Chapter one

Introduction

1.1Metal oxide and polymer nanocomposite material

There are many different materials with specific optical properties designed to attenuate light flux or, in general case radiation flux. Light attenuators are made in form of grids, iris diaphragms , scattering plates, rotating notched disks, interference light filters, photometer wedges, and solid ,liquid ,or gaseous light absorbing filters[1].Recently many research groups have investigated the optical properties of metal oxide /polymer nanocomposites as alternative light attenuators, as hybrid nanocomposites not only inherit the functionalities of semiconductors nanoparticles but also posses advantages of polymers such as flexibility film integrity and conformity [2]. The use of inorganic nanoparticles into the polymer matrix can provide high performance novel materials that finds application in many industrial fields. With this respect ,frequently considered features are optical properties such as light absorption (UV, laser and colour), and the extent of light scattering or, in the case of metal particles, photoluminescence , dichroism, and so on , and magnetic properties such as super paramagnetic , electromagnetic wave absorption ,and electromagnetic interference shielding [3]. The choice of polymer matrix is also manifold depending on the application that can be generally divided into industrial plastics, conducting polymers, and transparent polymers. For mechanical application industrial plastics are always chosen as the polymer matrix while transparent polymers such as PMMA are used as polymer matrix [4]. For optical application of polymer inorganic nanoparticles composite, inorganic nanoparticles of metals such as Au or Ag and semiconductors such as TiO_2,ZnO, or PbS are commonly used as 'optically effective additives[5]. Polymeric ZnO nanocomposites materials have attracted large interest because introduction of ZnO filler into polymeric matrices can modify the optical (e.g. shielding from UV and NIR radiation), electrical and mechanical properties. Zinc Oxide is an important electronic properties. It is a semiconductor, with a direct band gap of 3.3eV and a large excitation binding energy (60 MeV). The band gap value is equivalent to ultraviolet (UV) light energy, which means that ZnO has ability to absorb UV light [6]. LLDPE is a semi-crystalline polymer. Due to its excellent electrical and mechanical properties, is widely used as insulation material for electric power cables. Numerous studies have been performed to investigate the space charge distribution and electrical conduction in polyethylene systems. Combining ZnO nanoparticles with LLDPE should enhance its optical absorption spectra in solids provides essential information about the band structure and the energy gap in both crystalline and non crystalline materials. The lower energy part of the absorption spectra gives information about the atomic vibrations and higher energy part of the absorption spectra gives knowledge about electronic status in the materials[6].

1.2Research objectives

*To investigate the possibility of using ZnO/LLDPE nanocomposites in order to used as attenuator of high power laser.

*To measure the optical properties of LLDPE/ZnO (transparency, absorption coefficient) as a function of the weight percentage of Zinc oxide nanoparticles.

1.3Research organization

This research contains four chapters which are arranged follows:

* Chapter one the introduction, Chapter two the polyethylene/metal oxides nanocomposites, Chapter three the experimental part and Chapter four the results and discussion.

Chapter two

Polyethylene /metal oxides nanocomposites

2.1polyethlene

In its simplest form, a polyethylene molecule consists of a long backbone of an even number of covalently linked carbon atoms with a pair of hydrogen atoms attached to each carbon; chain ends are terminated by methyl groups. Polyethylenes comprise chains with a range of backbone lengths. Typically, the degree of polymerization is well in excess of 100 and can be as high as 250,000 or more, equating to molecular weights varying from 1400 to more than 3,500,000. Polyethylene molecules can be branched to various degrees and contain small amounts of instaurations. There are many types of branches, ranging from simple alkyl groups to acid and ester functionalities. In the solid state, branches and other defects in the regular chain structure limit a sample's crystalline level. Chains that have few defects have a higher degree of crystalline and density than those that have many. The properties of polyethylene such as melting temperature, extent of crystalline, modulus, and the mechanical behavior depend on many parameters like the method of manufacture, the addition of co monomers, as well as overall molecular weight. Polyethylene is manufactured by several major processes. These include high pressure polymerization (free radical polymerization), Ziegler-Natta type catalyzed polymerization, meta llocene polymerization, and metal oxide catalyzed polymerization. Polyethylene can be classified depending on their density, molecular weight, as well as the co monomers employed. Therefore, polyethylene comes in various forms differing in chain structures, crystalline, and density levels [7,8].

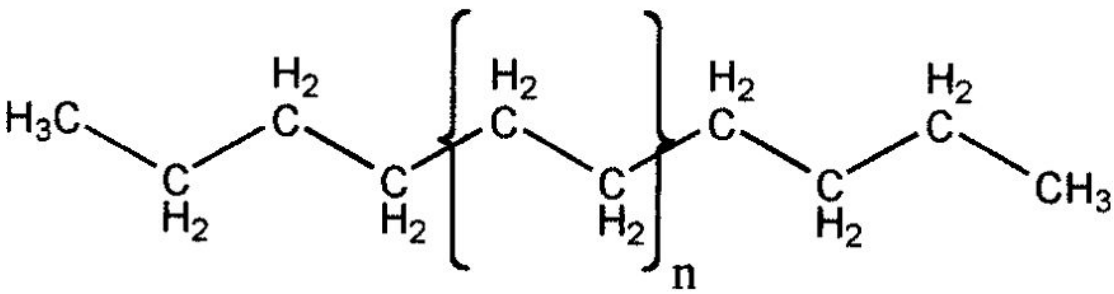

Figure 2.1 Chemical structure of pure polyethylene

2.1.1 Linear low-density polyethylene (LLDPE)

is a substantially linear polymer (polyethylene), with significant numbers of short branches, commonly made by copolymerization of ethylene with longer-chain olefins. Linear low-density polyethylene differs structurally from conventional Linear low-density polyethylene (LLDPE) because of the absence of long chain branching. The linearity of LLDPE results from the different manufacturing processes of LLDPE and LDPE. In general, LLDPE is produced at lower temperatures and pressures by copolymerization of ethylene and such higher olefins as butane, hexane, or octane. The copolymerization process produces a LLDPE polymer that has a narrower molecular weight distribution than conventional LDPE and in combination with the linear structure, significantly different rheological properties[9].

