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Studies on CNT, ZnO-CNT and undoped ZnO and their gas sensor results

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Abstract: ZnO-CNT nanostructures are usually employed to modify the electrode for sensor construction in terms of its high electron mobility. A simple perfume sprayer is used for the production of ZnO-CNT nanostructures to control experiments, the Cu plates was placed on the heater at a temperature of 200º C, we found that there was ZnO nanostructure on the surface of Cu substrate when it was sprayed in the same solution for a rather long time. The result is the same as that of the Cu substrate when performed temperature of 200º C, this nanostructure was used as the sensor material, in this paper. The growth morphology of ZnO - CNT could be deposited by perfume spraying. The possible growth mechanism of ZnO-CNT nanocrystals formation by this method has been tried to discuss as well as the optical properties has been demonstrated. The as-synthesized ZnO-CNT nanostructures were characterized using the scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray diffraction (XRD) pattern measured with Cu Kα radiation. The photoluminescence (PL) measurements excited by the 380 nm line from the He–Cd laser were done at room temperature CNTs are easy to be entangled and agglomerate due to their long length and low diffusive mobility in base fluids, so planning to study about their sensitivity for different gas concentrations].

Keywords: ZnO-CNT, photoluminescence studies, morphological studies and sensor studies.

Introduction

In recent years, nanostructured materials such as ZnO-CNT nanocomposites have also been incorporated into electrochemical sensors for biological and pharmaceutical analyses[1]. While they have many properties similar to other types of materials, they offer unique advantages including enhanced electron transfer, large edge plane/basal plane ratios and rapid kinetics of the electrode processes[2]. Nanocomposites of a variety of shapes, sizes and compositions are changing modern bioanalytical measurement[3].

Ching-Feng Li, Chia-Yen Hsu , Yuan-Yao Li et al reported that, an 80 nm-thick ZnO film was prepared via the sol–gel method at 500 ºC using zinc acetate, 2-methoxyethanol, and mono ethanolamine as precursors. Characterization of the film showed that it was composed of 20–30 nm sintered ZnO nanoparticles with good crystallinity. The NH_3 sensing properties of gas-sensing devices with a 5 µm gap that utilized the prepared ZnO film were examined. The highest sensor response (57.5%) was achieved with 600 ppm NH_3 in air at 150 ºC. The response and recovery times were 160 s and 660 s, respectively. This study also examined the effects of NH3 and oxygen concentration as well as the temperature on the sensor response performance. The findings show that oxygen plays an important role in the conductivity of ZnO thin films, and thus affects the sensor response toward NH_3[4].

Herrán, I. Fernández, E. Ochoteco, G. Caba˜nero, H. Grande et al reported that, the role of water vapour in ZnO nanostructures for humidity sensing at room temperature is presented and discussed. Experimental and theoretical results demonstrate that ZnO nanoparticles and nanorods, show different physico-chemical behaviour under different relative humidity atmospheres. While electrical current density increases as RH does in the case of the ZnO nanoparticles, ZnO nanorods show inverse behaviour. These facts are related to the capillary condensation and water electric dipole moment effects, respectively[5].

A low-cost sensing nanostructures devices was prepared by using this spray perfume analyzer techniques

Experimental

In the static position of this spray nozzle, the substrate size may be 1cm x 1cm for coating. But here we used 2.5cm x 2.5cm copper substrate for spraying. So a slight vertical and horizontal movement required for constant spraying. The droplets (mist) hit the copper substrate, where the solvent is entirely vaporized leading to the deposition of a rough film in which the transmission decreases markedly. At the optimum air flow rate the size of the mist particle is also optimum. So the thermal energy gained by the droplet is in such a way that it vaporizes just above the copper substrate and gives a good quality of powdered particles on the surface. They form a powdery precipitate on the substrate resulting in the decrease in transparency in the present work it has been observed that which gives highly transparent, good powdered particles by spraying[6].

Results and Discussion

ZnO-CNT and ZnO powdered particles, its full width at half maximum (FWHM) β is used in Scherrer formula,

$$D = \frac{0.9\lambda}{\beta \cos\theta} \qquad (1)$$

to calculate the crystal size (D) of the these three powder particles and its annealing temperature of 300º C were tabulated in the Tables 1,2,3 and 4. The grain size values calculated at different temperature are shown in Fig.1,2 and 3.

