TOYOTA CENTRAL R&D LABS., INC.

Norikatsu Ishikawa
Director

Toyota Central R&D Labs., Inc., in cooperation with the Toyota Group and research organizations throughout the world, carries out extensive research on automobile-related technologies, electronics, information and communications, functional materials, biotechnology, and environmental technology.

Since its founding in 1960, Toyota Central R&D Labs., Inc. has made many contributions to the micromachine field, developing the world's first strain gauge that incorporates the piezoresistive effect of silicon and conducting research on such silicon micromachining processes as silicon anistropic etching and anodic bonding technologies to aid in the practical utilization of pressure sensors and accelerometers developed by Toyota Group companies. In recent years, we have conducted research on a wide range of device, circuit, design, process, and evaluation technologies focusing on surface micromachining and silicon integrated sensors.

In process technologies, research on surface micromachining for the fabrication of microstructures using polysilicon, SiO_2 thin films and SOI wafers have been conducted, which includes vapor etching of sacrificial layers, surface coating and machining for sticking prevention, fabrication formation of thin film multilayer structures, and thin film vacuum encapsulation . Fig. 1 is a vibrating gyroscope (angular rate sensor) formed of three layers of polysilicon thin films produced using the above technologies. This 2-μm thick thin film structure is supported on four beams over a vertical gap of 2μm, as if floating in space. By inserting this type of sensor structure in a micro-chamber having the same thin film structure, we produced a on-chip vacuum-sealed angular rate sensor. This is the world's first sensor that allows us to verify operations for detecting angular rate .

In evaluation techniques, we have focused on evaluating the mechanical properties of thin film materials. We are developing such equipment as a device for measuring the Young's modulus and internal stress of a thin film membrane based on its pressure-deflection curve and a thin film tensile tester (Fig. 2) with an electrostatic chucking system for evaluating micro-sized specimens. We are also studying property evaluations necessary for designing and evaluating the reliability of micromachine devices. Using these technologies, we participated in a NEDO project called "the standardization of evaluation method of material properties for micromachines" implemented by the Micromachine Center through the last fiscal year.

In the future, we would like to expand our applications based on surface micromachining technologies to encompass micromachine devices incorporating not only sensors, but also actuators and the like.

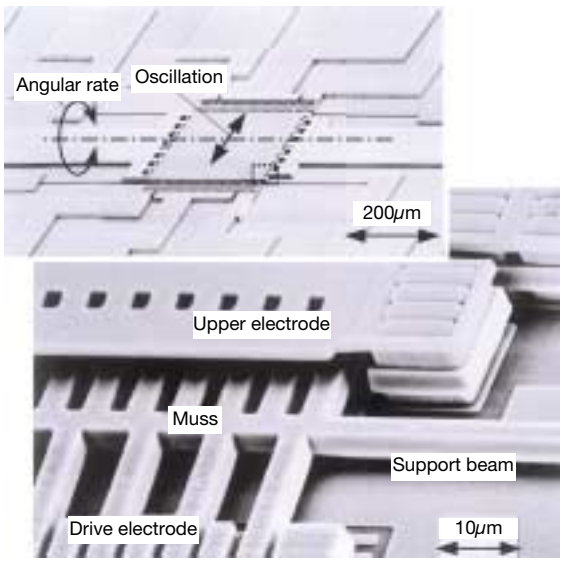

Fig. 1 Polysilicon vibrating gyroscope

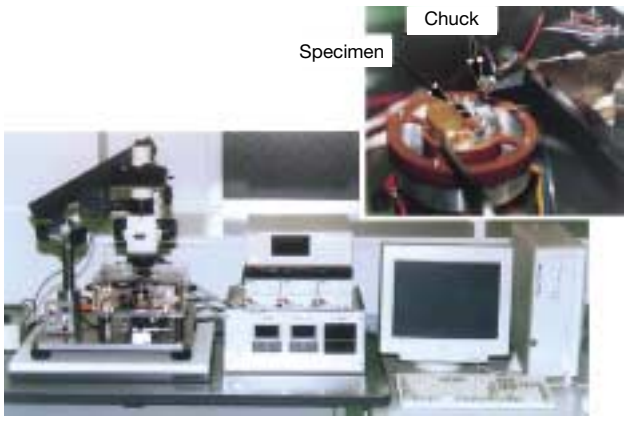

Fig. 2 Thin film tensile tester with electrostatic chucking system