

## **Investigation of Some Mechanical Properties of Ternary Polymer Blends Based on Polypropylene**

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**ABSTRACT:** One of the main problems that occur when preparing a polymer blend is the incompatibility between its components and this weakens the mechanical properties. So, in this work, use maleic anhydride grafted polypropylene (PP-g-MA) within limited proportions (1%) as compatibilizing agent to prepared two sets of polymeric blends by using twin-screw extruder. The first group contained (polypropylene (PP): X%poly methyl methacrylate (PMMA):1% (PP-g-MA)), whereas the second group consists of (polypropylene (PP): X% Ultra high molecular weight polyethylene (UHMWPE):1% (PP-g-MA)) with the ratios of secondary materials (PMMA and UHMWPE) in each group of polymer blends are (5%, 10% 15% and 20%). The results showed that the polymeric blends (PP: X%PMMA: 1%(PP-g-MA)) got higher values in tensile strength, elasticity modulus and hardness values, whereas, the polymeric blends (PP: X%UHMWPE: 1%(PP-g-MA)), got higher values in compressive strength. In this work, it was concluded that, the highest values of tensile strength, elasticity modulus, shore D hardness and compressive strength are 30 MPa, 0.55 GPa, 67.6 and 162.17 MPa respectively. As well as, the adding 1%(PP-g-MA) for both groups of the polymeric blends, it was act as an agent to effective compatibility between constituent of polymer blend, and the morphological analysis showed good compatibility between the components of polymeric blends.

**KEYWORDS:** Ternary polymer blends, PP, (PP-G-MA), UHMWPE, mechanical properties

### **INTRODUCTION**

At present, many of polymer blends contribute to fabricate a variety of polymeric materials to use for different applications, particularly in structural and medical applications, where they may combine the important characteristics of each blend component. Since none of the available polymers individually can meet all the required properties for a specific application. Miscible polymer blends are often preferred as compared with that have immiscible property. So, minimizing the interfacial tension and improving the adhesion between two phases usually attain satisfactory performance in immiscible blends. Compatibility of immiscible blends may be improved by adding a third component as compatibilizer agent (e.g., block or grafted copolymers) or by adding suitable functionalized polymers capable of enhancing specific interactions and chemical reactions in reactive systems. Consequently, a new production technology has been developed for improving some properties, such as thermal and mechanical stability depending on the blending of a polymer with another component. This kind of strategy allows the limitation of the cost in comparison with the synthesis of new polymeric materials. Controlling the morphological structures of blending polymers is the key point of the future development of this type of materials [1].

Hou, and Zhao prepared grafted polypropylene (PP) by one step free-radical melt grafting method in a single-screw extruder, and through FTIR and MFR tests. It was found that the addition of St to the melt grafting system as a co-monomer could significantly enhance the grafting degree of MMA onto PP and reduce the degradation of PP matrix respectively [2]. Diop et al. studied the blending effect to overcome the viscosity problem of UHMWPE with addition HDPE via solid-state shear pulverization (SSSP) method instead of a melting process due to the poor dispersion. Results showed that blending via SSSP leads to dramatic improvements in impact compared with the other methods of preparation [3]. Other studies in the field of blending have been established by a group of researchers who prepared three types of blends with the same matrix material (PS), which include (PS: X%LDPE), (PS: X%PP) and (PS: X%PMMA) that were prepared by twin-screw extruder. Results manifested that the impact strength of the prepared polymer blends increases with the increase of the secondary materials (LDPE, PP and PMMA) content in the blends [4].

Recently, Amandine studied the interaction between nylon 6, polypropylene and poly lactic acid. To improve

the compatibility between these immiscible polymers, a reactive compatibilization (maleic anhydride grafted polypropylene (PP-g-MA)) was used. All the blends were prepared in the melt method by using twin-screw extruder. Structures morphology of binary and ternary blends were investigated by using scanning electron microscopy (SEM) and atomic force microscopy (AFM). The PP-g-MA grafting process was observed to have a dramatic effect on the compatibility of both the binary and ternary blends [5]. Another study was done by improving the mechanical properties of the binary polymer blends [(HDPE: PVC), (HDPE: PP) and (HDPE: SAN)] that were prepared by using the friction stir processing method. The researchers indicated the marked increase in flexural strength, and fracture toughness properties and highest values for the polymer blends (HDPE: 15%PP) and (HDPE: 15 % PVC). As well, it was indicated that the prepared polymer blends have a high efficiency and without having free from any internal or external defects [6]. Alessia et al. investigated the effect of adding the polyethylene-grafted maleic anhydride (PE-g-MA) and a random copolymer of ethylene and glycidyl methacrylate as compatibilizers to modify the HDPE/PLA optimal blends. It was concluded that the blend, which contains equal amounts of HDPE and PLA, has a good balance between the amount of bio-derived charge and the acceptable mechanical properties [7]. Francesco et al., studied the degree of compatibilization of PA6/PP blends by using small amounts of photo-oxidized PP. It was found that the isotropic samples showed significant enhancements of the tensile properties upon adding the photo-oxidized PP [8].

The aim of this work is to improve the compatibility between two types of polymer blends (PP: X%PMMA) and (PP: X%UHMWPE) by adding a third component of (polypropylene-grafted-maleic anhydride (PP-g-MA)) within limited proportions (1%) to acts as the compatibilizer agent. As well, study the effect of adding different ratios of secondary materials (PMMA and UHMWPE) on some mechanical properties that are suitable for structural applications.

