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Letter to the Editor

Influence of Pt Doping on the Sensing Mechanism of La_2O_3/SnO_2 Thick Film for CO_2 Gas

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Abstract. *Thick film CO_2 sensors were fabricated using La_2O_3/SnO_2 loaded with Pt and in the unloaded form. The nano-crystalline powders of SnO_2-La_2O_3-Pt synthesized by high speed ball milling method were screen-printed on alumina substrates. The resistance of fabricated sensors were measured against different CO_2 concentration in the working temperature of 225°C. The composition that gives an acceptable resistivity for CO_2 was in the 3wt.% ratio of Pt.*

Keywords: CO_2 gas, thick film gas sensors, La_2O_3/ SnO_2, screen printing method, Pt.

Carbon dioxide (CO_2) is a colourless, odourless, and corrosive polluted gas that plays a significant role in greenhouse effect [1]. The influence of carbon dioxide depends on the concentration and duration of the exposure. Breathing a high concentration of CO_2 gas can result in health problem [2]. Although the lanthanum doped tin oxide (La_2O_3/SnO_2) thick film sensors have received more attention as a promising metal oxides for CO_2 sensing, this material cannot provide the high sensitivity to a carbon dioxide gas [3]. It was found that loading SnO_2 with noble metals such as palladium (Pd) and platinum (Pt) was effective in promoting the sensitivity of sensor faced with ethanol gas [4,5]. Doping noble metals lead to decrease the electrical resistance of the sensor for achieving high sensitivity. In this letter, we tried to report a doping of Pt with La_2O_3/SnO_2 for this purpose. In order to prepare Pt doped La_2O_3/SnO_2, the M–xylene medium was chosen to grind the sensitive powder by high speed ball milling at the room temperature (28±2°C) and speed of 450 rpm. The resulting precipitate dried at 50°C and calcined at 700°C in the air by tube furnace. To fabricate the sensor device, the powder was screen–printed on an alumina substrate and attached with Pt electrodes.

Gas sensing properties of fabricated sensor were measured inside the 4800 ml gas chamber equipped with humidity and temperature sensors. Fig. 1 shows the fabrication flow diagram of thick film gas sensor in this work.

The electrical resistances of loaded and unloaded fabricated sensors were measured in the air (R_a) and different ppm level of CO_2 (R_g) gas at operation temperature of 225°C. The Pt doping resulted in decreases in resistance compared to the unloaded La_2O_3/SnO_2. In this work, an optimum amount of Pt doping is approximately about 3 wt.%. Fig. 2 illustrates the electrical resistances of loaded and unloaded fabricated sensors in the air (R_a) and different ppm level of CO_2 (R_g) gas at operation temperature of 225°C.

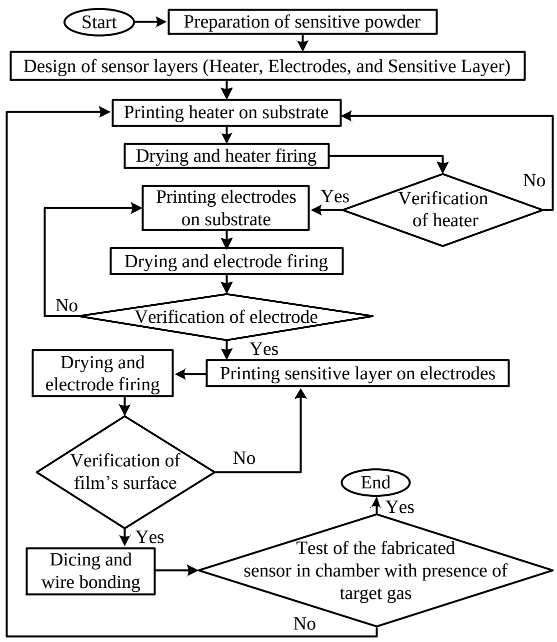

Fig. 1. Research methodology flowchart

The result shows that the resistance of both sensitive layer loaded with 3 wt.% Pt and unloaded have a negative correlation with the ppm value. The offset and slope

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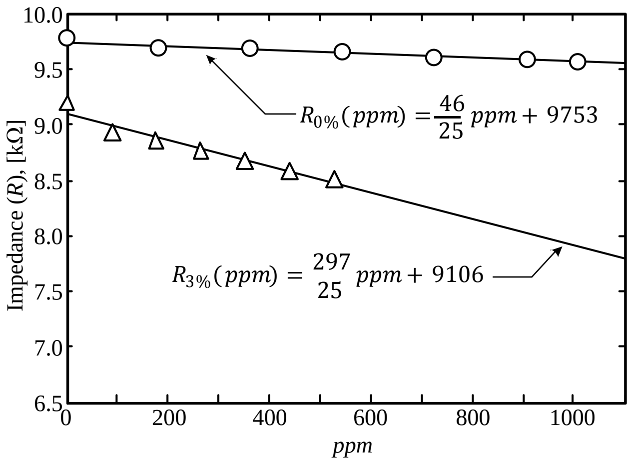

Fig. 2. Sensor resistance various concentrations of CO_2 for Pt (3wt.%) loaded La_2O_3 (2wt.%)/SnO_2 at 225°C

of suggested approximate mathematical models for these sensors were dissimilar. The slope of La_2O_3/SnO_2 sensor was −0.184 for the sensor without Pt, but it is significantly increased to −1.188 for the sensor with 3 wt.% Pt. Moreover, the offset was 9753 Ω for the sensor without Pt, but it is significantly decreased to 9106 Ω for the sensor with 3 wt.% Pt. Thus, it is predicted that the sensitivity of thick film La_2O_3/SnO_2 sensor will be modify by doping of 3 wt.% Pt. Further studies on sensitivity of La_2O_3/SnO_2 loaded devices using Pt are in progress.

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REFERENCES

[1] S. Dhannasare, S. Yawale, S. Unhale, and S. Yawale, "Application of nanosize polycrystalline sno2-wo3 solid material as co2 gas sensor," *Revista mexicana de física*, vol. 58, no. 6, pp. 445–450, 2012.

[2] A. L. Atchley, R. M. Maxwell, and A. K. Navarre-Sitchler, "Human health risk assessment of co2 leakage into overlying aquifers using a stochastic, geochemical reactive transport approach," *Environmental science & technology*, vol. 47, no. 11, pp. 5954–5962, 2013.

[3] M. Kim, Y. Choi, J. Bae, and T. Oh, "Carbon dioxide sensitivity of la-doped thick film tin oxide gas sensor," *Ceramics International*, vol. 38, pp. S657–S660, 2012.

[4] W. P. Zhou, S. Axnanda, M. G. White, R. R. Adzic, and J. Hrbek, "Enhancement in ethanol electrooxidation by sno x nanoislands grown on pt (111): effect of metal oxide–metal interface sites," *The Journal of Physical Chemistry C*, vol. 115, no. 33, pp. 16 467–16 473, 2011.

[5] M. Kugishima, K. Shimanoe, and N. Yamazoe, "Sensitization of sno2-based thick film sensor for ethylene oxide gas," in *Chemical Sensors VI: Chemical and Biological Sensors and Analytical Methods: Proceedings of the International Symposium*, vol. 2004. The Electrochemical Society, 2004, p. 43.