JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Study the Complex Optical properties of Chemically Synthesized Polypyrrole-Bi_2O_3-ZrO_2 Nanocomposite

Ashish Choudhary[a], Sandeep Waghuley[b], Umar Bhati[c]

[a]Department of Physics, Shri Shivaji Arts, Commerce and Science College,Akot, Dist: Akola, 444 101,India.
[b]Department of Physics, Sant Gadge Baba Amravati University, Amravati 444 602, India.
[c]Department of Physics, Shri Shivaji Arts, Commerce and Science College,Akot, Dist: Akola, 444 101, India
Corresponding author e-mail:ashishchou78@gmail.com (A.R.Choudhary)

Abstract

In this work PBZ (Polypyrrole-Bi_2O_3-ZrO_2) nanocomposite synthesized using *in-situ* approach. The XRD diffractrogram of prepared PBZ sample was taken to investigate structure and crystalline or amorphous nature. The surfaces and associated interfaces of PBZ sample examine by scanning electron microscopy. Ultraviolet-Visible spectroscopy is performed to determine sample composition of PBZ. From XRD pattern the particle size of PBZ nanocomposite calculated. The surface arrangement of PBZ nanocomposite inspected using SEM micrograph. SEM image revel that closely compact surface formed agglomerated region. UV spectroscopy results helps to determine different complex optical aspects like optical absorbance, extinction factor (coefficient), index of refraction, Optical conductivity i.e. electrical conductivity in the existence of an alternating electric field, real and imaginary function of dielectric constant. Optical properties that have various applications in the field of optoelectronic like light-emitting diodes, optical sensors, solar energy conversion, photo-electrochemical cells, photovoltaic solar cells etc.

Keywords: Complex Optical Properties; Polypyrrole; ZrO_2

Introduction

Due to some special features like easy synthesis, improved thermal stability, high electrical conductivity, outstanding chemical and air stability, low cost and low weight, Polypyrrole (PPy) is widely used in research field. For designing and manufacturing of new optoelectronic material detail study of optical properties is essential. Electrochemical polymerization technique is used by J. V. Thombare et al to prepare Polypyrrole. The ITO substrate is used to to deposited PPy thin film with potentiostatic electrodeposition method. Optical properties of as prepared PPy thin was investigated . The optical band gap of pure PPy films is 2.19 eV whereas the 50 kGy electron exposed PPy thin film exhibits band gap of 1.97 eV [1]. Highly porous PPy-coated TiO_2/ZnO nanofibrous mat made by Wang et al [2] for detection of ammonia gas.

In this work, we studied the complex optical properties of PBZ (Polypyrrole-Bi_2O_3-ZrO_2) nanocomposite. Different complex optical parameters were studied for chemically synthesized PBZ nanocomposite.

Materials and Methods

Analytical reagent grade (AR) Pyrrole monomer and aqueous solution of ammonium persulphate were used as starting chemicals.

The chemical oxidative polymerization method was adopted for preparation of PPy. The PPy prepared using monomer pyrrole and oxidant ammonium persulphate in 60:40 wt.% ratio is used for preparation of PPy .The polymerization takes place at room temperature at (303 K).The PBZ (Polypyrrole-Bi_2O_3-ZrO_2) nanocomposite prepared by adding 25 wt % Bi_2O_3 nanoparticles and 5 wt % ZrO_2 nanoparticles in PPy during polymerization.. The prepared sample was washed with distilled water and kept in oven for 24 hrs for dried out.

The XRD pattern of sample was investigated by X-ray diffractometer (XRD) (Rigaku Miniflex-II, X-ray diffractometer). The surface geography of sample was ditermined using scanning electron microscope (SEM) (JEOL JSM-7500F). The ultraviolet-visible spectroscopy technique is used to investigate data with the help of Agilent UV-VIS spectrometer Carry-60.