## MATERIALS AND METHODS

### Materials

Materials used in this work are polypropylene (PP) in a pellet form grade (500P), provided from Sabic Company, PMMA material supplied from China (Xiamen Keyuan Plastic Co., Ltd.) has density (1.18- 1.19 Kg/m<sup>3</sup>) and melt flow rate (2-3 g/10 min), ultra-high molecular weight polyethylene (UHMWPE) supplied from China in a pellet form have specific gravity (0.9 g/m<sup>3</sup>) and melt flow rate (2 g/10 min) and (polypropylene-grafted-maleic anhydride (PP-g-MA)) provided from China in a powder form with a melt temperature of 150 °C.

### Experimental procedures

In this work, two groups of ternary polymeric blends were prepared by melt-mixing technique using twin-screw extruder. The first group contains (PP: X% PMMA: 1% (PP-g-MA)), and the second group consists of (PP: X% UHMWPE: 1% (PP-g-MA)). The ratios of secondary materials (PMMA and UHMWPE) in each group are (5%, 10% 15% and 20%). Blends were mixed based on the selected ratios shown in Table (1) The extrusion parameters are shown in Table (2), the obtained samples were as plates with thickness 5 mm, and the prepared plates were cut according to the international specifications of each test.

**Table 1.** The weight percentages for components of polymeric blends.

Polymer blends	Weight Percentages			
	(100%)			
Neat PP				
PP: UHMWPE: (PP-g-MA)	94: 5: 1	89: 10:1	84: 15: 1	79: 20: 1
PP: PMMA: (PP-g-MA)	94: 5: 1	89: 10:1	84: 15: 1	79: 20: 1

**Table 2.** Extrusion parameters

Polymer systems	Temperature (°C)			Screw speed (rpm)
	Zone1	Zone 2	Zone 3	
Neat PP	190	200	210	45
PP: UHMWPE: (PP-g-MA)	190	200	210	45
PP: PMMA: (PP-g-MA)	195	205	210	45

## Mechanical and physical tests

The FTIR test was performed according to the international measurements (ASTM E1252) [9], by using Fourier infrared spectrometer manufactured by Bruker Optics Company type (TENSOR-27). The Infrared spectrum was used within a range of (400- 4000)  $\text{cm}^{-1}$ .

Tensile test specimens were prepared according to ASTM standard D638-87 [10]. The machine used (model WDW 200 E) made in China. The test was conducted at velocity of (2 mm/min) at ambient temperature, and tensile stress was applied till the failure of the sample.

Compression test specimens were prepared according to ASTM standard (D 695) [11]. The test was conducted at a velocity of (0.5 mm/min) at ambient temperature, by using machine (model WDW 200 E) made in China. The load was applied gradually to the longitudinally fixed sample, the increasing of the load continued until the failure of the specimen occurred.

Shore D was used to measure the hardness of samples, in this test, specimens having dimensions ( $10 \times 10 \times 5$ )  $\text{mm}^3$  were used. This test was carried out on a Durometer Shore D scale according to ASTM standard (D2240) [12]. To obtain a high accuracy in this test, the average of ten readings was taken in the different locations of each sample and taking into account that the samples are not subjected to any to mechanical vibrations during the test.

## RESULTS AND DISCUSSION

### Fourier transforms infrared spectroscopy (FTIR)

Fourier transformation Infrared spectrum (FTIR) was used to obtain a fully characteristic information about the chemical bonds and molecular structure for two groups of polymeric blends, the spectrum was run by applying the range of frequencies from (4000 - 400  $\text{cm}^{-1}$ ). Figure (1) shows the characteristics of FTIR spectrum for neat PP material, the bands observed at 2916.26 and 2837.48  $\text{cm}^{-1}$  confirms the presence of  $\text{CH}_2$  stretching band [13, 14]. The peak at 1454.64  $\text{cm}^{-1}$  confirm the presence of asymmetric in plane of  $\text{CH}_3$  bending and peaks at 1166.50  $\text{cm}^{-1}$  attributed to  $\text{CH}_3$  wagging, and the peaks at 997.42, 972.99 and 841.16  $\text{cm}^{-1}$  are attributed to  $\text{CH}_3$  rocking,  $\text{CH}_2$  rocking and C-C stretching, respectively, the infrared spectrum of neat PP in Figure (1) is quite similar to that reported by [14,15].

