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Research Article

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Effect Adding Silica Powder on Mechanical Properties for Low Density Polyethylene (LDPE)

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Abstract In this study, the mechanical properties of low density polyethylene (LDPE) that plant in the petrochemicals laboratory were studied with different percentage of silica powder (0%, 1%, 1.5%, 2%, 2.5% and 3%) with grain size approximately to 30 µm. It has several variables study such as tensile strength parallel to the surface (σ) in a three-point hook area and the area of weakness and the blocks as well as elongation (ε) and showed the results obtained that adding silica powder was working to reduce the spaces between the polymeric chains reflecting the possibility of high-polymer to bear the stress hanging on it and be the degree of homogeneity between high polymer and fillers. The samples was characterized by Zwick / Roell device and determined maximum tensile strength together with testing maximum strain. And already found 3% was better weight percentage for silica grains to improving the hardness, equally 1% was better for flexibility.

Keywords Low density polyethylene, Fillers, Silica, Mechanical properties

1. Introduction

Polymers have been known since ancient times for being essentially natural and used in daily life such as cotton, silk, rubber and other natural materials, [1] but the advent of this science occurred after the 1930s. The rapid development of technology in modern technology The last of the last century to the development of different new materials with unique characteristics of the most important polymers, and polymers today is one of the most important materials used in medical applications, military, engineering and agricultural [2].

A number of different factors (size of fillings, their organic nature, their concentration and the nature of overlapping with the polymer matrix as well as their chemical composition) play an important role in determining the physical properties of polymer composites [3-5].

The objective of this study is the manufacture of overlapping polymers of low density polyethylene (LDPE) and silica powder.

2. Experimental Side

2.1. Original material

In this study low density polyethylene produced by the General Company for Petrochemical Industries (Basra-Iraq) was used in the form of powder. Table (1) illustrates some of the properties of this pure polymer used in this research.

Table 1: Some properties of polyethylene and low density used in research

Property	**LDPE**
Trade Name	Scpilex (463)
Density (g/cm^3)	0.921-0.924
MeltIndex (g/10min)	0.28-0.38

2.2. Fillers

Silicon dioxide, also known as silica (from the Latin *silex*), is a chemical compound that is an oxide of silicon with the chemical formula SiO_2. It has been known since ancient times. Silica is most commonly found in nature as quartz, as well as in various living organisms [2,6]. In many parts of the world, silica is the major constituent of sand. Silica is one of the most complex and most abundant families of materials, existing both as several minerals and being produced synthetically. Notable examples include fused quartz, crystal, fumed silica, silica gel, and aerogels. Applications range from structural materials to microelectronics to components used in the food industry.

2.3. Preparing the samples

The samples are manufactured using the Mixer and Extruder device, which is supplied by the US company Haake at a temperature of (160° C) by adding the specified weight ratios. The mixture is then recycled at 50 cycles per minute and for 10min. The largest quantity can be mixed with this machine. (45-60) gm depending on the density, after the mixing process, the mixture is compressed using the hydraulic piston and the factory inside the diameter and equipped with a cooling system and two systems for heating and under temperature (175oC) and pressure (5tan) and for (3min) and then raise the pressure to (15) Tan) for 10 min.

2.4. Cutting the sample

The (20x20 cm) sample was pulled off to the cutter where the Automatic Hollow Diepunch-code 6050/000 is cut and equipped by the Italian CEAST Company to obtain models for thickness measurements (2.4 mm) Shown in Figure (1).

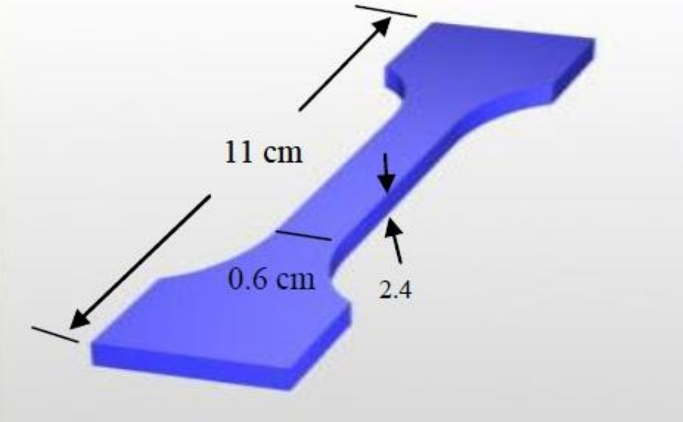

Figure 1: The model used to measure tensile strength

2.5. The measurements

The German Tensile was used to test the models by measuring tensile strength and compliance. The models were examined under ASTMD638 (1977) [7] , this device recorded the stress-bending curves of all models and the engineering tensile strength was calculated σ_M according to equation(1) as well as the engineering and true tensile strain (ϵ_B and ϵ_t) by using equation (2,3).