2.1.1.1 Production and properties

The production of LLDPE is initiated by transition metal catalysts, particularly Ziegler or Philips type of catalyst. The actual polymerization process can be done either in solution phase or in gas phase reactors. Usually, octane is the co monomer in solution phase while butane and hexane are copolymerized with ethylene in a gas phase reactor. LLDPE has higher tensile strengt_hand higher impact and puncture resistance than does LLDPE. It is very flexible and elongates under stress. It can be used to make thinner films, with better environmental stress cracking resistance. It has good resistance to chemicals. It has good electrical properties. However, it is not as easy to process as LLDPE, has lower gloss, and narrower range for sealing. gloss, and narrower range for heat sealing[9,10].

Table 2.1 Physical properties of linear low density polyethylene (LLDPE)[9].

Property	**Value**
Density	0.95 *g/cm³*
Surface hardness	48 SD
Tensile strength	30 MPa
Flexural modulus	0.35 GPa
Notched izod	1.06+ kJ/m
Linear expansion	20×10^{-5}/°C
Elongation at break	500%
Strain at yield	20%
Max. operating temp.	50 °C
Water absorption	0.01%
Oxygen index	17%
Flammability UL94	HB
Volume resistivity	10^{16} Ω·cm
Dielectric strength	25 MV/m
Dissipation factor 1 kHz	909090
Dielectric constant 1 kHz	2.3
Material drying	NA
Melting Temp. Range	120 to 160 °C
Mould Shrinkage	3%
Mould temp. range	22 to 60 °C

2.1.2Polymer nanocomposites

Nanoparticles and/or nanocrystals of metal oxide semiconductor material have been extensively studied in the past decade due to their unique properties and wide application in diverse areas. Many research groups have focused on dispersing metal oxide nanoparticles into polymer matrix, as the hybrid nanocomposites not only inherit the functionalities of semiconductor nanoparticles but also possess advantages of polymers such as flexibility, film integrity, and conformity. Among metal oxide materials, ZnO is a multifunctional n-type semiconductor with prominent physical and chemical properties such as wide band gap (3.4eV), large exaction binding energy (60meV), good chemical stability, and low dielectric constant. It is of particular interest in many applications including antireflection coating, transparent electrodes in solar cells, gas sensors, ultraviolet light-emitting diodes, piezoelectric devices, and surface acoustic wave devices. Combining ZnO nanoparticles with a polymer should enhance their optical properties such as fluorescence, transparence and radiation durability. The polymer/ZnO composites have been produced with many different matrices such as poly (vinylpyrrolidone), poly(methyl methacrylate) ,poly (hydroxyethyl methacrylate) ,poly (ethylene glycol) ,low density polyethylene ,poly(ethylene oxide) ,Nylone-6 ,polyurethane ,and polyimide (PI) ,Among the various polymers, PI is a promising matrix which has attracted a lot of interest for photonic applications because of its conjugate π-electron system. Moreover, PI possesses excellent dielectric properties, outstanding thermal and chemical stability, and low coefficients of thermal expansion .These attributes make the PI/ZnO composites have potential applications in optoelectronics, light-emitting diodes, photonics, and flat-panel display industries [9,11].

2.2 Metal oxide nanoparticles

Metal oxides play a very important role in many areas of chemistry, physics and materials science [12]. The metal elements are able to form a large diversity of oxide compounds [13] these can adopt a vast number of structural geometries with an electronic structure that can exhibit metallic, semiconductor or insulator character. In technological applications, oxides are used in the fabrication of microelectronic circuits, sensors, piezoelectric devices, fuel cells, coatings for the passivation of surfaces against corrosion, and as catalysts. In the emerging field of nanotechnology, a goal is to make nanostructures or nano - arrays with special properties with respect to those of bulk or single particle species [14,15]. Oxide nano- particles can exhibit unique physical and chemical properties due to their limited size and a high density of corner or edge surface sites. Particle size is expected to influence three important groups of basic properties in any material. The first one comprises the structural characteristics, namely the lattice symmetry and cell parameters [16]. The second important effect of size is related to the electronic properties of the oxide. In any material, the nano structure produces the so-called quantum size or confinement effects which essentially arise from the presence of discrete, Structural and electronic properties obviously drive the physical and chemical properties of the solid, the third group of properties influenced by size in a simple classification. In their bulk state, many oxides have wide band gaps and a low reactivity [17]. A decrease in the average size of an oxide particle do in fact change the magnitude of the band gap Metal-oxide particles such as $TiO2$ and ZnO, serve many functions in the various polymeric materials. Traditionally, they have been used as pigments to enhance the appearance and improve the durability of polymeric products, and usually they have been considered to be inert. As nanosized particles, these materials exhibit broad band UV absorption, a benefit that currently has been exploited only in sunscreen applications. Also, the addition of nano-particles would likely enhance the stiffness, toughness, and service life of polymeric materials, for example, in applications in which mar resistance is important. Optimizing the material properties of metal - oxide nanoparticle/polymer composites, the microstructure and dispersion (sizes and spatial distribution) of nanoparticles must be characterized as a function of different process conditions [18].

2.2.1 Synthesis of metal oxide nanoparticles

The first requirement of any novel study of nanoparticulate oxides is the synthesis of the material [17,18]. Several synthetic approaches have been developed for synthesizing nanoparticles over the past several decades. Regardless of the technique, nanoparticles synthesis techniques can generally be divided into two classes: gas-phase methods and condensed phase methods. These two classes of nanoparticle synthesis are characterized by unique advantages and limitations.