The grain size values calculated at different temperature are shown in Fig.1,2 and 3. The variation in grain size is less appreciable and it decreases nominally from about 31 nm, 15 nm and 21 nm when the temperature was 300 ^{o}C respectively. It reveals that grain boundary scattering plays a minor role on the carrier mobility in these films and impurity scattering may be considered to be dominant. Also, the position of (104,008 and 110) peak $(2\theta)_{all}$ is used to calculate the lattice constant 'a' of each these powder particles and its annealing temperature and the deviation Δa from the standard value of CNT, ZnO-CNT and ZnO was obtained. A negative value of Δa means lattice contraction and a positive value means lattice expansion. The structural studies of Figure 2, confirmed that CNT was fixed inside the ZnO lattices.

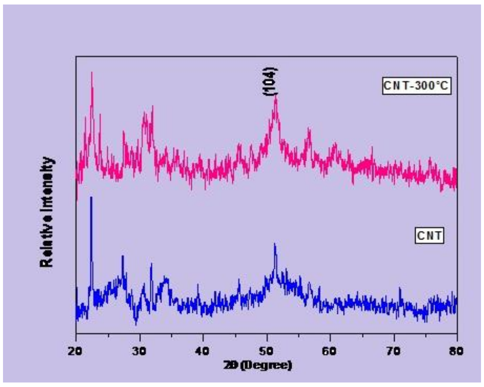

Figure 1 XRD pattern of CNT as prepared and 300^{0} C thin films

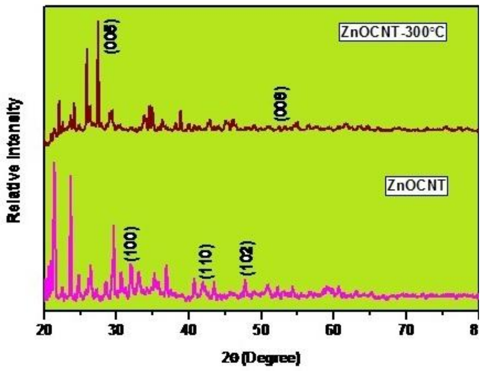

Figure 2 XRD pattern of ZnO-CNT as prepared and 300^{0} C thin films

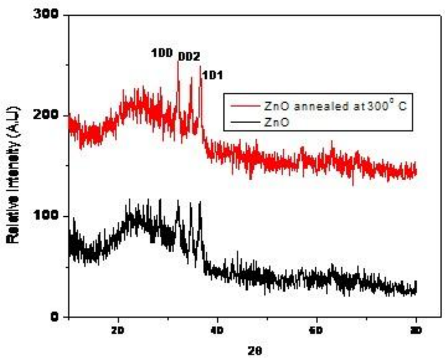

Figure 3 XRD patterns of ZnO as prepared and 300^{0} C thin films

The absolute PL intensities for each ZnO+CNT and CNT samples and its annealing temperature at 300^{o} C were shown in Figure 4, however, yield of PL intensity of CNT is very poor not reported here. This is partly due to the fact that the peak height of the PL and its annealed samples PL spectra do not coincide exactly at the intersection point with a maximal deviation of 5%, which is attributed to the different nature of background for PL. Two additional peaks species, which are not part of the subset investigated, show varying PL intensity as well. For the excitation wavelength of 345 nm, we get the emission wavelengths at 375 nm. When compared to CNT and its annealed samples, ZnO-CNT annealing at 300º C sample has high peak intensity values of the results shown in Figure 4.

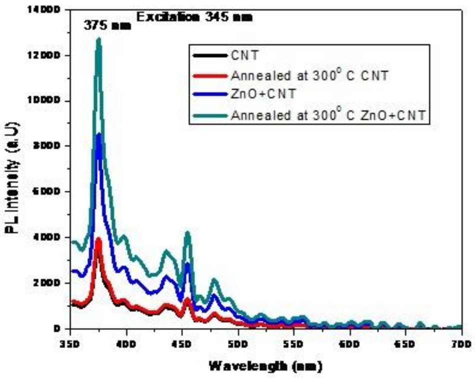

Figure-4 PL studies of CNT, ZnO-CNT and ZnO samples

Conclusion

CNT, ZnO-CNT and ZnO powder particles have been prepared by simple perfume Spray pyrolysis method on copper substrate. The effect of the structural, optical properties has been studied extensively. XRD evidence the formation of crystalline CNT, ZnO-CNT and ZnO in the present study with nano grained structure. Morphological studies and sensors studies are in progress for these materials.

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