Starting the BEANS Project

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This month, the Project to Develop Technologies for the Manufacture of Next-Generation Devices That Fuse Different Fields – a FY 2008 research and development project of the Ministry of Economy, Trade and Industry – was initiated. The "next generation devices that fuse different fields" referred to in the project's title are none other than the Bio & Electro-mechanical Autonomous Nano Systems (BEANS), the revolutionary devices of the future that the Micromachine Center has been studying for the past four years. As you know, BEANS is a concept for the creation of third-generation Micro Electro Mechanical Systems (MEMS) devices. A committee chaired by Professor Hiroyuki Fujita of the University of Tokyo was established and specialists from companies, universities and national reserch institute that are supporting members of the BEANS Research Center have pooled their knowledge and expertise to create these devices.

I am most gratified that BEANS have been selected as one of the candidates for application of the device manufacturing technologies that is the aim of the new project. I salute the enthusiasm and the efforts of all of you who have contributed their energies to involvement in BEANS research up to now. Thanks to your hard work, the Micromachine Center has been selected by the Ministry of Economy, Trade and Industry as the research promotion entity for the new project. In response, the BEANS Laboratory has been set up within the Micromachine Center to plan and propose new projects and conduct research promotion activities. This paper will provide an overview of the BEANS Laboratory and will cover its research management policy, research areas and research promotion organization in that order.

1) Research Management Policy

A basic policy for research management has been established in order to guide the project to success and ensure that its research achievements provide wide-ranging benefits to society. (**Fig.1**). The watchwords for this policy are "integration" and "open." The goal of the project is the integration of technologies in different fields, combining MEMS (which is the title of one of the research and development projects) with nanotechnology and biotechnology. The project will also work to establish ties between state-of-the-art technology centers and integrate company management with cutting-edge research. Another goal is to accomplish the heretofore difficult task of establishing a framework for fusion research. Moreover, since the research areas are pre-competitive research areas, a knowledge database containing both academic achievements and test data will be compiled to make the achievements and data widely available. In addition, steps will be taken to make licenses widely available for the patents and other intellectual property rights that have been acquired, to ensure that the research achievements contribute to the growth of domestic industries and the creation of new businesses. In addition, as personnel training and development is also considered to be of crucial importance, research management that integrates industry and academia will be conducted and an effort will be made to create interchange between young university researchers and company engineers. For this purpose, many managers that previously worked at companies and have experience in research management will be recruited to accelerate and effectively promote research.

2) Research Areas

Fig.2 shows the research areas planned for implementation at the BEANS Laboratory. Under this Basic Project Plan, there will be three major research areas:

(1) Bio and organic materials fusion process technologies
(2) 3-dimensional structure formation process technologies
(3) Micro/nanostructure large-area / continuous manufacturing processes

To these will be added one common research area: the compiling of a database of manufacturing technology development knowledge.

