Members' Profiles

Mechanical Engineering Research Laboratory, Hitachi, Ltd.

1. Introduction

The Mechanical Engineering Research Laboratory (MERL) is one of six research laboratories belonging to Hitachi, Ltd. With about 380 researchers, MERL utilizes its basic mechanical systems technology to support a wide array of products, from large-scale infrastructure installations, such as high-speed rail cars and large-capacity high-speed elevators, to compact information equipment, such as magnetic and optical disks.

Hitachi's first involvement with micromachines came when its Central Research Laboratory and Hitachi Research Laboratory began developing semiconductor sensors in the 1970s. MERL began working with micromachines in earnest in 1991 when it participated in the Micromachine Project headed by the Micromachine Center. During this project, MERL worked on developing micro-sized pumps and other mechanisms, challenging the limits of conventional micromachining that simply reduced the size of traditional mechanical structures. Today, we are committed to R&D on 3D micromachining aimed at producing mechanical elements through semiconductor micromachining technology. We are also designing unique micromachined structures capable of emulating the functions of conventional machinery. Thus, machining technology and design technology are essential to our R&D activities. The next section will outline our efforts in research and development.

2. R&D Activities

As we approach the twentieth year of our R&D activities on micromachines at MERL, the direction of our research has shifted. The general focus of research in the micromachine field is said to have changed from determining how to make them, to determining what to make. Similarly, MERL's focus in R&D has changed from developing micromachine technology to developing applications for this technology. However, in order to verify the applications, it is vital to have our base machining technologies in place to be able to develop key micromachined parts quickly. Our micromachine room is approximately 585 m^2 and equipped with various production facilities that we work hard at maintaining and expanding. One feature of these facilities is that they allow us to implement 3D micromachining on a variety of materials, including silicon, glass, metal, and resin. We have this capacity because different materials are needed for the different business areas that the Hitachi Group handles, such as silicon and semiconductor thin films used in the fields of sensors and actuators, glass and resin used in biotechnology and medicine, and metal and glass used in chemosynthesis.

MERL is also conducting R&D on wafer-level bonding technologies for assembling micromachines formed on various substrates and possesses the facilities to support such technologies as diffusion bonding, eutectic bonding, fusion bonding, and anodic bonding. Our packaging equipment can replicate actual environments of use by forming wiring to 3D structures and connections to interposers as a means of interfacing between prototype micromachines and the physical world.

MERL evaluates the functions of packaged micromachines in fluidic devices using a microfluidic system to perform actual analysis and chemosynthesis. For sensors and actuators, we evaluate their dynamic characteristics using our various test facilities. We are also capable of conducting reliability tests on micromachines using our expertise cultivated in electronic devices.

Thus, MERL has prepared an R&D environment that allows us to carry out the entire process of prototyping, packaging, and evaluation necessary for proceeding smoothly in the development of applications.

Lastly, I will give a brief description of MERL's design technology. In micromachines, the design must be sufficiently reliable to avoid numerous repetitions of trial production and evaluation. To achieve such reliability, it is important from the design stage to carry out development that considers not only links between known micromachine structures and manufacturing processes, but also how such micromachine structures can be used. To this end, MERL is developing techniques for linking structural designs and package designs for micromachines. As always, it is easier said than done, but we will continue working toward this goal while drawing on our twenty years of accumulated experience.

3. Conclusion

At MERL we have worked on the development of various micromachine-related technologies and are now conducting a support service to provide consulting outside of the company on well-established micromachine technologies. For more information on Hitachi's integrated support service, please visit the i-engineering Web site below.

http://www.hitachi.co.jp/rd/i-engineering/contents4.html

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