to 27. Number of students accepted in FY2007 Doctoral course: 29, master’s course: 20

The Doctoral Program in Materials Science and Engineering was established under the cooperation of the University of Tsukuba as Japan’s first linkage graduate school program. The start of this new form of education was realized through a run-up period of the conventional joint graduate school program together with the history of Tsukuba Science City and the historical backgrounds of the two institutions.

The purposes of establishing this Doctoral Program are to create new industries in the materials field and to educate students to become highly professional scientists or engineers with fundamentals and creativity through high-level cooperation and fusion of both research and education. This is realized by effective utilization, in education, of the advanced research capabilities and equipment possessed by NIMS in this research field. The intentions of this program are to foster human resources who aim at the peaks of research in the materials field, and to enable students themselves to contribute actively to research activities at the world level.

Another important purpose is to promote a system of integration and cooperation in Tsukuba Science City, and thereby contribute to the development of the Tsukuba area, through stronger cooperation with the University of Tsukuba.

Features

Our distinctive features of Doctoral Program in Materials Science and Engineering can be described by two keywords: “Advanced research environment” and “Internationalization.” “Advanced research environment” means students in the Doctoral Program can receive research guidance using cutting-edge equipment while engaged in advanced research projects at NIMS. As “Internationalization,” approximately half of the students in the Doctoral Program are foreign students from outside Japan, and events of the Doctoral Program as a whole, such as orientations, seminars, etc., are conducted in English. Students can also participate in various kinds of international exchange events held by NIMS.

Future plan

In the Doctoral Program, management of the system has been progressing smoothly by the tireless efforts of the entire teaching staff and strong backup by NIMS and the University of Tsukuba since the program was launched. While an independent graduate program in Materials Science and Engineering is only available in the doctoral course, the successful results of the program can be seen in the fact that the number of applicants and number of accepted students far exceeds the official annual capacity.

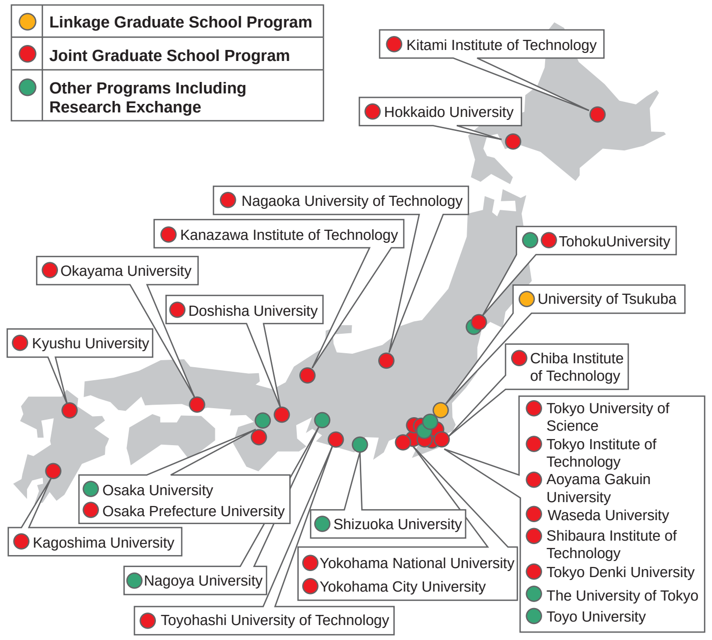
For further development of this Doctoral Program, it is important to secure a larger number of excellent students and improve the environment for education. To secure excellent students, active acceptance of foreign students from the master’s course level is being projected. Where the educational environment is concerned, the course curriculum is being expanded and improved, for example, by optimizing the basic courses and holding general seminars that give priority to the horizontal linkage between individual laboratories.

All members of the teaching staff hope to produce a large number of talented researchers who contribute to the development of the materials research field through these policies and efforts, and we are committed to making even greater efforts to this end in the future. I would therefore like to ask the continuing cooperation and understanding of all those concerned.

F A C E

NIMS Professors in Joint & Linkage Program

Collaboration with Domestic Universities



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Sensor Materials Center

Basic Research Project Aiming at Intelligent Sensors

In today’s society, various impediments that threaten a safe and secure society, including natural disaster, toxic substances/pathogens, terrorism/crime, and others have become serious problems. In creating a safe and secure society, detection (sensing) of these impediments as quickly as possible is important. Therefore, the main focus of work in the Senor Materials Center is basic research to elucidate the sensor functions of sensor/actuator materials and devices corresponding to the entry part of extreme sensor systems which are capable of responding to emerging threats, in other words, “intelligent sensor systems,” with the aim of realizing such systems.

