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Effect of Pt Doping on ZnO Nanoparticles

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Abstract : Pt doped nano ZnO were synthesized by using simple chemical addition method. The morphological, compositional and structural properties of pt doped ZnO nanoparticle were performed by XRD, scanning electron microscopy (SEM) & Energy dispersive spectroscopy (EDX).
Keywords: Nanoparticals; Pt doped ZnO; SEM; XRD; EDX

I. INTRODUCTION

Nanostructured materials have received much attention because of their novel properties, which differ from those of bulk materials [1, 2]. Control of dimension and morphology of materials has aroused the interest of researchers in the design of functional devices due to the optical and electronic properties of nanometer- and micrometer-sized materials, which determine their applications, can be adapted by varying their size and shape [3].Zinc oxide (ZnO), a versatile semiconductor material, has been attracting attention because of the commercial demand for optoelectronic devices operating at blue and ultraviolet regions [4]. ZnO is a wurtzite-type semiconductor with band gap energy of 3.37 eV and it has very large excitation binding energy (60 meV) at room temperature [5]. Recently, special attention has been devoted to the morphology, as ZnO can form different nanostructures [6-8]. Thermal stability, irradiation resistance and flexibility to form different nanostructures are the advantages that expedite its potential wide applications in photodetectors [9], surface acoustic wave devices [10], ultravioletnanolaser [11], varistors [12], solar cells [13], gas sensors [14], biosensors [15], ceramics [16], field emission [17], and nanogenerator [18].

Many methods have been developed to prepare ZnO particles, including the sol–gel and microwave method [19, 20], evaporative decomposition of solution [21], template-assisted growth [22], wet chemical synthesis [23], and gas-phase reaction [24]. To date, a variety of morphologies including prismatic forms [25], bipyramidal 1 Author to whom any correspondence should be addressed. and dumbbell-like [26], ellipsoidal [27], spheres [28], whiskers [29], nanotubes [30], nanorings [31] and columnar hexagonal-shaped ZnO [32] have been synthesized. Generally, the above methods require complex equipment and complicated operation, which can be called ‘noble’ methods. So, it is still a challenge to search for a simple route to prepare metal oxides nanoparticles with a high yield. Nano zinc oxide is non-toxic, with wide band gap has also been identified as a promising semiconductor material for exhibiting ferromagnetism (RTFM) at room temperature when doped with most of the transition metal elements [33]. Transition metal doped nanostructure is an effective method to adjust the energy level surface states of ZnO, which can further improve by the changes in doping concentrations of doped materials and hence in its physical and especially optical properties [34].

In this paper, the simple chemical addition method may produce pt doped ZnO material; furthermore, the chemical addition may produce single phase material at lower temperature and shorten the synthesis time. Our investigations have been focused on the preparation and characterization of pt doped ZnO nanoparticle by X-Ray diffraction (XRD) and Scanning electron microscopy (SEM) respectively.

II. EXPERIMENTAL DETAILS

2.1.1. Preparation of Pt doped ZnO nanoparticles

ZnO Oxide was synthesized using a mechanochemical and conventional solide- state method. All the chemicals used for the preparation were of analytical grade. It includes ZnO, Poly vinyl alcohol (1%) and acetone. All the solutions were prepared in Millipore water obtained from Millipore water system for the preparation of ZnO nanoparticle. Weighted 5 g of ZnO powder and mixed thoroughly in an aceton medium using agate mortar pestle for 2 hr and dry it. The powder of ZnO has been taken in 100 mL beaker and adds 3-4 mL 1% poly vinyl alcohol. The mixture is sticky. Dry the mixture with a natural process. This mixture is added with 150 mL Millipore water. The solution was allowed to centrifuge in presence of water and acetone to remove impurities. The process of centrifuging was repeated three- four times to remove most of the impurities for the solution and allowed to dry at room temperature. The reaction was carried out at 100 ^{0}C for 2 hr in a muffle furnace. The dried powder of ZnO is used for the pt doping. The special arrangement was made to add dropwise aqueous solution of 1% 0.05 M platinum chloride solution into the dried 1 g of ZnO nanoparticalsolution with constant stirring. After complete reaction, the precipitated was washed 2 to 3 times with distilled water, then pure pt doped ZnO power in a glass beaker was placed in a microwave oven (in put power 800W) about 30 minutes with on-off cycle (20 second on - 40 second off). The pt doped ZnO nanoparticle is used for the characterization by XRD & SEM & Energy dispersive spectroscopy (EDX) respectively.