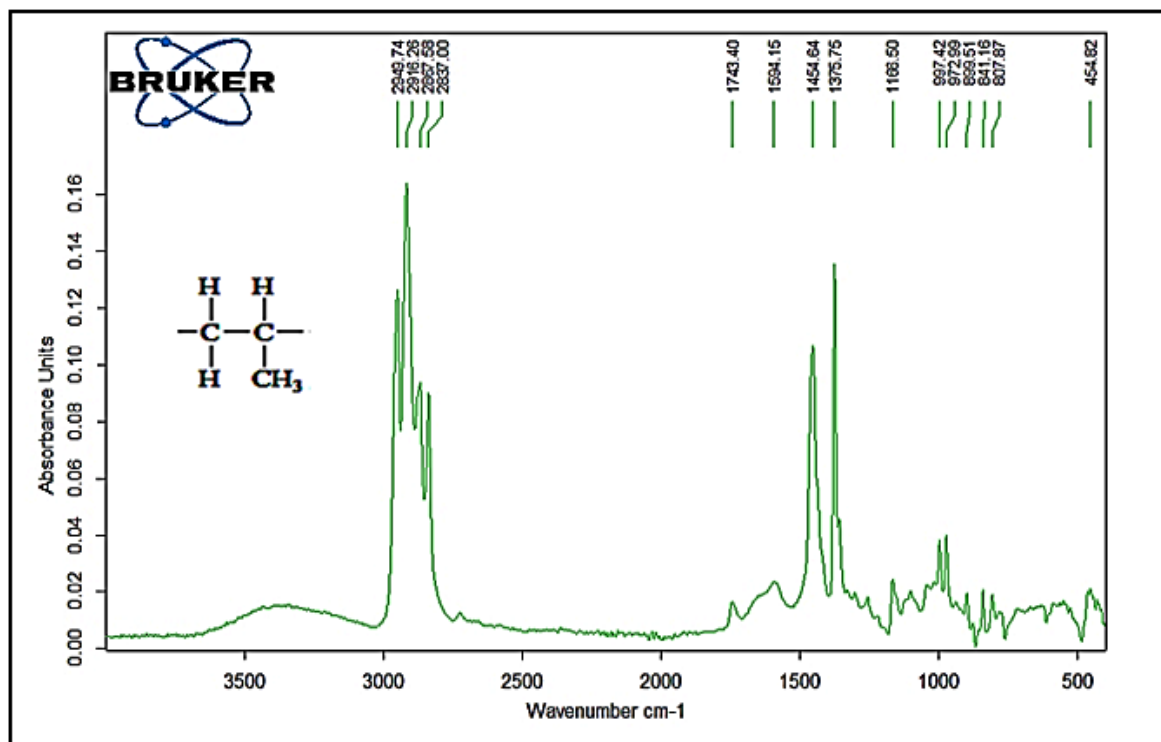
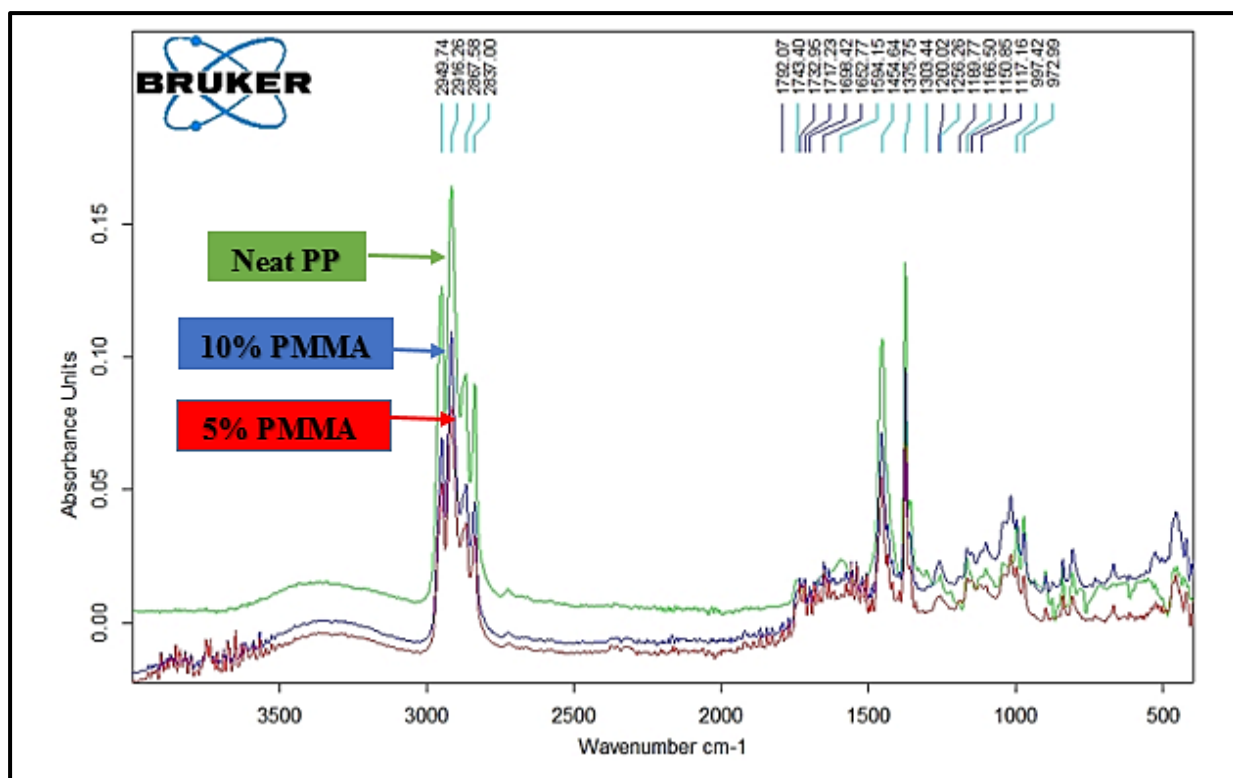


