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STUDY OF SnO_2 PVA- $CuSO_4$ MULTILAYER GAS SENSOR

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ABSTRACT

Solid state gas sensors have great advantage due to their fast sensing response, simple implementation and low price. The solid state gas sensors changed the physical and chemical properties when exposed to different gas atmosphere. Looking into technological and environmental importance many research workers develop the solid-state gas sensors. It is extremely needed to develop the selective, high sensitive and minimum size CO_2 gas sensor. The PVA-$CuSO_4$ and SnO_2 are used in multilayer form on glass substrate screen-printing technique was used. The sensor response to CO_2gas is examined and was used static and dynamic characteristic are studied. On and off time are calculated. It was observed that the sensitivity of the sensor increases with increase in CO_2 gas concentration.

Key words: Sensor, CO_2 gas, SnO_2 multilayer

INTRODUCTION

In our physical word, emission of pollutant gases increasing the strict legal limits. It is hazardous to our human life. Hence it is necessary to develop high performance gas sensor for detection of gases.

Nowadays, there is great interest in using sensing devices to improve environmental safety and control/monitoring of CO_2 gas because it is known as a green house gas which contributes to global warming. It has been observed that SnO_2 is a prominent material used for CO_2 gas sensor. Mostly metal oxides are sued for development of sensors. But less attention seems to have been given on electrical conducting polymers such as polypyrrole, polythiphene, polyacetylene and polyaniline which have unique properties such as low density, versatility in methods of production[1], high anisotropy of electrical conduction, and non-metallic temperature dependence of conductivity[2], as regards to CO_2 gas sensing. Their potential application include sensors for chemicals and bimolecular[3,4], field effect transistors[5], light-emitting diodes[6], and capacitors[7]. Many conducting polymers have shown changes in resistivity on expose to different gases and humidity.

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EXPERIMENTAL

Thin film sensors of $CuSO_4$ $5H_2O$ -PVA composite with multilayer SnO_2 are fabricated. Chemicals polyvinyl alcohol (PVA), Sodium laruyl sulfate (SDS), copper sulfate pentahydrate ($CuSO_4$, $5H_2O$), SnO_2, and ethyl cellulose, butyl carbitol acetate were used. Distilled water was used as solvent.

For preparing the PVA/$CuSO_4$ composite, 0.0868 g of $CuSO_45H_2O$ and 0.0051 g of sodium lauryl sulfate (SDS) were dissolved in 10ml distilled water under vigorous stirrings for 1 h. Then 0.5001 g PVA (4.72 wt. %) was dissolved in the above mentioned solution. The mixture was heated at 90^0C for 6 h under continuous stirring and then the mixed solution was cooled to room temperature for 24 h. SnO_2 was used to prepare multilayer sensor. The binder for screen printing was prepared by using 8wt% butyl carbitol with 92 wt % ethyl cellulose. Then this solvent added drop by drop in SnO_2 powder to obtain the proper viscosity of the paste. The prepared sample composition in the different weight of the $CuSO_4$ $5H_2O$ (0.0868, 0.1, 0.15 and 0.2 g) and PVA and SDS is used. The composite $CuSO_4$/PVA solution spread on the clean that glass plate uniformly Allow it to keep it for 24 h, at room temperature (300K) for drying. The solution of SnO_2 is used to form a layer an the composite film keep it for 24 h at room temperature. For the resistance measurement, the sliver paint was deposited on adjacent side of dried SnO_2 multilayer. The voltage divider method is used to determine resistance change of sensor films in test gas.

The gas chamber having dimension 30 x 30 x 30 cm^3 with attached CO_2 gas flow meter was used for keeping the sensors for testing. The gas flow was adjusted to obtained ppm concentration with time. At one side of chamber, a small airtight hole was made for keeping the samples. The sample holder with attached heater and thermocouple was used. The two vales one for gas inlet and other for gas outlet, were made to the chamber. The change in resistance and the sensor was carried out in a CO_2 gas environment at different ppm level and at room temperature (300 K).

RESULTS AND DISCUSSION

The sensitivity of the sensor is defined as –

$$S = \frac{R_g - R_a}{R_a} = \frac{\Delta R}{R_a}$$

were R_g and R_a are the resistances in presence of gas and air respectively.