2.2.1.1 Condensed Phase Methods

The first class of nanoparticle synthesis techniques involves manipulation of materials in the condensed (solid or liquid) phases. Solid-phase particle production methods include high-energy ball milling [19] and combustion synthesis [19]. where high amounts of applied energy literally break down a solid precursor. Combustion synthesis enables the production of relatively large quantities of material, and the properties of the product are controlled via the ratio of oxidant to fuel in the mixture .

2.2.1.2 Gas-Phase Methods

Several gas-phase synthetic techniques have been used to prepare nanoparticles. These methods use both inert and reactive atmospheres at a variety of pressures. Gas phase nanoparticle synthesis methods include electrospray[19], flame pyrolysis,vaporization and condensation using lasers and other heat sources[20], laser ablation and plasma synthesis. These methods feature the rapid cooling of evaporated material to induce nucleation and growth of nano particles.

2.3 Zinc Oxide nanoparticles

2.3.1Brief overview of ZnO

Today, when the world is surmounting on the roof of technology and electronics, mostly dominated by compatible electronic equipments and thereby creating the need for materials possessing versatile properties. The type of material a very common category of material comes out that is “semiconductor”. Germanium get famous due to possession of property like low melting point and lack of natural occurring germanium oxide to prevent the surface from electrical leakage where as silicon dominates the commercial market for its better fabrication technology and application to integrated circuits for different purposes .As time passes on, the rapid growing world demands a material that should possess inherent properties like larger band gap, higher electron mobility as well as higher breakdown field strength. So on making investigation about such a material the name of compound comes out is “Zinc Oxide” which is a wide gap semiconductor material very well satisfying the above required properties also Zinc oxide possessed many versatile properties for UV electronics, spintronic devices and sensor applications. Zinc oxide is an inorganic compound with the formula ZnO. It usually appears as a white powder, nearly insoluble in water. The powder is widely used as an additive into numerous materials and products including plastics, ceramics, glass, cement, rubber (e.g. car tyres), lubricants, paints, ointments, adhesives, sealants, pigments, foods (source of Zn nutrient), batteries, ferrites, fire retardants, etc. ZnO is present in the Earth crust as a mineral zincates; however, most ZnO used commercially is produced synthetically The research on ZnO is catching fire right from the beginning of 1950, with a number of reviews on electrical and optical properties like N-type conductivity, absorption spectra and electroluminescence decay parameter [21].

2.3.2 Fundamental properties of ZnO

2.3.2.1 Crystal structure of ZnO

Zinc oxide crystallizes in three forms: hexagonal quartzite, cubic zinc blende, and the rarely observed cubic rock salt. The quartzite structure is most stable and thus most common at ambient conditions. The zincblende form can be stabilized by growing ZnO on substrates with cubic lattice structure. The hexagonal and zincblende ZnO lattices have no inversion symmetry (reflection of a crystal relatively any given point does not transform it into itself). This a nd other lattice symmetry properties result in piezoelectricity of the hexagonal and zincblende ZnO, and in piezoelectricity of hexagonal ZnO. The lattice constants are a = 3.25 Å and c = 5.2 Å; their ratio c/a ~ 1.60 is close to the ideal value for hexagonal cell c/a = 1.633 [22].

2.3.2.2 Optical properties

ZnO is a direct band semiconductor and a transparent conductive material. ZnO films are transparent in the wavelength range of 0.3 and 2.5 µm, and plasma edge lies between 2 and 4 µm depending on the carrier concentration. It is well known that a shift in the band gap edge appears with an increase in the carrier concentration. This shift is known as Burstein-Moss shift. Optical transitions in ZnO have been studied by a variety of experimental techniques such as optical absorption, transmission, reflection, spectroscopic [23].

Table 2.2 Basic physical properties of ZnO[23].

Property	**Value**
Lattice parameter at 300 K	
A	3.2495 A°
C	5.2069A°
c/a	1.602
Density	$5.606 gcm^{-3}$
Stable phase at 300 K	Quartzite
Bond length	1.977 µm
Melting point	1975oC
Thermal conductivity	0.6 , 1-1.2
Static dielectric constant	8.656
Refractive index	2.008, 2.029
Energy gap	3.4 eV, direct
Exaction binding energy	60 MeV
Iconicity	62%
Heat capacity Cp	9.6cal/mol K

2.3.3 Synthesis of ZnO nano particles

As we all know any material in its nano form is more demandable than in its bulk form because in nano level the material undergoes a drastic change in its property and has versatile application. Thus zinc oxide which is a multifunctional material with a large direct band gap created anxiousness in the scientific minds to enhance the research on one dimensional nanostructure especially oxide materials. The properties if zinc oxide makes the material eligible exists in various shapes in the form of nanostructures exhibiting a varieties of properties like piezoelectricity, optical transparency, conductivity, solar cell, UV and visible photoluminescence, optical nonlinearity and many more. But obtaining various shapes of nanostructures merely depends on different processing techniques. Methods which are related to the synthesis of various shapes of zinc oxide nanostructures are chemical and thermal vapor deposition laser ablation, vacuum arc deposition, electrochemical, and hydrothermal process. But all these methods reported possesses many complex steps; require sophisticated equipments and rigorous experimental conditions [24].

2.3.4 Application of ZnO nano particles

Zinc oxide due to its versatility and multi functionality creates attention in the research field related to its applications. Each property of ZnO has its own applications. Starting from the wide band gap of ZnO makes it enable to form clusters consisting of ZnO nano crystals and ZnO nano wires. Also due to the wide band gap, synthesis of P–N homo junctions has been reported in some literatures but clarity on stability and reproducibility has not been established yet. Many fine optical devices can be fabricated based on the free-exciton binding energy in ZnO that is 60 meV because large exciton binding energy makes ZnO eligible to persist at room temperature and higher too. Since ZnO crystals and thin films exhibit second- and third-order non-linear optical behaviour, it can be used for non-linear optical devices. Third-order non-linear response has recently been observed in ZnO nano -crystalline films which make it suitable for integrated non-linear optical devices. Generally, the advantage of tuning the physical property of these oxides like zinc oxide becomes the root cause for the synthesis of smart application device [24].