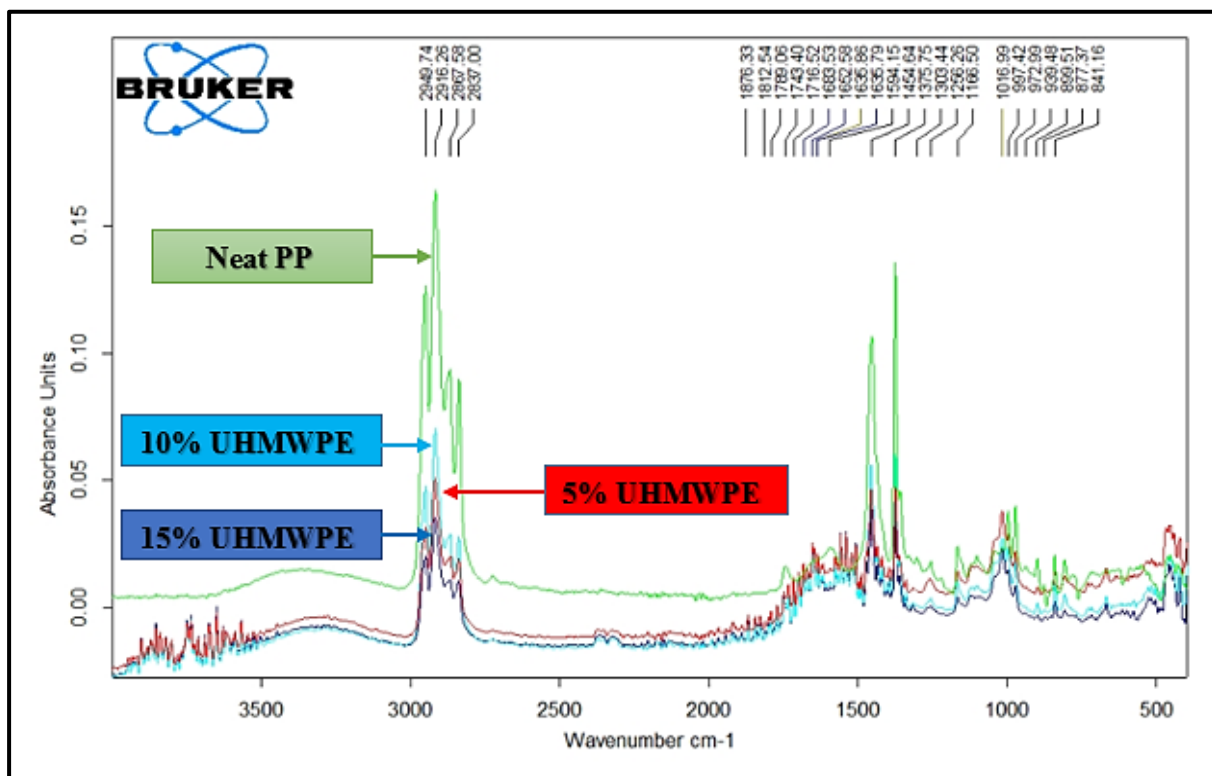
Figure 1. FTIR spectrum for neat polypropylene material

The FTIR spectra of polymers blends (PP: X%PMMA: 1 % (PP-g-MA)) with different ratios of PMMA (0, 5 and 10%) are shown in Figure (2). From this figure, it is observed that all the characteristics vibration bands of polypropylene (Figure 1) are presented in FTIR spectra of ternary polymer blend. Moreover, several peaks related to PMMA and (PP-g-MA) observed in all samples of these polymer blends, the main characteristic band related to PMMA was noticed at  $1733.04\text{ cm}^{-1}$ , which corresponds to C=O stretching band. The vibrations bands due to the deformation modes of  $\text{CH}_3$  groups appeared at ( $1456.88\text{ cm}^{-1}$ ),  $1454.64\text{ cm}^{-1}$ ) and ( $1375.75\text{ cm}^{-1}$ ). Medium bands at ( $1260.02\text{ cm}^{-1}$ ) and ( $1257.82\text{ cm}^{-1}$ ) correspond to C-O stretching modes [16]. The bands at ( $1190.17$  and  $1150.85\text{ cm}^{-1}$ ) correspond to  $\text{CH}_3$  wagging, and two bands at ( $1140.87\text{ cm}^{-1}$ ) are due to the  $\text{CH}_3$  twisting. In addition to that, from the infrared spectra of these polymer blends (PP: X%PMMA: 1 % (PP-g-MA)), no any other new peak or the shifts in peaks locations are observed, but there is a clear decrease in peak intensity with increasing PMMA content in the blend. This indicates the occurrence of physical bonds and the absence of any chemical reactions or cross linking that can occur as a result of the mixing process [17].



**Figure 2.** FTIR spectrum of polymeric blends (PP: X%PMMA: 1 % (PP-g-MA)) as a function of PMMA content in blend

The FTIR spectra of polymers blends (PP: X%UHMWPE: 1 % (PP-g-MA)) with different ratios of UHMWPE (0, 5, 10 and 15%) are shown in Figure (3). From this figure, it is observed that all the characteristics vibration bands of polypropylene (figure 1) are presented in FTIR spectra of ternary polymer blend (PP: X%UHMWPE :1%(PP-g-MA)). Moreover, several peaks related to UHMWPE and (PP-g-MA) are observed in all samples of these polymer blends, on the other hand, no any other new peaks or the shifts in peaks locations are noted, but there is a clear decrease in the peak intensity with increasing UHMWPE content in the blend.

