Accepted Manuscript

Improved gas sensing performance of p-copper oxide thin film/n-TiO_2 nanotubes heterostructure

Onur Alev, Erdem Şennik, Zafer Ziya Öztürk

PII: S0925-8388(18)31139-3

DOI: 10.1016/j.jallcom.2018.03.268

Reference: JALCOM 45498

To appear in: *Journal of Alloys and Compounds*

Received Date: 13 September 2017

Revised Date: 6 March 2018

Accepted Date: 21 March 2018

Please cite this article as: O. Alev, E. Şennik, Z.Z. Öztürk, Improved gas sensing performance of p-copper oxide thin film/n-TiO_2 nanotubes heterostructure, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.03.268.

Improved Gas Sensing Performance of p-Copper Oxide Thin Film/n-TiO_2 Nanotubes Heterostructure

Onur Alev[a], Erdem Şennik[a], Zafer Ziya Öztürk[a,*]

[a]Gebze Technical University, Department of Physics, 41400 Kocaeli, Turkey

Ketwords: CuO/TiO_2, Gas sensor, Heterostructure, Nanotubes, Metal-oxide, Anodization.

Abstract

CuO thin film/TiO_2 nanotubes heterostructures were fabricated to investigate the effect of p-n heterojunction on sensing properties. TiO_2 nanotubes were synthesized via anodization of Ti foil. Then, CuO thin film was covered on the nanotubes by oxidation of thermally evaporated Cu layer. For comparison, sensor devices those are composed of only CuO thin film and composed of TiO_2 nanotubes have been also fabricated. The heterostructure was characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy-dispersive X-ray (EDX) spectroscopy. Fabricated sensor devices were exposed to H_2, ethanol, acetone, chloroform and NO_2 gases at different operation temperatures. Experimental results showed that the heterostructure sensor has better performance toward H_2 in sensing with low operation temperature, low detection limit and high sensor response compared to TiO_2 nanotubes and CuO thin film. Moreover, the formation of heterostructure not only increased response toward H_2 but also dramatically decreased response toward VOCs and NO_2. These improved sensing properties are attributed to the heterojunction between CuO thin film and TiO_2 nanotubes.

1. Introduction

Metal-oxides (MOx) are pre-eminent candidates in applications of gas sensor such as medical use, air quality monitoring, food industry and detection of hazardous gases due to their high sensitivity, low cost, easy fabrication and adaptability [1-5]. Among these MOx materials, TiO_2, is one of the most widely used n-type semiconductors[3]. TiO_2 has also been studied for many other applications in medicine and electronics such as transistors, solar cells, and batteries [6-9]. In the last decades, nanostructures of TiO_2 have been widely studied in the field of gas sensors due to their high surface-to-volume ratio, extension of the surface charge region, excellent chemical and thermal stability, faster response and recovery time [6, 10-14]. It was reported that 1D TiO_2 nanostructures show promising sensing performance toward H_2 [15, 16], ethanol [17], acetone [18], CO [19] and NO_2 [20] at working temperatures between 300-600˚C.

In recent years, due to the strong demand for better sensor properties for almost all sensor applications, studies have focused on different heterostructures based on metal-oxides