Results and Discussion

Amorphous nature of PBZ nanocomposite confirmed using XRD pattern as shown in figure 1, as there is no sharp peak in XRD pattern. Our sample XRD pattern match with Dubal et al. [3] and Palaniappan et al. [4], XRD results. Debye Scherrer's formulation method is used to calculate the particle size of PBZ nanocomposite.

$$D= (K \lambda /\beta \cos\theta)$$

where D is usual crystallite dimension (nm), K is a shapes factor (K=0.9), λ is the wavelength of X-ray source equals 1.540 Å, β is the full width at half maxima and θ is the diffraction peak angle. Using Debye Scherrer's equation, the particle size of PBZ nanocomposite calculated, was found to be 16.24 nm.

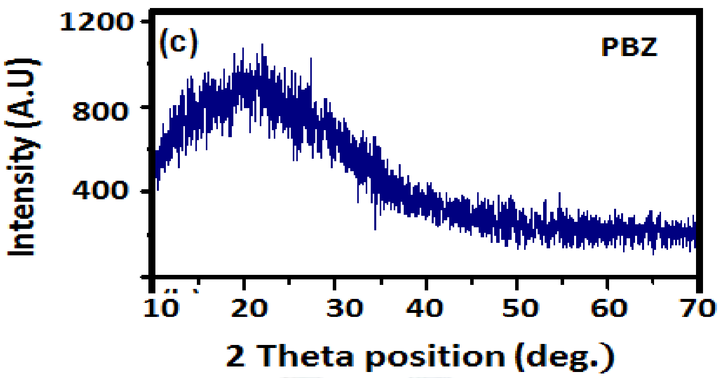

figure 1. XRD pattern of PBZ nanocomposite

Figure 2 shows SEM micrograph gives morphological information of PBZ nanocomposite; it has uneven morphology and particle size which might be attributed to the formation of PPy layer formed by polymerization process. The micrograph pattern exhibits that nanocomposite sample was densely compact and formed agglomerated region. This irregular morphology is appropriate for gas sensing due to huge area for adsorption of gas molecules [5].

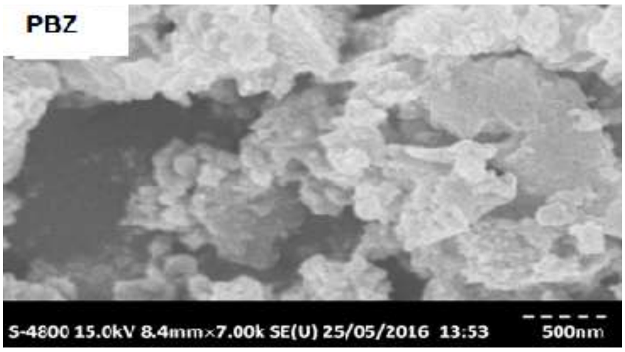

figure 2. Sem micrograph of PBZ nanocomposite

Figure 3 indicate the UV-VIS spectra PBZ nanocomposite prepared by of chemically synthesis method. The presence of metal oxide nanoparticles in polymeric matrix confirmed using intense absorption tail at 221 nm. The surface plasmon resonance band overlapped with absorption band of PPy defined due to broad peak appears in sample at 310-365 nm [6].

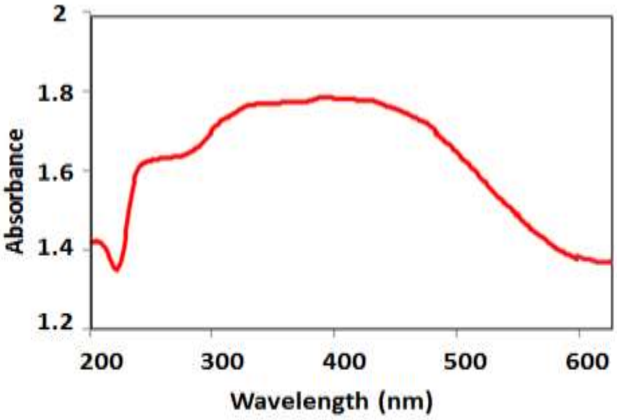

figure 3. UV-VIS spectra

Figure 4 investigate the distinction of extinction coefficient of PBZ nanocomposite. From graph, extinction coefficient value decreases in almost exponential manner ranges from 3-5.5 eV. The graph specifies that sample traps longer wavelength effectively than lower wavelength [7].

