Column

Current State of Nanobiotechnology Research and MEMS

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Nano-bio research is currently attracting a great deal of attention in fields ranging from basic science and key technology fields (such as electricity, electronics, machine, physics, chemistry and life sciences) to biotechnology, medicine and pharmaceutical research. [1) - 4)] Nano-bio research falls into two broad research categories: nanobiology (also known as nano-bioscience), a research field of life science using nanotechnology, and nano-biotechnology, a research field created through the integration of biotechnology with nanobiotechnology. (**Fig. 1**)

Nanobiology involves research to determine the properties and structure of biological molecules at the single molecule level, as well as research into primarily molecular motors and biomachines and other molecular assemblies and intracellular bioreaction imaging and so on. Nanobiotechnology is rapidly expanding from basic technologies such as gene expression and protein measurement technologies using chips, sensors and MEMS to application fields such as medical diagnosis technologies, nanomaterial-based drug delivery systems, gene therapy, systems engineering, regenerative medicine and nanomedicine. (**Fig. 2**) Moreover, with the recent progress in MEMS and nanotechnology, research is expanding in the domain that fuses nanobiotechnology with nanobiology.

Effective use of MEMS technology is becoming an important key to successful nano-bio research, particularly in the currently active research domain that fuses nanobiology and nanobiotechnology. Up to now, molecules and molecular assemblies were the principal target of nano-bio research. However, MEMS is also coming to play an extremely important role in research into more complex systems such as cells and structures. For example, with MEMS it is possible to analyze the single-molecule gene expression information inside a single cell, something heretofore thought to be impossible. It is also now possible to study techniques for producing chemical energy by applying mechanical energy to a single-molecule motor. Moreover, it is also becoming possible to use MEMS to conduct research into cell patterning (used in cell manipulation and regenerative medicine) and so on.

There has been considerable progress in nano-bio research in recent years, particularly in terms of the creation of research domains in which research would be impossible without nanobiotechnology. Achievements in nano-bio research are currently having a tremendous impact on the life sciences, to the extent of rewriting what we know as common knowledge about the life sciences. Moreover, most of this new research has been created as a result of the deployment of MEMS in nanobiotechnological research. However, the use of MEMS in nanobiotechnological research has just begun, and most of the technologies produced through MEMS are not yet being applied in nanobiotechnological research. In the future, the deployment of various MEMS technologies in nanobiotechnological research will bring about a technological revolution in the life sciences, as well as in medical treatment and pharmaceutical research. These technologies are expected to help us solve the mysteries of life and aid in further progress in medical treatment and pharmaceutical research.

1) Baba, Yoshinobu ed. "Nanotechnology and medical treatment" Nippon Rinsho, February 2006)
2) Baba, Yoshinobu ed. "Isolation and measurement technologies in the nanotechnology and biotechnology MEMS era" (CMC Publishing Co., Ltd., 2006)
3) Baba, Yoshinobu ed. "Nanobiology: Using nanotechnology to transform biology" (Cellular Engineering, August 2006)
4) Baba, Yoshinobu ed. "New directions in nanobiotechnological research made possible by chemistry" (Modern Chemistry, November 2006)

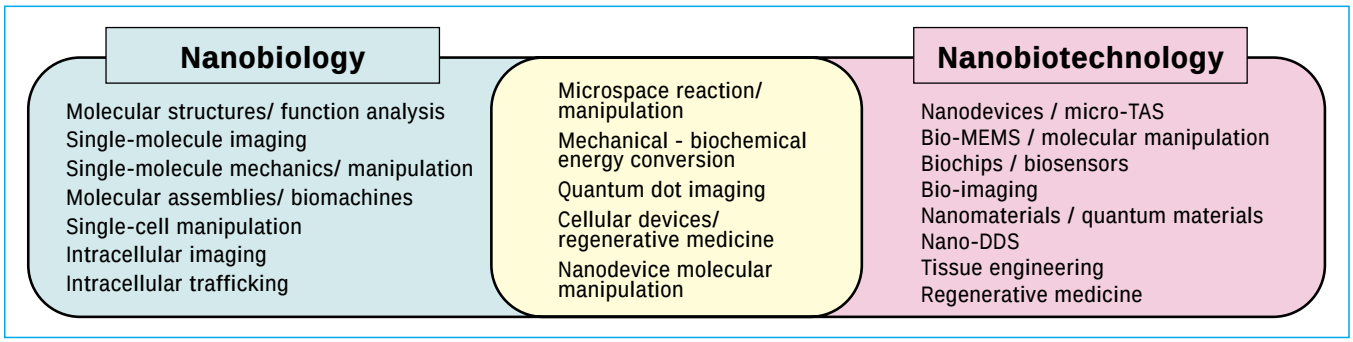

Fig. 1 Nano-bio research domains

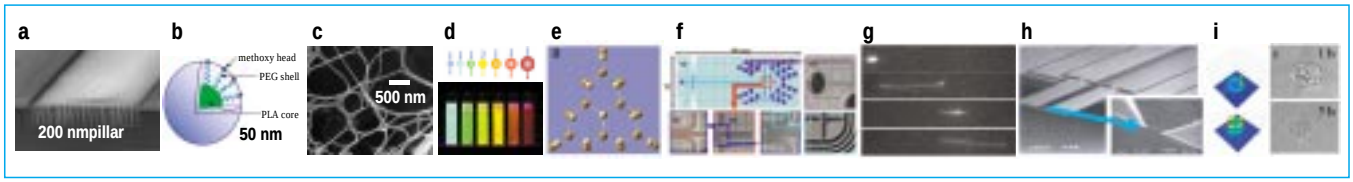

Fig. 2 Nanobiotechnologies studied by the Group
a. Nanopillar, b. Nanobowl, c. Nanofiber, d. Quantum dot, e. Quantum dot cluster
f. Biodevice, g. Monomolecular imaging, h. Nanotweezers, i. Intracellular molecular imaging