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Synthesis and Characterization of Polyethylene /Silica Nano composite

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Abstract: *Polyethylene/silica nano composite was synthesized in different concentration includes 2%, 3%, 4%, 10%, 20%, 30%, 40%, and 50% of silica. The samples were subjected to physical evaluation; the result showed that the amount of silica was changed the optical properties (the maximum absorbance was at 284 nm) and the composite had moderate refractive index in infra-red region but it is de shielding in part of ultra violet region.*
Mechanical properties was enhanced, the highest load was 5.4 to sample that contain 4% weigh of silica.

Keywords: Polyethylene, silica, nano composite, physiochemical properties.

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1. INTRODUCTION

Polyethylene is one of thermoplastic polymer ،it has wide range of uses and many different manufacturing processes. Polyethylene can be classified into several different categories but mostly do not depend on it is density and branching. The main forms of PE are High-density polyethylene (HDPE), High molecular weight HDPE (HMWHDPE), ultra high molecular weight density polyethylene (UHMW-HDPE), linear low-density polyethylene (LLDPE), and very low-density polyethylene (VLDPE). These are divided based on density and branching. Generally, the most used PE grades are HDPE, low-density polyethylene (LDPE) and medium-density polyethylene (MDPE). Properties of PE composites depend on the molecular weight of PE, experimental conditions and reinforcement types and amounts.

It is important to know the structure and properties of PE composites to control and modify the needed properties of each application.
Silica is the most extensively used as support ، it has several properties that make it attractive as catalyst support: it is relatively chemically inert, stable at high temperatures, and can be synthesized with several pore size, volumes and surface areas. In addition, silica is relatively inexpensive support, ideal for the production of commodity polymers such as polyolefin's. It is hybrid inorganic materials and the interactions between silica and polyethylene matrix are mainly physical action, the interface bonded strength is weak [(1).] The poor physical interaction between the organic and the inorganic components leads to poor mechanical and thermal properties. In contrast, strong interactions between the polymer and the layered silicate nano composites lead to the organic and inorganic phases being dispersed at the nanometer level. As a result, nano composites exhibit unique higher properties than conventional composites. Wenxi Cheng، Wei Miao، Linqi Zhang and Jin Peng were prepared series of PE/ SiO_2 nano composites and obtained covalent bonds between SiO_2 and PE and Tensile strength، modulus and elongation at break of PE/ SiO_2 was large compared to pure Pe[(1).] High-density polyethylene (HDPE) is a widely applied thermoplastic polymer, characterized by good tensile properties, flexibility, low cost and chemical resistance. [(2)] ، Saad Mohmed hamza found electrical conductivity of low density polyethylene resin reinforced by variety weight fracture (1%، 2%، 3%، 4%، 5%) was decreased from 5×10^{-14} before adding silica to 8.7×10^{-17} (ohm.cm) $^{-1}$ after addition (5%) from silica at (40℃) [(3).] Some authors have concluded that the appropriate percentage of NS must be small (1-5 wt%) to avoid agglomeration of particles during mixing, while others have indicated that properties can Also be improved with higher dosages up to approximately 10 wt% if these nano particles are successfully dispersed in the initial cementious mixture[(4)] .

Composite materials can be classified in different ways. Broadly, polymer composites can be classified into two groups on the basis of reinforcing material.

They are fiber-reinforced polymer (FRP) and particle-reinforced polymer (PRP) composites. In the last decade, thermoplastic composite industry has shifted from the use of high performance advanced composites to cost-effective engineering composites by using different fibers [5].

And yet the intimate blending of silica and PE remained a challenge because of the very different nature of these polymers and because of the general difficulty in handling PE, which is devoid of any functional group [6].

Objectives of this study:

This study aims to:

- Synthesis of nano silicon dioxide
- Support of polyethylene by silicon dioxide (PE/Sio_2)
- Characterize of PE/Sio_2
- Study of mechanical and optical properties of the obtained product

2. EXPERIMENTAL:

2.1 Devices and equipment

Heating mantle swastika scientific instrument, thane, Mumbai, India, Glass road, Beakers, Volumetric flask.

2.2 Chemicals

All chemicals used in this research of analytical grade type

Polyethylene $(C_2H_4)_n$, Toluene ($C_6H_5CH_3$), Silicon dioxide (SiO_2), Hydrochloric acid (HCl), Sodium silicates(Na_2SiO_3), Sodium bisulphate ($NaHSO_3$).