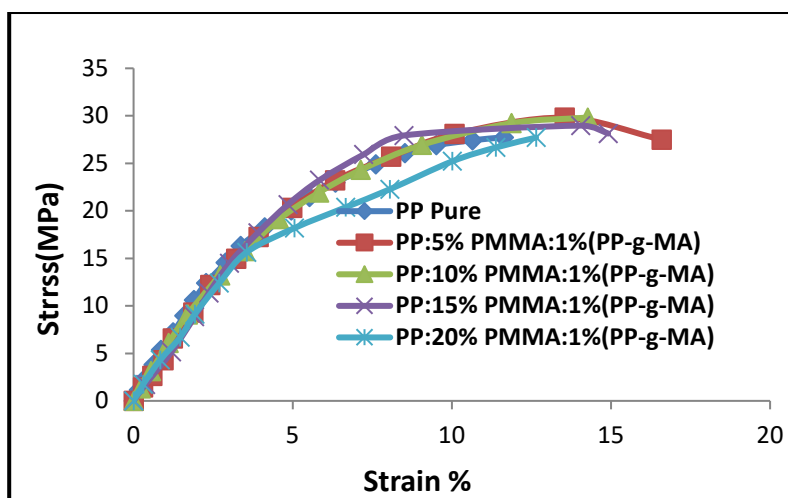


**Figure 3.** FTIR spectra of polymeric blends (PP:X% UHMWPE:1% (PP-g-MA)) as a function of UHMWPE content in blend

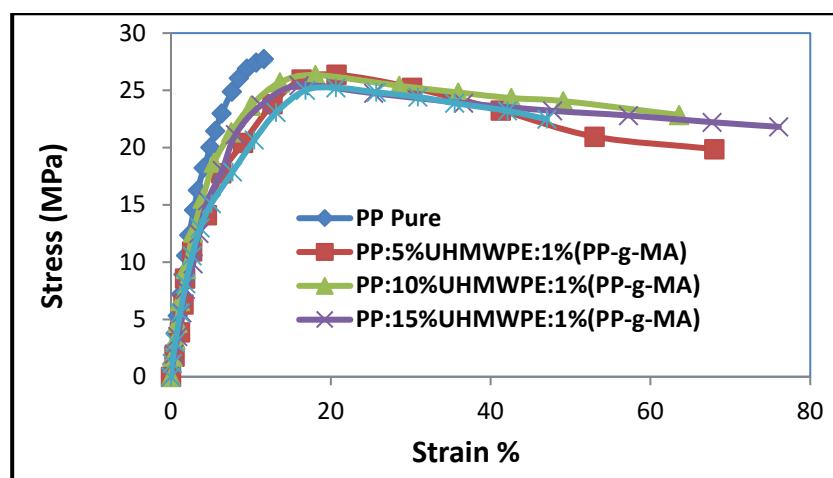
On the other hand, it can be seen from FTIR spectra for the two groups of ternary polymer blends (Figures 2 and 3) that the addition (PP-g-MA) to polymers blend leads to the appearance of absorbance bands at  $1710$  and  $1780\text{ cm}^{-1}$ , assigned for cyclic anhydride groups [18], the intensity of peaks at ( $1456.88$ ), ( $1375$ ) and ( $1165.86\text{ cm}^{-1}$ ) diminishes, showing that MA has been introduced as a graft onto PP [19].

#### Tensile Results

Tensile inspection was mainly achieved to investigate (stress-strain) curves behavior for polymer blends. Figures (4) and (5) demonstrates the (stress-strain) curves behavior for base material (neat polypropylene) and for two groups of ternary polymer blends (PP: X%PMMA: 1%(PP-g-MA)) and (PP: X%UHMWPE :1%(PP-g-MA)), respectively for different ratios (0, 5, 10, 15, and 20 wt.%) for each of PMMA and UHMWPE content in blends. The behavior of (stress-strain) curves of ternary polymer blends (PP: X%PMMA: 1%(PP-g-MA)) (Figure (4)) changes to hard and tough behavior when adding (PP-gMA) at constant ratio (1%) and PMMA at different ratios to the neat PP. This result is related to the nature of PMMA and its molecular chains. It is generally known that the PMMA is hardener, more brittle and stronger as compared to neat polypropylene, but these properties may be decreased something due to the addition of 1% (PP-g-MA) to the blend, where it was mentioned elsewhere that the addition of (PP-g-MA) material reduces the brittle behavior and increases the compatibility between blending components [16, 20]. Furthermore, the behavior of (stress-strain) curves of ternary polymer blends (PP: X%UHMWPE: 1%(PP-g-MA)) (Figure (5)) changes from the hard behavior of neat polypropylene to the soft and tough behavior for ternary polymer blends due to the nature of the molecular chains of UHMWPE material and the behavior of (PP-g-MA) material in the blend, as mentioned earlier.



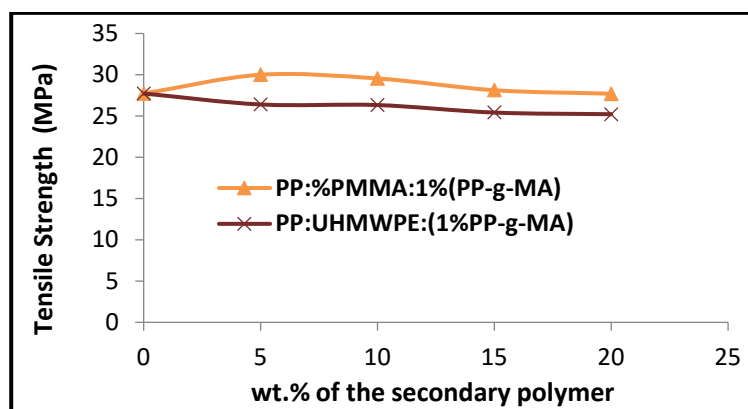
**Figure 4.** Stress-strain curve of ternary polymer blends (PP: X% PMMA: 1% (PP-g-MA)) as a function of PMMA content in the blend.



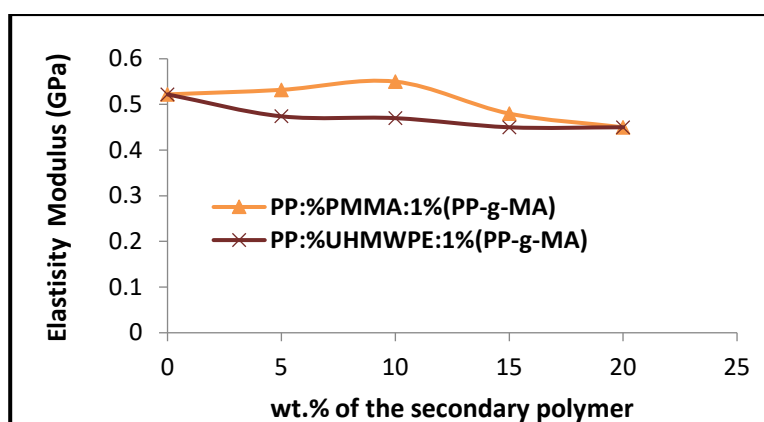
**Figure 5.** Stress-strain curve of ternary polymer blends (PP: X% UHMWPE: 1% (PP-g-MA)) as a function of UHMWPE content in the blend.

