Introduction of Research Unit

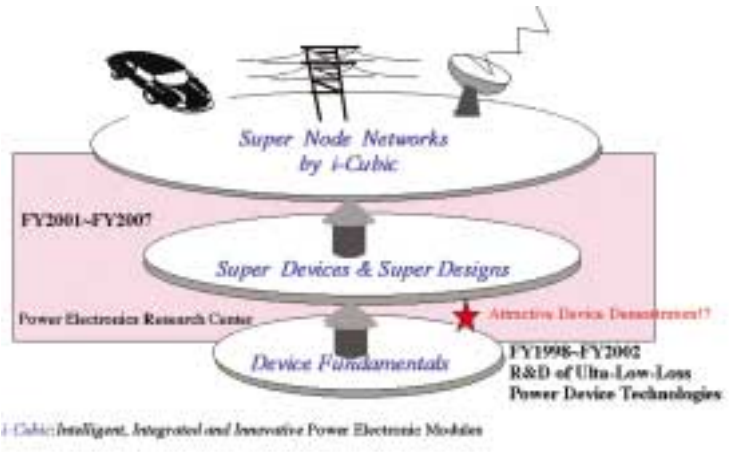
Research units of AIST are the core of its research activities, among 54 research units, 40 are already introduced in the first issue of AIST Today. The rest of 14 units are introduced in this second issue, completing the profile of all the research activities at AIST.

Power Electronics Research Center

At present the electric energy power ratio in total energy consumption (electrified %) is 41% in Japan. Extraordinary progress in information technology, spread of electric cars and dispersed power supply stations, such matter will certainly cause increase of electric power demand in energy supply much more. The technology making electric power optimum in generation, storage, transportation and consumption is the power electronics technology. The key issues in it are developing the electric power conversion unit with low loss, compact in size and working in high speed. The crucial components in the conversion units are the power devices. Of course at present Si devices are dominated, but their capabilities come to their limits due to the material parameters of Si semiconductor. Wide band gap semiconductors like silicon carbide (SiC), gallium nitride (GaN) and diamond (C) show high capability beyond the limit of Sidevices.

Since 1998 we have put forward the national project "R&D of Ultra-Low-Loss Power Device Technologies" as a five year plan together with companies and universities, and have been aiming the establishment of basic technologies for making SiC and GaN devices. Cooperative research together with Advanced Power Device Laboratory conducted by FED (R&D Association of Future Electric Device) is applied to basic R&D on crystal growth, device process and device design and evaluation. Three distributed laboratories have been developing the fundamental devices to demonstrate the superiority of SiC to Si.

In order to realize the conversion units with ultra-low-loss, higher temperature and higher speed operaion utilizing the advantage of SiC and GaN devices (called super devices), it is not enough only developing the devices. The development of the new design techniques (super design) on circuit, elemental parts, materials, packaging and also reliability are necessary. The system design for introducing such units into the node in electric power networks (super node network) is of another importance. In addition the feasibility study on the technological and economical impacts of this new technology on the society is indispensable. We are planning to promot these three subjects concurrently.



Computational Biology Research Center

Bioinformatics is a comprehensive science that treats a wide range of biological phenomena from the standpoint of information theory. These phenomena range from the genome sequence to the 3D structures and functions of protein molecules and the mutual relationship among such elements within a cell and a body. With the aim of becoming a core base for bioinformatics research in Japan, the Computational Biology Research Center features advanced information science theory and large-scale high-speed computational systems to its R&D efforts to help achieve dramatic advances in bioinformatics study and to contribute to its systemization.

Gene finding and protein structure prediction using a large-scale PC Cluster (1024 processors)

Institute of Mechanical Systems Engineering

Missions and Activities

Mechanical Engineering, an integrated art of extended scientific disciplines and technologies, serves a common foundation for a wide variety of industrial sectors. With continued effort into research and development of materials, processing techniques, integration and system assembly, together with a quest for their associated basic sciences, our institute is dedicated to the advancement of manufacturing technologies in industry and proposes technological guidelines that will allow us to realize a sustainable growth in the society of the 21st century.

Bearing these missions in mind, we will not only present the study results to academia but evolve them into practical products by maintaining a close contact with those in global industries. To meet the our society's requirement in an appropriate and timely manner, we will promote research to provide a solution to immediate needs of industries and also to tackle high-risk technological challenges to achieve intermediate- and long-term goals.