2.3 Methods:

2.3.1 Preparation methods:

i. Preparation of Ultra Pure Silicon Dioxide:

30 g of sodium silicates were weighted and pour into a beaker (250 ml), then were dissolved in 50 ml of hydrochloric acid, 50 ml of distill was added then shaken until the solution was completely dissolved, 35 g of sodium bisulphate was dissolved in 100ml of water; the solution was stirred vigorously with glass rode until it's completely dissolved. The contents of the first beaker was poured into the second beaker and mixed thoroughly a thick jelly-like precipitate was formed. The precipitate was poured into a porcelain crucible and heated, then it was dried and weighted

ii. Preparation of Polyethylene/Silica Nano Composite (as tablet)

0.9 g of polyethylene was weighed in volumetric flask and, warmed on the heating mantle to 80℃. 0.1g of silicon dioxide was added to viscous polymer solution with good mixing until the solvent was evaporated and the sample was glued on glass road .

The steps was repeated for four times by used :(0.2g of SiO_2 and o.8g of PE)،(0.3g of SiO_2 and o.7 g of PE)،(0.4g of $SiO_2$and 0.6g of PE)and (0.5 of $SiO_2$and 0.5 of PE) .samples were formed as tablet to use in IR ,UV spectroscopy

iii. Preparation of Polyethylene/Silica Nano Composite (thin film)

A 4.95g of PE were weighed into beaker and 20 ml of toluene was added، the mixture was heated on heating mantle to 80℃ .0.05g of SiO_2 was added to viscous polymer with strong mixing ،the blend was decanted in petry dish. The steps was repeated for two times with (0.03g of SiO_2 and 4.97g of PE) and (0.01g of SiO_2 and 4.99g of PE).Samples were used in tensile test

2.3.2 Characterization methods:

i. Method of Accoutering Samples for Infra Red Spectroscopy:

Each sample was dissolved partially in 10 ml of toluene. Small of solution was placed on glass slide.

ii. Method of Accoutering Samples for Ultra Violet Spectroscopy:

Each sample was dissolved partially in 10 ml of toluene and the cell was filled from solvent.

iii. Method of tensile test:

The thin film samples were cuted by use of dong done cutter.

3. RESULTS:

3.1. Characterization of silica/polyethylene composite:

i. Fourier transform-infra red spectroscopy:

It is clear from figure 3.1 below there is Strong C-H stretching modes at 2851 and 2917 corresponding to polyethylene-methylene bending these signals were identical with the characteristic features of bulk PE.

- The samples were inflexible and hard to cut.

With addition of nano silica, the IR spectra exhibit an absorption behavior for mid IR in the wave range of 700-1000 cm^{-1}

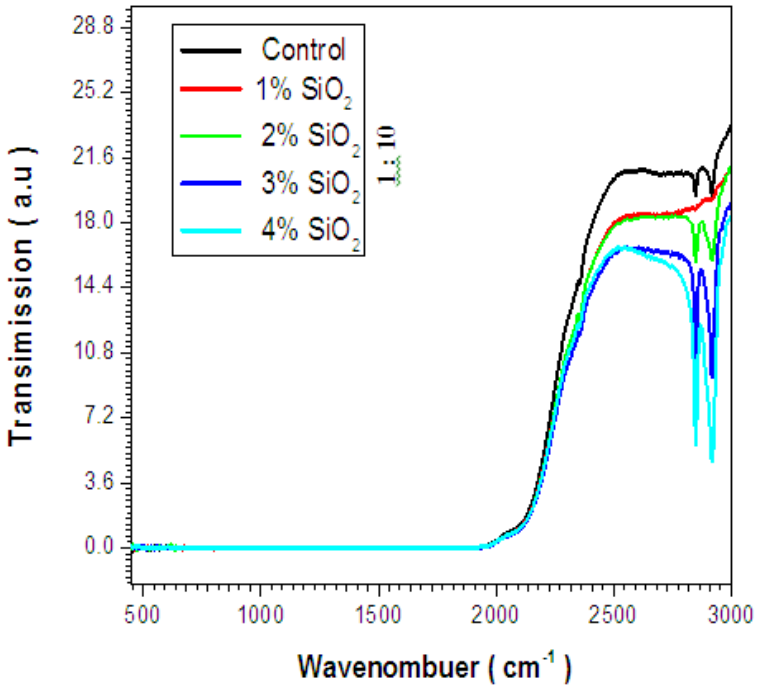

Figure 3.1: FTIR spectrum of polyethylene/silica composite

ii. Focus FTIR spectrum:

From the focus FT-IR we could say that the peaks at 400-500 corresponded to silica; The IR absorption capacity of composite is a function of the silica content .the higher silica content, the higher the IR absorbance