$\sigma_M = F / A$ (N/mm^2) (engineering tensile stress .... (1)

$\epsilon_B = \Delta L/L = (L-L_0)/L$ (engineering tensile strain) .... (2)

$\epsilon_t = \delta L/L$ (increment tensile strain)

$\epsilon_t = \int_{L0}^{L} \delta\epsilon = \int_{L0}^{L} \delta L/L = \ln (L/L_0) = \ln (1+ \epsilon_B)$ true strain ....(3)

Where F = the force of the pieces (N) and A = the area of the sample section (mm^2).

According to the YONG model of models using the stress-bending curves according to the following relationship:

(Young's modulus) Y = stress/strain.

3. Results and Discussion

Figure(2) shows the relationship between the parallel force acting on the surface with strain at different percentage of the additive concentration, where we observe the obvious effect of the addition on the hardening of the polymer where the tensile strength at 3% (12.2 Mpa) and it was at the lowest at 1% (10.6 Mpa), as well as the strain was the best (181.9%) at 1.5% concentration and the lowest was at 3% (18%). Figure (3) shows the relation between tensile strength vertical on the surface with different percentage of the additive concentration . Figure(4) shows variation of the strain with different percentage of the additive concentration.

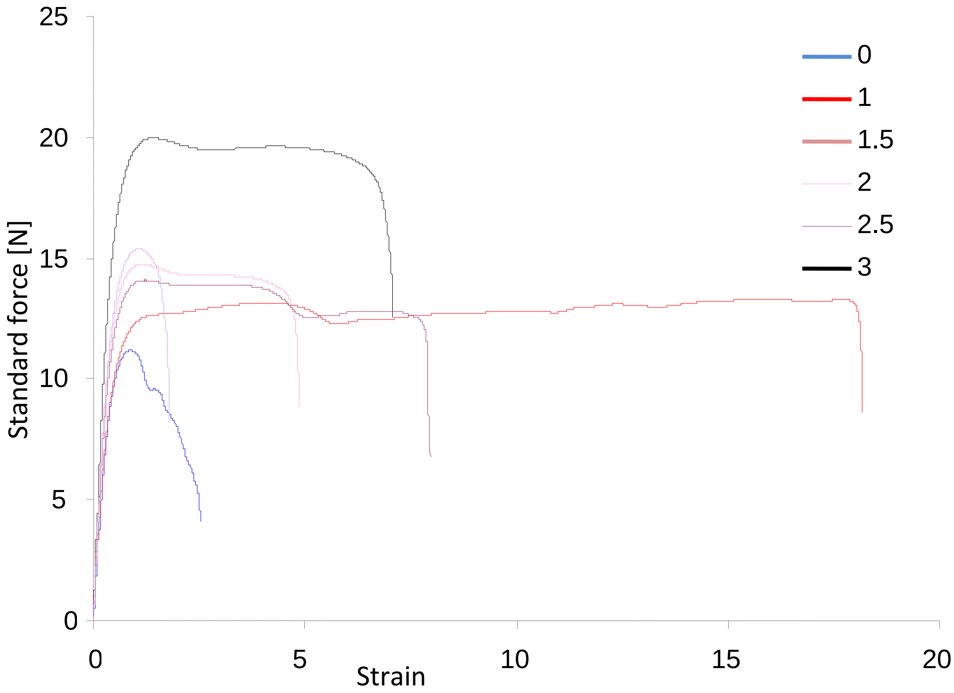

Figure 2: Variation of strain as a function of the force with different additive percentage of silica powder to LDPE