- Main Research Items
  - Environmentally Conscious Manufacturing System
  - Micro/Nano scale fabrication
  - Reliability Engineering

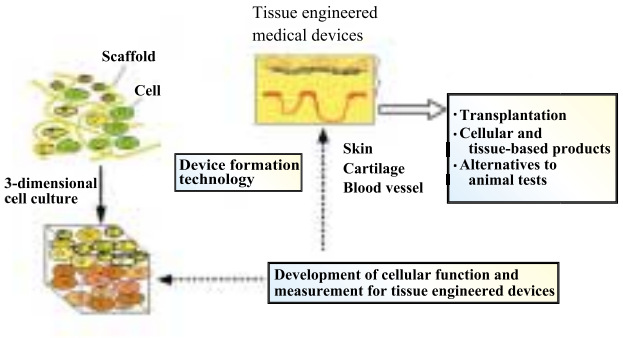
Tissue Engineering Research Center

Tissue engineering is a technology to create tissues or organs formed by cells. The products, tissue engineered medical devices (TEMDs), are applied for repair and regeneration of tissue or organ function. The technology is a key for advanced medical technologies to cure incurable diseases. It is also needed to solve the shortage of human organs for trans-plantation and to reduce the cost of medical care, which is now suppressing national economy. TEMDs are also applicable to evaluating and sensing chemicals, which are currently assayed by animal tests for the purpose of screening the efficacy of newly developed medicines.

Tissue engineering requires the integrated development of generic technologies.

Research items are as (1) technologies of three-dimensional cell culture, (2) genetic technologies and genome informatics, (3) development and differentiation biology, (4) screening of stem cells and its application. Some detailed technological research subjects, on item (1) for example, are novel design of scaffolds, three-dimensional culture of cells, mixed and controlled culture of variety kinds of cells, biochemical and physical stimulation of cells to regulate the functions, etc. Controlled cell proliferation and tissue formation methods should be realized also by the combination of the fundamental researches of (2) - (4). On a par with these R&D subjects the production of TEMDs is to be implemented by the operation of a cell-processing center (CPC) in TERC in close cooperation with medical schools of universities. Process and quality control of cell growth, proliferation and tissue/organ formation are to be developed.

The exploration of technological value and the possibility of industrialization will be investigated as a basis for future research and technological development.



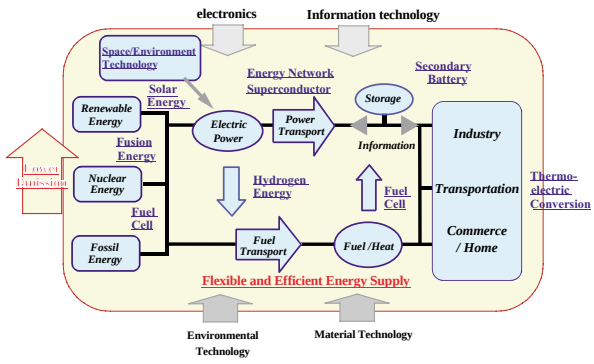
Energy Electronics Institute

Energy is essential to support ever growing and spreading human activities, and must be supplied sufficiently and steadily. One the other hand, it is also required to minimize environmental effect, like global warming, and to hand over healthy earth to the next generation. To fulfill these requirements, a totally new energy supply system with maximum use of clean energy sources and efficient and flexible energy flow through generation to consumption must be constructed.

The Energy Electronics Institute conducts research and development of innovative electric power technologies to realize the future energy system by combining rapidly progressing electronics/ionics, material and information technologies.

Major research subjects are, distributed power generation by fuel cell, solar cell and thermoelectric conversion, efficient and flexible power transmission by superconductor and power electronic device with network and information technologies, and long term R&Ds of ultimate energy sources like hydrogen energy or fusion energy.

Major Research Subjects of Energy Electronics Institute



Advanced Semiconductor Research Center

The semiconductor industry offers wide variety of core technologies for the advancement of the information society. The mission of Advanced Semiconductor Research Center (ASRC) is to deploy the R&D works on the semiconductor technology and to contribute to the growth of the semiconductor industry.

ASRC is applying to the NEDO project "Fundamental Research and Development of Next-Generation Semiconductor Materials and Processes" also known as " Semiconductor MIRAI Project" through collaboration with the industries and universities, to carry out the R&D works. It is expected that this effort will bring up ASRC to the leading-edge R&D center of the semiconductor technology based on broad cooperation among scientists and engineers of the industrial, academic and government sectors, functioning as a COE (Center of Excellence) with sophisticated R&D potential for the semiconductor technology.