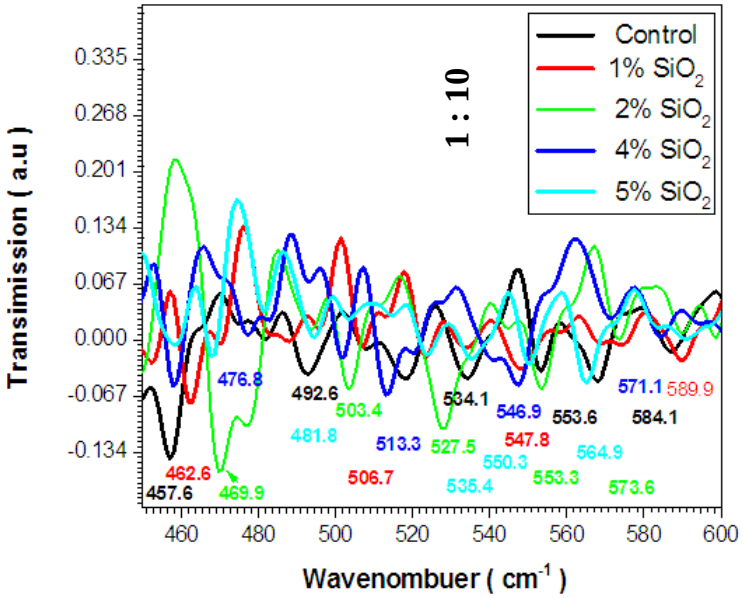

Figure 3.2: focus FTIR Spectrum of polyethylene/silica composite

3.2 Ultra violet spectroscopy:

As show in below figure all samples have absorbance, as amount of silica increase the absorbance increase and the lamda max of all samples is 284 which is characteristic of silica composite.

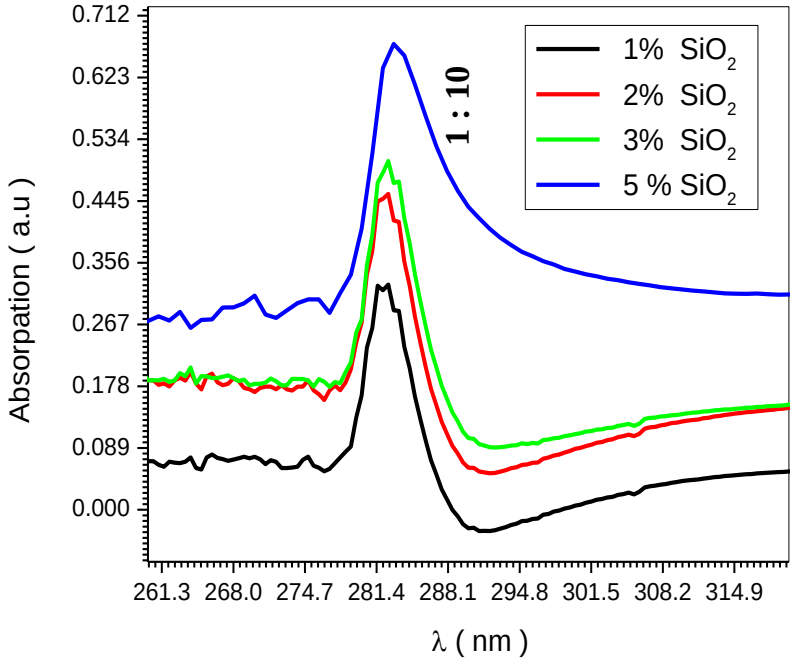

Figure 3.3 absorption spectrum of polyethylene/silica composite

3.3 Ultra violet transmission:

The results of different silica/polyethylene shown below and From this result, it could be conclude that nano silica particles would be capability of IR irradiative absorption, in turn resulting in a remarkable decrease in thermal energy loss to the surrounding.

