Effect of MoO3 doping and grain size on SnO2-enhancement of sensitivity and selectivity for CO and H2

Abstract

MoO_3-doped SnO_2; nano-particles were prepared using sol-gel method with 0.1 molar solutions of SnCl4-5H_2O and MoO_3 with different doping concentration from 5.03 x I0“ to 5.04 * 10-3. The average grain size varies from 12 to 80 nm obtained by varying calcinations temperature from 3(l(l to9(l(l “C, Thick film samples,of about 15 pm thickness, were tested for Co and H2 in the concentration range of 15-1000 ppm in ambient air. The samples exhibit selective response to CO and H; at I40 and 240 'C. respectively. The sensitivity increases with doping concentration for H1.Whereas, fur CO. it incntttses rapidly till the doping concentration of 2.0l X 10-3: mol and then reaches to saturation. The observed maximum sensitivity factor for CO at 2.01] x 10-3 mol doping is ~30. whereas for H2, it is 10 at 5.04 ><10-3 mol doping. The response and recovery time is ~5 and l0 s respectively.

l. Introduction

Over the past few decades. solid state sensors based on semi-conducting oxides and composites are the subject of study for detection of various hazardous gases like H2 [I-3]. NOx [4]. H2S [5] and CO [(6-13)]. etc. The gas sensing mechanism involves the redox reaction at the surface. leading to the changes in the depletion layer in the grain and hence changes in the electrical resistance [l,2,(6—8)]. Although such sensors are in daily use, their absolute stability is still poor susceptible to a high degree of drift even with slight change in the ambient conditions [l,6-8]. The important factor. which is still to be addressed. is the selectivity of the sensors towards a particular gas or species [l-14|. The main disadvantage of the commercially avail- able sensors is the high temperature operation due to which the power consumption is of main concern.

In the group of hazardous gases. CO is being focused due to its serious toxicity with no smell and hence attaining the importance to control at sub-ppm level. An extensive research is being carried out using various metal

oxides like ZnO, In_2O_3, MoO_3, SnO; as smart sensor materials [ll
for better sensor performance. Amongst these, SnO; is the most studied and suitable candidate as it represents a good compromise between cost (economy) and reliability along with comparatively low operating temperature with a disadvantage of in-stability and sensitivity to various gases [l- 6.l I-20]. Therefore, still this material needs to be studied to improve the lacking features. It has been so far demonstrated that the sensing characteristics of SnO; based sensors can be improved by considering several factors like decreasing of crystallite size. The composition and valency control, addition of some noble metals as catalyst like Pt, Pd, etc. or addition of various metal oxides [l-5,8,12-16]. Relatively small efforts have been done to study the effect of MoO_3 with the earlier mentioned metal oxide in comparison with noble metals [IO]. In the present work. An attempt is made to improve the SnO_2 sensor performance with $M00_5$ doping for CO and H_2 gases. As the starting point, calcination temperature and the doping concentrations are varied systematically and also effect of grain size on the sensitivity is also carried out.