ASRC is obliged to contribute to the technology development in the semiconductor industry and to the progress in related science and technology. For this purpose, ASRC selects R&D themes of primary importance on the basis of the future trend of the semiconductor technology and finds the pathway to overcome the technology roadblocks through the scientific approach. In this way, the basic semiconductor technology will be consolidated to ensure continued development of the semiconductor industry. Particularly, with intention of contributing to the technology innovations for realizing the 70-50 nm technology-node ULSIs and beyond, extensive research on new materials, fabrication processes, and device and circuit technologies will be conducted as explained below.

Research Initiative for Thin Film Silicon Solar Cells

In the 21st century, it is one of the most important issues to solve the trilemma to provide the sufficient energy for the sustaining development of economy under the restrictions of resources and environmental preservation. Solar cells have attained increasing attentions as a promising candidate for this solution. Especially in these several years, improvement in the cell performance, price reduction and grid connection to electricity line have successfully facilitated the introduction of solar cells up to 100,000kW in Japan (about the half of the total amount in the world). Japanese government announced that they are planning to increase the total amount of solar cells up to more than 50,000,000kW (200 times the present value) in the next 30 years. In order to achieve this target, further development of thin film solar cells with lower cost and higher performance is strongly required. Figure 1 shows the roadmap of solar cell technology development. Silicon and compound semiconductors (such as $CuInSe_2$) have been studied as thin film materials extensively. And it is silicon solar cells that are thought to be crucial from its environmental safety and natural abundance.

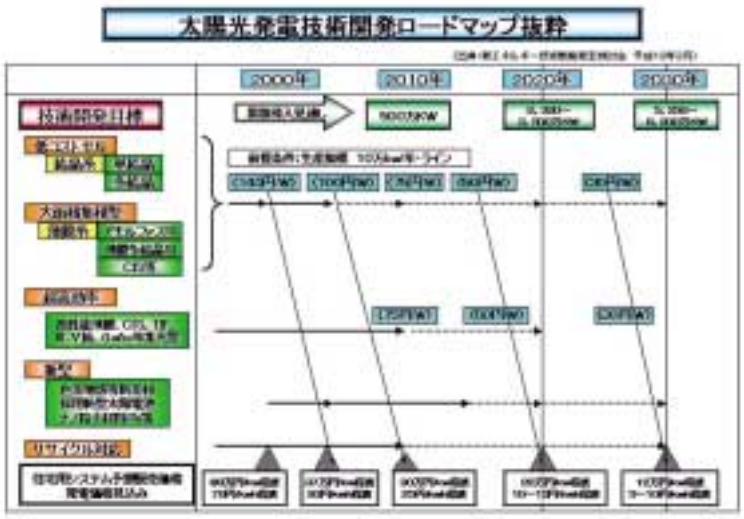


Figure 1: (by courtesy of PVTEC)

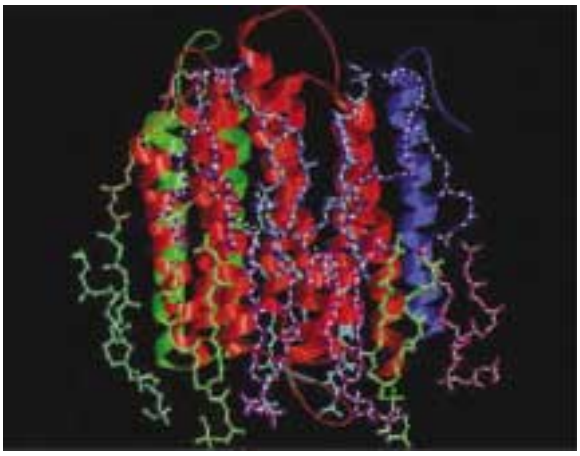
Biological Information Research Center

It is expected that the Life Science Era is coming, since the most of the human genome sequence was roughly analyzed by the end of the 20th century.

That is also the era that genome science is moving closer to Industry through researches on functions of genes and proteins based on human genome sequence data. They are so called post-genomic researches.

From standpoint of bioscience, the center (BIRC) purports to acquire, arrange and integrate biological information contained in the genome sequence data.

There are three research groups in BIRC. Main projects are i) three dimensional structure determination of membrane proteins, ii) functional analysis of human full-length cDNA and iii) construction of integrated biodatabase.