Because the sensor function basically recognizes the signals generated as a result of the interaction between solid surfaces, molecules, photons, and electrons as optical/electrical signals, we are conducting basic research in connection with reactions, structures, and defects at the surface/interface of solids or their host bulk matrix. Based on a fundamental knowledge of these features, the Center’s aims are to develop ultraviolet (UV) sensors and lead-free electrostriction materials, and to develop micro actuators, which are an indispensable function for constructing multi-sensors.

Research challenges for the Sensor Materials Center

1. Research on thin film/powder processes

Because materials in a thin film or powder state display unique properties not found in the bulk, these materials are increasingly important as sensor/actuator materials. Therefore, as seen in Fig. 1, the Sensor Materials Center is actively researching manufacturing processes for these materials utilizing the world’s most advanced devices.

2. Research on defect structure/properties of solids

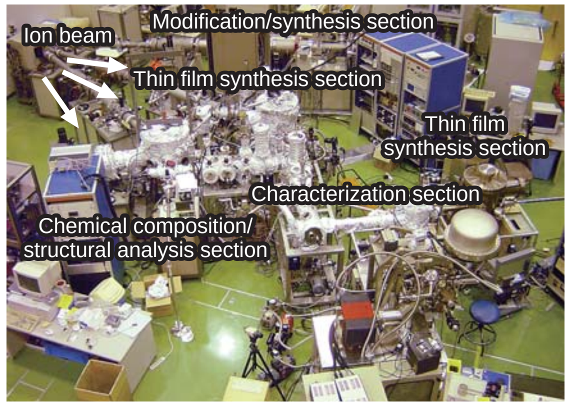
There is a close relationship between sensor/actuator functions and the defect structure inherent in materials. Although the materials handled by the respective groups in the Sensor Materials Center are different, research is being carried out based on the common item of defects.

3. Research on optical/electrical properties

Among sensor functions, the transducer element function is assigned the role of obtaining the signals generated as a result of interactions in the form of optical/electrical signals. Because basic research on physical properties is indispensable for realizing higher transducer functions, the Sensor Materials Center is actively engaged in research on the physical properties of sensor materials.

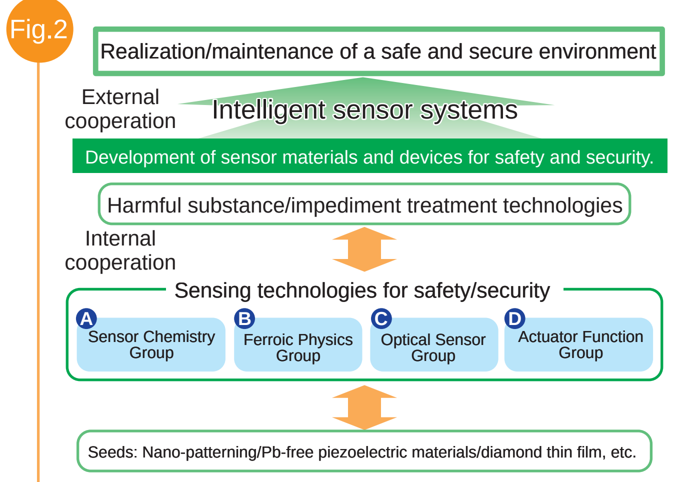
To carry out the research on these issues efficiently, the Sensor Materials Center has established the four research groups shown in Fig. 2, and is carrying out research in a wide range of fields in close cooperation with other research units in NIMS and universities and private companies in Japan and other countries, bearing in mind the importance of developing its research results to sensor materials/systems which are capable of responding to emerging threats.

Fig.1



Synthesis/characterization devices enabling 2MeV ion beam treatment.Using this equipment, the Center performs monozukuri (manufacturing) making full use of ion engineering.

Fig.2

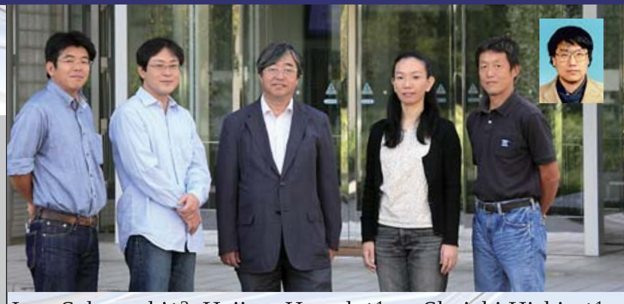


The Sensor Materials Center

Research on Sensor Function Using Surface Plasmon Resonance Method

- Aiming at the Establishment of a High-throughput Sensor Material Search Method -

Sensor Chemistry Group, Sensor Materials Center[*1]
Opto-Electronics Group, Optronic Materials Center[*2]