2.4 Optical properties of LLDPE/ZnO Nanocomposites

LLDPE is semi – crystalline polymer, due to its excellent electrical and mechanical properties, is widely used as insulation material for electric power cables. Numerous studies have been performed to investigate the space charge distribution and electrical conduction in polyethylene systems. Combining ZnO nano particles with LLDPE should enhance its optical and electrical properties [25].The study of the optical absorption spectra in solid provides essential information about the band structure and the energy gap in both crystalline and non crystalline materials. The lower energy part of the absorption spectra gives information about the atomic vibrations and higher energy part of the absorption spectra gives knowledge about electronic status in the materials.

Chapter three

Experimental part

3.1 Materials

Commercial LLDPE was supplied by ALVIN FACTORY FOR PLASTIC-Omdurman(molecular weight = 218.00, Density = 0.915 - 0.925g/cm^3), absolute alcohol purity=98%, zinc acetate dehydrate $ZnC_4H_6O_4$ (molecular weight =219.51, Density=1.735 g/cm^3, purity=99%), Hydrogen peroxide H_2O_2 (molecular weight =34.0147g/mol, Density =1.4 g/cm^3, purity=32%, MEDICAL LABORATORIES LABS - SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY), distilled water.

3.2 Methods

3.2.1 Synthesis of ZnO nanoparticles

the sol-gel method was used for preparation of zinc oxide nanoparticles (ZnO-NPs). In a typical procedure 12.6g of zinc acetate dihydrate was added to 400 ml of double distilled water with continuous stirring to dissolve zinc acetate completely. Then the solution was heated to 50℃ and 600 ml of absolute alcohol was added slowly with stirring. After this, 6ml of H_2O_2 (32%) was added drop wise to the vessel and mixed it using a magnetic stirrer to get an almost clear solution. This solution was incubated for 24 hours and the solution was dried at 80℃ for several hours to obtain white nano zinc oxide. Nano zinc oxide was washed several times with double distilled water to remove the byproducts. After washing, the ZnOnanoparticles were dried at 80 ℃ in hot air oven. Complete conversion of zinc oxide will occur during the drying process.[7,13].(IN AFRICA CITY OF TECHNOLOGY).

3.2.2 Preparation of ZnO/LLDPE nanocomposites

Zinc oxide/LLDPE nanocomposites were prepared by solution mixing. The LLDPE polymer was dissolved in hot xylene first and then the powdered zinc oxide nanoparticles was added to the solution and mixed well. Different weight percentages (5, 10, 15, and 20%) of the nanoparticles were used. The resulting nanocomposites were dried in an oven at 80C° for an hour. Thin films of the polymer nanocomposites were obtained by pressing the dried polymeric materials between two hot surfaces at 150C° for 5 minutes. A uniform thickness of about 0.8 mm was obtained.

Figure3.1 Shows the ZnO/LLDPE nanocomposites

3.2.3 Characterization methods

Diode laser: with wavelength (675-915)nm and two powers(80,200)mW, was used in this work (supplied by laser systems laboratory-Institute of laser-Sudan University of Science and Technology). The most homogeneous parts and have uniform thickness of the thin films were exposed to the laser light. The following table shows the specification of the laser diode technique.

Table 3.1 The technical specification of Diode laser 200mW.

CW output power	200mW
Wavelength	(675-915)nm
Operating mode	CW
Power stability(rms,over1hour)	10
Beam diameter (at the aperture)	1.5mm
Operating current	300mA (1-20)mW 650mA (50-200)mW
Optimum operating temperature	(20-30)C°

Detector: (spectral range :400nm-1400nm).

Digital multi meter:(Power supply:9V, Battery type: NEDA 1604 9V 6F22) From the characterization there is many optical properties can be studied, the absorption coefficient, transparency and intensity of diode laser by ZnO/LLDPE was calculated ,before the irradiate of samples by diode laser the background of detector was recorded ($I_{\circ}$)then after irradiate laser the intensity of transmitted beam through each sample was measured .

Figure 3.2 shows the Devices used in the experiment

Firstly: transparency (T) its ratio between the intensity of transmitted beam (I_t) and intensity of incident beam ($I_\circ$)

$$T = \frac{I_t}{I_\circ} \qquad (3.1)$$

Secondly: absorption coefficient (μ)

The absorption coefficient can be calculated according to the relation:

$$I_t = I_\circ e^{-\mu x} \qquad (3.2)$$

$$-\mu = (\ln \frac{I_t}{I_\circ})/x \qquad (3.3)$$

Then

$$\mu = (\ln \frac{I_\circ}{I_t})/x \qquad (3.4)$$

Where $\boldsymbol{I_\circ}$ and $\boldsymbol{I_t}$ are the intensities of incident and transmitted beams respectively, μ is the absorption coefficient and the ($\boldsymbol{x}$) is the thickness of samples ($\boldsymbol{x}$ =0.008cm) was measured using Vernier Caliper with accuracy=0.001mm).

Chapter four

Results and Discussion

The aims of this chapter are to present the results of the work and to discuss it.

4.1 Results

Table: (4.1) shows the measurements of intensity for transmitted beam (I_t) using detectors in spectral range 400nm-1100nm. The calculations of absorption coefficient and transparency of LLDPE/ ZnO nanocomposites were carried out using diode laser 915nm ,80 mw.

$$I_{\circ} = 5.23 \text{ mA}$$

Table 4.1: measurement of of intensity for transmitted beam (I_t) and calculation of absorption coefficient and transparency.