Structure of GPCR

Smart Structure Research Center

The Smart Structure Research Center (SSRC) is a leading international center for smart structure research to enhance the performance, safety, and reliability of civil infrastructures, ground and space transportation systems as well as biomedical instruments and devices, etc. The mission of the SSRC is to provide a R&D focus for broadening of fundamental understanding of smart materials and material systems that possess multifunctional capabilities, and for development of new technologies that utilize the materials for the design of smart structures and systems to optimize their services, performance, and safety.

SSRC will invest its intellectual, financial, and facility resources in new knowledge discovery, and new technology development, adaptation and utilization to support the industries for the continued growth of intelligent engineering-including planning, design, construction, inspection and diagnosis, monitoring, maintenance, and renewal-that are civil, mechanical, or aeronautic and astronautic based.

SSRC will make creative use of its resources in research on innovative materials and smart structures and in development of emerging technologies, including sensing and actuating systems and devices of various scales, wireless data management, and condition monitoring and control systems of integrated or interfaced software and hardware. SSRC will strive to become:

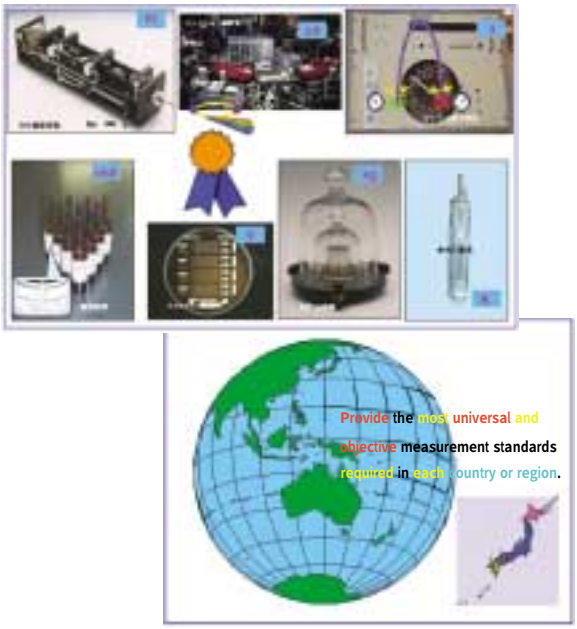
1. A technology bridge that serves as a linkage between government and industry to innovate smart structure development in industry;
2. An opportunity creators being a source of new job and new industry creation based on spin-off technologies from the center; and
3. A premier place of pioneering research that will be institutionalized as a leading international center for leading smart structure research.

It is expected that all major research work will target for prototyping and physical demonstrations in lab or field related to engineering applications with well defined purposes. Hence, SSRC emphasizes team work and center approach, targeted application research, demonstration tests, engineering products, and other knowledge and technical deliverables of engineering importance.

Metrology Institute of Japan

The Metrology Institute of Japan (MIJ) conducts R&D for the metrology and dissemination of the measurement standards over the country and takes the technical responsibility of national metrology institute of the country (NMIJ) in the global metrological activities, by cooperating with other three sectors of AIST. Measurement standards, including certified reference materials, are systematized under the standards and certifications policy of the government as the core of the national measurement system which guarantees the traceability of all measurement results to the national primary standards. The R&D for the measurement standards is dedicated to realization and improvement of primary standards according to the concept of the SI units, consisting of seven base units and many other derived units and also to improve the calibration and testing technology in order to establish the reliability of all kinds of quantitative evaluations.

The national measurement system is generic techno-infrastructure supporting the qualities of economical, social, technical and scientific activities of individuals both domestic and international, such like competitiveness of domestic economy in global market, maintenance and preservation of social capital, improvement of quality of life by environmental, medical, pharmaceutical R&D and finalization of R&D in leading edge technology to the industrial sector. The MIJ is also responsible to the technical conformity assessment of measurement instrument both legal and voluntary regulation in the society. The cooperative R&D among the different fields of metrology enables pursuit of higher precision in a primary standard and new method for the realization of the unit and calibration of standards of atomic, nanoscopic and gigascopic world.



Provide the most universal and objective measurement standards required in each country or region.

Institute of Molecular and Cell Biology

In the so-called post genomic research era, the major interest has been focused on the discovery of new genes and their corresponding new proteins based on the nucleotide sequences of the human genome. Furthermore, all biological components, including proteins and lipids as well as sugars, will be reexamined from the genomic viewpoint to understand more clearly the functions of cells, tissues, and organs. We will pursue industrial application of such drastic advancements in genomics and molecular biology as one of the core research units in this newly formed national institute.