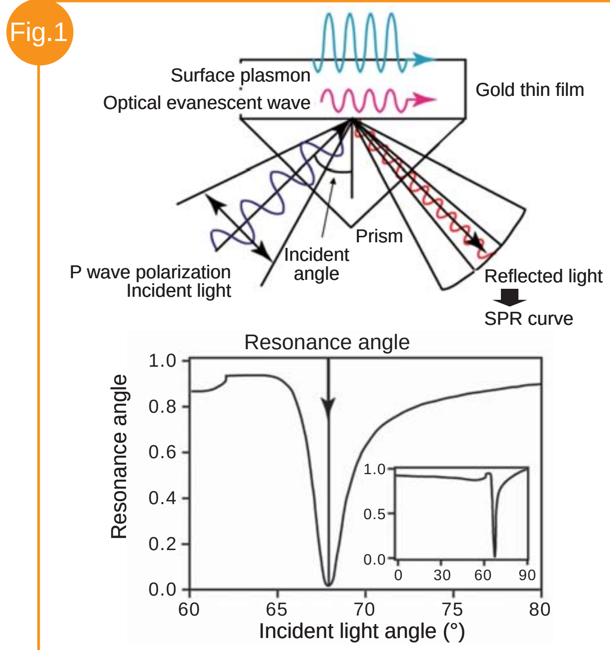
Isao Sakaguchi[*2] Hajime Haneda[*1] Shuichi Hishita[*1]
Takeshi Ogaki[*1] Noriko Saito[*1]
Masaki Nakamura[*1](Upper Right)

Familiar sensors include chemical sensors, as represented by gas sensors. Because the search for sensor materials that react to new substances is time-consuming, a high-throughput sensor material search method is demanded. For this purpose, we are considering application of the combinatorial ion implantation method, which makes it possible to obtain specimens containing heterogeneous added elements from the ppb (part per billion) to the percent order in one experiment. The combinatorial ion implantation method can be used to prepare specimens in which a large number of materials with different compositions/properties are arranged in 2-dimensional micro regions (these specimens are called a “2-dimensional library”). In order to discover suitable materials for sensors from this library, the sensor function must be evaluated in the micro region. Therefore, in this project, we carried out basic research with the aim of establishing a sensor material search method utilizing this technique by focusing on the phenomenon of surface plasmon resonance (SPR; see **Fig. 1**), which makes it possible to evaluate the sensor function of micro regions.

SPR, as shown in **Fig. 1**, is a phenomenon in which resonance occurs under designated conditions when light is totally reflected by a metal surface (gold thin film), and is the result of the interaction between light “evanescent light” escaping at the nm order length to the thin film side and surface plasmons generated in the gold thin film. Analysis of 2-dimensional micro regions should be possible by scanning this incident light. Because resonance conditions are extremely sensitive to changes in the surface of the gold thin film, it is possible to detect substances adsorbed on the surface. In order to recognize designated chemical species, it is necessary to modify the gold surface. In biosensors, a molecular recognition capability is given to the sensor by fixing DNA or a protein on the gold surface. In this project, we used specimens modified with various kinds of oxide semiconductor materials, assuming application to semiconductor sensor materials. This article introduces the results of vapor deposition of inorganic oxides (ZnO and TiO$_2$) with a thickness of several nm on a gold surface. **Fig. 2** shows the hydrogen detection characteristics obtained by SPR. As seen in this figure, the gold surface is inert with respect to hydrogen, but extremely high detection sensitivity for hydrogen was obtained by modifying the gold surface with ZnO or TiO$_2$. When activity for NO$_2$ was evaluated, a pure ZnO surface showed activity approximately 20 times greater than that of a gold surface, revealing the possibility of ppb order analysis. Thus, this research found that it is possible to search for semiconductor sensor materials using SPR.

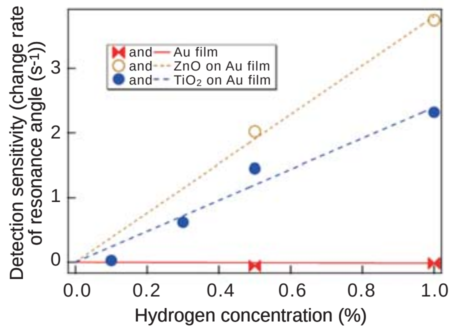
The results described above were obtained with the cooperation of the NIMS Opto-Electronics Group. As a policy for the future, the Sensor Chemistry Group will develop a 2-dimensional micro region evaluation technique for sensor functions using a combination of SPR and the combinatorial ion implantation method in cooperation with external groups.

Fig.1



Concept of spectrum measurement by SPR method.

