Strategies for Further Development of MEMS Industries and Emerging Applications

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MEMS R&D began with pressure sensors in the 1970s and by the latter half of the 1990s had spread to applications in such fields as optics, radio frequency, biotechnology, and μ-TAS. At its current level of maturity, MEMS technology for microspaces enables us to freely create and operate devices at the research and development level while gradually producing tangible products. In the future, we plan to expand R&D on applications in nanospaces and to build an infrastructure for the MEMS industry by producing end products with technologies that have been perfected. At this symposium, we discussed strategies for vitalizing the MEMS industry by categorizing MEMS products in terms of their market scale and the amount of added value MEMS gives to the products.

Fig. 1 shows the results of our efforts to categorize MEMS products. The inkjet printer head is an example of a great success because MEMS technology is indispensable for its production and the inkjet printer head is a mass-produced product. Therefore, the printer head was positioned in the upper right of the graph. Accelerometers occupy the bottom right of the graph since they can be replaced with mechanical means. Digital micromirror devices (DMD) employed in projectors are now competing fiercely with liquid crystal devices and are thus positioned in the center of the graph. Optical MEMS switches are also products that could not be produced without MEMS technology. However, since they are produced in low quantities, the switches have been placed in the upper left of the graph. Hence, MEMS products can be divided into three categories: (1) mass-produced MEMS products, (2) products unique to MEMS in which the system functions as a consequence of MEMS, and (3) indispensable MEMS products that could not be realized without MEMS. Products in Fig. 1 above the solid line are successful products. In the future, we anticipate the development of such new MEMS products as tire sensors and such consumer products as accelerometers and gyroscopes for category (1); products for medical diagnosis including biochips for analyzing DNA in category (2); and scanning probe microscopes and devices for manipulating objects at the atomic/molecular level in category (3).

The success and failure of MEMS products depends on the market scale and the degree of MEMS added value. One strategy we can draw upon for MEMS products is mass-production in category (1) aimed at reducing costs, as in the example of semiconductor chips. However, in addition to mass-produced products, opportunities for MEMS may lie in key components of high added-value systems in categories (2) and (3). Therefore, we examined problems and solutions in commercializing product groups for which small quantities of numerous varieties are inevitably produced.

Despite their small production, these MEMS products require expensive production equipment. There is also a shortage of high-level designers that possess sufficient knowledge related to the MEMS manufacturing process. However, by utilizing a MEMS foundry service, customers who possess no such expensive manufacturing equipment can manufacture products using the foundry's expensive equipment and processing technologies. As the network of MEMS foundries grows, it will be possible to obtain a variety of services at one location.

A lot of time and expense is required for developing MEMS products, as many design modifications and much trial production is necessary for producing an optimal product. However, with advances in computer-aided design, it will be possible to view the final structure of a MEMS product virtually so that the amount of trial production can be minimized, thereby greatly reducing the time and costs for development. Further, all too often manufacturers do not make full use of MEMS properties due to an insufficient knowledge of MEMS. However, we hope to resolve this issue by providing a knowledge database containing extensive data accumulated by universities and research institutes over a twenty-year period, and equipped with an excellent search engine.

In conclusion, we hope to construct a foundry network, a computer-aided design environment, and an infrastructure facilitating technical transfer from universities and research institutes through collaboration among foundry businesses, equipment and material suppliers, software vendors, research institutes at universities, and government agencies. By doing so, we are confident that we can accelerate the industrialization of various applied fields requiring small numbers of diverse products, as well as the industrialization of mass-produced products.

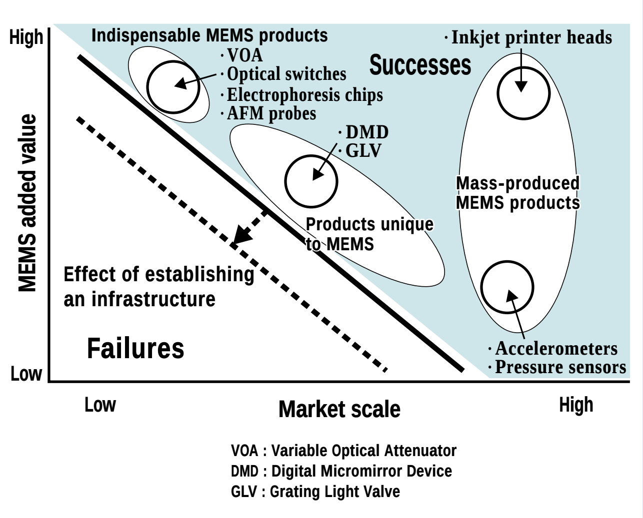

Fig. 1 A map of MEMS products