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Manganese Doped Zinc Oxide Nanoparticles Prepared By Sol-Gel Technique: Optical and Structural Properties

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Abstract: Nano-science and Nanotechnology have now developed as the most important fields to a technological revolution in the novelperiod. Nanotechnology includes investigation across the disciplines such as medical, biology, chemistry, engineering, and physics so on. This present task used Nanosized Mn-doped ZnO nano particles was prepared by sol-gel method. In present study optical and structural properties of Mn-doped ZnO nanoparticles have been examined by XRD and UV/VI Spectrophotometer. The X-ray diffraction exploration reveals that the Mn-doped ZnO crystallizes in a single stage polycrystalline nature with wurtzite lattice and with all percent of doping, the peaks are shifting seldom and doping of Mn is possible. The UV/Vis spectra of the nanoparticles indicate a decrement in the band gap energy from 2.90, 2.86, 2.75, 2.67, and 2.62 eV respectively, for 2%, 4%, 6%, 8%, 10% doping concentration.

Keywords: Nano-particles, Optical, Structural, Energy, Mn-doped ZnO.

INTRODUCTION

Nanoparticles and their applications have drastically shifted science in the direction of a completely new philosophy in the last few years. Because nanoparticles have a bigger surface area per weight than larger particles, they are more reactive and effective than other molecules, which modified the properties of many conventional materials. Nanoparticle research is currently a very promising scientific topic due to the vast range of potential and prospective applications, particularly in the fields of biomedicine, optics, and electronics. Nanoparticles serve as a link between bulk materials and atomic or molecular structures, bridging the gap in scientific understanding.

Nanotechnology can be termed as the synthesis, characterization, exploration and Nanosized materials (1 to 100 nm) for the development of novel materials. The word "Nano" comes from the Greek word "dwarf," which meaning "little or insignificant". One nanometer is a billionth of a meter (1nm = 10^{-9} meter). Zinc oxide (ZnO) has been studied extensively in the past. It has been the focus of thousands of study publications over the last 100 years, dating back to 1935 [6].This procedure becomes prominent in Nano crystalline films, where the surface fields is sizably voluminous. In the bulk-cognate techniques, oxygen molecules in the grain boundaries contribute to photoconductivity. For UV-detection, the expeditious component, due to the generation of photo carries and their radiative and non radiative recombination through the restricted centers, is of more preponderant paramountcy [5]. In the present task we studies optical and structural properties of ZnO and Mn-doped ZnO nanocrystals synthesized by aqueous solution techniques.

EXPERIMENTAL TECHNIQUES

Manganese doped zinc oxide nanoparticles were arranged by sol-gel technique. The preliminary composed was $Zn_{1-y}Mn_yO$ (y=0.02, 0.04, 0.06, 0.08, 0.10). The ZnO nanoparticles was arranged according to the direction in Spaniels and Anderson (1991). This present work the synthesis was carried out under ambient-temperature condition Classically, 9.8 mmol $Zn(OAC)_2{\cdot}2H_2O$ and 0.2 mmol $Mn(OAC)_2.4H_2O$ were dissolved at 70^0C in 200 ml ethanol under stirring, subsequently cooled in 50^0C. In a second flask, 5.0 mmol $LiOH{\cdot}H_2O$ dissolved in ethanol was added drop wise under stirring during 1 hour to we get Zn Mn acetate solution. The product was stirred for another hour at 50^0C and cooled down a room temperature. After that the solution was absolutely clear 800 mLn-hexane were added to precipitate the doped ZnO. Then the precipitate of doped ZnO was separated by centrifuging at 4500 rpm for 1 h. The obtained precipitate was washed with 100ml ethanol, 300ml n- hexane and centrifuged at 4500 rpm for 3 h, and then drying at 60^0C for 3 h.