Preparation condition

Addition of 0.05 M $PtCl_2$ solution	gm of ZnO
1 ml	1 gm
3 ml	1gm
5 ml	1gm

III. MATERIAL CHARACTERIZATION

3.1. X-ray Diffraction

In order to understand the structural properties of ZnO-Pt doped sample of different concentration 1 ml, 3 ml,5 ml fired at 100^{0}C temperature in air atmosphere, the X-ray diffraction study was undertaken. X-Ray diffraction analysis of ZnO-Pt doped samples were carried out in the range 20-70^0 range using CuKα radiation. Fig.1. shows an XRD pattern of ZnO-Pt doped sample plotted in the range 20-70^0(2Θ) verses intensity having several peak of ZnO-Pt indicating random orientation for the hexagonal wurtzite nature and measured interplaner distance agreed with the value reported for ZnO-pt doped in literature. The observed peak match well with the reported in Inorganic Crystal Structure Database [ICSD] Coll. Code: 067454 [35,36].

Matches with calculated values ,confirming the hexagonal wurtzite structre. Pt doping did not affect the ZnO grain size, crystallinity, and the particle morphology. The higher peak intensities of an XRD pattern is due to the better crystallinity and bigger grain size.This clearly indicates that the structure of ZnO-Pt doped film is polycrystalline in nature. Besides except ZnO peaks, no other impurity peak is seen, suggesting formation of the single phasic ZnO.

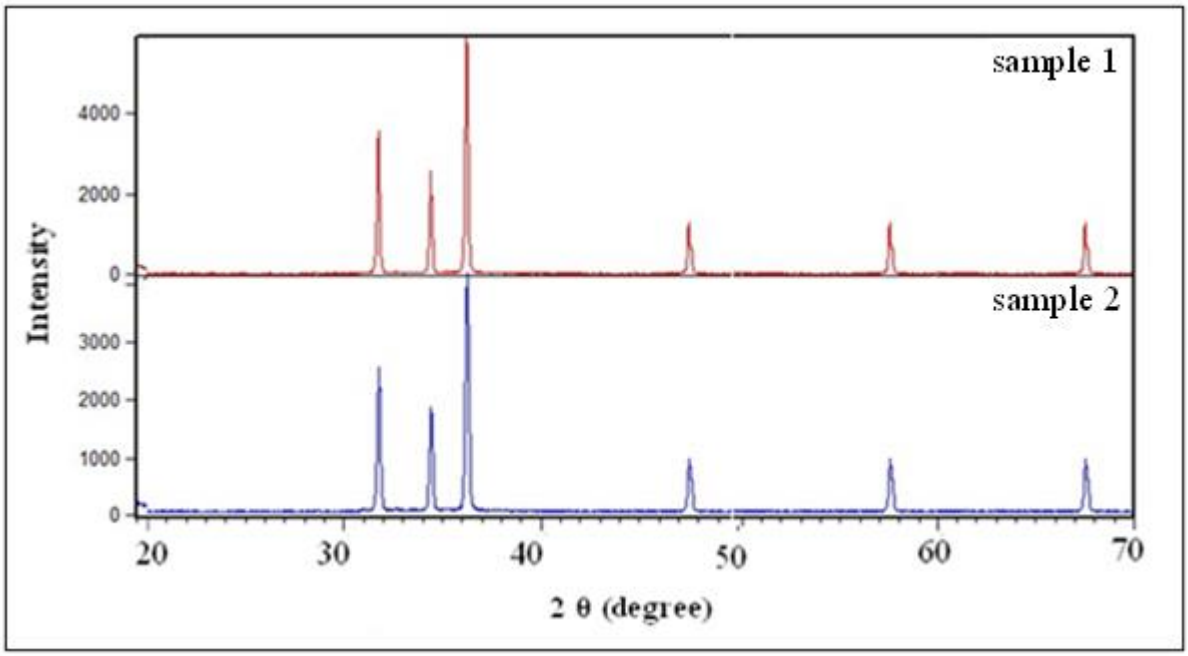
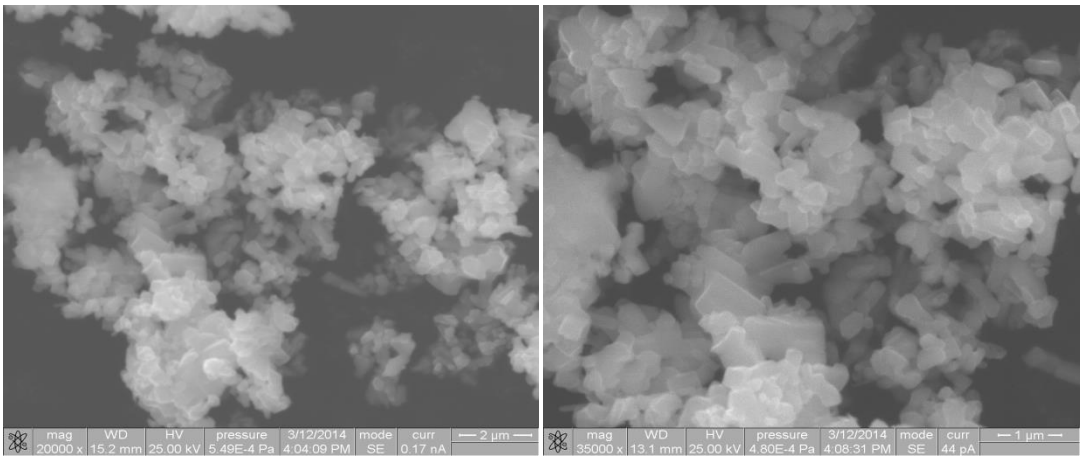