Fig.2



Detection sensitivity for hydrogen gas

Success in Development of 1500MPa Class Low Alloy Steel with High Impact Strength

Physical Metallurgy Group, Structural Metals Center*1
Intense Research Group, Innovative Materials Engineering Laboratory*2
Progressive Materials Research Group, Innovative Materials Engineering Laboratory*3

Managing Director
Yuuji Kimura*1, Kaneaki Tsuzaki*1, Tadanobu Inoue*2, Fuxing Yin*3

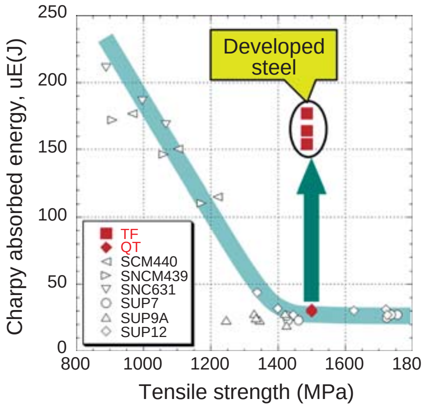
High impact toughness means that a material will not become brittle and fracture when a load is suddenly applied. Impact toughness is one important mechanical property for safe use of structural materials. Industrially, this property is evaluated by the Charpy impact test, as specified in the Japanese Industrial Standards (JIS Z 2242), and similar tests. Charpy impact tests are performed using test pieces in which a U- or V-shaped notch has been introduced. The test piece is fractured by striking the surface on the opposite side of the notch with large hammers. Impact toughness is evaluated by measuring the energy required for fracture (Charpy absorbed energy).

Recently, heightened expectations have been placed on the development of ultra-high strength steels with tensile strengths of 1500MPa (megapascal) class and higher, and members made from those materials, with the aim of realizing next-generation steel constructions and achieving further weight reductions in transportation equipment in order to prevent global warming by reducing CO_2 emissions. In particular, these materials will have important economic merits, if minimal addition of alloying elements, which reduce cost and bear excellent recyclability, enables to realize high strength in steels. In steels with tensile strength of 1000 MPa and higher, room temperature tensile strength and impact toughness are normally satisfied by applying a combination of heat treatment processes, namely, quenching and tempering. However, because steels with tensile strengths of 1300 MPa and higher have extremely low impact absorbed energy of several 10 J (Joule) or less, application as structural members had been limited. In recent work, we succeeded in developing a 1500 MPa class low alloy steel bar with excellent fracture resistance under impact at room temperature (**Fig. 1**), which overcomes this limitation. Because the chemical composition of this steel includes only small amounts of C, Si, and Cr, it has excellent recyclability (0.6%C-2%Si-1%Cr steel, mass%). The production process is also a comparatively simple thermomechanical treatment process, comprising quenching and tempering, followed by rolling into bars at a temperature of around 500 °C, at which the steel is soft and ductile.

Normally, in impact tests of 1500 MPa class steels, a crack propagates rapidly in the striking direction and the material fractures into two virtually equal pieces. In contrast, as a distinctive feature of the developed steel, it displays resistance to crack propagation in the impact direction, and a lamellar fracture behavior, in that the crack develops at right angles to the direction of impact, in much the same way that wood splits in layers when bent (**Fig. 2**). This fracture behavior is attributable to the dense fibrous metal microstructure which is formed internally in the steel material by the thermomechanical treatment process.

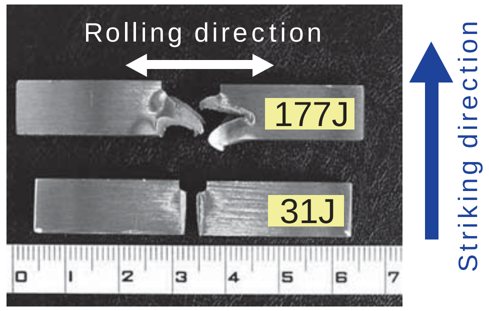
The newly-developed thermomechanical treatment is also applicable to conventional steels for machine structural use, and is therefore expected to be a key technology for realizing ultra-high strength components such as bolts and shafts.

Fig.1



Relations between the room temperature tensile strength and Charpy absorbed energy of the developed steel (TF) and quenched and tempered steel (QT). Data for JIS steels for machine structural use (National Research Institute for Metals, Fatigue Data Sheet Technical Document, 5 (1989)) and JIS spring steels (National Research Institute for Metals, Material Strength Data Sheet Technical Document, 9 (1995)) are also shown by open white marks.