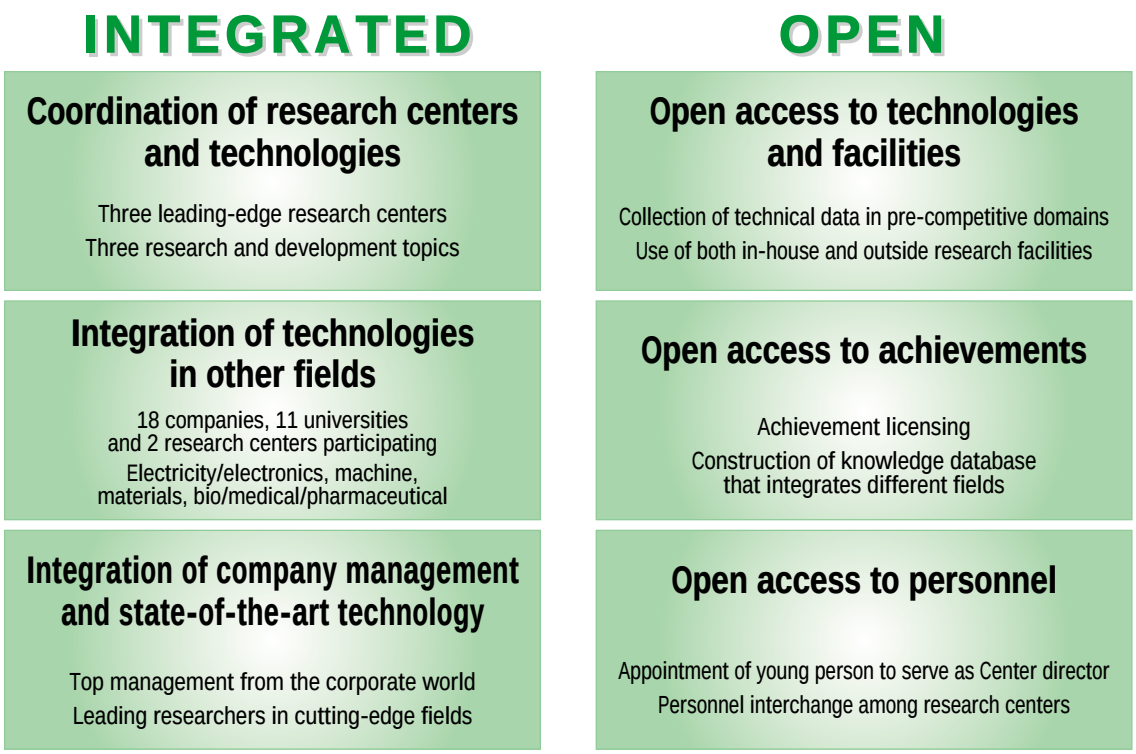

Fig 1 BEANS Research Center Policy: Integrated and Open

Research Topic 1　Bio and organic materials fusion process technologies (1) Process technologies for nano-interface fusion (2) Process technologies for the formation of bio and organic material higher-order structures
Research Topic 2　3-dimensional structure formation process technologies (1) Ultra-low damage / high-density three-dimensional nanostructure formation technologies (2) Three-dimensional nanostructure formation technologies for integrating different types of functions (3) Three-dimensional nanostructure formation technologies for use in aerospace applications　(Note: implemented by the Institute for Unmanned Space Experiment Free Flyer)
Research Topic 3　Micro/nanostructure large-area / continuous manufacturing processes (1) Process technologies for the formation of high-grade nanofunction membranes over a large area in non-vacuum environments (2) Process technologies for continuous fine processing / integration of fibrous substrates
Research Topic 4　Creation of a knowledge database for next-generation device manufacturing technologies that integrate different fields

Fig 2　Research Topics Studied by the Beans Research Center

(1) Bio and organic materials fusion process technologies

The goal in this area is the development of process technologies for achieving the device functions and mechanisms needed in next-generation health, medicine and environmental fields. In addition to the conventional inorganic dry materials such as silicon, research and development will be conducted for fusion processes that utilize the unique functions of bio and organic materials such as synthetic organic molecules, biomolecules, cells, structures, microorganisms and so on. One example is technologies to enable biological organic materials (such as lipid bilayer membranes, hydrogels and peptide synthesis) to be handled freely within microsystems.

(2) 3-dimensional structure formation process technologies

As a core technology for BEANS devices, process technologies will be developed for integrating inorganic and organic nanostructure materials on silicon, glass or other 3-dimensional structures to achieve functions not possible with silicon alone. The ultra-low damage etching conducted up to now using neutral particle beams has been developed into a method of creating 3-dimensional nanostructures that achieve surface smoothness at the atomic layer level, enabling the formation of “bottom up” structures through the self-assembly of nanomaterials on the surface of three-dimensional nanostructures. This will make it easy to manufacture terabit class high-density recorders and ultra-sensitive sensing devices.

(3) Micro/nanostructure large-area / continuous manufacturing processes

One of the efforts in this area involves the development of process technologies for the continuous manufacture, over a large area and in non-vacuum environments, of microstructure high-grade functional materials for use in electronic devices. This can be achieved by combining atmospheric pressure plasma equipment with nanomaterial coating technologies and self-assembly technologies. Another effort is the development of processing technologies capable of continuously nanoimprinting or forming functional membranes on glass fibers and other fibrous substrates. There are also plans to develop weaving technologies to turn these fibrous substrates into cloth. This would create an applied technology with wide-ranging applications for industry.

3) Research Promotion Organization

This project will be promoted by the BEANS Laboratory, a new entity set up within the Micromachine Center. The BEANS Laboratory will include three research centers, one for each research area: Life BEANS, 3D BEANS and Macro BEANS. These three research centers will be set up outside the Micromachine Center. Life BEANS will be located at the University of Tokyo and Kyushu University. 3D BEANS will be located at the University of Tokyo as well. Macro BEANS will be located at the National Institute of Advanced Industrial Science and Technology (AIST) in Tsukuba (see Fig. 3). In this way, the

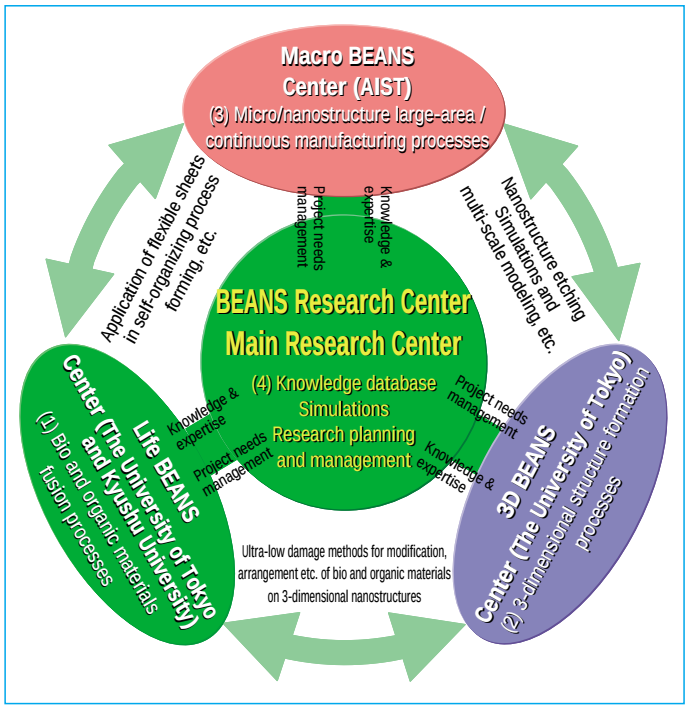

Fig 3　BEANS Research Center: Cooperation with Other Research Centers

research activities of the BEANS Laboratory will be conducted in three separate locations, but the research planning and budgeting for project areas, personnel allocation and other aspects of project management will be centralized at the BEANS Laboratory. Moreover, project management will live up to the “Fuse Different Fields” part of its name by accelerating integration and coordination among the three centers with regard to research areas, and by ensuring close cooperation among these centers. During this fiscal year, 18 companies, 11 universities and 2 research centers are scheduled to participate in the project, with the involvement of a total of 102 researchers from companies, universities and research centers. Apart from the research achievements, it is project management that will be the key to the success of the project. As we move forward with this project, I hope we can count on the continued understanding and cooperation of all who are involved in the BEANS project.