An Overview of Projects Planned for 2010

First administered directly by the Ministry of Economy, Trade and Industry in 2008, the Hetero-functional Integrated Device Technology Development Project (the BEANS Project) was converted last year to a commissioned project under the New Energy and Industrial Technology Development Organization (NEDO). The BEANS Project is now entering its third year, which is the interim evaluation year. We will be implementing the following R&D projects (1)–(4) in order to achieve our interim goals. Owing to a supplementary budget carried forward from last year, we have also added a fifth R&D project, but the details of this project will be provided in the next issue.

1. R&D Project (1): Development of bio/organic material integration processes

1A) Bio/nano interface treatment

We will develop a process for forming lipid bilayers that function stably for more than two hours in order to establish a research foundation for future implantable devices and ultrasensitive molecular measuring devices. Based on the results of forming molecular imprinted interfaces through electron beam-induced polymerization, and molecular surface modification of biocompatible polymers, we will select materials and techniques for forming biocompatible interfaces. We will further evaluate high multistage reactivity based on microbial models using carbon dioxide fixation, for example.

2A) Biomaterial higher-order structure formation

In order to create a foundation for future pharmacokinetic screening and artificial organ research, we will conduct experiments to implement glucose-responsive fluorescent gel beads in mice and verify the effectiveness of the beads to find a suitable implanting location. We will also acquire guidelines on selecting a technique for inducing the formation of billiary canaliculi by controlling the spatial organization of cells.

1B) Organic/nano interface treatment

We will narrow the organic nanostructure formation processes by means of nanoimprint lithography and the filling process in order to create a research foundation for highly sensitive and efficient organic devices using synthetic organic materials such as future organic semiconductors. We will also study a new technology for crystal growth control, wherein organic materials are filled using nano-marking. In addition, we will propose device designs making use of orientation, create functional devices with unique light and electronic properties, and verify the effectiveness of the processes.

2B) Organic material higher-order structure formation

In order to create a research foundation for highly sensitive and efficient organic devices using synthetic organic materials such as future organic semiconductors, we hope to establish processes for forming self-assembled nanostructures such as organic molecular nanopillar structures having a less than 50 nm diameter, organic molecular nanoporous structures with uniform pores of less than 100 nm diameter, and mesh or linear structures having a less than 100 nm line-and-space (L/S) pattern.

2. R&D Project (2): Development of novel fabrication technology for 3D nano structures

1) Top-down fabrication of monolayer-flat, defect-free 3D structure

In addition to achieving defect-free silicon nanostructures with an aspect ratio of 30 or greater using neutral beam etching, we will also control the sidewall inclination and isotropic/anisotropic nature of etching. We will demonstrate the superiority of ultra-low-damage etching in producing MEMS structures to conventional techniques. We also hope to improve the speed and selectivity for the formation of 3D structures through nano-domain modification with a femtosecond laser.

2) Bottom-up-technology for heterogeneous integration of materials and functions on 3D platform

As an example of highly conformal supercritical-fluid deposition on 3D nanostructures, we will form functional film through conformal deposition of oxide film, metal film, and organic film on the surface of microchannels having an aspect ratio of 30 or greater, or complex 3D surfaces. We will also develop a technology for site-selective formation of functional nanostructures, such as nanoparticles, nanodots, and nanotubes, on probe arrays or pillar arrays.

3) 3D nano-fabrication for aerospace applications

Since our interim objectives of developing a basic technology for the optimal structural design of filters for multiband observation from space, element and basic processing technologies, and basic evaluation techniques were met last year ahead of schedule, this fiscal year we will branch off and study practical applications of these technologies.

3. R&D Project (3): Development of large-area continuous process of micro/nano structure

1) Non-vacuum, large-area deposition techniques of high-quality nano/micro materials

We will install and set up a gush-type atmospheric pressure plasma deposition apparatus and develop a basic process for forming films with electronic functions and films with mechanical functions. We will also clarify the specifications for equipment capable of covering larger areas by studying scanning techniques. We will also develop a large-area nanomaterial coating technology capable of depositing a uniform film thickness within $\pm 10\%$, with a patterning resolution no greater than 200 μm.

2) Continuous nano/micro-machining and integration process for fiber substrates

We will develop a film coating process for fiber substrates employing a die coater with a high speed of 10 m/min or greater. We will also establish a 3D patterning technology for the curved surfaces of fiber substrates, a reel-to-reel imprinting technology having a high feeding speed of 5 m/min or greater, and a 3D hollow fiber formation technology. In addition, we will develop a basic weaving integration process for weaving heterogeneous fiber substrates.

4. R&D Project (4): Building up of a knowledge database for hetero-functional integrated device technology development

Functions and categorization considered by the Knowledge Database Compilation Committee will be incorporated in the knowledge database system. We will also upgrade the functions of the database system and continue to accumulate more data from the BEANS centers and the four working groups to enrich the database.