

Preface

Evolution in nanoscience and nanotechnology has created new opportunities to influence future society through creation and accumulation of wisdom, technological innovations, and applications to society. It is predicted that we will face further deterioration in global warming, exhaustion of natural resources, shortage of food and potable water, and congested cities without that evolution.

In order to solve or mitigate these serious global issues in the future, advanced functions created by nanoscience or nanotechnology should be combined with life, information, and materials science and engineering, which can evolve into integrated intelligent nanosystems. The “Creation of Nanosystems with Innovative Function Through Process Integration” program was launched in 2008 as one of the CREST (Core Research for Evolutional Science and Technology) programs in Japan to pursue the construction of nanosystems, which could be the first step toward the integrated intelligent nanosystems through the integration of top-down and bottom-up processes. One of these has been developed for nanofabrication of large-scale semiconductor integrated circuits and the other is exemplified by self-organization using autonomous chemical reactions. One of the coeditors was assigned as a research supervisor of the program. In the beginning, the nanosystems were envisioned as new functional electron devices with their critical dimensions far less than the miniaturization limit of current semiconductor technology. This was achieved by using the self-organized structures of bio-materials and autonomous chemical reactions. Nano-bio devices with capabilities of handling single cells and molecules also were accomplished by probing their dynamic behaviors using highly advanced semiconductor technology, and thus are expected to bring dramatic progress in diagnosis, clinical treatments, and drug development.

In the project, 16 of many excellent proposals were selected with the aim of realizing intelligent nanosystems over 3 years, and the research based on each proposal has been performed for 5 years. This book is the result of those efforts to realize the nanosystems, which can be classified into the following six groups:

1. Nano-bio devices utilizing advanced semiconductor technology
2. Nano-bio devices utilizing micro- and nano-fluidics technique
3. Advanced electronic and photonic devices utilizing a biotemplate technique
4. Synthesis of unique nanostructured materials and their energy, display, and catalysis applications
5. Electronic and photonic devices on soft substrate
6. Thermal and mechanical application of spintronics.

We understand that there is still a long way to go, but we believe that these attempts are important first steps toward the construction of intelligent nanosystems to resolve issues in the fields of energy, electronics, and health and medical care.

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