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Authors: Mehar Bhatnagar, Shivani Dhall, Vishakha Kaushik, Akshey Kaushal, Bodh Raj Mehta



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Improved selectivity of SnO₂:C alloy nanoparticles towards H₂ and ethanol reducing gases; role of SnO₂:C electronic interaction

Mehar Bhatnagar, Shivani Dhall, Vishakha Kaushik, Akshey Kaushal, Bodh Raj Mehta*

Thin Film Laboratory, Department of Physics, Indian Institute of Technology Delhi, Hauz Khas, New Delhi- 110016, India

Abstract

In the present study, changes in the sensing properties of SnO₂ on Carbon incorporation have been investigated in detail. The gas sensing response of size-selected SnO₂ and SnO₂:C alloy nanoparticles prepared by gas phase deposition method have been investigated for H₂ and ethanol over a varied temperature range (50°C- 200°C). The incorporation of carbon into SnO₂ lattice results in a large change in the sensing behaviour towards the two gases both having reducing nature. SnO₂:C nanoparticles show positive sensing response for H₂ and negative sensing response for ethanol, whereas SnO₂ nanoparticles show a normal sensing response of an n-type semiconductor towards both the reducing gases. Observed values of activation energy of sensing and energy levels of O-vacancies observed in the PL spectra of SnO₂ and SnO₂:C are consistent with these results. (i) Catalytic C-H interaction and (ii) modified work function of SnO₂ and C on hydrogenation resulting in alteration of electronic exchange between SnO₂ and C, and (iii) passivation effect of carbon during SnO₂-ethanol interaction along with a possibility of reduction in SnO₂ sites in SnO₂:C nanoparticles, are responsible for the observed behaviour. The present study shows that the incorporation of C in SnO₂ nanoparticles results in excellent selectivity towards H₂ and ethanol (both having reducing nature) in the low temperature range, normally not observed in oxide based resistive sensors.

Key words: size-selected SnO₂:C alloy nanoparticles, PL, selectivity, reducing gases, catalytic effect

* Author to whom all correspondence must be addressed.

Electronic mail: brmehta@physics.iitd.ac.in

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