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Author: A.A. Mane A.V. Moholkar

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Effect of film thickness on NO_2 gas sensing properties of sprayed orthorhombic nanocrystalline V_2O_5 thin films

A. A. Mane [a,b], A. V. Moholkar [*, a]

[a] Thin Film Nanomaterials Laboratory, Department of Physics, Shivaji University, Kolhapur 416 004, India

[b] General Science and Humanities Department, Sant Gajanan Maharaj College of Engineering, Mahagaon, 416 503, India

* Corresponding author: avmoholkar@gmail.com

Abstract

The nanocrystalline V_2O_5 thin films with different thicknesses have been grown onto the glass substrates using chemical spray pyrolysis (CSP) deposition method. The XRD study shows that the films exhibit an orthorhombic crystal structure. The narrow scan X-ray photoelectron spectrum of V-2p core level doublet gives the binding energy difference of 7.3 eV, indicating that the V^{5+} oxidation state of vanadium. The FE-SEM micrographs show the formation of nanorods-like morphology. The AFM micrographs show the high surface area to volume ratio of nanocrystalline V_2O_5 thin films. The optical study gives the band gap energy values of 2.41 eV, 2.44 eV, 2.47 eV and 2.38 eV for V_2O_5 thin films deposited with the thicknesses of 423 nm, 559 nm, 694 nm and 730 nm, respectively. The V_2O_5 film of thickness 559 nm shows the NO_2 gas response of 41 % for 100 ppm concentration at operating temperature of 200 ºC with response and recovery times of 20 s and 150 s, respectively. Further, it shows the rapid response and reproducibility towards 10 ppm NO_2 gas concentration at 200 ºC. Finally, NO_2 gas sensing mechanism based on chemisorption process is discussed.

Keywords: Nanocrystalline V_2O_5 thin films; Chemical spray pyrolysis; XPS; NO_2 gas sensor