

Research on Thermal Type MEMS Flow Sensor Using Thermopile

Sho Sasaki

This paper reports the R&D achievements on practical application of thermal type MEMS flow sensor with thermopile. Conventionally, many researches on thermal type MEMS flow sensor have been reported, but most of them are utilizing the device with Pt resistor. This device has problems of adjustment of the heater and temperature measuring resistors from bridges, and small resistance temperature coefficient of Pt proportional to output voltage.

As for the solutions, the method of raising output voltage by series-connected thermopile is considered. But larger thin membrane for wiring area is necessary, because the thermopile has cold junction on Si substrate and hot junction on thin membrane that connected in series. Conventionally, anisotropic wet etching or DRIE from backside of Si substrate, or isotropic dry etching using XeF₂ from front side of Si substrate to fabricate the membrane. But the chip size would be larger because the sidewall becomes not vertical by anisotropic etching. XeF₂ isotropic etching has the same problem because the space for side-etching while forming membrane from front surface is required. In contrary, DRIE has advantage for small chip size by its vertical etching but it requires high processing cost due to the single wafer processing.

Consequently, in this research, (100) single crystal Si substrate is used to minimize chip size with unique H-shape etching hole and anisotropic etching from the wiring surface. As the result, 1 x 1 mm² square size in 1.5 x 1.5 mm² chip size. This new chip has total 54 thermocouples on this wide membrane by AlCu wiring and n-type polysilicon which is utilized in general LSI process, and the heater is fabricated by n-type polysilicon. With the small, highly sensitive and highly practical MEMS flow sensor was realized, and 6 types, 14 products were released.

And MEMS flow sensor was applied on unique PC mouse. The flow sensor was settled in the cavity on back side of PC mouse. And the sensor measures the flow of the air in the cavity as the movement of mouse. PC mouse can be miniaturized like optic mouse, and can measure mouse's movement at very slow (1 mm/s) to very fast (100 mm/s) speed even on mirror or glass surface like ball mouse.