Journal of Fuzzy Systems and Control, Vol. 2, No 3, 2024
ISSN: 2986-6537, DOI: 10.59247/jfsc.v2i3.218

Characterization of Tensile Strength and Degradation of Polymer Blend Reinforced with Black Carbone

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***Abstract*—Samples of polymeric sheets of high-specification polycarbonate, which is characterized by high resistance in its pure form, were prepared and combined with low-density polyethylene sheets, which show low specifications relative to polycarbonate in equal proportions of (PC-%LDPE) (100%,80% 50%,20%). The preparation of the layered polymer mixtures was carried out using the micro-mixing method using an extruder. The effect of the binary polymer blends (PC-%LDPE) was demonstrated in increasing the maximum strength, and the effectiveness of advanced mechanical properties. The degradation of polymeric sets had little effect with the reinforcement of 20% of black carbon powder compared to other ratios.**

Keywords*—Polymer Blends, Extruder, Black Carbon Powder, Tensile Strength, Degradation Rate

I. Introduction

Polymeric materials have always been and still are more common materials for industrial uses and applications than the usual conventional materials because they have appropriate properties according to the labor market and the applications used in our daily lives [1]. The ease of use has made polymers preferred materials compared to other commonly applied materials such as metals, ceramics, and others, where technologies appeared a long time ago [2]. New science in polymer technology. These polymers must perform under existing conditions such that they require a specific application [3].

The approach used to manufacture polymers as mixtures is considered an important method in the production of manufacturing industries for products with high resistances and low economic efficiency. The practice of polymer mixtures also. The mixture between the polymeric materials is mixed properties that change the properties of the primary material in any proportion, so it is taken into account that the materials have a physical affinity to form combinations with flowing patterns in properties and not random, which makes the mixing process ineffective [4].

Some studies have found that the materials are sometimes ineffective when mixed, as there is a difference in the bond strengths between the polymer chains, which weakens the mechanical properties in optimal cases, as was found in the study of Hafez et al., where high-density polyethylene was used once and low-density polyethylene again with polypropylene, and a comparative study. Between them, the results of the parameters for elasticity, shear, and tensile were different [5]. Moreover, SEM results regarding the polymeric mixture showed that 20% HDPE: 80% PP and 20% LDPE: 80% PP are immiscible mixtures [6]. Many researchers have also studied the mixing of more than one type of polymers, such as in (PS), which are (PS:%LDPE), (PS:%PP), and (PS:%PMMA), which are mixed at high temperatures by means of a mechanical extruder, which performs the melting and physical mixing. They also found out the results of the strength of the effect of mixing time and speed for the matrix used (LDPE, PP, PMMA) [7].

The aim of the current research is to prepare two sets of binary polymer mixtures represented by (PC-%LDPE) with different weight percentages and compare the mechanical properties for use in the manufacture of water, food, and medicine containers and compare the amount of dissolution with different types of solutions.

II. Expermainatal part

A. The Used Materials

1. Polycarbonate

Makrolon 2800, Bayer AG, Leverkusen provided by the general company of chemical industries) has a wide range of applications and usage because it is characterized by transparency and, clearly, thermal resistance as a result of its structure even to 130ºC. elastic stability up to 150ºC without any stabilizer to elasticity. Fig. 1 polycarbonate inner structure and application [8].

Fig. 1. Polycarbonate inner structure and application

2. Low-density Polyethylene

Applications: These materials are used as cups, bags, tank linings, and compressed gas pipes. Its chemical specifications include resistance to factors affecting structural structures. It is also a good chemical and does not decompose easily with water. However, its economic specifications include low cost. As for the mechanical properties: tensile strength - coefficient of strain expansion, which is relatively low for the rest of the polymers. Material resistance Low-density polyethylene polymer is considered to have medium industrial advantages, but it enriches the manufacturing and application factors and achieves abundant industrial revenues as it exists in nature The changes caused by high temperatures on polymeric chains allow this type of polymer to have many variable formations, especially in the case of the presence of additives such as fiber-reinforced materials or nan powders. Fig. 2 Polyethylene low density, inner structure, applications [9].

