

Toward the Achievement of 3rd Generation MEMS: Bio & Electro-mechanical Autonomous Nano Systems (BEANS)

Keiichi Aoyanagi, Executive Director, Micromachine Center

MEMS: The “Beans” of Industry

In recent years, Micro Electro Mechanical Systems (MEMS) have become a key part of industry. These devices are incorporated into a wide variety of final products and provide high added value. Examples of development efforts and products include mirror devices for optical switches used in the field of optical communications and so on, cantilevers used in atomic force microscopes, pressure sensors and acceleration sensors used in automobile components and the like, and radio frequency (RF) MEMS switches used in wireless communication systems.

In Japanese, the expression *sangyo no kome* (literally “the rice of industry”) is used to indicate a key element of industry, such as steel manufacture during Japan’s period of rapid economic growth or the semiconductor chips that are now core devices used in many products. MEMS devices have been called not the rice but the “beans” of industry. This is because, although tiny, MEMS are a source of vitality and provide outstanding utility and functions to the products in which they are incorporated.

The beans metaphor is applicable in other ways as well. There are many different types of beans (soybeans, adzuki beans, peanuts, green beans etc.), and they are used to make many bean products (natto, miso, tofu, soy milk, adzuki bean paste etc.). Similarly, there are many different types of MEMS devices, and they are used in many different types of products.

Development of MEMS

The first generation single-functional MEMS devices – those used primarily to replace existing single-function components due to their compact size – are currently in development. These products constitute an enormous market and include pressures sensors, acceleration sensors, inkjet printer heads and so on. These first generation MEMS devices constitute most of the domestic market that is estimated at JPY 440 billion yen.

However, in order to respond to the future needs of the automobile, information and telecommunications, safety and security, environment, medical care and other fields, second generation multifunctional MEMS devices (fine MEMS) that are ultra-compact and offer advanced functions and high reliability will be needed. For this reason, a three-year fine MEMS technical development project was initiated in fiscal 2006. The purpose of this project was to support the development of these second generation fine MEMS devices through research into (1) complex technologies to implement nanofunctions, (2) integrated construction with semiconductor chips, and (3) methods to connect MEMS components in a highly integrated manner. Practical application of fine MEMS technologies is expected in five to ten years.

Expectations for BEANS (technologies of the future that will create new lifestyles)

MEMS technologies hold great promise for the society of the future 20 years from now. In order to realize this promise, further advances in MEMS technology are needed, as well as the fusion of this technology with nanotech materials technology and biotechnology to create third generation MEMS (future devices on the frontier of MEMS research) that will create new lifestyles and have a revolutionary impact on society. Efforts must be made now to establish the technical infrastructure that will enable the creation of these future devices. Accordingly, based on the results of a study conducted by the Micromachine Center (MMC) at the behest of the Mechanical Social Systems Foundation, MMC has called for a project to develop the technical infrastructure to fuse nanotechnology and biotechnology with electrical and mechanical systems, in order to create autonomous devices and systems called Bio Electro-Mechanical Autonomous Nano Systems (or BEANS). With the support of the Council on Competitiveness Nippon (COCN), MMC is asking relevant parties to help make this a national / NEDO project beginning in fiscal 2008.

