Effect of Metal Loading on H_2 Sensing Properties of SnO_2 Modified with Mesoporous SnO_2

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In order to clarify the effect of metal loading on the H_2 sensing properties of thick film semiconductor gas sensors, several SnO_2-based powders have been prepared and tested. SnO_2 powder was prepared by calcination of tin oxalate at 600°C for 5 h. Loading of 0.5 wt% Ru or Pd on the SnO_2 (0.5M/SnO_2, M = Ru or Pd) powder was conducted by a conventional method. Procedure of surface modification of the SnO_2 powder with a mesoporous SnO_2 (m-SnO_2) layer has been described elsewhere.[1)] Response of the sensors was measured to 1000 ppm H_2 in air at 250-550°C. Magnitude of the response was defined as the ratio (R_a/R_g) of sensor resistance in air (R_a) to that (R_g) in 1000 ppm H_2 balanced with air.

Figure 1 compares the H_2 sensing properties of thick film sensors (film thickness: ca. 30-40 □m) prepared with several SnO_2-based powders. The surface modification with an m-SnO_2 layer led to improvement of H_2 response in the temperature range studied, and the improvement became remarkable by the repetition (see the data for m-SnO_2(*2*)/SnO_2). Loading of Ru or Pd on the SnO_2 powder was also effective, especially at lower temperatures than 400°C. The improvement induced by the surface modification may be explained by diffusion control of gaseous O_2, while that induced by the loading by the chemical sensitization effect.

More significant improvement in H_2 response could be achieved with the twice surface modification of 0.5Ru/SnO_2 (see the data for m-SnO_2(*2*)/(0.5Ru/SnO_2)), as shown in Fig. 2, whereas the Ru loading after the surface modification (see the data for 0.5Ru/m-SnO_2(2) /SnO_2) resulted in comparable response with that for a unloaded sensor. In contrast, the maximum H_2 response was ca. 25 at most in the case of m-SnO_2(*2*)/(0.5Pd /SnO_2). Thus, the m-SnO_2(*2*)/(0.5Ru/SnO_2) sensor exhibited the highest H_2 response among the sensors studied. But, the sensor showed rather slow recovery, whereas its response was very fast. These results suggest that the markedly improved response of the m-SnO_2(*2*)/(0.5Ru/SnO_2) sensor arises from a synergy effect of the diffusion control and the chemical sensitization. The Ru loading after the surface modification may reduce the permeation amount of H_2 into the SnO_2 surface, and the Pd loading before and after the surface modification may induce a similar result due to higher catalytic activity than Ru.

1) T. Hyodo, S. Abe, Y. Shimizu, M. Egashira, *Sens. Actuators B*, **93**, 590 (2003).

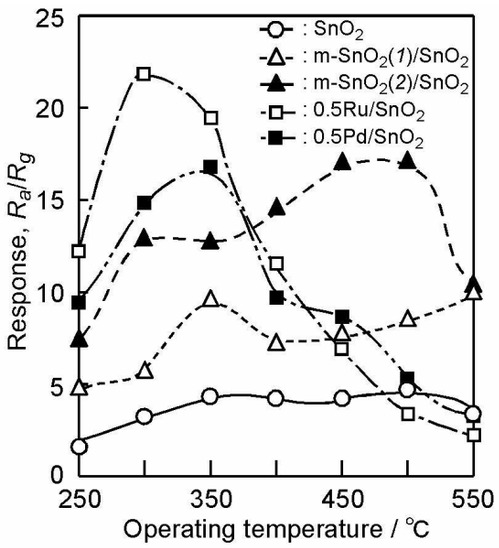

Fig. 1 Operating temperature dependence of response of sensors to 1000 ppm H_2.

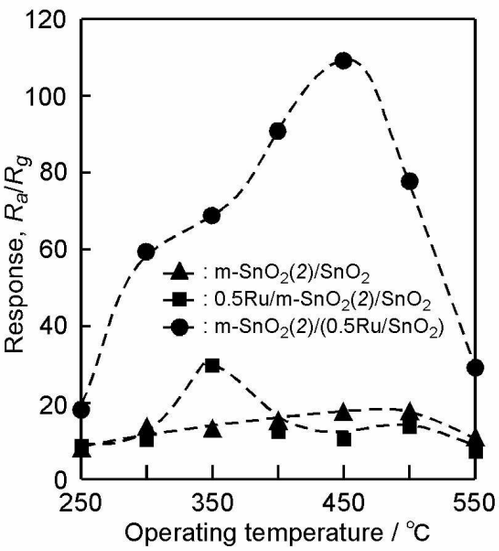

Fig. 2 Operating temperature dependence of response of sensors to 1000 ppm H_2.

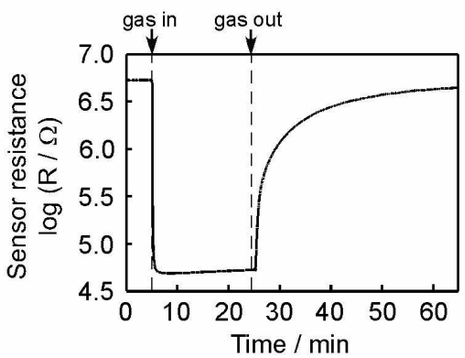

Fig. 3 Response transient of m-SnO_2(*2*) /(0.5Ru/SnO_2) to 1000 ppm H_2 at 450℃.