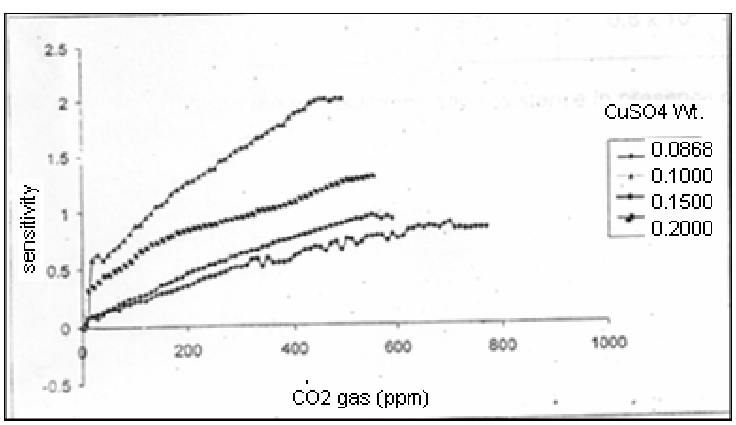

Fig. 1: Sensitivity variation with concentration of CO_2 at room temperature (301 K)

Fig. 1. The sensitivity of the sensor increase linearly with CO_2 gas concentration and found to be maximum for higher concentration of gas it reaches to the saturation.

Static Responses

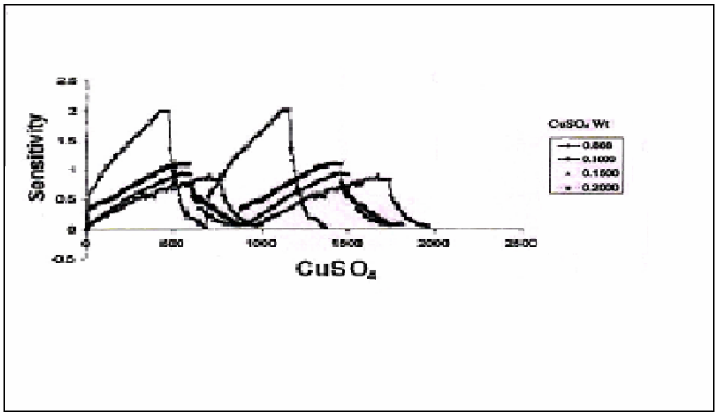

Fig. 2: Static response of multilayer gas sensor

The Fig 2 is shows the static response of the multilayer film at room temperature. It is observed that the sensitivity (S) of the sensor increases with increase in CO_2 gas concentration. The response and recovery time are two important parameter to characterize a sensor. The responses time it is define as the time taken to reach 90% of response when gas is ON. The recovery time is defined as the time taken to reach 90% of recovery when gas is turned off.

It is observed that the response and recovery time is found to be less for0.1g $CuSO_4.5H_2O$ film. The gas sensing is entirely depend on the surface morphology of the film. This film shows nano crystalline structure. Which was observed from SEM. Fig. 3 shows the variation of sensitivity with $CuSO_4$ concentration of at room temperature and 200ppm CO_2 gas. The sensitivity is found to be highest for 0.1 g $CuSO_4.5H_2O$.

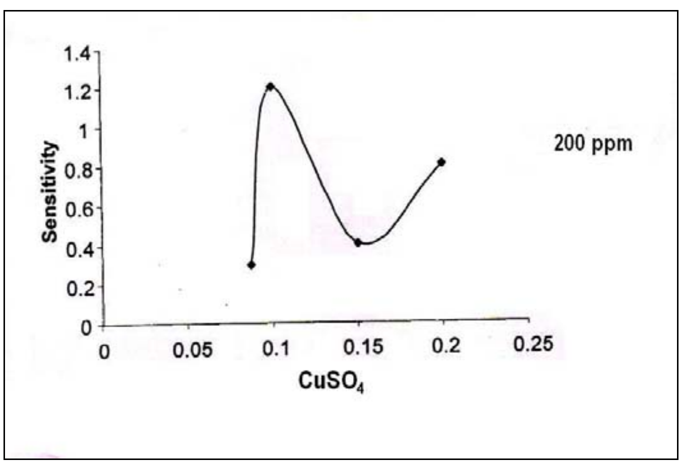

Fig. 3: Variation of sensitivity against $CuSO_4.5H_2O$ concentration

Variation of sensitivity with $CuSO_4$ concentration at room temperature and 200ppm of CO_2 gas is shown in Fig. 3.

CONCLUSION

The sensitivity variation with different concentration of CO_2 gas at room temperature along with static and dynamic response is studied. Recovery and responses time are determined.

The sensitivity of the film having 0.1 g of $CuSO_4$ is found to be more sensitive for CO_2 gas environment. It is interesting to note that especially this film have nano-crystalline size. The sensitivity of the samples increases with increase in CO_2 gas concentration. The response and recovery time are found to be 420 and 310 S respectively for this film.

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