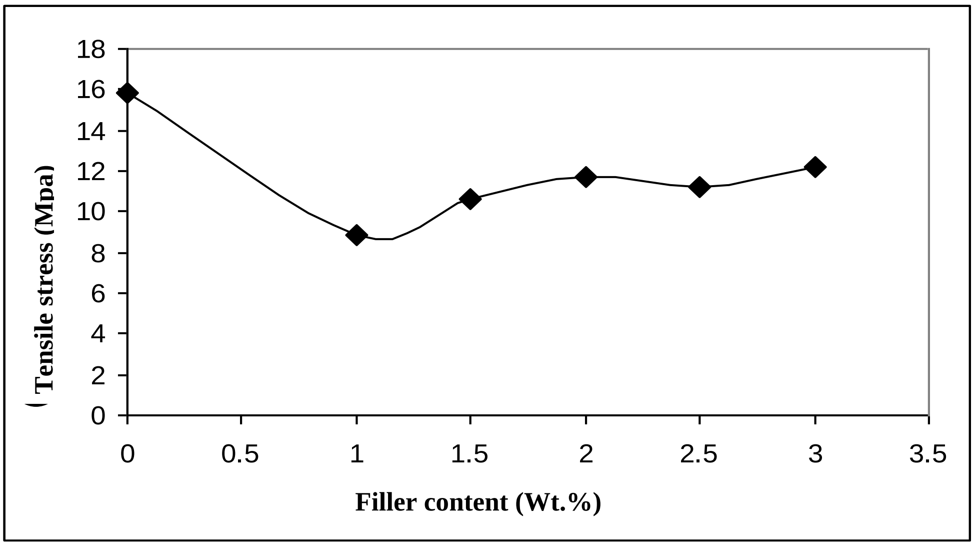

Figure 3: The relation between vertical tensile stress with different additive presentations of silica powder

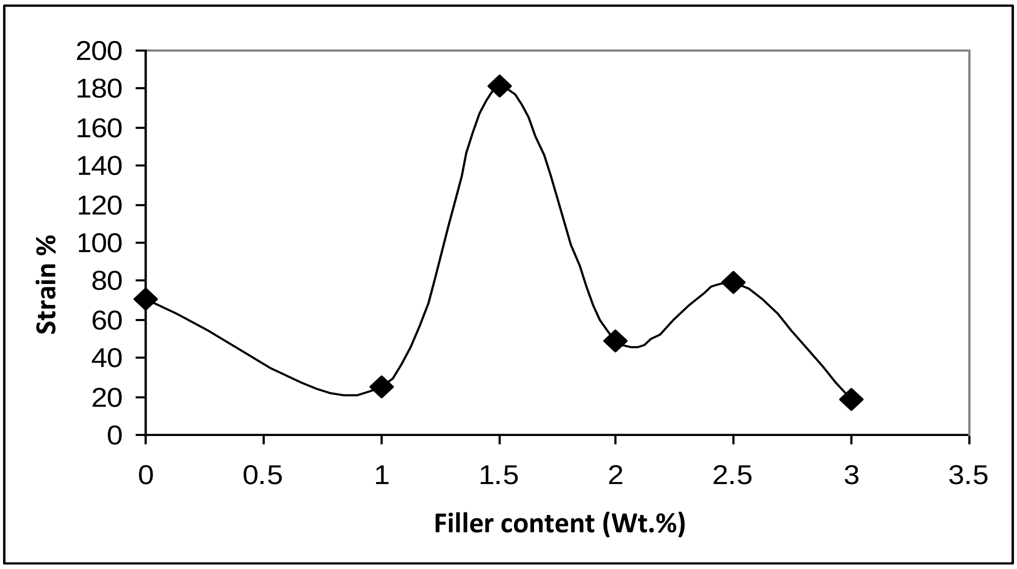

Figure 4: Variation of the strain with different percentage of the additive concentration

Table 2: Mechanical properties for (LDPE) polymer with different additive presentations of silica powder

Filler content (wt.%)	σ_M (MPa)	ε_B	ε_t	Young modulus (Mpa)
0	15.8	0.709	0.536	420.4
1	8.87	0.253	0.226	557.3
1.5	10.6	1.819	1.036	108.4
2	11.2	0.796	0.586	252.6
2.5	11.7	0.486	0.396	458
3	12.2	0.18	0.166	1280

Measuring tensile toughness U_T can be considered as the area under the entire stress- strain curve which indicates the ability of the material to absorb energy or the total amount of work done per unit volume to fracture as shows in equation below:

$$\text{Work per volume} = \int_0^{\varepsilon} E\, \varepsilon\, d\varepsilon = E\, \varepsilon_B^2 / 2$$

Table 3: The toughness for LDPE polymer with different percentage for filler content

Elastic energy = $E\, \varepsilon_B^2/2$

Filler Content (wt.%)	U_T (Mpa)
0	105.66
1	17.84
1.5	179.33
2	80.02
2.5	57.28
3	20.74

Table 3: Toughness (UT) for (LDPE) polymer with different additive presentations of silica powder

Filler Content (wt. %)	U_T (Mpa)
0	105.66
1	17.84
1.5	179.33
2	80.02
2.5	57.28
3	20.74

4. Conclusion

We conclude that the addition of silica powder to low density polyethylene has a significant impact on mechanical properties And already found 3% was better weight percentage for silica powder to improving mechanical properties such as hardness ,strong, and brittle, the uniformity of the hardness of the polymer due to the homogeneous distribution of silica inside the polymer chain which fills the blanks between the polymer chains that's reason to exhibit long elastic region, equally 1% was better for flexibility that polymer was exhibit more plasticity with high plastic fracture strain and consequently after moderate elastic region there is long plastic region .

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