ZnO%	I_t**/mA**	**Transparency (T)**	**absorption coefficient µ** mm^{-1}
0	1.80	0.34	133.33
5	0.95	0.18	213.21
10	0.45	0.09	306.61
15	0.23	0.08	390.51
20	0.15	0.03	453.91

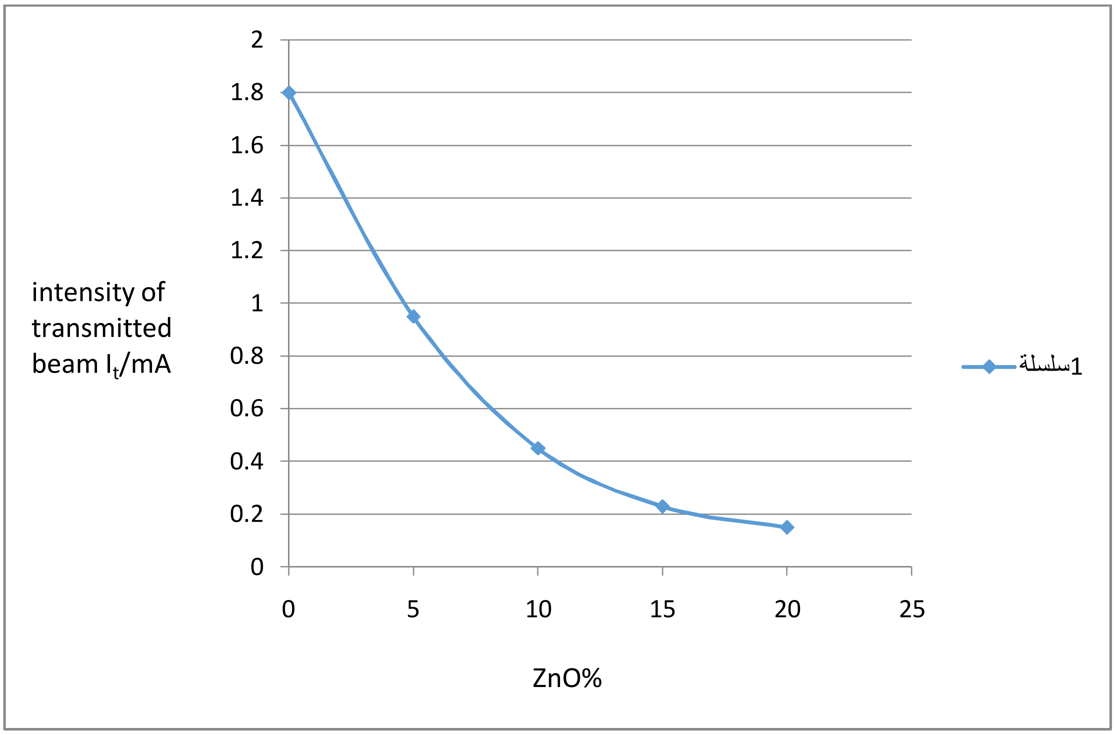

Figure 4.1Relation between intensity of transmitted beams(I_t/ mW) of diode laser (915nm),80mW and ZnO nano particles concentration.

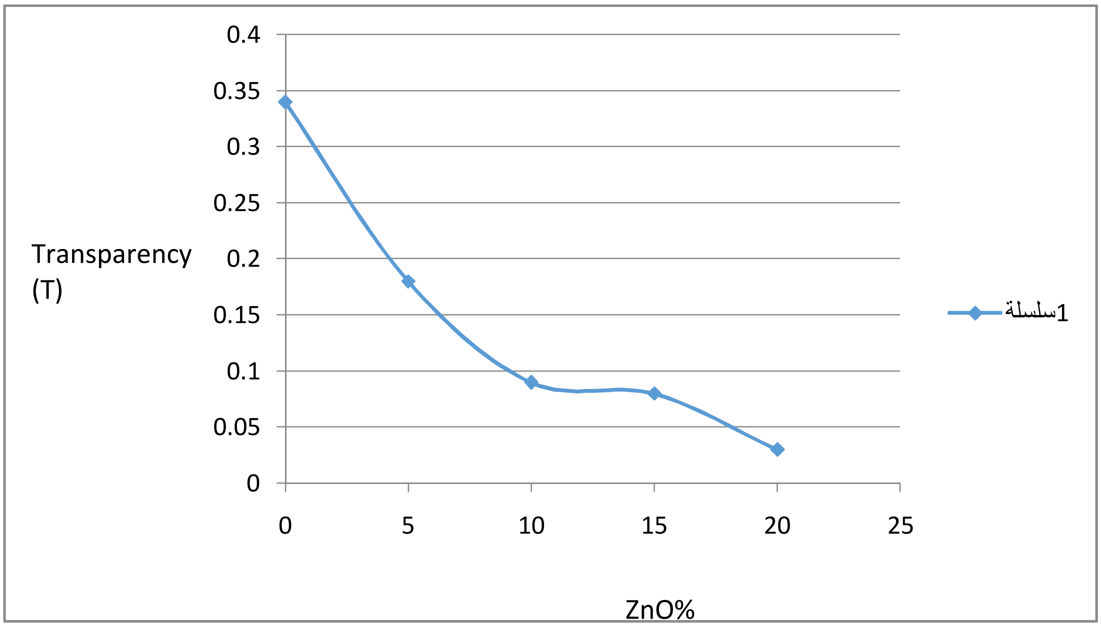

Figure 4.2 Relation between the Transparency and ZnO nano particles concentration using diode laser(915nm),80mW.