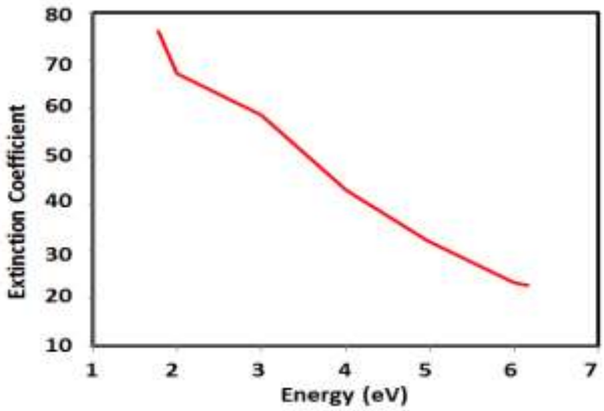

figure 4. Extinction coefficient of PBZ nanocomposite.

Figure 5 represents the change of refractive index. The value of R.I. are similar with absorption study of sample. The refractive index value raises sharply around 221 nm and start to reduce up to 600 nm.

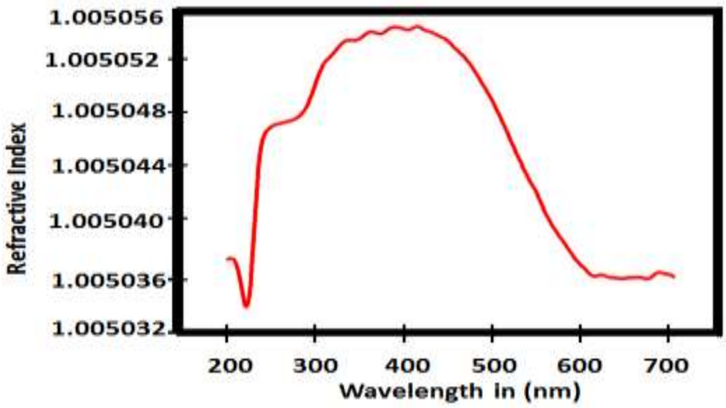

figure 5. Refractive index spectra.

Figure 6 determine the change of optical conductivity, respectively. From graph optical conductivity value found approximately constant between 2.8-4 eV

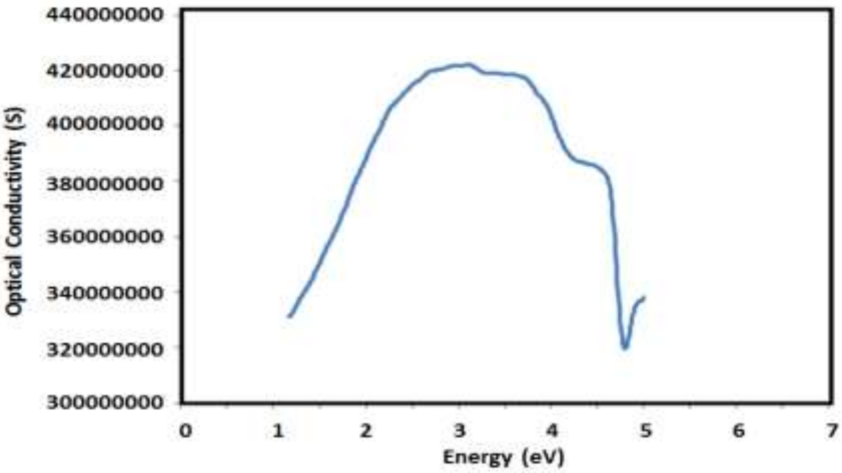

figure 6. Optical conductivity spectra of PBZ nanocomposite.

Figure 7 displays the difference of real and imaginary dielectric constant as a function of energy. The real dielectric constant is measure has ability to slows down of velocity of light. From graph we conclude that, both curve falls exponentially with photon energy up to 5.5 eV., The real and imaginary dielectric constant remains constant in the values in between 5.5-6.5 eV. The term Imaginary dielectric constant access absorbs energy from an electric field due to dipole motion [8,9].

