

Novel Semiconductor Printed Type Gas Sensors for New Requirements to Gas Detectors

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SnO₂ semiconductor gas sensors have been first put to use to detect the leakage of combustibles such as LPG and TG and widely used in various fields because of some advantages like small-size, long life and low cost. Of these, the detection of combustible gases for domestic use is the largest market and over 80 million sensors have been so far utilized. Moreover, demands for detecting toxic CO generated by incomplete combustion have been rapidly arisen in recent years and commercialized CO detector in northern part of America. As for CO detectors, a conventional SnO₂ gas sensor has disadvantage, as it is impossible to drive the sensor with batteries for a long-term because of its power consumption around 500mW. And the length of power cable limits the place for installation of a CO detector. A CO sensor with low power consumption is, therefore, strongly required for battery operation. In Japan, on the other hand, gas leak detectors with incomplete combustion alarm have been recently introduced mainly in TG supplying areas.

In general, SnO₂ gas sensors are heated at the relative high temperature from 300 to 500 to detect CH₄, whereas the sensors are used below 300 in the case of sensing CO because of its higher combustibility of than CH₄. In order to detect both CH₄ and CO, the combination of a CH₄ sensor and a CO sensor has been used so far. There are, however, some disadvantages such as higher cost, larger size and more complicated circuit so that a single sensor capable for detection of CH₄ and CO is strongly demand.

To meet with the above requirements, novel semiconductor printing type gas sensors using SnO₂ have been developed and evaluated for practical application. The one is a battery operable CO sensor using pulse-heating method. The other is single sensor detecting CH₄ and CO using alternate temperature cycle.

1. Battery operable CO sensor using pulse heating method

Fig.1 shows the sensor structure with multi layers consisting of SnO₂ sensing material loaded with Pt, glass electrical insulator, and RuO₂ heater and glass thermal insulator. The sensor was heated for 14msec. every 150sec. according to the driving condition shown in Fig.2. By pulse heating operation, the power consumption of the sensor is only 0.09mW so that it is possible to operate the sensor for two years with a 9V alkaline battery. Fig.3 shows the relative sensitivity to various gases of the sensor. As indicated in the figure, the sensor shows excellent sensitivity to CO since the sensitivity curve to CO shows a sharp drop in sensor resistance as CO concentration increases. In comparison, sensitivity to ethanol is very low as evidenced by the relatively flat slope of its sensitivity curve and high resistance values. The sensor showed the excellent long-term stability as

well.