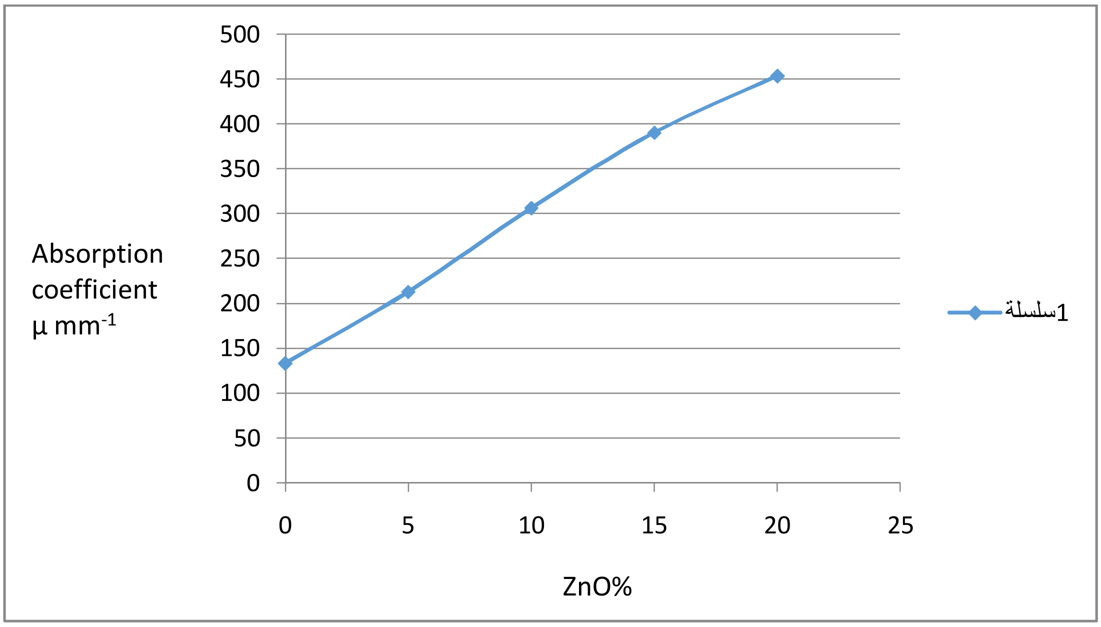

Figure 4.3Relation between the absorption coefficient and ZnO nano particles concentration using diode laser(915nm),80mW.

Table: (4.2) shows the measurements of intensity for transmitted beam(I_t) using detectors in spectral range 400nm-1100nm and calculations of absorption. Coefficient and transparency of LLDPE/ ZnO nanocomposites were carried out using diode laser 820nm,200mW.

$$I_{\circ} = 1.50 \text{ mA}$$

Table 4.2: measurement of of intensity for transmitted beam (I_t) and calculation of absorption coefficient and transparency.

ZnO%	I_t/mA	Transparency (T)	absorption coefficient μ mm^{-1}
0	0.45	0.30	150.49
5	0.18	0.12	265.03
10	0.15	0.10	287.82
15	0.12	0.08	315.72
20	0.11	0.07	326.59

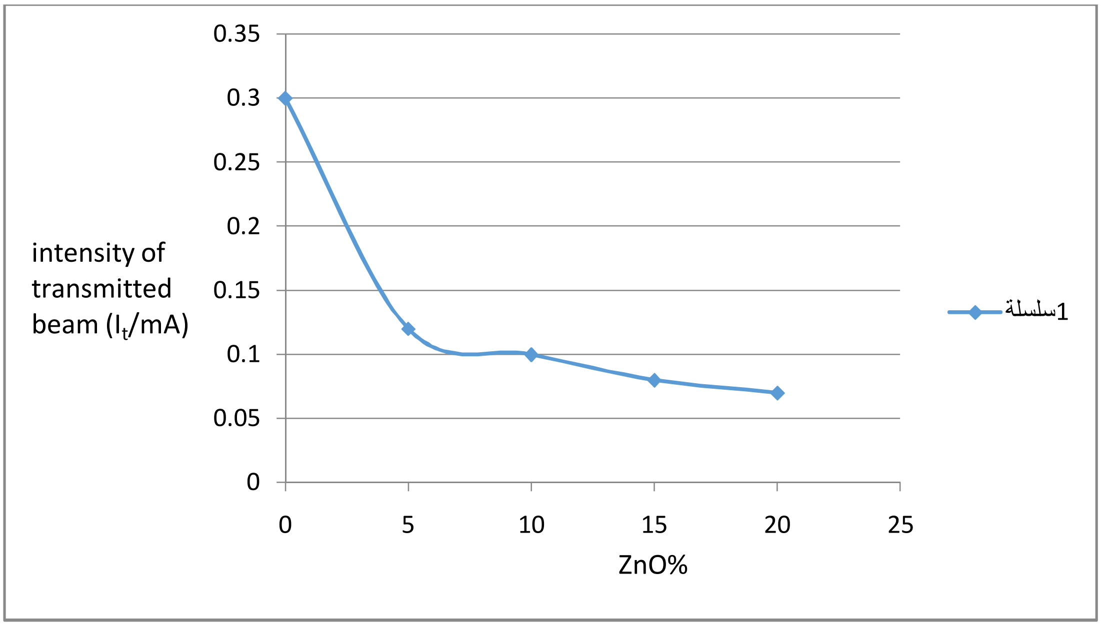

Figure 4.4 Relation between intensity of transmitted beams(I_t/mw) of diode laser (820nm),200mw and ZnO nano particles concentration.