Fig. 2. Polyethylene low density, inner structure, applications

B. Carbon black

Carbon black powder is considered a polymeric material that is used in various industrial applications that may lead to incomplete combustion results for organic materials or petroleum products. Such powders are characterized by a small granular size of up to 100 microns, which gives them a high surface area, as they are characterized by high surface tension and strong bonding between the particles are very high. Fig. 3 Carbon black powder [10].

Fig. 3. Black carbon powder

C. Samples Manufacturing

The manufacture of samples from polymeric materials using the twin-screw extruder shown in Fig. 4 produces thin ribbon-shaped polymer sheets consisting of a specific mixture, and the weights are calculated. The drawn weights were also determined according to the volumetric proportions chosen from polycarbonate and low-density polyethylene polymers, as shown in Table 1. Blend of PC- LDPE Mixed using Machine (General Company for Chemical Industries - Baghdad)) to form long strips of polymer mixtures (approximately 1.5 mm thick), after which stainless steel metal molds were used according to the tests that must be examined, such as in tensile and hardness tests and fluid analysis according to American specifications for testing materials (ASTM).

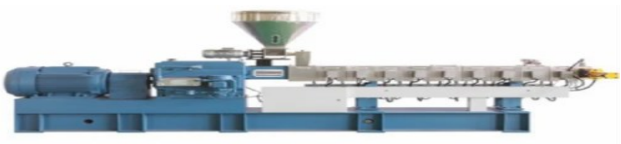

Fig. 4. Scraw extruder produces thin layer sheets of blending polymers

D. Mechanical Tests

The tensile test specimen was prepared according to ASTM standard D638-87 [11] Fig. 5 shows a polymer sample of tensile test. Using a programmed tensile testing device linked to a computer, which applies a load force of approximately (1 KN) with a speed of the tensile device (20 mm/min). As shown in Fig. 6, the device is internationally called 1195 by the manufacturer (Instron). The model used is placed between the jaws of the device and tied tightly. A diagram ($P - \Delta l$) is obtained. Through it, the (stress-strain) diagram ($\sigma - \varepsilon$) is calculated through equations included and programmed in the device, through which the maximum strength (UTS) of the samples used as the subject of the study is calculated [12].

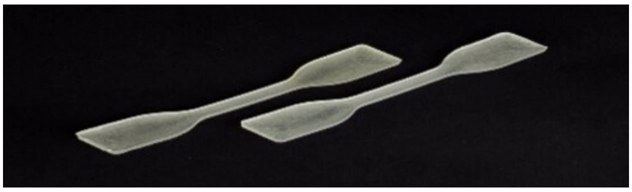

Fig. 5. Polymer sample of tensile test

Fig. 6. Tensile machine Model 1195 manufactured by (Instron)

Table 1. Polymer blend weight percentage

Polymer blends	Weight Percentages				
PC-LDPE	100:0	80:20	50:50	60:40	20:80
PC-LDPE (20%carbone powder)	100:0	80: 20	50:50	60:40	20:80

Table 2. Extruder parameter

Polymer system speed (rpm)	Zone temperature			Screw
	Zone-1	Zone-2	Zone-3	
PC	220	220	220	36
LDPE	185	185	185	36
PC/ LDPE	155	155	155	36

III. RESULTS AND DISCUSSION

A. Tensile Strength Results

Through the tests that were carried out, including the mechanical properties, which included testing the tensile, hardness, and degradation, which was done using American testing specifications, the results were as follows:

Tensile strength, the results showed that the high plasticity of the low-density polyethylene polymer is greater than the plasticity of polycarbonate, which showed high strength, and it depends on the nature of each polymer. It is interesting that the blending or mixing is physical, without the molecules interfering with each other, as higher percentages of polycarbonate showed higher tensile strengths compared to low-density polyethylene as shown in Fig. 7 polycarbonate and poly ethylene low density under test stage arrived to ultimate tensile strength [13].