Figures (6 and 7) evince the tensile strength and Young's modulus, respectively for both groups of polymers blends (PP: X% PMMA: 1% (PP-g-MA)) and (PP: X% UHMWPE: 1% (PP-g-MA)) as a function of secondary material (PMMA or UHMWPE) content in polymer blends. From these figures, it is found that the tensile strength and elasticity modulus values increased with of addition PMMA material to polymer blend (PP: X% PMMA: 1% (PP-g-MA)), and tensile strength reached to maximum values at ratio 5% of PMMA in the blend, then the tensile strength value decreased with the increase of PMMA content to larger than 5% in blend but it remained higher than of the PP base material within the limits of addition ratios. Moreover, the elasticity modulus values for this group of blends reached their highest values at ratio 10% of PMMA in the blend and then decreased to less than that for the base PP material when increasing the addition ratio of PMMA to more than 10%. Whereas, the tensile strength and elasticity modulus values for second group samples of the polymer blend (PP: X% UHMWPE: 1% (PP-g-MA)) decreased with the addition of UHMWPE material for all addition ratios to the polymer blends. Furthermore, the tensile strength and elasticity modulus values of the first group samples (PP: X% PMMA : 1% (PP-g-MA)) are larger than those of the second group samples (PP: X% UHMWPE: 1% (PP-g-MA)) of ternary polymer blend. These results may be related to the chemical structure of PMMA chains, where the presence of the methyl ( $\text{CH}_3$ ) and methacrylate ( $\text{COOCH}_3$ ) groups on every other carbon atom of the main carbon chain provides considerable steric hindrance and thus makes polymer blends tough and relatively strong [21]. But, the presence of another polymeric material having a high

molecular weight structure and tough as UHMWPE produced polymer blend (PP: X%UHMWPE : 1%(PP-g-MA)) less strong compared to matrix material and polymer blend (PP: X%PMMA: 1%(PP-g-MA)). This result may be related to nature of chains structure for each of PP and UHMWPE materials, where it was reported elsewhere [22, 23] that the polymers of different molecular weights can produce an immiscible blend that results in a decrease in mechanical properties.

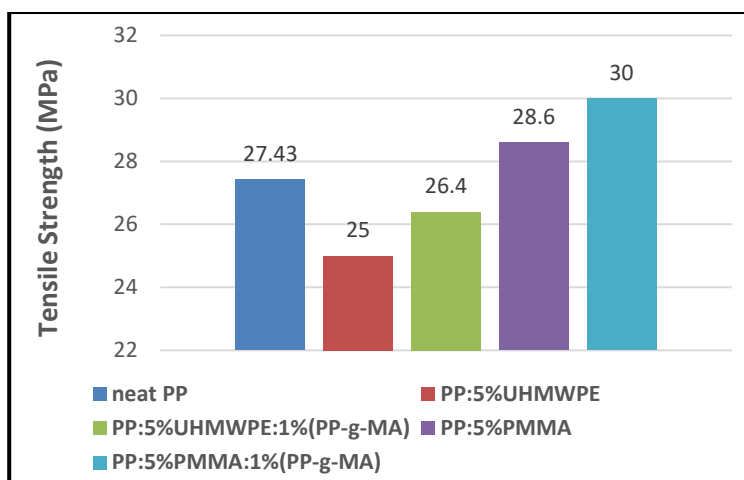


**Figure 6.** Tensile strength for both groups of ternary polymer blends as a function of PMMA or UHMWPE content in the blend.



**Figure 7.** Elasticity modulus for both groups of ternary polymer blends as a function of PMMA or UHMWPE content in the blend.

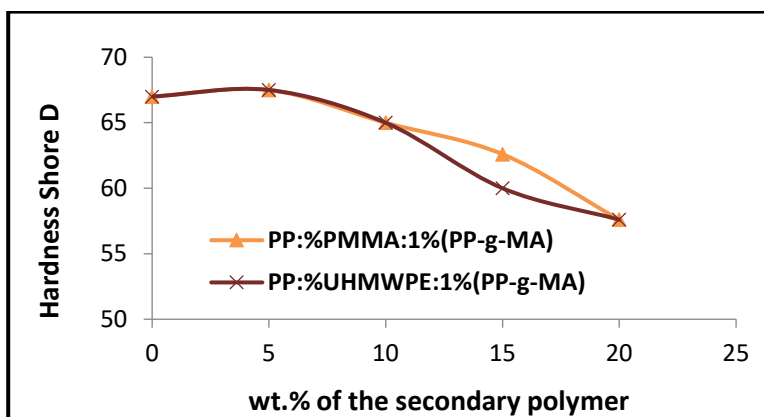
The effect of adding 1% (PP-g-MA) as the compatibilizer agent on the tensile strength is shown in Figure (8). Where, this figure exhibits the tensile strength values before and after adding 1% ratio of (PP-g-MA) to polymer blends, which have 5% ratio of the secondary materials [(PP: 5%PMMA) and (PP: 5%UHMWPE)]. From this figure, it was observed that adding 1% of (PP-g-MA) to blend (PP: 5%PMMA) increased the tensile strength value from 28.6 MPa to 30 MPa, and adding 1% of (PP-g-MA) to blend (PP: 5%UHMWPE) increased this value from 25 MPa to 26.4MPa. So, addition of (PP-g-MA) within limited proportion (1%) for both groups of the blend's sample will act as an agent to provide an effective compatibility among the constituents of polymer blend, this results agrees with that mentioned in literature [18, 22]. As well, it was found from this figure that the sample of ternary polymer blend (PP: 5%PMMA : 1%(PP-g-MA):) got the higher value in tensile strength as compared with the tensile strength value of neat PP material as control sample and the ternary polymer blend sample (PP: 5%UHMWPE : 1%(PP-g-MA)) and this may be related to the nature of chains structure for each of PP, PMMA and UHMWPE materials.