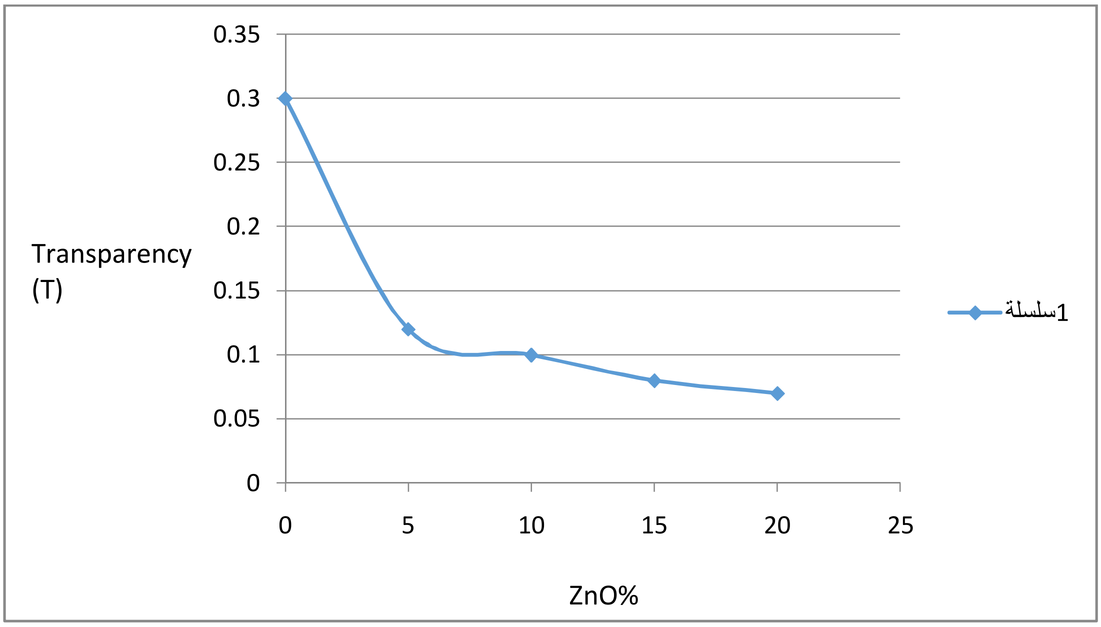

Figure 4.5 Relation between the Transparency and ZnO nano particles concentration using diode laser(820)nm,200mW.

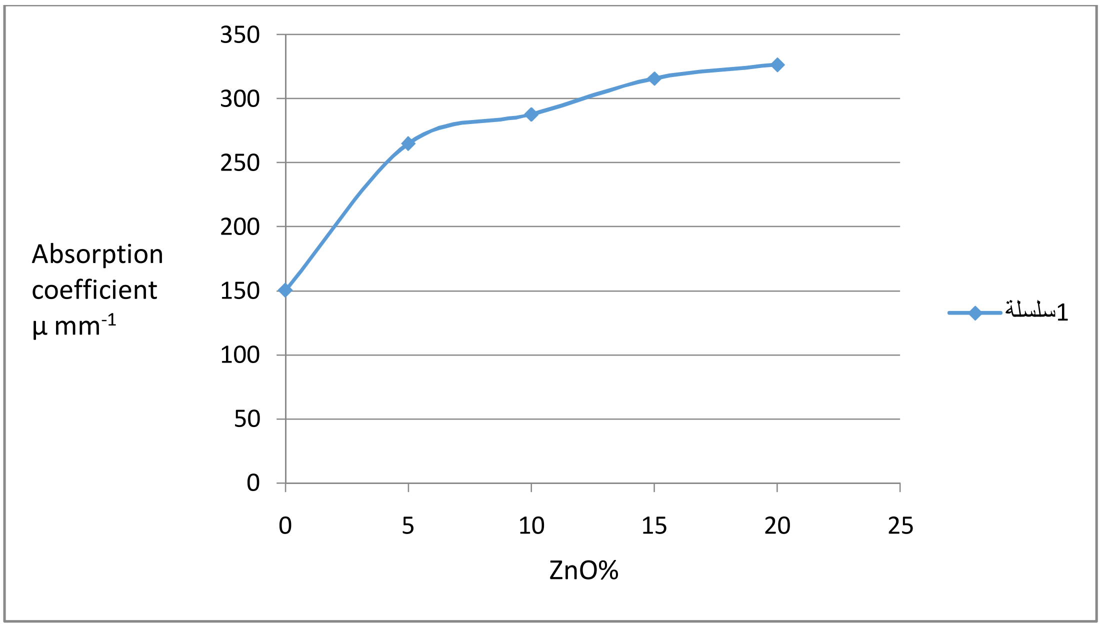

Figure 4.6 Relation between the absorption coefficients and ZnO nano particles concentration using diode laser(820)nm,200mW.

4.2 Discussion

As can be observed from the table 4.1 and Figures 1 to 3, the incorporation of Zinc oxide nanoparticles significantly decreases the intensity of the transmitted beam as well as the transparency of the LLDPE matrix whereas the absorption coefficient is profoundly increased. The addition of 5% of ZnO nanoparticles to LLDPE matrix results in 52% decrease in the intensity of the transmitted beam, 52% decrease in the transparency, and 159% increase in the absorption coefficient that return to the energy gab of ZnO. The subsequent addition of ZnO nanoparticles up to 20% does change these values but not very significantly compared to the change between the neat LLDPE and the 5% nanocomposite sample. The change in the measured values upon the incorporation of ZnO could be due to the excellent light absorbability of the nanoparticles as well as to their homogeneous dispersion within the polymer matrix. The homogeneous dispersion of the nanoparticles was proposed because 20% ZnO which is fourtimes the first addition could not change the values significantly. It has been reported in the literature [26] that ZnO nanoparticles have excellent light absorbance in the visible region which is agreement with our results.From table 4.2 and Figures 4 to 6 the observations, a large decrease in the intensity of transmitted beam of laser and transparency of LLDPE with ZnO nanoparticles as fillers by using laser with power(1100)mW. The addition of 5% of ZnO nanoparticles to LLDPE matrix results in 40% decrease in the intensity of the transmitted beam, 40% decrease in the transparency, and 176% increase in the absorption coefficient.

4.3Conclusion

Nanocomposites samples of LLDPE with different concentration of ZnO nanoparticles prepared and optical properties transparency and absorption coefficient has been investigated, and the results indicated that the transparency decrease while absorption coefficient increase with increasing the concentration of ZnO, from the results we concluded that that the chemical structure of LLDPEis not change by ZnO nanoparticles, it remains in dispersed form but it changes the optical properties. From the changes of the laser beam with power and wave length (915nm),80mW nad(820nm),200mW transparency and absorption coefficient we can concluded that the ZnO / LLPDE might be use as a good light attenuators.

