THIN FILM GAS SENSOR CHARACTERISTICS OF 0.5WATT CLASS

G. E. Jang[a], Q. X. Wu[b] and C. C. Liu[b]
[a]Department of Materials Science & Engineering, Chungbuk National University, Cheongju, Chungbuk 361-763, Korea
[b]Electronic Design Center, Case Western Reserve University, 10900 Euclid Ave.
Tel : +82-43-261-2412 Fax : +82-43-274-8925
E-mail : gejang@chungbuk.ac.kr

1. Introduction

A considerable number of metal oxide films are sensitive to gases and are being in solid-state gas sensors and electronic noses. MoO_3 has been well known from applications in the field of catalysis for oxidation reactions of hydrocarbons and alcohol [1] and electomagnetism [2]. Recently semiconducting MoO_3 has been developed as a new gas sensing element[3,4] because of its high reactivity and easy reduction. The MoO_3 is an n-type semiconductor with an oxygen deficiency. The band gap is 3.2eV and the electrical resistivity at room temperature is the order of 10^{10} Ω · cm, measured on a sintered pellet[5]

Sensitivity, selectivity and stability are the most important characteristics of gas sensing materials. Moreover power consumption of sensor is another critical issue for the successful application in the field.

In this work, nanoparticled MoO_3 thin film was deposited on glass substrate of 250micron thickness by sputtering technique. Typical size of sensor including interdigitated sensing element was 5.0mm in length and 3.8mm in width. Sensor was systematically evaluated in terms of different gas concentration such as H_2, alcohol, methanol and acetone.

2. Experimental

The sensor were fabricated by using conventional silicon IC technology. The microsensors were using 4 metal masks for photolithography process and a shadow mask. Initially 2,000 Å Pt was deposited by DC sputtering on the back side of pyrex glass substrate for heater and temperature detector. After lift-off of heater and temperature detector interdigitated Mo films for electrode was made by means of rf magnetron sputtering. The deposition was performed under 100% Argon atmosphere for 60min on glass substrate of 250㎛ thickness. The working and basal pressure was maintained at a constant level of 2mtorr and 2 X 10^{-3}mtorr respectively. The film thickness was around 2,000㎛. The film deposition condition was summarized in Table 1.

Table 1. deposition conditions

Deposition Condition	
- basal pressure (torr)	2×10^{-6}
- working pressure (mtorr)	2
- distance between target and substrate	20㎝
- deposition temperature(℃)	Room
- working gas	100% Ar
- substrate	pyrex glass (250㎛)
- film deposition time	60 min.
- film thickness (Mo)	2000Å

After sputtering the molybedenum was annealed in air for 550℃ for 3hrs. Typical size and structure of microsensor are shown in Fig. 1 and 2. The gas sensing experiments were carried out in a computer-controlled gas measurement system. The measurement atmosphere is provided by a gas mixing system, based on mass flow controllers. The gas under test were H_2, acetone, methanol and alcohol at operation temperature between 100 and 250℃. Total applied power for

heater was about 0.45Watt.

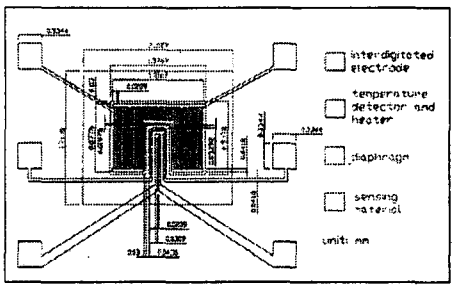
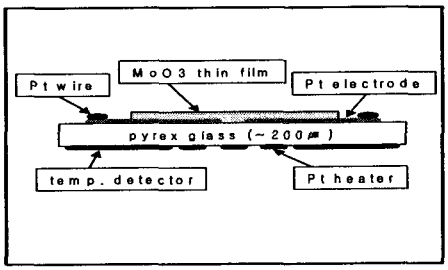
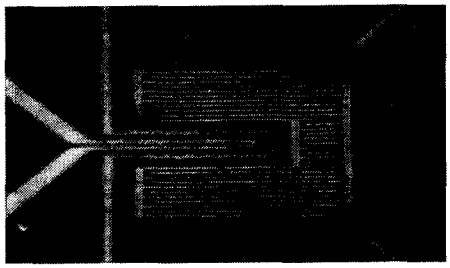


Fig. 1 Schematic diagram of sensor design.



