Effect Of Γ-Rays On Some Mechanical Properties Of PP/HDPE Blends

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Abstract

The extrution method was different used to prepare melt blends of polypropylene (PP) and high density polyethylene (HDPE), after extraction the mixture were molded into sheets and left in air to cool. The samples of thickness (5mm) were cut to preform tensile test according to (ASTM D638). All the samples were subjected to gamma irradiation in presence the oxygen. The absorbed doses were (50, 100 and 150 Gy) at irradiation dose rate 19.8 rad/min, the tensile test preformed for non-irradiated and irradiated samples, then from the stress-strain curves we obtained the value of elongation at maximum, tensile strength and young's modulus. The result showed that there is significant effect of the blended rates and the radiation doses on the mechanical properties of the polymers.

الخلاصة

استخدمت طريقة البثق لتحضير خلطات مختلفة من البولي بروبلين والبولي اثيلين وبعد البثق تم قولبة الخليط الى الواح وتركت لتبرد بالهواء. العينات المحضرة كانت بسمك (5 mm) وقطعت لأجراء فحص الشد اعتمادا على المواصفات القياسية (ASTM D638). جميع العينات شععت بأشعة كاما معدل طاقتها 19.8 rad/min بوجود الاوكسجين وبجرع مختلفة هي (50, 100 and 150 Gy) بعدها فحصت العينات المشععة والغير مشععة بواسطة فحص الشد، ومن منحنيات (الاجهاد–الانفعال) حصلنا على اعظم استطالة، اجهاد الشد ومعامل يونك. النتائج اظهرت ان تغيير نسب الخلط وتأثير اشعة كاما يكون لها تأثير ملحوظ على الخواص الميكانيكية للبوليمرات.

1. Introduction

The use of radiation in the processing of polymers is gaining more and more interest because it can be suggested as an alternative to the traditional chemical methods to modify the molecular structure of polymers. The possibility of processing the final shape of the polymeric material in the solid state opens up new opportunities to obtain materials with well-tailored properties [Albano *et.al,* 2005]. γ-Ray irradiation doses do not require catalysts, so there are no catalyst residues in the final product to interfere with physical properties. There is no heat treatment to degrade thermally sensitive components, and the dosage of irradiation can be controlled easily. The main chains may be degraded or crosslinked by the gamma-ray irradiation, with both processes usually taking place concurrently[In Jae *et.al,* 2003]. Gamma-radiation effects on most commercial polymers have been widely investigated. They consist of modification of structural and mechanical properties, the extent of which depends on chemical structure and morphology of the polymers and on the irradiation conditions. On the other hand there is an increasing interest in polymeric systems obtained by blending two or more homopolymers[Rizzo *et.al*, 1983]. Blends of polyolefins have become commercially important with properties of the blends better than those of the parent homopolymers[Kostoski *et.al*, 1986]. For this purpose polyethylene-polypropylene blends have been chosen, because ionizing radiation effects on these two homopolymers are significantly different[Rizzo *et.al*, 1983]. The morphology, mechanical properties and crystallization behavior of PE/PP blends were reported by several researchers.

Lee [Lee *et.al*, 1991] found that mechanical properties of PE/PP blends are closely related to the morphology. Jose et al. [Jose *et.al*, 2004] they obtained poor mechanical properties of PP + HDPE blends due to incompatibility of these components and found that the addition of HDPE to PP decreased tensile strength at break, elongation and yield stress. Decrease of tensile strength and yield stress is faster with EPDM addition in PP+HDPE blends. The aim of this work is to compare the effect of gamma rays on the mechanical properties of polypropylene and polyethylene blends. Methods to access the extent of radiation-induced changes in polymeric materials include mechanical testing (elongation at max, tensile strength and young's modulus**).**

2. EXPERIMENTAL PART

2.1 Materials

The materials used in this investigation were Polypropylene(PP), HC 206TF, (supplied by Borealis, melt index (160-155)ºC, density (0.908 g/cm^3); high density polyethelen (HDPE), (lupolen 5723 supplied by basf melt index (190°C), density(0.956 g/cm^3) .

2.2 Preparation of PP–HDPE blends

Samples polymers and blends of PP+HDPE prepared by melt extrusion using single screw extruder, the extruder operation conditions were 45 rpm and temperature of the front zone, mix chamber zone and rear panel zone are chosen to be 200 ^{o}C. After the extrution, dumbbell test specimens were prepared by compress molded into sheets about 5 mm thickness in laboratory carver press at 200ºC and 25 MPa, the molded sheets were air-cooled.

