DBSA Doped Ppy-WO_3 Hybrid Nanocomposite: A Room Temperature NO_2 Gas Sensor

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Abstract-The room temperature operating chemiresistive NO_2 gas sensor based on DBSA doped PPy–WO_3 hybrid nanocomposite films have been fruitfully synthesized by different weight percentages (10-50%) of DBSA in PPy–WO_3 hybrid nanocomposite. The sensor was fabricated on glass substrate using simple and cost effective drop casting method. The gas sensing performance of sensor was carried out for various toxic analytes like NO_2, C_2H_5OH, CH_3OH, H_2S and NH_3. The sensor shows superior sensitivity and selectivity towards NO_2 gas. Also the sensor can effectively detect 5 ppm concentration of NO_2 gas with reasonable response of 12%. The excellent reproducibility and stability properties lead the sensor as a promising material in the field of gas sensor. Structural, morphological and compositional analyses evidenced the successful formation of DBSA doped PPy–WO_3 hybrid nanocomposite with uniform dispersion of DBSA into PPy–WO_3 hybrid nanocomposite.

Keywords- PPy;WO_3; Hybrid nanocomposite; XRD; FESEM; Gas sensor;

INTRODUCTION

Increasing industrialization makes it necessary to constantly monitor and control pollution in the environment. In most industrially developed countries very strict ambient air quality standards for toxic gases have been established. In order to protect the environment and to prevent human from being harmed by toxic gases the detection of toxic gas has become increasingly important. Nitrogen dioxide (NO_2) gas, is one of the most common and dangerous air pollutant and hazardous in terms of both health risk and environmental damage [1]. The major sources of NO_2 gas are domestic heat burners, exhaust gases of automobiles, combustion of fossil fuel, chemical factories, food processing plants, and power plants [2]. Therefore, it is crucial to detect NO_2 gas at room temperature with low cost, reliable, highly sensitive and reproducible gas sensor systems. A promising approach to develop efficient sensor is to use novel materials based on conducting polymers, semiconducting metal oxides and nanocomposite.

EXPERIMENTAL DETAILS

Preparation of PPy-WO_3 (50%) hybrid nanocomposite

First PPy-WO_3 (50%) hybrid nanocomposite was prepared by mechanical mixing method [3]. DBSA doped PPy-WO_3 nanocomposite was prepared by adding 10 - 50 weight percentage of DBSA into PPy-WO_3 (50%) nanocomposite matrix by solid state synthesis method. The prepared powder was dissolved in m-cresol solvent and stirred for 11 hours at room temperature to get casting solution. In order to prepare the films, the casting solution was deposited on glass substrate (10 x 10 mm2) using drop casting method and dried at room temperature. The proposed schematic formation of DBSA doped PPy-WO3 hybrid nanocomposite sensor is shown in fig. 1.

Characterizations and gas sensing tests

DBSA doped PPy-WO3 hybrid nanocomposites were characterized by powder X-ray diffractometer (Rigaku, Ultima IV, Cu 40 kV/40 mA, λ=1.5406A0) with scan range 100 - 800. The morphology of films was observed by FESEM Model: MIRA3 TESCAN, USA, operating at 15 kV. The gas sensing tests were performed on two probe custom fabricated room temperature gas sensing measurement unit.

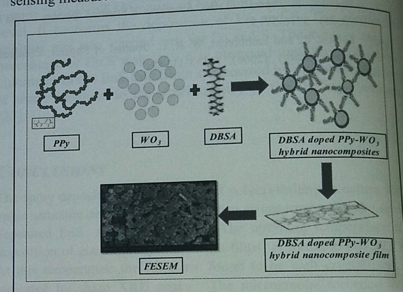

Fig.1. Proposed schematic formation of DBSA doped PPy-

RESULTS AND DISCUSSION

XRD analysis

The X-ray diffraction (XRD) pattern of 20% DBSA doped PPy-WO_3 hybrid nanocomposite is shown in fig. 2 (a). The XRD pattern is in excellent agreement with a reference pattern (powder diffraction file no. 71-0131) of tungsten oxide indicates that no additional crystalline order arrangement has been introduced into the hybrid composites and the DBSA has no influence on crystallization performance of PPy-WO_3 hybrid nanocomposite. Moreover, the intensities of the diffraction peaks of 20% DBSA doped PPy-WO_3 hybrid nanocomposite are weaker. This suggests that DBSA is well dispersed in PPy–WO_3 (50%) hybrid nanocomposite and there is a interaction between DBSA and PPy–WO_3 (50%) hybrid nanocomposite [4, 5].