Fig.2

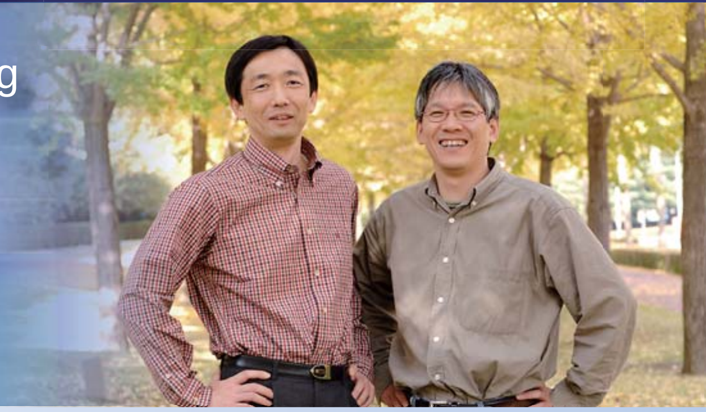


Appearance of U-notch test piece after Charpy impact test
Top: developed steel (TF), bottom: quenched and tempered steel (QT). The numbers in the figure show the Charpy absorbed energy of the test pieces.

Polarized Organic Light-emitting Diodes Fabricated by Using Very Thin Photoaligned Films

- Alignment Control of Organic Semiconductor Molecules by Photoaligned Polymer Films -

Nano Architecture Group,
Organic Nanomaterials Center



Group Leader
Kenji Sakamoto Kazushi Miki

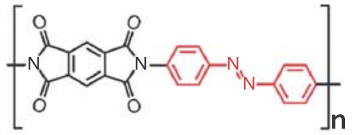
As can be imagined from the shapes of organic molecules, their functions are anisotropic. In order to realize high performance/high functionality organic devices by taking maximum advantage of their functions, a technology for producing thin films with controlled alignment of organic molecules on a substrate is important. We are focusing on photoaligned thin films of polyimide containing azobenzene in the backbone structure (Azo-PI) as a promising template substrate for aligning organic molecules. The molecular structure of Azo-PI is shown in **Fig. 1**.

When a thin film of the precursor of Azo-PI (polyamic acid: Azo-PAA) is irradiated with linearly polarized ultraviolet light (LPUVL), the photoisomerization cycle of the azobenzene molecule, which is accompanied by random rotation of the molecular axis, is induced. Since the photoisomerization cycle is repeated until the molecular axis of azobenzene becomes perpendicular to the polarization direction of the LPUVL, the Azo-PAA backbone rotates towards the plane perpendicular to the polarization direction. The alignment of the Azo-PAA backbone in a designated region can be controlled selectively by performing LPUVL irradiation through a photo-mask. After photoalignment treatment, a thermally and chemically stable photoaligned Azo-PI film is obtained by baking the Azo-PAA film.

The photoaligned Azo-PI film works as an excellent molecular alignment template for polyfluorene (PFO), which is a promising blue light-emitting polymer material. Since light emission from PFO is polarized along the backbone, a polarized polymer-based light-emitting diode (PLED) can be fabricated by using a highly-oriented PFO thin film as the light-emitting layer. Polarized PLEDs are expected to be promising high efficiency backlights for liquid crystal displays, because they are low-cost, thin, flat, and large-area polarized light sources. However, since polyimide is a good electrical insulator, a conventional polyimide alignment film, whose thickness is normally more than 10 nm, cannot be incorporated in PLEDs. If the film thickness can be reduced to a few nanometers, tunneling injection of the charge to the light-emitting layer becomes possible, enabling application to PLEDs. We found that the thickness of the photoaligned Azo-PI film can be reduced down to 1.6 nm without decreasing its alignment ability for PFO. This is because photoalignment causes no mechanical damage of the alignment film. Using a 2.8-nm-thick photoaligned Azo-PI film, we fabricated a polarized blue PLED, whose device structure is illustrated in **Fig. 2**. **Fig. 3** shows light emission from the device, which is polarized parallel to the alignment direction of PFO. A polarization ratio of 29 (wavelength: 459 nm) and a brightness of 700 cd/m^2 were achieved. Although the device structure has not been optimized, characteristics equal or superior to those of conventional polarized blue PLEDs fabricated using hole-transporting alignment layers were obtained. This suggests that further improvement in device characteristics can be expected after optimization of the device structure.

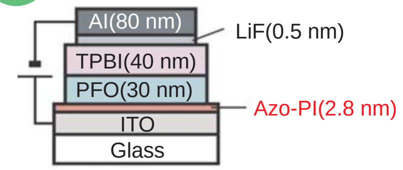
The photoalignment technology introduced in this article is also applicable to pentacene, which has attracted considerable attention as an organic transistor material. Thus, it is expected to be a promising technology for achieving high performance/high functionality in organic optical/electronic devices.