**Figure 8.** Comparison of the tensile strength values between neat PP material and two types of polymer blends [(PP: 5%PMMA) and (PP: 5%UHMWPE)] before and after adding 1% ratio of (PP-g-MA) to them.

#### Hardness Results

It is noticed from Figure (9) that the hardness values of the two groups of polymeric blends [(PP: X%PMMA: 1%(PP-g-MA)) and (PP: X%UHMWPE: 1%(PP-g-MA))] decrease with increasing the ratios of each of the PMMA or UHMWPE content in blends to larger than 5% ratio. As well, the hardness values for the polymer blend samples (PP: X%PMMA: 1%(PP-g-MA)) are slightly higher than its counterparts of polymer blend samples (PP: X%UHMWPE: 1%(PP-g-MA)). This result may be related, as mentioned earlier, to the nature of polymeric chains structure for each of PP, PMMA and UHMWPE materials [21]. On the other hand, the nature of polymeric chains structure for each component in the blend perhaps leads to produce amorphous structure, especially at ratios higher than 5% and this will increase the free volume structure which eventually leads to a decrease in the hardness values for each sample of polymer blend.



**Figure 9.** Shore D hardness of ternary polymer blends as a function of PMMA or UHMWPE content in the blend.

#### Compression Results

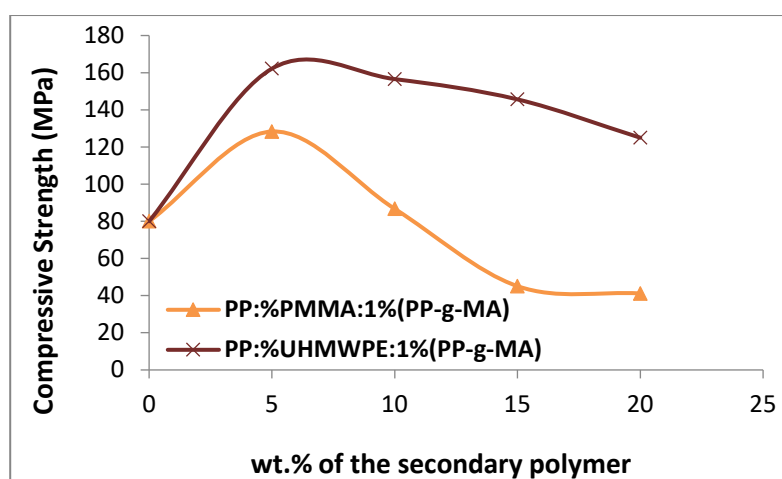
It is noted from figure (10) that the compressive strength values of the two groups of polymer blends increase with the addition each of PMMA or UHMWPE to polymeric blends and reached to the higher values at 5% ratio. This may be related to the chemical structure of PMMA chain that having the methyl ( $\text{CH}_3$ ) and methacrylate ( $\text{COOCH}_3$ ) as two side groups on every other carbon atom of the main carbon chain and this provides considerable steric hindrance about the movement of polymeric chains. Thus, it leads to make the polymeric blends as a rigid material leading to the production of a polymeric blend possessed higher compressive strength as compared to neat PP material that has a flexible structure [24]. Increasing the percentage of PMMA to more than 10% in the blend may be led to the formation of a structure with higher free



volume, leading to lower the compressive strength for this polymer blend.

On the other side, the addition of another polymeric material instead of PMMA material like UHMWPE material, which have a linear structure of polyethylene and has an extremely high molecular weight and highly aligned, has increased the compressive strength [21]. Therefore, this polymer has lower free volume structure as compared with PP and PMMA, so, blending this polymer with PP material will lead to produce a polymer blend having the microstructure possessed lower free volume as compared with PP. Therefore, the produced polymer blend has a high compressive strength compared to neat PP.

In addition to that, the samples of polymer blends (PP: %UHMWPE: 1%(PP-g-MA)) have higher values of compressive strength as compared with their counterparts of polymer blend samples (PP: %PMMA: 1%(PP-g-MA)). This may be due to the higher crystallinity and high molecular weight of UHMWPE material, therefore, this polymer blend produces the lower free volume structure as compared with the polymer blend have PMMA, where this blending material has a random molecular structure as a result of unsymmetry in the structures of side groups, so, it produced a completely amorphous structure with a high free volume, which was leading to produce polymer blends samples possessing lower compressive strength values.