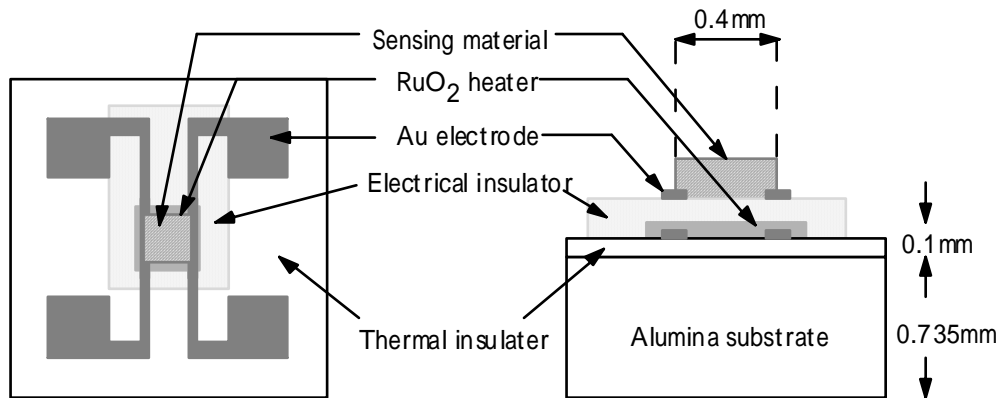


Fig.1 Structure of battery operable CO sensor

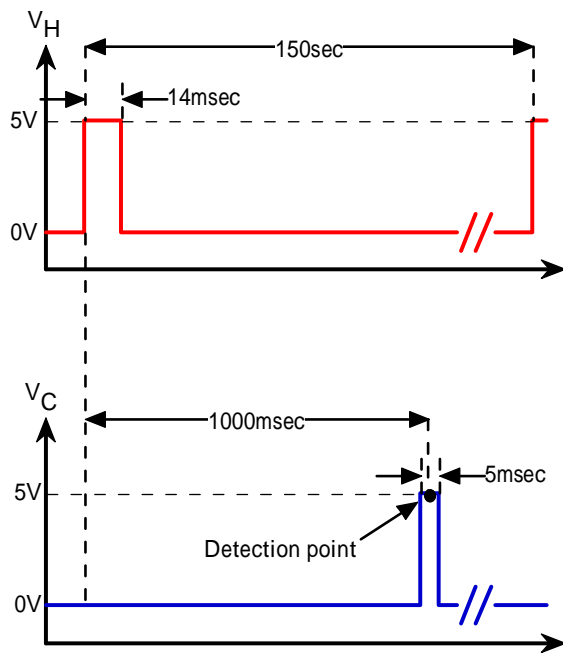


Fig.2 Circuit voltage cycle

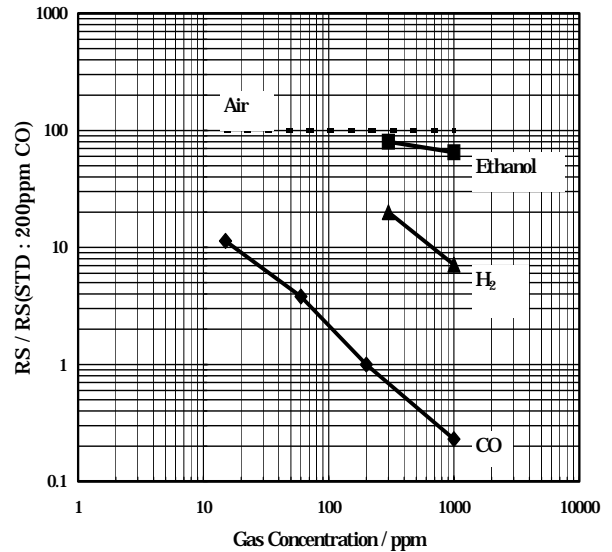


Fig.3 Sensitivity to various gases

2. Single sensor detecting CH₄ and CO using alternate temperature cycle

Fig.4 shows the sensor structure of the sensor. The sensor has two sensing materials, one is for CH₄ detection consisting of SnO₂ loaded with Pt and the other is for CO detection consisting of SnO₂ loaded with Pt and Pd. RuO₂ heater was located under the CH₄ sensing element in order to utilize the heater power effectively. The sensor was alternatively heated at high temperature for 3sec. then

at low temperature for 9sec. as shown in Fig.5. CH₄ was detected at the end of high temperature period, while CO was detected at the end of low temperature period. By using the alternate temperature cycle, the sensor can detect both CH₄ and CO every 12sec. Fig.6 shows the relative sensitivities to various gases of the sensor. As indicated in the figure, the sensor shows excellent sensitivity and selectivity to both CH₄ and CO. The sensor showed the excellent long-term stability as well.