Fig.1



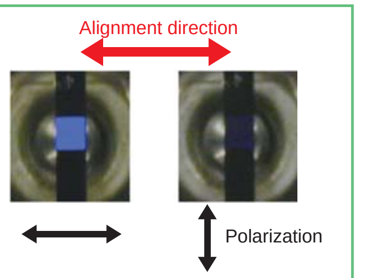
Molecular structure of Azo-PI.

Fig.2



Device structure of the polarized PLED fabricated using a 2.8-nm-thick photoaligned Azo-PI film. TPBI (1,3,5-tris (N-phenylbenzimidazole- 2-yl) benzene) is used as an electron-transporting layer; ITO (indium tin oxide) is used as a transparent electrode. Polarized light is emitted from the ITO electrode side.

Fig.3



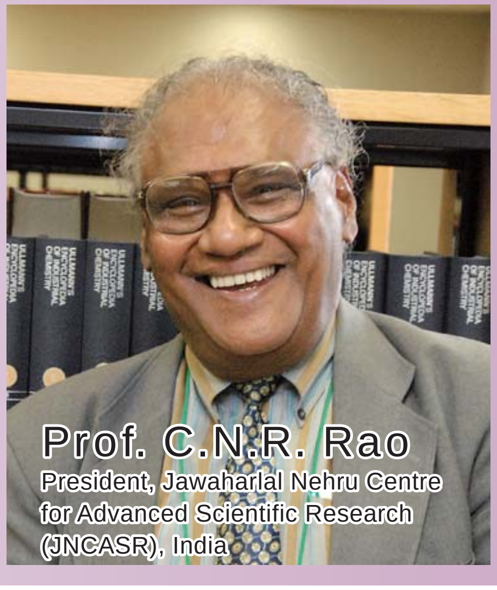
Polarized light emission from the blue PLED. The red arrow shows the alignment direction of PFO; the black arrows show the polarization axis of a sheet polarizer inserted between the device and the camera. This figure shows that light emission from the device is polarized parallel to the alignment direction of PFO.

SPECIAL Interview

Passion and dedication to materials science for nearly half a century

"I am very happy with being a scientist, I do not want to be anything else. Nothing else in life can give me such satisfaction. There's no other life I'd rather have. I am the happiest man."

Indian scientist Prof. C.N.R. Rao is one of the world's top researchers, having made prolific contributions to materials science. NIMS NOW caught up with him in July while he was in Japan for a lecture at the ICYS-ICMR Summer School on Nanomaterials 2007.



Prof. C.N.R. Rao
President, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), India

Dr. Rao's career spanning nearly half a century has been characterized by boundless energy and astonishing productivity, as well as dedication to his profession and his country. Author of over 1,400 scientific papers, he still publishes on average 30 to 35 papers a year. His 41st book, on nanomaterials, just came out.

After obtaining his bachelors degree at the University of Mysore in 1951, Dr. Rao earned a masters degree from Banaras Hindu University, then moved to the U.S.A. and gained a Ph.D. in 1958 from Purdue University, and did post-doctorate work at the University of Chicago, University of California at Berkeley, and Purdue. At the time he was offered full professorships in the United States and could have remained there to pursue a successful career as a scientist, but having experienced the excitement and celebrations of Indian independence as a young student in 1947, he chose to return to his homeland and participate in the development of Indian science.

Please tell us about your early days.

Rao - *Those early days were an agonizing time. When I went back to India in 1959, there were absolutely no facilities, so I started from nothing. It was a hard time to be a scientist in India. The labs had no equipment. We did not even have a spectrometer, which was tough for a spectroscopist like me, but we still managed to scrounge equipment and materials and were able to publish many papers. We would go all over the world to work at major facilities, but we were so poor we didn't even have the money for taxis. So we would borrow equipment, and bring home suitcases full of little wires, chemicals, tools and whatever we could find. My team managed to do high-quality science by doing creative work on relatively simple problems, using simple instruments. I wrote two books at the time, one on spectroscopy and the other on solid-state chemistry, which have been reprinted and translated into dozens of languages, and many of my papers from those years have been frequently cited.*

How about your current work?

Rao - *I am currently working in several areas, including transitional metal oxide-related materials, a field I have been pursuing for many years, especially in multiferroics, materials that are magnetic under an electric field and show electrical polarity under a magnetic field, all within the same phase. I'm also interested in the field of hybrid materials, as well as nanomaterials, such as nanocrystals, nanowires and nanotubes, and properties and phenomena, and various types of spectroscopy. I'm also involved in studies on x-ray scattering, reflectivity and diffraction, especially liquid-liquid interfaces, using synchrotron facilities all over the world.*

Recently we built a new nano laboratory in Bangalore. I was delighted to have the opportunity to build the facility, to train a large number of students and to conduct a lot of research. And I am still publishing because there is so much to write. Michael Faraday (1791-1867, the discoverer of electro-magnetic induction) defined science with the three words "work, finish and publish", and I would agree with that. If you have something important to do, finish the work and publish it. I am still sticking to that creed.

