Development of Pollution Gas Sensors for the Energy Saving in a Clean Room

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Keywords: Semiconductor gas sensor, WO_3, Low power consumption, Draft exhaust control

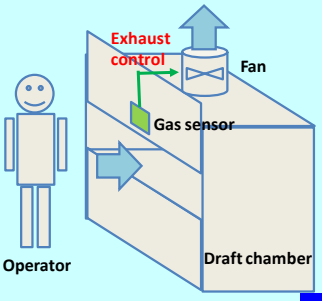
Abstract

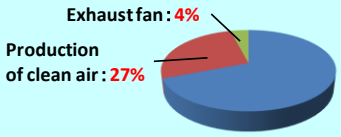
◆ Low-power and high-sensitivity WO_3 gas sensors are developed.
◆ The gas sensors contribute to the energy saving in a clean room by the draft exhaust control.

Objective

Development of low-power and high-sensitivity WO_3 gas sensors which can detect pollution gases (acid and alkaline gases) in ppb level in a clean room

By the control of the exhaust fan of the draft chamber according to the concentration of the pollution gases, not only the power consumption of the exhaust fan but also the power consumption concerning the clean air production is reduced.

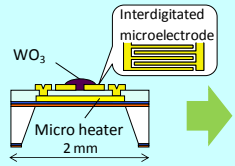




Proportion of the energy consumption in a clean room

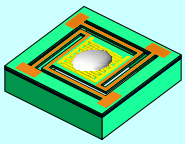
Effect of the energy saving: ▲5%

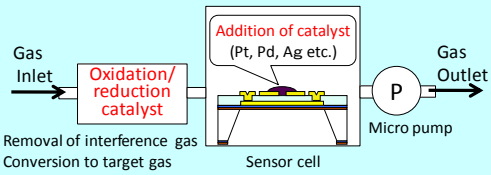
Methods



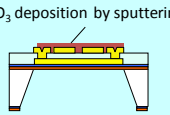
Present gas sensor

Detection of NO_2, O_3 in ppb level is possible.





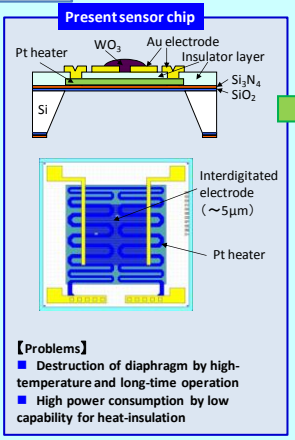
- Removal of interference gas
- Conversion to target gas



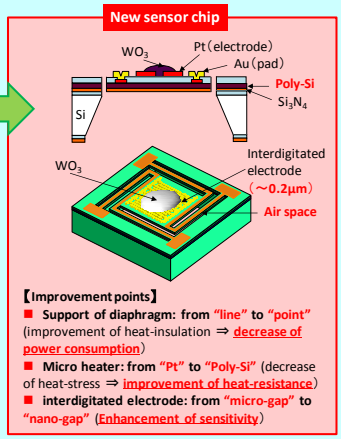
■ **Optimum design of MEMS sensor chip**
⇒Improvement of heat-resistance
⇒Low power consumption
⇒Enhancement of sensitivity by nano-gap electrode

■ **Examination of potentiality of present sensor**
⇒Optimization of operation temperature
⇒Expansion of detectable gases by combination of catalyst

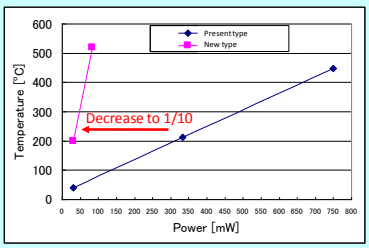
■ **WO_3 deposition by sputtering**
⇒Improvement of controllability of layer thickness
⇒ Enhancement of sensitivity by optimum layer thickness
⇒ Enhancement of sensitivity by nano-porous processing



【Problems】
■ Destruction of diaphragm by high-temperature and long-time operation
■ High power consumption by low capability for heat-insulation



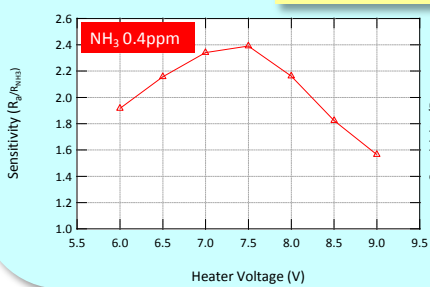
【Improvement points】
■ Support of diaphragm: from "line" to "point" (improvement of heat-insulation ⇒ decrease of power consumption)
■ Micro heater: from "Pt" to "Poly-Si" (decrease of heat-stress ⇒ improvement of heat-resistance)
■ interdigitated electrode: from "micro-gap" to "nano-gap" (Enhancement of sensitivity)

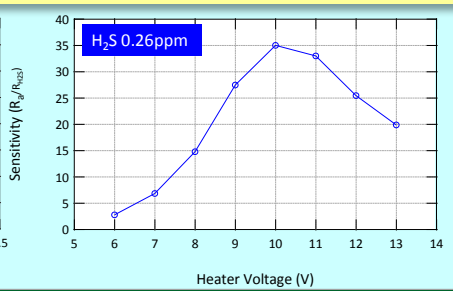


Simulation result of the comparison between present and new sensor chip on the power consumption

Results

NH_3 and H_2S were detected in ppb level and the power consumptions were reduced to 1/2~1/3 in first trial sensors. Now second trial sensors are under evaluation.





Kind of gas	Version of sensor	Max. Sensitivity (Ra/Rg)	Power consumption (@Max. sensitivity) (mW)
NH_3	Present	1.7@0.5ppm	112
	First trial	2.4@0.4ppm	60
H_2S	Present	8.8@0.5ppm	288
	First trial	35@0.26ppm	102