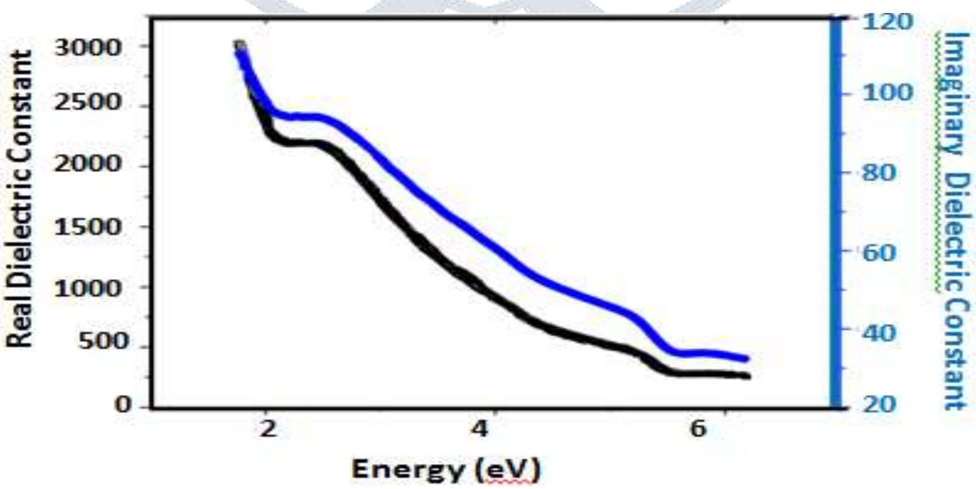

figure 7. Plot of real and imaginary dielectric constant as a function of photon energy.

Conclusions

In short, we successfully manufactured PBZ nanocomposite easily by chemical polymerization technique using in-situ approach and its complex optical properties are investigated. The particle size of

PBZ nanocomposite is calculated from XRD which is found to be 16.24 nm. In SEM analysis shows densely compact and formed agglomerated region, which is suitable for gas sensing. The real and imaginary dielectric constant remains constant in the range lies in between 5.5-6.5 eV for PBZ sample. The measurement of extinction coefficient indicates that sample strongly traps higher wavelengths. Besides PBZ sample has significant properties of real and imaginary dielectric constant.

Acknowledgement

The authors of are very much grateful to Head, Department of Physics Sant Gadge Baba Amravati University, Amravati for providing necessary facilities.

References

1. Thombare J. V., Rath M. C.. Han S. H., & Fulari V. J. *Journal of Semiconductors, 34*, 093001-093005(2013).
2. Wang Y., Jia W., Strout T., Schempf A.,. Zhang H, Li B., Cui J., Lei Y., *Electroanalysis*, *21*, 1432–1438(2009).
3. Dubal D. P., Patil S. V, Jagadale A. D. & Lokhande C. D. *J. Alloys and Compounds 509,* 8183- 8188(2011).
4. Palaniappan S. P. & Manisankar P. *Mater. Chem. Phys. 122,* 15-17(2010).
5. Wales D.J., Grand J., Ting V.P., Burke R.D., Edler K.J., Bowen C.R., Mintova S. & Burrows A.D. *Chem. Soc. Rev. 44,* 4290–4321(2015).
6. Kate K.H., Singh K. & Khanna P. K. *Synth. React. Inorg. Met. Org. Nano-Metal Chem. 41,*199-202 (2011).
7. Nemade K.R. & Waghuley S.A. *Results in Physics 3,* 52– 54 (2013).
8. Nemade K.R. & Waghuley S.A.*Int. J. Metal, 201*,389416-389420(2014).
9. Bakr N.A., Funde A.M, Waman V.S., Kamble M.M., Hawaldar R.R., Amalnerkar D.P., Gosavi S.W., Jadkar S.R. *Pramana: J. Physics, 76* 519– 531(2011).