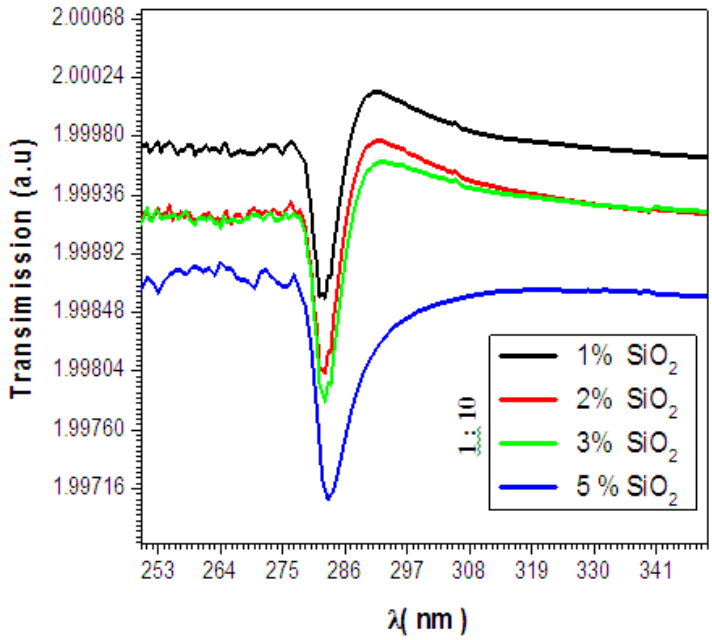

Figure 3.4: transmission spectrum of polyethylene/silica composite

3.4 SPR spectrum

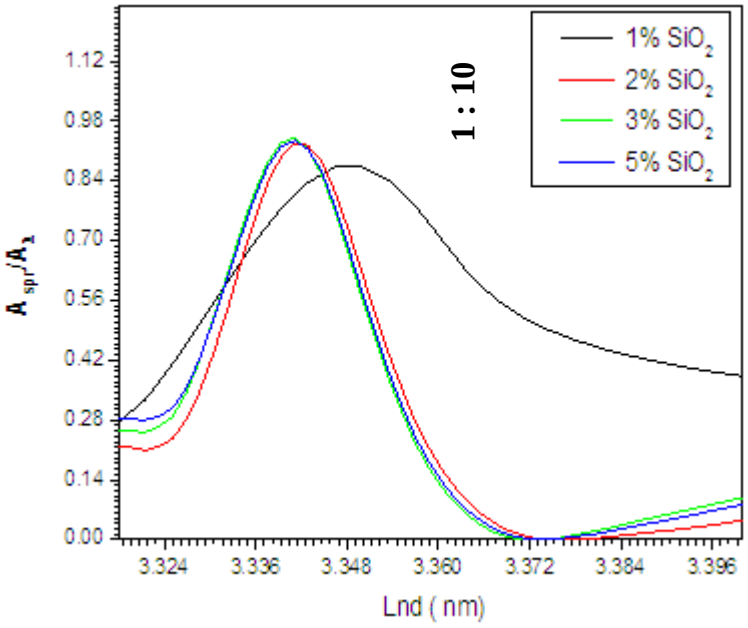

Figure 3.5: Calculated ratios of absorbance values of PE/SiO_2 in dependence of their diameter

3.5 Energy band gap:

Insulator materials have large energy band gap and semi conductor particle (silica) have narrow band gap and weak electron bonded when electron is added (removed) to the bottom of the conduction band (from the top of the valence band) of a conjugated polymer, the conduction (valence) band ends up being partially filled and a radical anion(cation), commonly termed as a polarons, the formation of polarons causes the injection of states from the

bottom of the conduction band and top of the valence band into band gap. So that silica is decrease resistance and energy band gap.