The composition of the prepared PP+HDPE blends were 100+0, 75+25, 50+50, 25+75, 0+100 wt %.

2.3 Gamma irradiation

All the samples were subjected to gamma irradiation in air at room temperature and in presence of oxygen. The absorbed doses were 50, 100 and 150 Gy at irradiation dose rate 19.8 rad/min.

2.4 Mechanical Measurements

Tensile tests were performed in according to with ASTM D638 standard test method using Instron testing machine the specimen is clamped in the testing machine jaws and the lower movable jaw is moved downward at a fixed rate. The stress or force that resists the elongation process was plotted against the elongation or strain.The load applied was (0-50000) N.

3.RESULTS AND DISCUSSION

Mechanical properties data that obtained from the stress-strain curves of non-irradiated and irradiated pure PP and its blends containing 25,50,75,100 % of HDPE are presented in Figs. 1 to 3.For the non-irradiated samples we found that the higher value of the elongation at max ,Fig. 1, were for pure HDPE. and the higher value for the tensile strength, Fig.2, were for pure PP. also the tests showed that the minimum value of the elongation at max and tensile strength where for the blended samples which attributed to the poor interfacial adhesion between the blends component

That agree with (Nina Vranjes)[Nina *et.al*, 2007], who found that the tensile strength of neat PP was the highest and with addition of HDPE were reduced, and the highest value of the elongation had the neat HDPE, the blends of them showed very low values of elongation. The influences of irradiation on the mechanical properties of polymers are different depending on the polymer crosslink or degradation. Radiation induced degradation always make mechanical properties in worse. On the other hand, radiation cross linking sometimes may improve the mechanical properties

of polymers[Adriana *et.al*, 2007]. Influences of irradiation on both elongation at max and tensile strength are shown in Fig. 1 and Fig. 2.

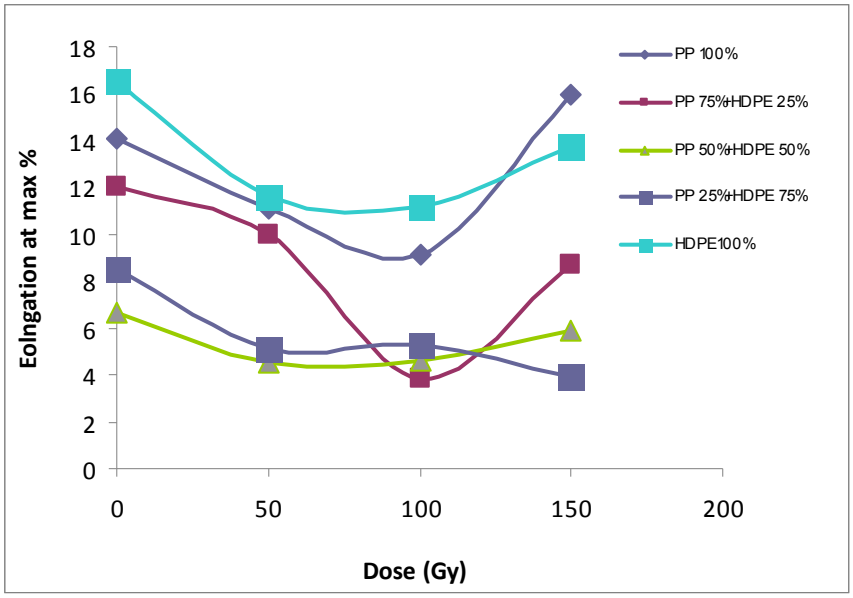

Figure 1. Elongation at max %

Figure (1) show the reduce of the elongation at max for all irradiated samples specially in the blends containing higher percentage of HDPE, at 100(Gy) there is slightly increases of the elongation at max in the samples contain higher percentage of HDPE. But the samples that contained higher percentage of PP continue in decreasing with increasing the absorbed doses until the dose reach to (150Gy) there is a fast increase in the elongation at max for these samples. These changes explained due to chain scission which reduce the elongation and cross linking which increase the elongation.

