Development and application of semiconductor gas sensor using MEMS technology

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MEMS is the device that integrates machine element parts, sensors, actuators, and electric circuits on one silicon substrate etc. There are some kinds of marketing product using MEMS technology now. For example, an inkjet printer head, a pressure sensor and so on.

If we use MEMS technology for semiconductor gas sensor, some merits are expected. The present market demands a more compact, lower power consumption and lower cost sensor. Therefore, we have begun the development of the new type gas sensor using MEMS technology as the next generation sensor. The main feature of our MEMS chip is to have an air-bridge structure. In this structure, the gas sensing element, the sensor electrode, the insulation layer and the heater are formed on a support layer which is floated in the air through a cavity, this makes it possible to heat the sensing element efficiently.

In this presentation, we will talk about the three usages of the MEMS sensor.

1. CH_4 sensor for battery-operated domestic gas leak detector
2. Air quality sensor for home air cleaner and air conditioner
3. Air quality sensor for car's ventilation system.

1. The development of CH_4 sensor for battery-operated domestic gas leak detector

The number of city gas accidents decreases as the city gas leak detector spread throughout the market. However, the market penetration of city gas leak detectors has stagnated at an insufficient level which could cause accidents. Since city gas whose main component is methane which is lighter than air, the detector must be installed near the ceiling with wiring. The wiring which makes construction cumbersome and unsightly is one of the factors that market penetration has stagnated. Therefore, a battery-operated domestic gas leak detector is strongly required.

By using MEMS technology, intermittent operation of the heater, and suitable gas sensing material, we could develop a CH_4 sensor for battery-operated domestic gas leak detector.

2. The development of air quality sensor for home air cleaner and air conditioner

We expect a low power consumption air quality sensor by using MEMS technology. The power consumption of the MEMS air quality sensor is reduced to about 20mW, which is a tenth or less of conventional one. By using MEMS technology, we obtained the gas sensing characteristics almost equal to that of conventional sensor. Additionally, we tried some ideas to reduce the sensor manufacturing costs.

3. The development of air quality sensor for car's ventilation system

Car's ventilation system keeps the air in a car's cabin fresh and clean with reducing pollutants inflow into the cabin. Presently, car's ventilation systems are used mainly in high-end cars. For usage in various cars, the sensor cost reduction is strongly requested. MEMS type sensor does not only have lower power consumption but also is compact in size and suitable for automatic assembly process. We have started to develop the inexpensive air quality sensor with MEMS technology.

Total power consumption of two sensing elements in the MEMS sensor was 45mW and reduced to a tenth of the conventional sensor. By using MEMS technology, we obtained the sensor which has good primary performance the same as conventional one, low power consumption and is compact in size and advantageous for automatic assembly process.

This type sensor using MEMS chip and the small ceramic package enables surface mounting, we can expect not only car's ventilation system but also various usages, for example, a small type air quality sensor for air conditioner, an alcohol sensor installed in cellular phone and so on.