Fig. 8 shows the behavior of blends of PC/LDPE times and the same blends reinforced with black Carbone (5%,10%,15%,20%), and Fig. 9 shows the improvement of ultimate tensile strength of blending polymers reinforcing with black carbon powder, the best ratio 20% and that give the polymeric blending higher strength as illustrated in Fig. 9 because the nature of carbon powder due to dispersed type of carbon powder which strengthens the polymeric blends, and the physical bonding is more intertwined as agreement with other researcher.

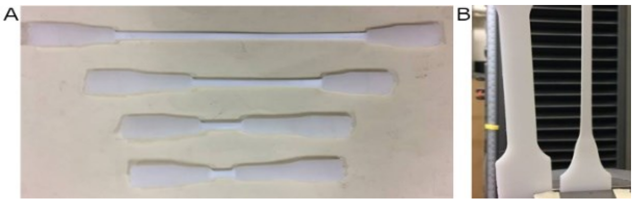

Fig. 7. Polycarbonate and polyethylene low density under test stage

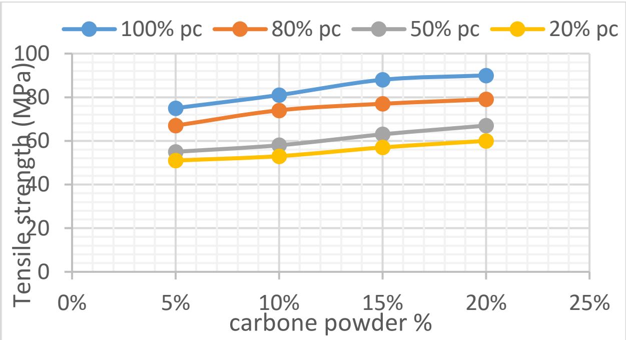

Fig. 8. Relationship between tensile strength and Carbone black ratio

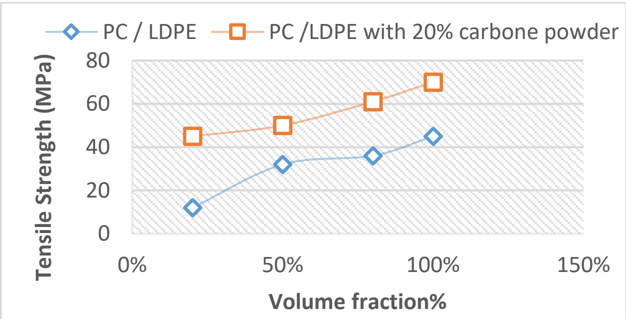

Fig. 9. Relationship between tensile strength with volume ratio of polymeric blending reinforcing with 20 % carbon powder

B. *Polymer Degradation Results:*

We note that the polymeric blend group was affected by water in little rate compared with pure polymer [14]-[20], so the blending increased the degradation resistances as shown in Fig. 10.

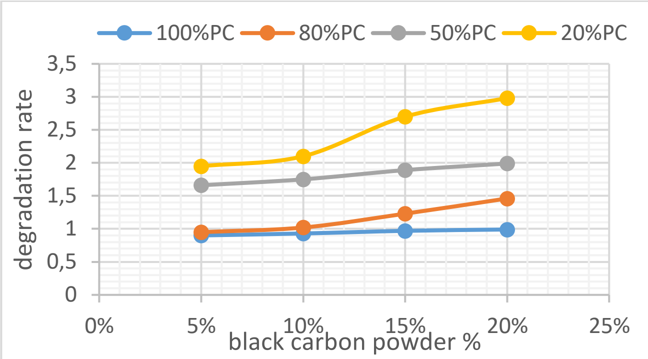

Fig. 10. Relationship between degradation rate and Carbone black powder ratio

IV. Conclusion

Ultimate tensile strength of polymeric blends improvement with 20% black carbon powder. Degradation resistances of water decreased with polymeric blends reinforcing with Blending mixing temp. Extruder using polymeric materials according to types of polymers with black carbon powder.

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