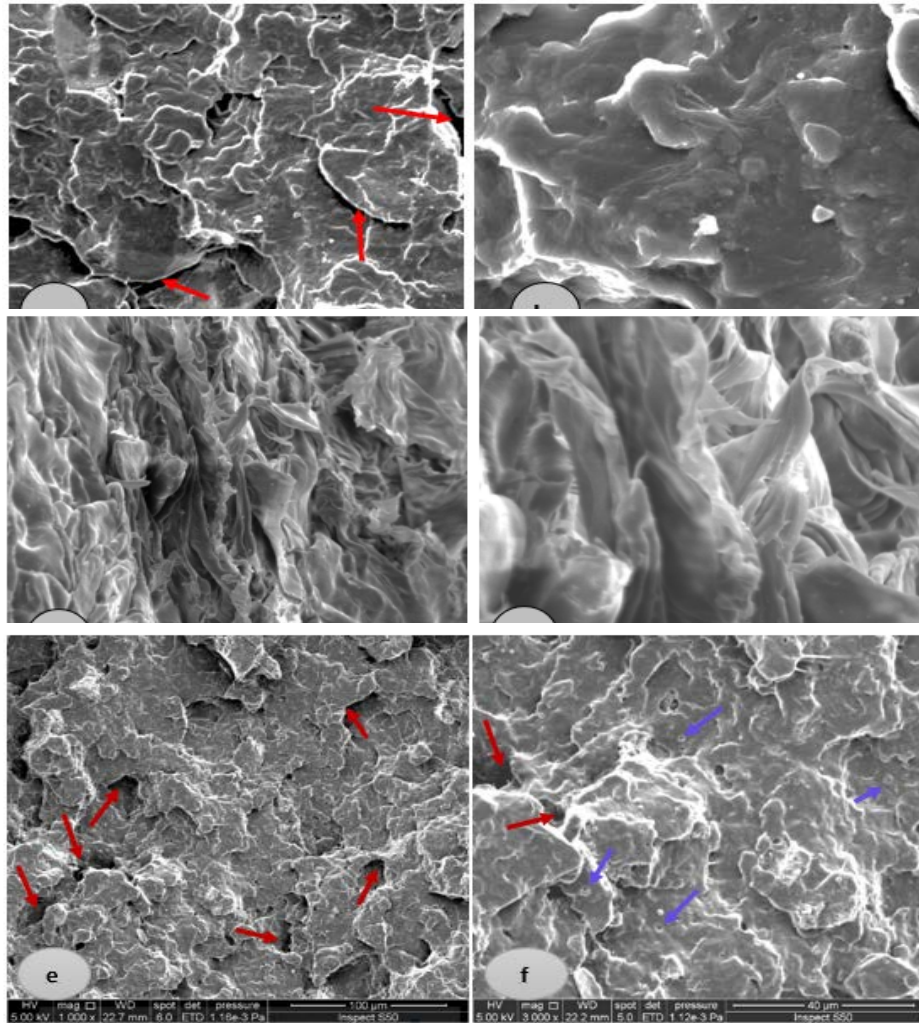
**Figure 10.** Compressive strength of the ternary polymer blends as a function of PMMA or UHMWPE content in the blend.

#### Morphology of Fracture Surface

The fracture surfaces of the tensile test specimens were examined by using a scanning electron microscope (SEM). The key point to phase morphology composed of the co-continuous phase and dispersed phase depends on the nature of components, ratio of components, component melt viscosities and processing conditions. Fracture surface morphology of the modified polymers blends [(PP: 5%PMMA: 1%(PP-g-MA)) and (PP: 10%UHMWPE: 1%(PP-g-MA))], was improved by adding (PP-g-MA) at 1% ratio to act as compatibilizer agent material. The blend structure morphology is presented in figure 11 (a- f) at two different magnifications (1000X) and (3000X). Where, figure 11 (a and b) illustrates that the fracture surface morphology of a neat PP material as control sample has a smoother structure morphology compared with a blend's morphology and it has some microscopic cracks which are indicated by arrows with a red color. This result is in a good agreement with the other workers' result [25]. Microscopic images in figure 11 (c and d) shows a good dispersion of PMMA material in the blend, and figure 11 (e and f) depicts that the UHMWPE material is dispersed in the morphology structure of polymer blend. As well, these microscopic images clearly reveal two different morphologies for polymeric blends depending on the constituents of blend and their ratios in the blend. Where from figure 11 (c and d)), it was noticed that there is co-continuous morphology in the structure of polymer blend (PP: 10% PMMA: 1%(PP-g-MA)) with a good dispersion of PMMA material in the blend and as a result, it was difficult to identify the individual polymers in this blend.

Whereas, microscopic images in figure 11 (e and f)) evincea heterogeneous morphology with a dis-continuous structure for the fracture surfaces morphology of polymer blend (PP: 10%UHMWPE: 1%(PP-g-MA)), this

morphology show immiscibility of polymer blend with sharp interfaces and poor bond strength, with the appearance of some microscopic pores through this structure's morphology which are indicated by arrows with a red color. This result may be related to the nature of polymeric chains structure for each of PP and UHMWPE, as well as, they have high difference in the molecular weights, leading to produce an immiscible blend [26]. On the other hand, this can be attributed to poor compatibility at the interface of all constituents of polymer blends (PP: X%UHMWPE: 1%(PP-g-MA)) which led to a decrease in the mechanical properties, as previously mentioned. In addition, the microscopic morphology (figure 11 (f)) indicates to the formation of a dispersed phase of UHMWPE material in irregular shapes and sizes, which appear through the microscopic morphology of polymer blend, as indicated by arrows with blue color. It is widely accepted that a compatibilizer material has two main roles in the control of blend morphology, one of them is the prevention of the coalescence of secondary materials and the other is the reduction of interfacial tension [27-31].



**Figure 11.** SEM fracture surface morphology of (a) and (b): Neat PP, (c) and (d): ternary polymer blend [PP: 5%PMMA: 1%(PP-g-MA)] and (e) and (f): ternary polymer blend [PP: 10%UHMWPE: 1%(PP-g-MA)] , where: (a), (c) and (e) at magnification (1000X), and (b), (d) and (f) at magnification (3000X).

## CONCLUSIONS

Mechanical characteristics of polymer blend [PP: X%PMMA: 1%(PP-g-MA)] showed higher values compared with the polymer blend [PP: X%UHMWPE: 1%(PP-g-MA)]. The accepted compressive strength of the second blends group manifested higher values compared with the first blend.

The maximum values of mechanical properties (Young's modulus, compressive strength and shore D hardness) were obtained at low ratio of secondary material for both groups of polymer blend, except the tensile strength

gives the maximum value of the second group at (10wt.%) ratio of UHMWPE.

In FTIR test observed no peak shifts but decrease in peak intensity with increasing PMMA and UHMWPE ratios in the blends.

SEM pictures elucidated a good compatibility and a continuous blend of the first blends group, while the second blends group (PP: 10%UHMWPE: 1%(PP-g-MA)) exhibited the immiscibility of polymer blend having a bad compatibility with a heterogeneous morphology, and dis-continuous structure with sharp interfaces.

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