RESULTS AND DISCUSSION

In two different techniques such as hydrothermal method (Oxalate Decomposition) and Sol-gel techniques. In this present study we selected Sol-gel method for the synthesis and characterization

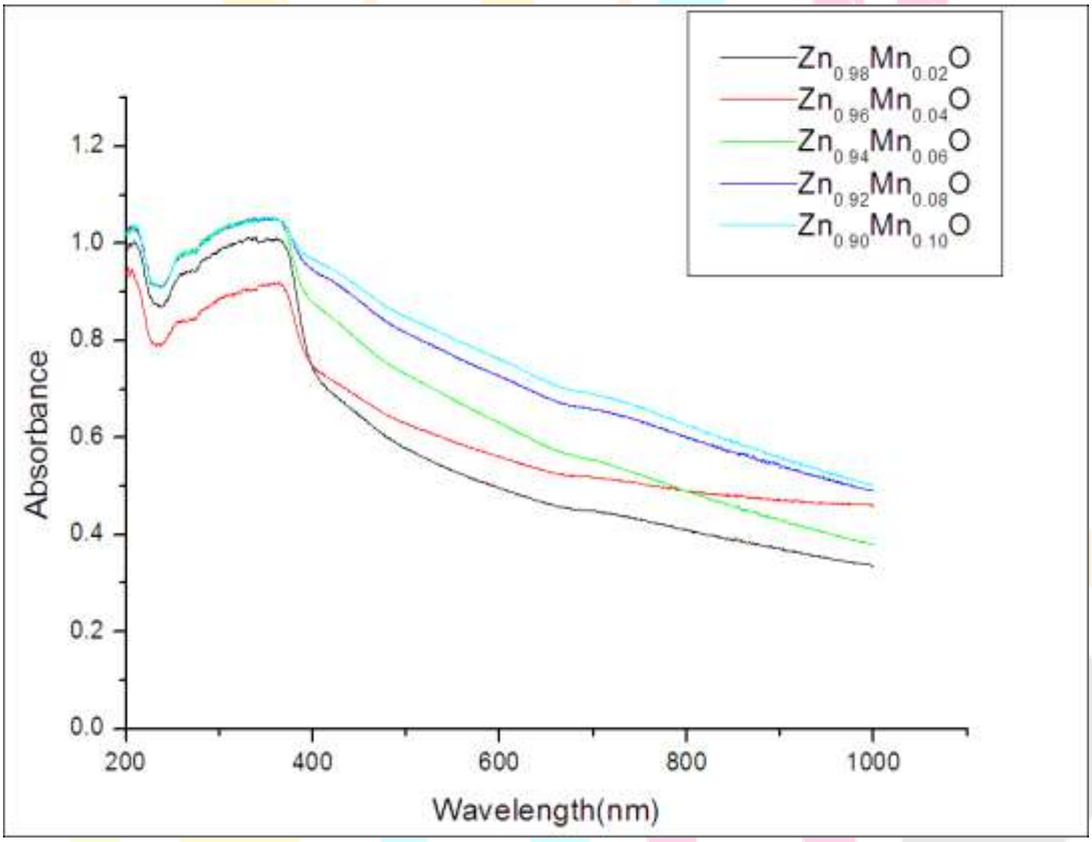

Figure:1 Absorbance against wavelength

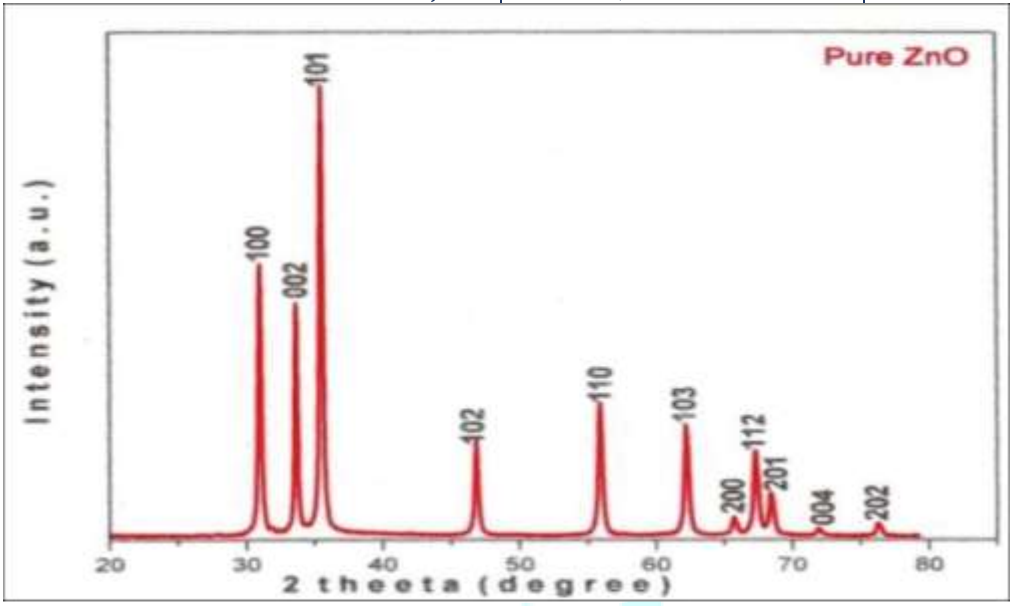

Figure:2 Pure ZnO

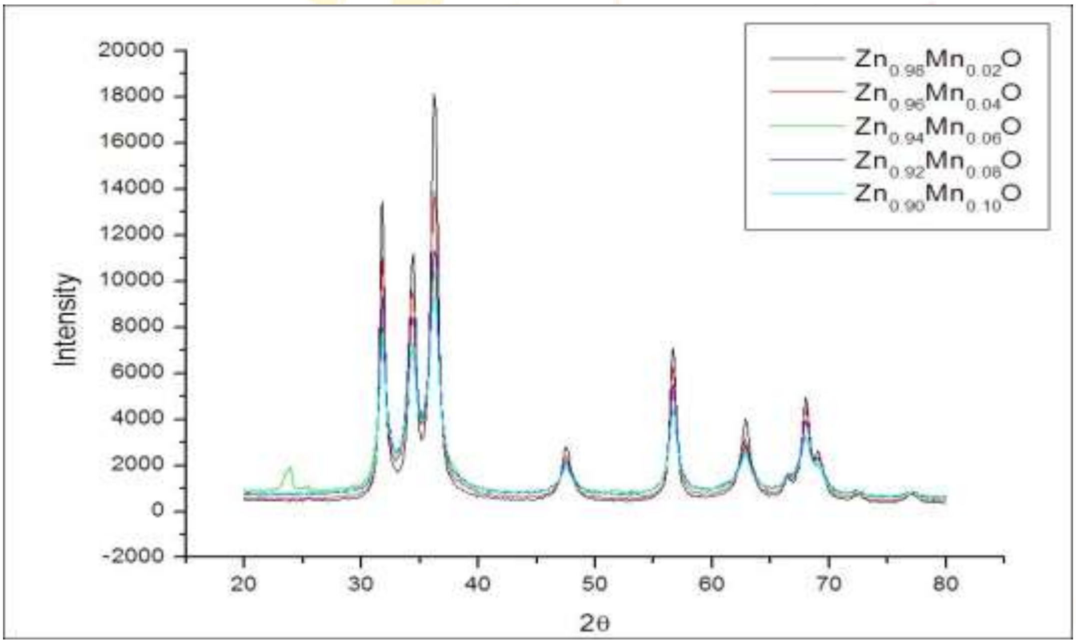

Figure:3 XRD pattern of 2% wt., 4% wt., 6% wt., 8% wt., 10% wt. Mn doped ZnO

The XRD patterns of pure ZnO and Mn-doped ZnO with diverse Mn concentration are described as Figure 2 and 3. The characteristic peaks of ZnO (100), (002), (101), (102), (110), (103), (200), (112), (201), (004) and (202) are find out in the investigated diffractometers and we observed that the manganese doped ZnO and pure ZnO all peaks match the hexagonal ZnO structure depicted as Figure 2 and 3.