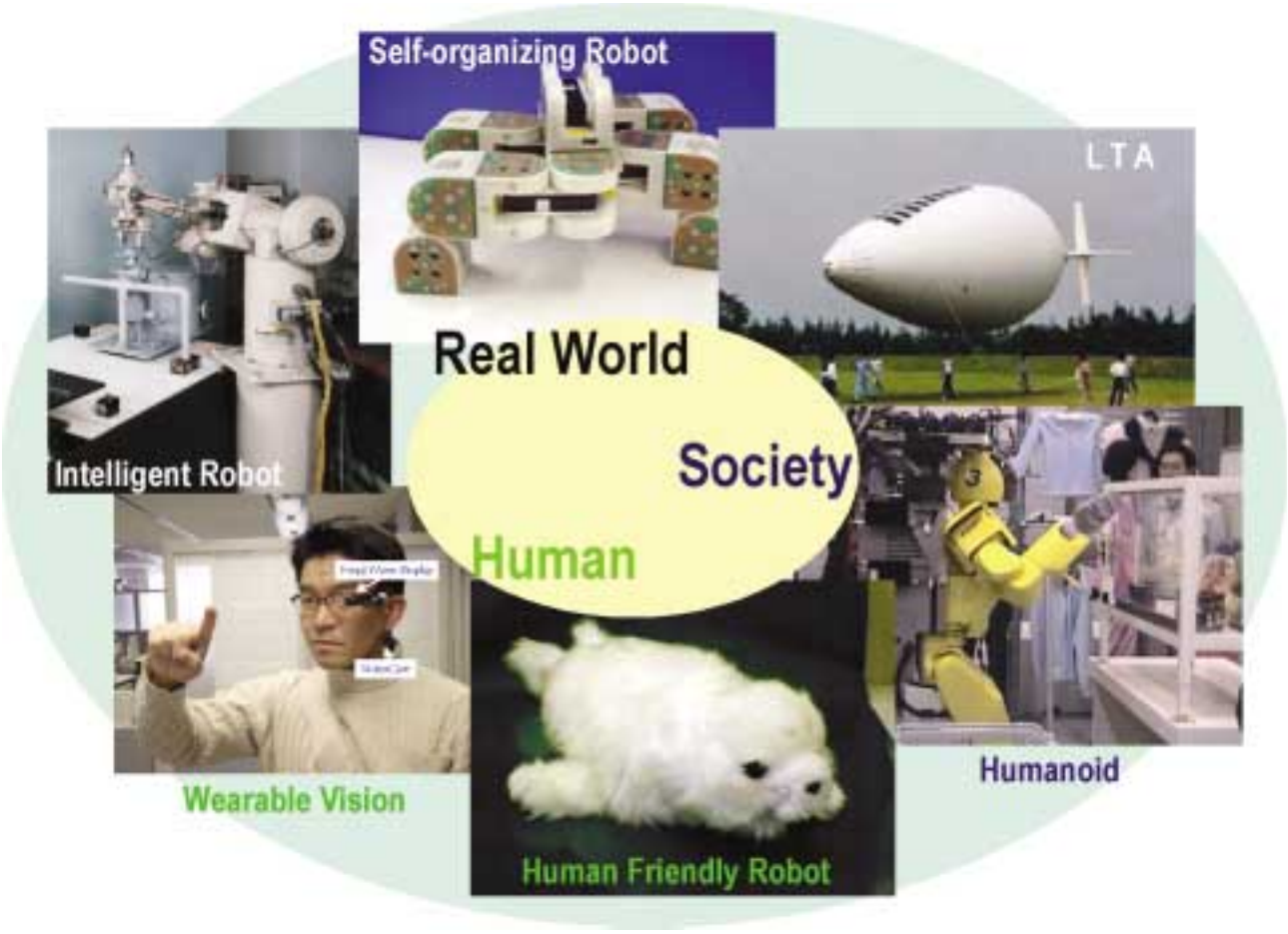
We will continuously try to increase our performance in the international academic community as before, and, as a leading institute, promote the technology transfer of our knowledge to the industrial sector to create new industrial developments in biotechnology. At the campus of AIST in Tsukuba, we have started a new national project for the comprehensive analysis of the human genes related to glycosylation in collaboration with companies under METI (Ministry of Economy, Trade and Industry) program. Additionally, a small venture company was founded to utilize our patents on DNA microarrays for diagnosis of cancers and for the survey of environmental hormones.