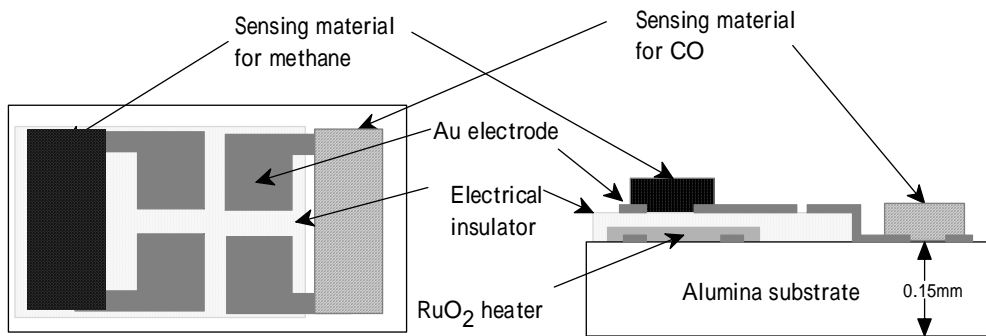


Fig.4 Structure of CH₄ and CO sensor

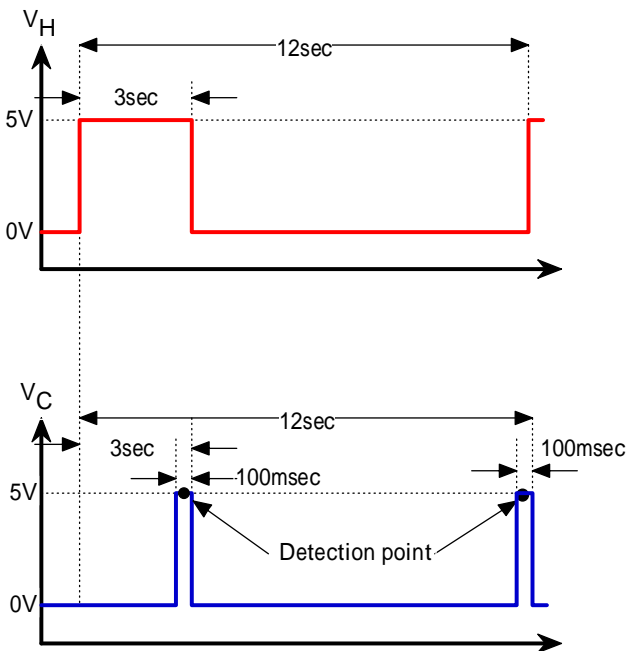


Fig.5 Circuit voltage cycle

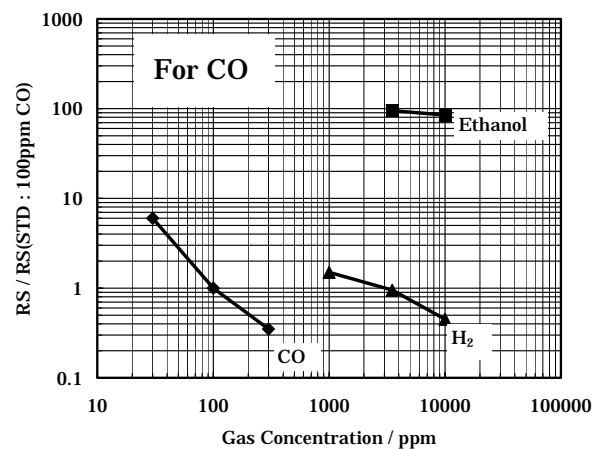
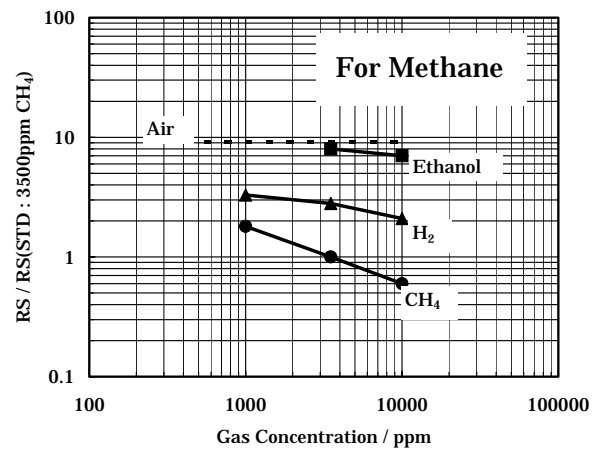


Fig.6 Sensitivity to various gases