(a)



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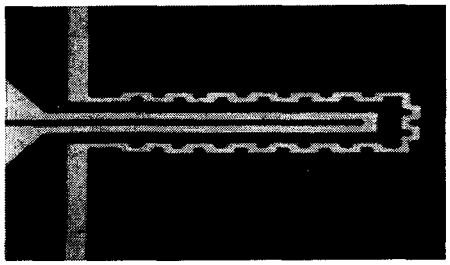

(c)

Fig. 2 The typical sensor structure;
(a) cross sectional overview of sensor
(b) interdigitated electrode and MoO_3 film and
(c) heater and temp. defector

3. Results and discussion

Fig. 3 shows the XRD diffraction patterns of MoO_3 thin film as electrode.

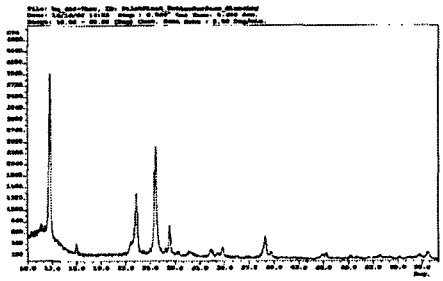

Fig.3 XRD patterns of MoO_3 film (550℃, 3 brs)

After annealing for 3hrs at 550℃ , the film was fully crystallized and demonstrate pure MoO_3 structure. Fig. 4 shows SEM surface morphology of MoO_3 film.

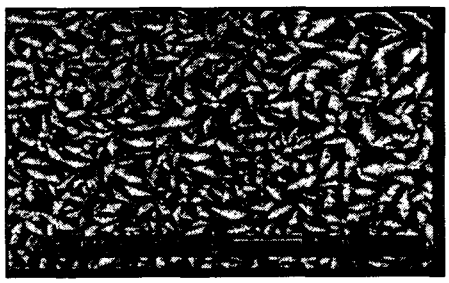

Fig.4 SEM image of MoO_3 film.

The film morphology was uniform, dense and plate-like structure. The typical grain size was about 1㎛. The gas sensing properties was evaluated in terms of different gas atmospheres. Fig. 5 demonstrates the gas sensing behavior to H_2 gas.

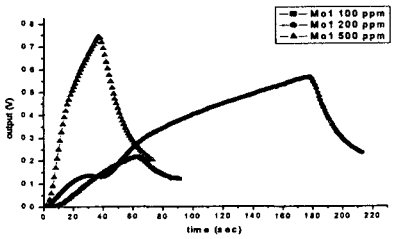

Fig. 5 Gas sensing characteristics in terms of different H_2 concentration.

Especially thin film sensor shows high sensitivity and selectivity to H_2 gas. The response time to H_2 gas was about 30sec in 500ppm of H_2 gas concentration after gas detection. As can be seen in Fig. 6, the sensitivity relatively increased with increasing heater power from 0.3 to 0.45Watt.

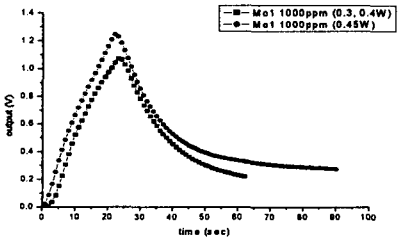

Fig. 6 Gas sensing characteristics in terms of different heater power.

Figs 7, 8 and 9 show different gas sensitivity measurements in terms of methanol, acetone and alcohol atmospheres respectively.

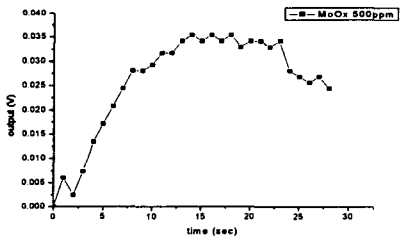

Fig. 7 Gas sensing characteristics in terms of acetone concentration.

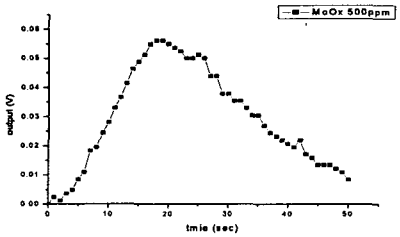

Fig. 8 Gas sensing characteristics in terms of alcohol concentration.

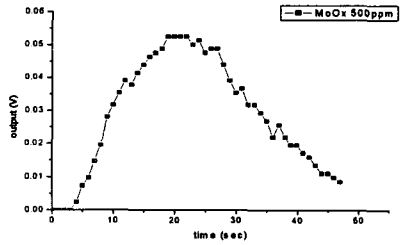

Fig. 9 Gas sensing characteristics in terms of methanol concentration.

4. Conclusion

1) Thin film sensor of MoO_3 was successfully fabricated by IC technology on pyrex glass of 200 ㎛ in thickness.

2) The grain size was plat like and typical size was about 1㎛.

3) MoO_3 film gas sensor shows especially high sensitivity to H_2 reducing gas atmosphere. The applied heater power was lower than 0.5Watt.

Acknowledgement

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References

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