Another area of concern for Dr. Rao has always been the quality of science education. He recently published a book to help children understand chemistry, which has been translated into several languages. He spends a lot of time traveling around India and other countries giving multimedia presentations to generate interest in science among children.

He is the National Research Professor of India and Linus Pauling Research Professor and Honorary President of the Jawaharlal Nehru Center for Advanced Scientific Research in Bangalore. He is chairman of the Scientific Advisory Council to the Indian Prime Minister, a capacity in which he has served five Indian prime ministers, starting with Rajiv Ghandi.

What do you think about NIMS?

Rao - *I consider that NIMS is one of the world's best centers for materials science, and I think it's wonderful that such a major institution has an International Center like this, with young people from all over the world coming to work here. Very few institutions are doing as much as the NIMS international program, and I am very happy about that.*

What about your own research?

Rao - *I hope to be doing research until the day I die. I am almost 75. My wife says, "You forget you're 75, you act like a 25-year-old. When are you going to stop?" but I enjoy working and writing papers. I have so much to write, it's wonderful. … You know, it's a very good life, being a scientist. There's no other life I'd like to have.*

NIMS NEWS

New NIMS Fellow

NIMS established the Fellow system to create an environment in which outstanding researchers can engage in research activities in a deliberate manner. On November 1, 2007, Dr. Kenji Kitamura, Managing Director of the Optronic Materials Center, was appointed as a new Fellow.

Dr. Kitamura has an impressive record of achievements in connection with the growth and characterization of optical single crystals and processing of these materials as devices, and in particular, in research on the defects and properties of ferroelectric single crystals. He is also actively involved in the management of venture companies with the aim of utilizing research outcomes.

Kenji Kitamura

Doctor of Science (1983). Completed the Master's Course in sciences at the Graduate School of the University of Tokyo (1974). Joined the National Institute for Research in Inorganic Materials (1974; this organization, under Japan's Science and Technology Agency, was one of the predecessor institutions of NIMS) and became Senior Researcher in the same institute (1983). Appointed Director of the Advanced Materials Laboratory, NIMS (2001) and Managing Director of the Optronic Materials Center, NIMS (2006). Professor, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University (since 1998; concurrent appointment). Establishment/Research Advisor (concurrent) to the NIMS authorized venture company, Oxide Corporation (established in 2000). Establishment/Director (concurrent) of NIMS authorized venture company, SWING Ltd, (established 2003).

Dr. Kitamura's comment on his appointment

Recently, I was appointed as a NIMS Fellow and also received an appointment as a Principal Investigator at the new International Center for Materials Nanoarchitectonics (MANA), which is somewhat removed from the organization that I have been part of until now. While carrying out research projects, I myself have also been concerned with how research results of NIMS are recognized and used in society. In that process, I have taken on the challenges of starting up venture companies, measures related to patent licensing, and the like. Taking advantage of this experience, including overseas, I plan to put effort into technology transfer based on the results of research of NIMS, as well as human exchanges, particularly in the United States, and will devote myself to diverse kinds of cooperation from a more global viewpoint and the nurturing of the next generation of researchers.

The NIMS Advisory Board

(November 7, 2007) – The NIMS Advisory Board meeting was held with attendance of the Chairperson of the Board, Prof. Humphreys (photo, at the center on right of table) of the University of Cambridge. Board members expressed opinions on a variety of topics, including the research strategy for NIMS as it begins the 2nd Mid-Term Program, the outline of achievements, and candidates for members of the Advisory Board during the 2nd Mid-Term Program. New members will be appointed based on these opinions, and the next Advisory Board meeting is scheduled in May 2008.

The 7th NIMS Forum

(November 1, 2007) – The 7th NIMS Forum has been held at the Tokyo International Forum on the topic of "Advanced Materials Research and Technology Transfer."

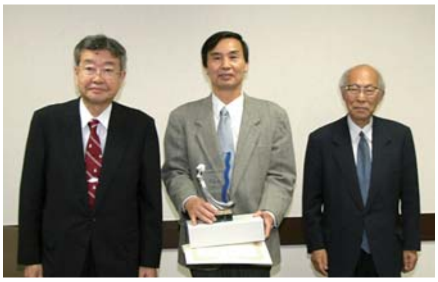
Following an opening greeting by President Prof. Teruo Kishi of NIMS and a guest greeting by Director General Tamotsu Tokunaga of the Research Promotion Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), oral presentations were given on project research in six research fields at NIMS and exploratory research by the Advanced Nano Materials Laboratory and Innovative Materials Engineering Laboratory. There had 68 research reports with the potential for technology transfer and active discussions at the poster session. We had a total of 463 visitors to the forum and believed these visitors could encounter materials research has new breakthroughs potential and future practical application.

