

## Study The Mechanical Properties of LDPE and Its Composites

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### Abstract:

The use of wood flour (W.F.) and pragmitis communis (P.C.) as a filler in low density polyethylene (LDPE) was studied in several concentration 10-50%w/w . The mechanical properties of LDPE and its composites , tensile strength at 10-20% w/w concentration increased while for other filler ratio decreased . The elongation of these composites decreased with increase the filler percent , Young modulus and hardness increase while impact strength and fracture energy were decrease with the increased of filler percent .

### الملخص:

تم مزج البولي أثيلين واطى الكثافة مع نشارة الخشب وقصب الأهوار كمائنات لتكوين مزائج بوليمرية بنسب 10-50%w/w ودرست الخواص الميكانيكية للبوليمر وللمزائج البوليمرية المحضرة . أوضحت الدراسة زيادة قوة الشد عند تركيز 10-20% ونقصانها عند النسب الأخرى ، ونقصان الاستطالة للمزائج البوليمرية المحضرة بزيادة نسبة المالى المضاف ووجدت زيادة في معامل يونك والصلادة بينما قلت قوة التصادم وطاقة الكسر بزيادة نسب المالى المضاف للمزائج البوليمرية المحضرة .

### Introduction:

Polyethylene is classified to three types low density (LDPE) which is usually branched chain, medium density polyethylene (MDPE) that is hexene copolymer and high density polyethylene (HDPE) which is predominantly linear chain , find important applications in molding , blow objects and electrical insulation[1].Probably one of the most important properties of polyethylene its mechanical properties , generally the mechanical performance of a thermoplastic depends upon the molecular structure ( largely established during polymerization ) and the special arrangement of molecules ( established by the fabrication process) [2]. Molecular structure includes morphology , that is the organization and orientation of folded chain lamellae in crystalline polymer which has an important influence on tensile strength , toughness and elongation at break [3,4] .Wood fibers are the basic raw material for the paper making industry . Among the many varieties of wood species a violable , soft wood pulp dominate in the paper production . Other wood species such as aspen and birch are available in high volume are not fully exploited[5].

The use of cellulosic fiber in thermoset and thermoplastic polymer has been limited as a result of problems in dispersing the filler in polymer matrix [6]. Such materials are described in Raj et al [7] study the mechanical properties of HDPE with cellulosic fibers. Goettler in U.S. patent has shown that the adhesion of discontinuous cellulose fibers to a matrix of vinyl chloride polymer can be improved by incorporating with bonding agent which is a cyclic trimer of toluene diisocyanate [8], Raj et al[9] use of wood flour as a filler in MDPE , the wood fiber and cellulose effective on mechanical properties and given improved

properties . Study the mechanical properties of MDPE reinforced with new lignocellulose fiber , calcium carbonate and fiber glass . Hassan et al were studied the mechanical properties of LDPE which reinforced with lignin and cellulose acetate [11] . Lyu [12] was studied the improving mechanical properties of LDPE and its composites.

The present study emphasizes the analysis of some mechanical properties for LDPE and its composites by using the wood flour and *pragmitis communis* (p.c.) as a filler with the percent 10-50% w/w .

#### Materials:

- 1- Low density polyethylene (LDPE) grade 463 was supplied by state company for petrochemical industries .
- 2- Wood flour from the wood tree .
- 3- *Pragmits communis* from the *pragmits* southern of Iraq .

#### Experimental:

Total of 60 gm were mixing by rheomix 600 which attached to Haake 90 rheochorder torque rheometer . Total time of mixing 15 min. , r.p.m. is 64 and temperature 175C°, percent of fillers in LDPE are 10-50% w/w . All samples were compression molding in a laboratory press P.H.I. at 160-175 C° under 5 ton for 3 min. and then raise the compression to 15 ton for 6 min. . These samples were cut by automatic hollow die punch to dumbbell shape . Mechanical measurements were made on an Instron tester (model 1193) at room temperature . Crosshead speed is 50 mm/min. and chart speed is 10mm/min. .

#### Results and Discussion:

The mechanical properties of polyethylene were depended on its chemical composition as well as its microstructure . Since the mechanical properties of polyethylene depends largely on its crystallinity content which decrease when branches are introduced along the polymer chain , the amount and type of branching can be controlled by adjusting the crystallinity and the density of polyethylene [13,14].

In this paper we are studying the mechanical properties of LDPE by mixing with 10-50% w/w of wood flour and *pragmitis communis* as fillers , fig. (1) shown LDPE has high value from tensile strength 8.7 MPa at 10-20% w/w of fillers because the long chain branching which lead to increase the free volume and decrease the interaction between the chain [15-16] , at 30-50% w/w the tensile strength decreasing with the increase of filler percent (8.4-8) for W.F. and (8.3-7.85) M.Pa for P.C. Fig.(2) shown that the elongation of LDPE (130%) greater than the elongation of its composites , when the addition of fillers the elongation was decreased with the increases of fillers ; at 10% is 110% w/w for W.F. and 114% for P.C. The continues of decreasing with increase of fillers percent because the decreasing of function groups in the fillers [11] and the elongation of polymer with fillers less than from polymer matrix[10,17] .