Fig.1 XRD of Pt doped in ZnO with different concentration 3 ml (sample 1), 5 ml (sample 2)

3.1.2. SEM analysis

The scanning electron microscopy is useful technique to observe surface morphology of deposited films. Figure-2. Shows SEM images of nanostructure ZnO-Pt thick film fired at 500^0C in the air. Microstructural characterization was carried out by using scanning electron microscopy. SEM indicated rod type nanostructure. However some residual, intragranular porosity was seen. The film fired at 500^0C has good adhesion. Therefore it is used for gas sensing. The surface morphology (SEM) of ZnO nanoparticle, which reveals the particles size was found to be about 10 nm with hexagonal shape.



(a) (b)

Fig.2 SEM image of Pt doped in ZnO with different concentration 3 ml (a) & 5 ml (b)

3.1.3. Elemental Analysis (EDX)

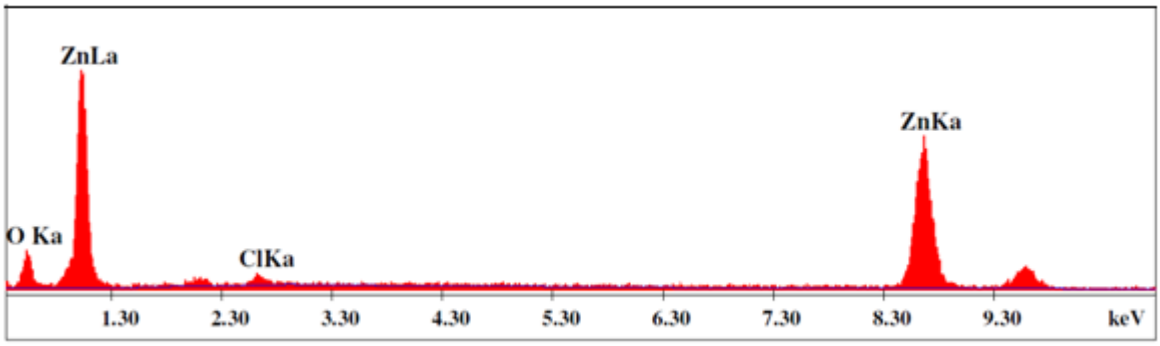


Fig.4. EDAX Spectrum of Pt doped ZnO

The composition of Pt doped ZnO nanoparticle fired at different temperature was analyzed by energy dispersive spectrometer (6360LA) (EDX).The EDAX was recorded in the Binding energy region between 0-10 KeV was shown in fig.4.The spectrum peak reveals the presence of Zn, O & Cl at 8.30 ,0.5 & 2.45 KeV respectively, which confirms the presence of Zn O & Cl in the film.

IV. CONCLUSION

The present study illustrates that the mechanochemical method which produce single phase material at lower temperature and shorten the synthesis time. X-Ray diffraction (XRD) result showed that the obtained Pt doped ZnO nanoparticles were composed of hexagonal with very good crystallinity. Scanning electron microscopy (SEM) result showed that the average partial size was obtained 10 nm.

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