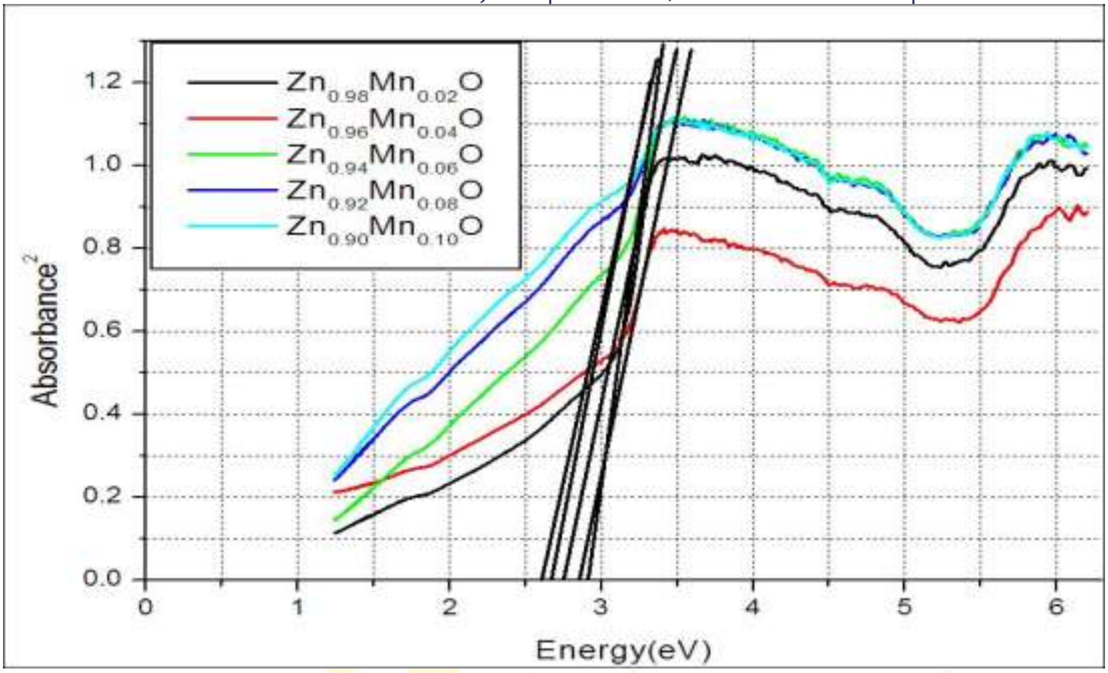

Figure:4 Square of the absorbance against energy

The quantity of absorption in a material depends on both the energy of the incoming light, the density of electrons in the valence band and the density of empty states in the conduction band. For a direct band gap semiconductor, like ZnO, a rather good approximation is to describe both the valence and conduction band close to the band edges as parabolic. In such a case the absorption coefficient "α", will be proportional to the square root of the energy difference between the band gaps E_g. In practice this intrinsic band gap is given as the intercept with the energy axis of a linear fit to the square of the absorbance data in an energy interval slightly above the band gap, where the data is linear. For Mn-doped ZnO that is, $Zn_{1-y}Mn_yO$ where y=0.02,0.04,0.06,0.08,0.10 optical band gap was found as 2.90, 2.86, 2.75, 2.67, and 2.62 eV respectively, depicted as shown in figure 4.

CONCLUSION:

Field of nanotechnology represents in stimulating and rapidly increasing research area that crosses the limitations among physical, life and engineering sciences, chemical science, and etc. Nanotechnology is fast developing industry, posing a substantial impact on economy, society and environment. These tasks worked on the several levels of Mn-doped ZnO were synthesized by sol-gel techniques. Characterization was carried out by XRD, and the band gap measured by UV-visible reflectance. For $Zn_{1-y}Mn_yO$ where y=0.02, 0.04, 0.06, 0.08, 0.10, the optical band gap was get as 2.90, 2.86, 2.75, 2.67, and 2.62 eV respectively, The band gap of 2% Mn doped ZnO was the maximum. The band gap of 2% Mn doped ZnO is 2.90eV.

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