For details of the sessions, including abstracts, please visit the following URL:
http://www.nims.go.jp/nimsforum/ (in Japanese)
*The cover shows scenes from the NIMS Forum.

"Nano Flowers" selected as an Excellent Work in the Science and Technology "Beauty" Panel Exhibition

Zinc sulfide (ZnS) is an important material as a phosphor (fluorescent substance). It is possible to produce nano-sized artificial crystals (nanocrystals) by reacting powders of ZnS and SiO (silicon monoxide) in nitrogen gas at 1300°C. These nanocrystals show beautiful symmetrical patterns with a hexagonal or triangular shape, like that of a daisy (6 petals) or an iris (3 petals). These beautiful nanocrystals, which are produced by artificial crystals, have been dubbed "Nano Flowers". A design was created by combining these with a photograph of single crystal silicon nanowires (diameter: approx. 100nm) as stems of the flowers. These nanowires were produced by thermal reaction of a silicon-based gas (Si_2H_6) with a gold nanodot catalyst.

This work was submitted to a panel exhibition at Nihonbashi, Tokyo during the 48th Science and Technology Week, and to the Science and Technology "Beauty" panel exhibition at the Ostec Exhibition Hall in Osaka by the cooperation of the Organization on Science and Technology from July 19 to August 31. The "Nano Flowers" was selected as an excellent work by visitors' vote with high evaluation and was awarded at the ceremony held at the Ostec Exhibition Hall on November 5.



From the left, President Takuya Hirano, Japan Foundation of Public Communication on Science and Technology (Vice-Chairman, Organization on Science and Technology), Dr. Yoshio Bando, NIMS Fellow, and Prof. Akito Arima, Chairman, Japan Science Foundation (Chairman, Organization on Science and Technology).

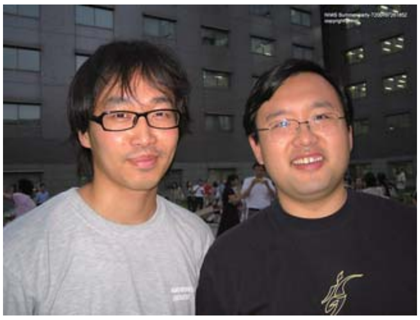
Beautiful "Nano Flowers" created by artificial crystals. (nanocrystals photographed by Yoshio Bando and G. Shen; nanowires photographed by Hiroshi Suzuki and Masahiro Tosa)

Hello from NIMS

Ryugakuseikatsu (Study Abroad) in Tsukuba Science City

Hello, I am Young-Gwang Ko from Korea. I came to Tsukuba and joined the joint doctoral program of NIMS and the University of Tsukuba in April 2007. Previously, I majored in polymer science and engineering at Kumoh National Institute of Technology in Korea. In the past, I studied antimicrobial nanofiber sheets, post-operative tissue anti-adhesion membranes, and a rapid cell sheet recovery system. Now, I am studying in the Biomaterials Center at NIMS. My research field is polymeric biomaterials and tissue engineering. The Group Leader is Dr. Guoping Chen.

Tsukuba has an excellent environment for scientists. There are many unique parks, sports facilities, and interesting shops (various restaurants, shopping malls) that can help me relax after a day of hard work. I often try to discover some special items at shopping malls. In addition, many impressive festivals are held (for example, the Tsukuba Matsuri). In particular, a number of scientists are living in Tsukuba. In fact, Tsukuba Science City was designed to promote high level research and education. Sometimes I feel lonely because my hometown is far away, but my international friends from the University of Tsukuba and NIMS help me feel better. Now I have made some friends from China, Poland, America, Thailand, India, and other countries. In times of stress, I walk along a park path covered by a forest. Life in Tsukuba is a valuable experience for me. I like this space. and ryugakuseikatsu is becoming exciting as time goes on.



[At the NIMS summer party 2007 with Mr. Lu]

Young-Gwang Ko (Korea)
University of Tsukuba, Ph.D. Student/NIMS
Junior Researcher (April 2007 - Present)
Organoid Group, Biomaterials Center

[At the welcoming party with Organoid Group members (First row, third from left: Managing Director of Biomaterials Center, Prof. T. Tateishi, third row, first from left: Group Leader, Dr. G. Chen, second row, second from right: author)]

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