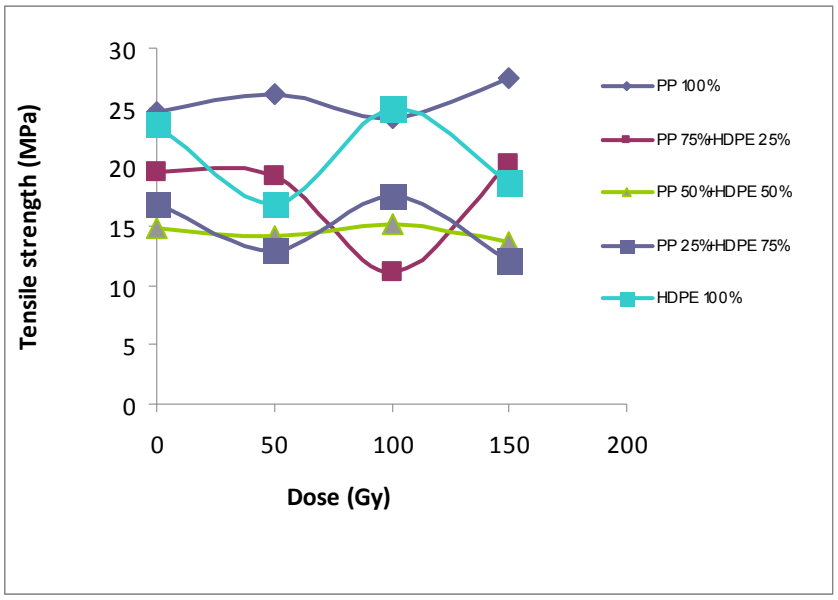

Figure 2. Tensile Strength

Figure (2) shows that the tensile strength of pure PP and the blend of (PP 50%+ HDPE 50%) slightly changes with increasing the absorbed dose the explanation of this behavior is that the gamma rays induct the cross linking and the chain scission of polymer backbone approximately at the same rate; this agree with [Adriana *et. al*, 2007], who found that in the case of PP the cross-linking and chain scission reaction proceed at almost the same rate. Where in case of pure HDPE and the blend of (pp 25%+HDPE 75%) there is decrease in tensile strength at (50Gy) and an increase at 100(Gy), then the tensile strength back to decrease at (150Gy). That attributed to the chain scission at the doses (50Gy) and (150 Gy) and the crosslink at the dose (100Gy).

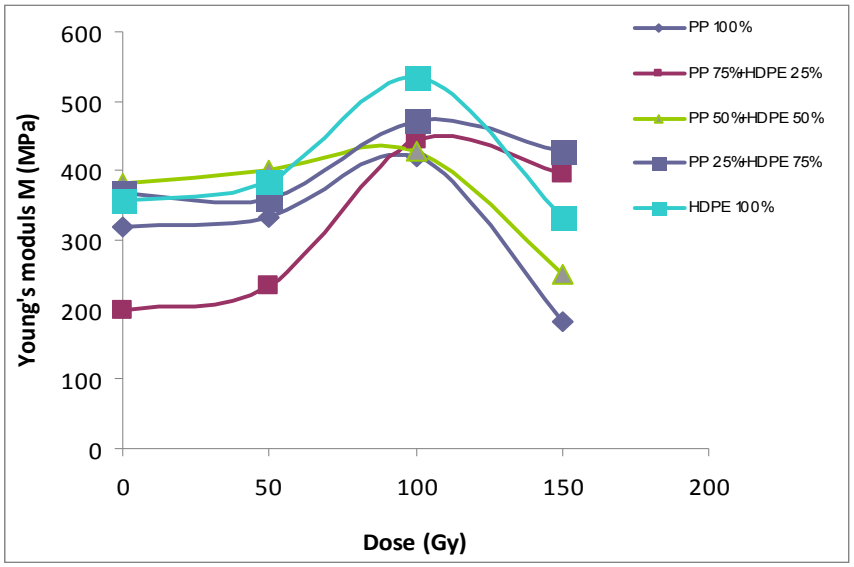

Figure 3. Young's Modulus

Figure (3) shows the variation of young's modulus, which obtained from the slope of the linear part of the stress-strain curve, with the absorbed doses. We found that the modulus of all samples increases at the doses from (50Gy) to (100Gy) then its decreases at (150Gy), but these changes happened at different rate where the highest increasing was for the blends which containing higher percentage of HDPE that attributed to increase the cross-linking reaction which leading to increasing the hardness of polymer and increasing its molecular weight and improving its mechanical properties. We observed that it is possible to improve the mechanical properties of the polymer by increasing the cross-linking in the polymer chains by radiation.

4. Concluton

The mechanical properties for the pure samples of PP and HDPE were better than these of their blends because of the poor adhesion between the blends component. We observed that it is possible to improve the mechanical properties of the polymer by increasing the cross-linking in the polymer chains by radiation it with gamma rays. The general behavior of the samples in this work were tends to scission that because of the gamma rays induced oxidative degradation due to chain scission of polymer backbone, where the free radicals that result from radiation process interact with the oxygen; because the radiation process done in presence the air. That lead to induced degradation in the mechanical properties.

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