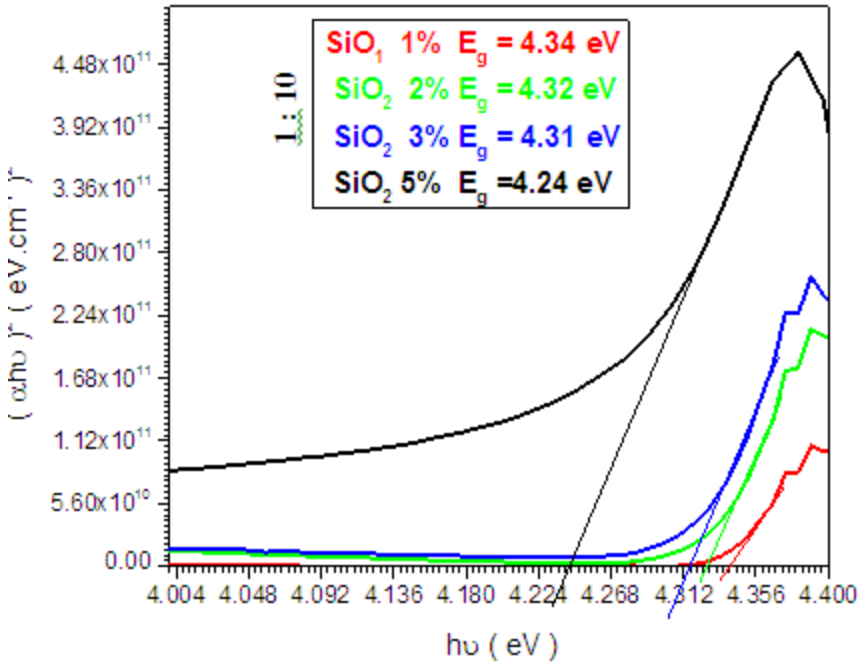

Figure 3.6: Energy band gap

3.6 Refractive index:

Polyethylene has high refractive index arrive to1500 nm so from figure 3.7 we observes that silica is decrease the refractive index of composite until it is arrive to lowest value 1.5 nm which is close to refractive index of pure silica (1.58) whereas highest value was in UV region. We conclude that this composite is shielding ultra violet radiation, as amount of silica increase the composite become transparent.

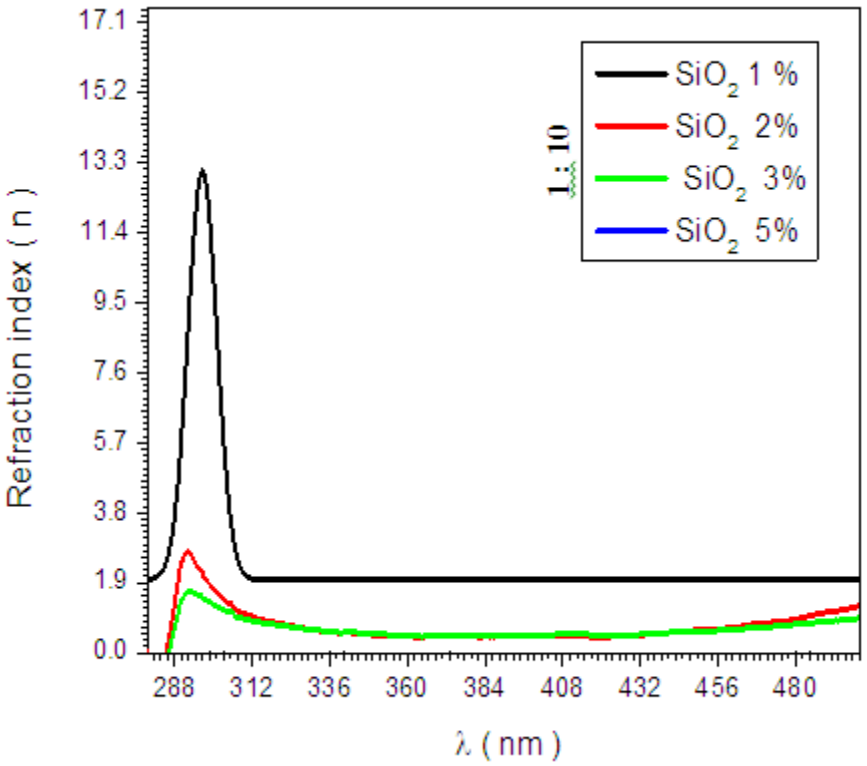

Figure 3.7: Refractive index

3.7 Particle size of Polyethylene /Silica nano composite:
Particles size for composites was calculated mathematically from UV spectrum by Surface Plasma Resonance.

Table 3.2: Particle size of Polyethylene/silica nano composite

Sample	Particle size
10%	13.6 nm
20%	23.26 nm
40%	35.8 nm
50%	41.99 nm

All size was between 13.6-41.99 nm indicating that the samples are nano composites.

3.8 Tensile Test:
The thin film sample was cuted by use dog bone cutter and the result as below

Table 3.4: Tensile Test

Sample	Thickness	Load
0.01 g of silica	0.5-0.7	4.9 kg
0.03 g of silica	0.15-0.19	5.01 kg
0.05 g of silica	0.17-0.16	5.4 kg

The samples are white milky, from the result it can be observed that samples are able to tensile by high load and as amount of silica increase the capable of sample to endurance of load is increase that mean silica is enhance the mechanical properties which widens the application of this filler.

4. CONCLUSIONS:

The properties of polyethylene are changes after addition of silica particles:

- Addition of nano silica particles could enhance the IR absorption performance of the composite.
- The composite is transparent in infrared region and opaque in some region of ultra violet.
- Introduction of small amount of silica in polyethylene matrices lead to substantial improvements of mechanical per forces of the resulting sample.
- The electrical properties are Near to conductor than insulator.
- Silica and polyethylene have identical transparencies.

5. RECOMMENDATION:

We recommend for expands studies in optical properties of polyethylene /silica composite to use in protect from ultra violet because it has high refractive index in UV region.

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