4.4Recommendations

*Study of electrical properties of ZnO/LLDPE nanocomposite.

*Experimenting with a number of oxides material on the polymer because of its important applications in our daily lives.

* Study the properties of ZnO nanoparticles are available if required hardware.

* Provision of materials and devices laboratory special postgraduate studies in order to facilitate the practical side.

References

[1] Yang,Li.Li. Synthesis and Optical Properties of ZnO Nanostructures, Linköping University, Norrköping, Sweden,2008*ISSN: 0280-7971.

[2] Vijaya S. Sangawar Manisha C. Golchha.Polymer/Nanomaterials Research Laboratory, Govt. Vidarbha Institute of Science and Humanities, VMV Road, Amravati -444602 India Volume : 2 | Issue : 7 | July 2013 • ISSN No 22.

[3] Shanghua Li, Meng Meng Lin, Muhammet S. Toprak, Do Kyung Kim,and Mamoun Muhammed1. Nanocomposites of polymer andinorganic nanoparticles for opticaland magnetic applications, Division of Functional Materials, Royal Institute of Technology, August 2010.p3.

[4] A.J. Peacock. Handbook of Polyethylene: Structures, Properties, and Applications. Marcel Dekker Inc., New York (2000) p.1-6, 43-66.

[5] Peacock, A. J., and L. Mandelkern. J. Polym. Sci., Polym. Phys. Ed. 28 (1990): 1,917.

[6] Shuxiang Mu,1,2 Dezhen Wu,1 Shengli Qi,1 and Zhanpeng Wu. Preparation of Polyimide/Zinc Oxide Nanocomposite Films via an Ion-Exchange Technique and Their Photoluminescence Properties. Journal of Nano materials ,Volume 2011 (2011), Article ID 950832, 10 pages ,http://dx.doi.org/10.1155/2011/950832.

[7] Riyadh M. Alwan, Quraish A. Kadhim, Kassim M. Sahan, Rawaa A. Ali, Roaa J. Mahdi, Noor A. Kassim, Alwan N. Jassim, Synthesis of Zinc Oxide Nanoparticles via Sol – Gel Route and Their Characterization, National Center for Packing and Packaging, Corporation of research and industrial development, Iraqi Ministry of

industry and minerals 2015, Nanoscience and Nanotechnology 2015, 5(1): 1-6,DOI: 10.5923/j.nn.20150501.01.

[8] Pomogailo, A.D, Kestelman , V.N, Metallopolymer Nanocomposites, Springer-Verlag Berlin Heidelberg 2005. ISSN 0933-033x.

[9] C. N. R. Rao, G. U. Kulkarni, P. J. Thomas, metal–polymer nanocomposites,2005, Naples, Italy, ISBN 0-471-47131-3 (Cloth).

[10] G. H. Michler, F. J. Baltá-Calleja, Mechanical Properties of Polymers Based onNanostructure and Morphology,2005, New York. ISBN 1-57444-771-8 (alk. paper).

[11] Alexander B. Morgan, Charles A. Wilkie, flame retardant polymer nanocomposites, United States of America,2007, ISBN 978-0-471-73426-0 (cloth).

[12] Meissner, J. Pure Appl. Chem. 42 (1975): 551.

[13] Shuxiang Mu,1,2 Dezhen Wu,1 Shengli Qi,1 and Zhanpeng Wu . Preparation of Polyimide/Zinc Oxide Nanocomposite Films via an IonExchange Technique and Their Photoluminescence Properties. Journal of Nano materials, Volume 2011 (2011), Article ID 950832, 10 pages,http://dx.doi.org/10.1155/2011/950832.

[15] Rodriguez, J.A., Fernandez- Garcia, M; (Eds.) Synthesis, Properties and Applications of Oxide Nano-particles. Whiley: New Jersey, 2007.

[16]D. Malpass. Introduction to Industrial Polyethylene: Properties, Catalysts, and Processes. John Wiley & Sons Inc., USA (2010) p.1-22.

[17] A.J. Peacock. Handbook of Polyethylene: Structures, Properties, and Applications. Marcel Dekker Inc., New York (2000) p.1-6, 43-66.

[18] Wyckoff, R.W.G. Crystal Structures, 2nd ed; Wiley: New York, 1964.

[19] Wesley Odell Gordon. Metal Oxide Nano-particles: Optical Properties and Interaction with Chemical Warfare Agent Stimulants. Virginia Polytechnic Institute and State University- 2006.

[20] Shingo Tachikawa, Atsushi Noguchi, Takeharu Tsuge, Masahiko Hara, Osamu Odawara and Hiroyuki Wada . Optical Properties of ZnO Nanoparticles Capped with Polymers, Tokyo Institute of Technology, Published: 17 June 2011.

[21] Hahn, H. Nanostructured Materials 1997, 9, 3-12.

[22] S. K. Mohanta, D. C. Kim, B. H. Kong, H. K. Cho, W. Liu, and S. Tripathy, Sci. Adv. Mater.,2(2010)64.

[23] C. Jagadish and S. J. Pearton, "Zinc Oxide Bulk, Thin Films and Nanostructures Processing, Properties and Application" Elsevier (2006)

[24] C. Jagadish and S. J. Pearton, Zinc Oxide Bulk, Thi n Films and Nanostructures Processing, Properties and Application" Elsevier (2006).

[25] S. K. Mohanta, D. C. Kim, B. H. Kong, H. K. Cho, W. Liu, and S. Tripathy, Sci. Adv. Mater.,2(2010)64.

[26] Shingo Tachikawa, Atsushi Noguchi, Takeharu Tsuge, Masahiko Hara, Osamu Odawara and Hiroyuki Wada . Optical Properties of ZnO Nanoparticles Capped with Polymers, Tokyo Institute of Technology, Published: 17 June 2011.