Fig. (3) show Young modulus of LDPE is less than of its composites 52 MPa. , after addition of fillers show Young modulus increase with the increasing of filler ratio 184.7,171 to 50 % w/w of W.F. & P.C. Fig. (4) show the hardness of LDPE and its composites , LDPE hardness 55.2 less than the composites because

the branching of chains ; 66, 69 for 50% w/w of W.F. & P.C. as the decreasing of free volumes between the polymer chains with increasing reaction of polymer with fillers lead to increase in hardness [18-19] . Impact strength fig.(5) shown that decrease with increasing fillers concentration because of the nature of fillers .The distribution of polymer matrix lead to decrease the impact strength of that composites [10,20] . The fracture energy decreased rapidly as a filler percent increased in samples fig.(6) . The lower fracture energy values of the wood flour composites may be due to the relative shortness of the wood fiber , which reduces the effective loading ability of the fiber in the matrix , in P.C. the fracture energy decreased with the increasing of fillers concentration too , because of the wood fibers poorer efficiency of stress transfer than *pragmitis communis* [17,21-22] .

### CONCLUSION:

Tensile strength , the elongation , impact strength and fracture energy were decreased with the increasing of filler ratio . While Young modulus and hardness were increased with increasing that percent .

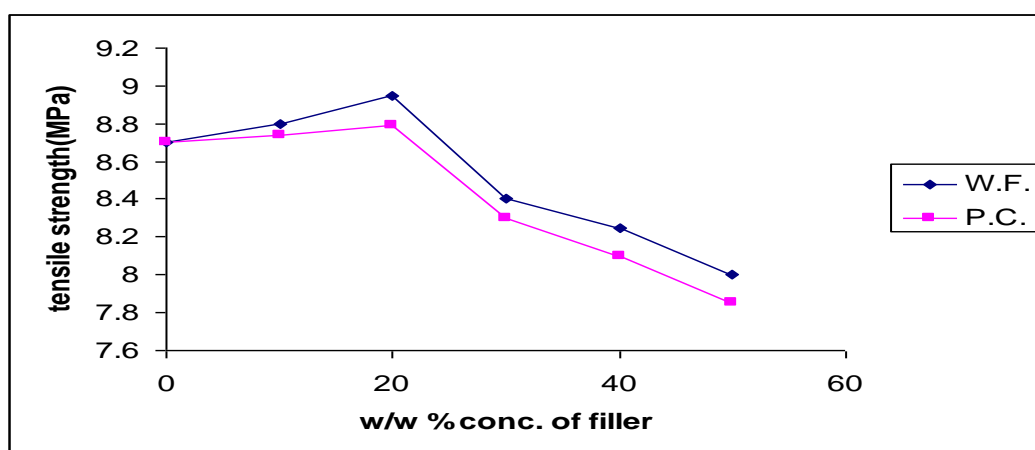


Fig.(1) Effect of fillers on tensile strength of LDPE

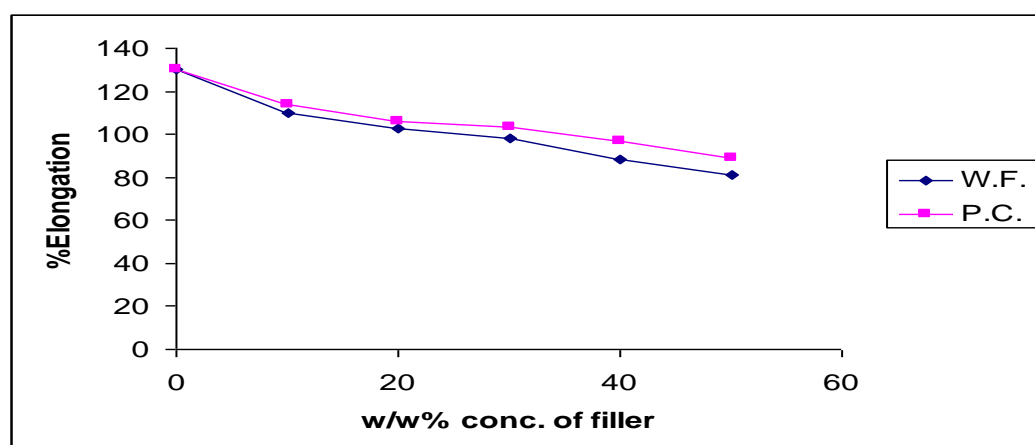
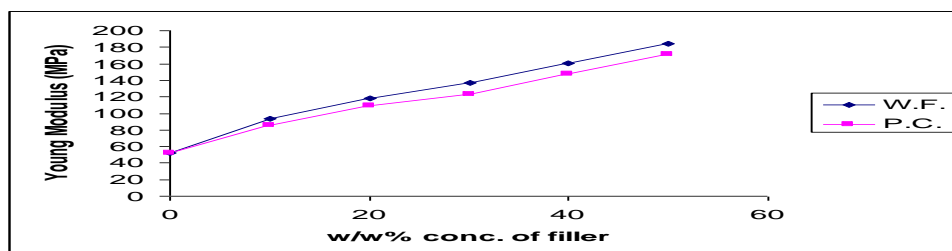
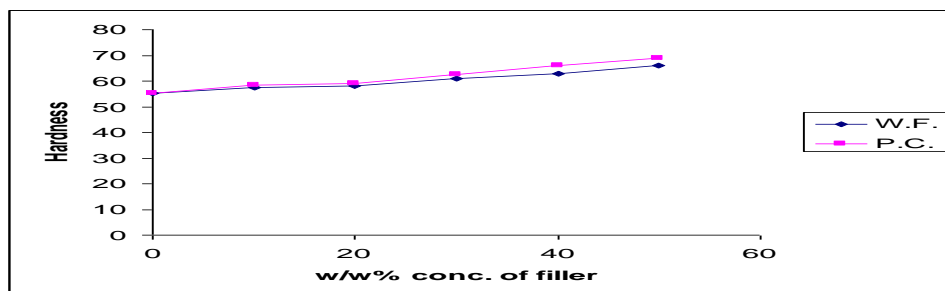


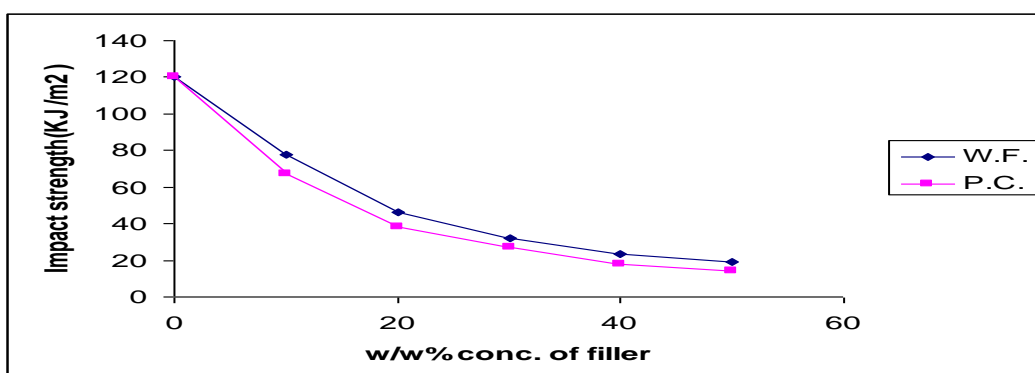
Fig.(2) Effect of fillers on elongation of LDPE



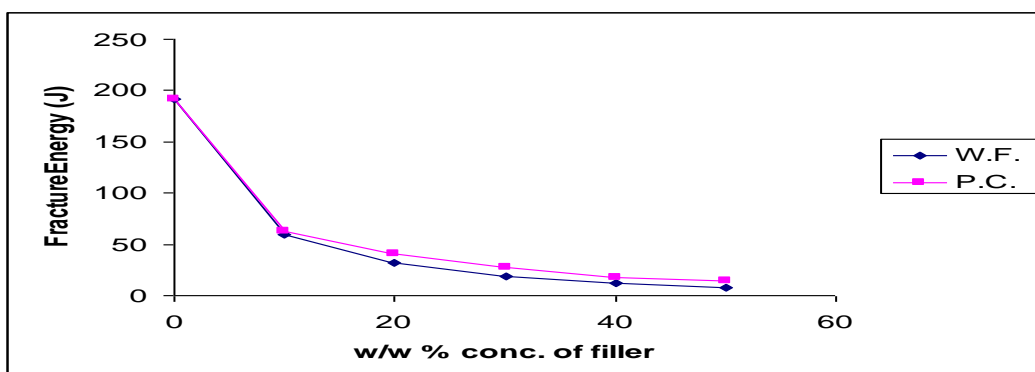
**Fig.(3) Effect of fillers on Young Modulus of LDPE**



**Fig.(4) Effect of fillers on Hardness of LDPE**



**Fig.(5) Effect of fillers on Impact strength of LDPE**



**Fig.(6) Effect of fillers on Fracture energy of LDPE**

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