Intelligent Systems Institute

The objective of the Intelligent Systems Institute is to conduct researches on fundamental and component technologies, system integration technologies for the computer-oriented intelligent systems, and also physical systems which support human activities in the real world. In the 21st century, "IT" i.e. information and computer network technology is one of the key technologies to improve human life. Also the IT driven systems that provide physical services to human will be important. In order to guarantee sustainable prosperity in our society in the future, the institute promotes advanced R&Ds relating to computer/information science, robotics and mechatronics with the emphasis on the following topics:

1) Human assist intelligent systems (Human friendly robotics, Humanoid, Human support and Welfare technologies, etc.)
2) Industry-oriented / Social-need-oriented systems (Intelligent security systems, ITS, Advanced factory automation systems, Field robotics, etc.)
3) 3D Vision and its applications to real world understanding
4) Human-centered communication systems
5) Fundamental topics for intelligent systems (Learning, Robotic skill, etc.)

To achieve the above missions and to create new industrial activities, the institute will plan to challenge various researches and new projects together with industrial and/or university partners.



Nanoelectronics Research Institute

Mission

The mission is to create various innovation seeds of electronics technology by performing systematic research from physics and materials science to electron devices and their systems. Transfer of technological seeds including patents, new electronic materials and nanofabrication technologies to companies are within the mission.

Research scope and outline

Research activities are grouped in the following three subjects.

(1) Physics and material science

Search and elucidation of new electron phenomena and materials and development of their application technologies are carried out with the aim of creation of new function electron devices and breaking of performance limitations of the existing devices. Especially, researches on new superconductive phenomena and materials, new oxide materials and application to new function devices are intensively carried out. The following four research groups are collaborating for this subject.

· Condensed Matter Physics Group
· Low-Temperature Physics Group
· Superconducting Materials Group
· Oxide Electronics Group

(2) Next generation LSI technologies

Research and development of nanoscale transistors including new gate-insulating materials, spintronics devices, quantum effective devices and electronic measurement devices with ultrahigh precision are carried out for developing the technology platform required by the next generation LSI. The following six research groups are collaborating for this subject.

· Silicon Nanoscale Devices Group
· Analysis and Instrumentation Group
· Superconducting Devices Group
· Flux-Quantum Devices Group
· Spintronics Group
· Novel Electron Devices Group

(3) System integration technology

In order to connect the information space with the real human environment, it is important to realize intelligent interfaces excellent in portability and accessibility to humans. Here, the technology that integrates and interconnects image input/output devices with various LSIs onto a single Si chip is currently developed. The following two research groups are promoting this subject.

· Microsystems Group
· High Density Interconnection Group

Nanotechnology Research Institute

Mission

As a principal driving force of science and technology in the 21st century along with information technology and biotechnology, expectations are now high on nanotechnology. This is an emerging technology area laid on the nanometer (one billionth of a meter) regime, in which deliberate manipulation of materials with atomic or molecular precision gives rise to revolutionary materials, devices and systems with unprecedented density and functionality even at ultralow energy and material consumption.

Nanotechnology is a generic field with unlimited future possibilities, existing at the root of every technical discipline related to materials engineering. The Nanotechnology Research Institute (NRI) is the core of the diverse nanotechnology activity in the AIST, and is strongly committed to long-sighted and strategic advancement of methodology and concepts in nanomaterials science, elucidation and utilization of novel physical, chemical and biological phenomena on the nanometer regime, and their extension to industrially relevant technologies.

R&D Vision and Strategy

The interplay between the basic science and the applied technology is a vital element of nanotechnology. A leap from know-how driven empirical industrial technology to that with a clear theoretical logic and predictions is a characteristic feature therein. The NRI emphasizes the foresight role played by theory and computational science in nanotechnology, develop novel nano-processing and characterization technologies, and promotes substantial R&D's aimed at the development of novel nanomaterials, nanodevices and nanobiotechnology.

Our R&D vision and strategy rest on the concept of "fusion" of:

- Technical disciplines,
- Approaches:Unification of top-down (fabrication) and bottom-up (self-organization) approaches,
- People: Intimate collaboration among industry and academia, and the balance between the team play and the individual activity,
- Basic and applied research:Identification of industri-ally relevant basic R&D subjects and encouragement of technology spin-offs.

Research Groups:

- Nanomaterials Theory Group
- Nano-dyanmics Group
- Near-field Nano-engineering Group
- Single Molecular and Interfacial Engineering Group
- Nanocluster Group
- Molecular Nano-Assembly Group
- Supramolecular Chemistry Group
- Molecular Nanophysics Group
- Bio-nanomaterials and Surface Interactions Group