The effect of UV – Radiation on Thermal and Mechanical Properties of (PP/LDPE) Blends

Balkees M. Aldabbagh[1] **, Hanaa J. Al shimary**[2] **, Adnan R. Ahmmed**[3]

[1] *Department of Applied Science, University of Technology , Baghdad . Iraq*
[2] *Department of Material, College of Engineering, Unversity of Babylon , Babylon , Iraq*
[3] *Department of Physics, College of Education for pure Science, University of Tikrit , Tikrit , Iraq*

Abstract:

UV-rad effected on thermal and mechanical properties (density, Shore D hardness, melt flow index, DSC) properties were studied for polypropylene (PP) blended with low density polyethylene (LDPE) at different ratios (10% PP+90% LDPE), (25%PP+75%LDPE). Results shows decreasing of blend density with increasing of PP content and increasing of it after UV-RAD for (15 hr.), also Shore D hardness decreased at the first ratio of PP (10%) then it increased with increasing of PP contain. Also Shore D increases after UV rad for (15 hr.). Melt flow index (MFI) decreased after UV rad, also the UV rad leads to increasing of crystallinity regions of blends.

Key words: LDPE blends, Melt flow index, UV rad, shore D, DSC

Introduction:

Blending of tow polymers to more economic interesting is often used. Mixing of tow or more polymer types at liquid state leads to an improvement in the resultant blend especially mechanical and thermal properties. In recent years, the use of and research on polycarbonate blends increased significantly due to the new apps in Medical, packaging, and other areas and the development of novel polyolefin [1]. Blending of PP and different PE largely is immiscible blend because there are an phase separation occurred during cooling/ crystallization process [2].

There are an advantages of polymer blending, involve enhancement of many mechanical properties, thermal and rheological properties, generally we can classify the purpose of blend by : [I] develop of materials with coveted properties. [II] Low coast materials. [III] Recycling of industrial plastic waste [3].

There are many research has been done on the polycarbonate blends of polyethylene and polypropylene and observed when the PP content is high in mixture, PP spherulites is possible to distinguish them, and LDPE appeared as a domains in mixture. While when polypropylene content little it disappears and shows a continuous polyethylene phase [4].

The rheological behavior of polymer melts plays an important role in processing and shaping, it is possible use of the melt flow index (MFI) as a signal to rheological and flow properties of the blends. MFI is a measure of thermoplastic polymer melt influx . It is defined as the mass of polymer, in grams, flowing in ten minutes through a capillary of a specific diameter and length by applied pressure[5].

There are many factors which effect in blends properties especially polyolefin blends such as UV radiation. When the polymer subject to UV- rad, C-C and C-H bonds are broken and leading to decomposition of polymer, for this reason the polyolefin polymer is very susceptible to the sunlight, for limiting from this phenomenon, must some UV stabilizer are used such as UV absorb to limit the photo-oxidation by increasing the duration in the induction period[5].

The UV absorbers dissipate the absorbed light energy from UV rays as heat by reversible intramolecular proton transfer. This reduces the absorption of UV rays by the polymer matrix and hence reduces the rate of weathering. Typical UV-absorbers are benzotriazoles and hydroxyphenyltriazines for polycarbonate [6].

There are many searches about LDPE and there blends with PP, in 1997 Liar and Ness studied the melt flow index of LDPE/PP, they found the melt flow of blends improved with little content of LDPE and HDPE [7].

In 2005 A. Dhoble et. al, studied the mechanical and rheological properties of PP-LDPE blends under chaotic advection blender, they proved there are an improvement in the result blend properties [8].

In 2009 N. Saleh et. al, studied some phisical properties and morphology of HDPE/LDPE blend before and after UV rad for 300 hr. The results obtained in this work show that the density of pure HDPE and HDPE/LLDPE blends increased with the increasing the exposure time, also immersing of blends in water leads to damage and this damage increased with the increasing of the exposure times also, the water absorbed is increased [9].

Materials and methods

Low Density polyethylene (H301-Braskem) and polypropylene (BC 818-Braskem) were used. The specific gravity of the PP is 0.90 and that of the LDPE is 0.91 g/cm^3, Blends of (LDPE:PP) were processed in an injection-molding machine with various LDPE/ PP weight contents, namely PP0, PP10, PE25, as in Table 1.

Table 1. show the sample that prepared at this search

Sample name	LDPE content	PP. content
PP0	**100%**	**0**
PP10	**90%**	**10%**
PE25	**75%**	**25%**

These blends were processed at 170 ^oC injection temperature, the density of blends was measured according to Archimedes' law. Shore D hardness was measured by Shore D hardness durometer tester CS-292D, and the melt flow index (MFI) measured by Zwick melt flow index testers, DSC curves by NTEZSCH machine.

Results and Discussion:

Density of blends:

Density of blend samples were shown in Fig. (1), we notice the density of blends decreased with increasing of PP content. This is because the PP has lower density than the LDPE sample of blend follows the rule of mixture because immiscibility, while the density of blends increased after UV-rad for (15 hr.), this is because the UV-rad leads to increasing of cross linking of blends, while the cross link efficiency decreased with increasing of PP content and this is also leads to decrease of density of blends with increasing of PP content after radiation as in Fig. (1) [10].

Shore D Hardness

Fig. (2) Show the effect of PP content on Shore D hardness of blends we show it decreased with 10% PP content while it increasing with increasing of PP content at (25)%, this is because the nature of PP which is more stiff than LDPE then increasing of PP content leads to decreasing of Shore hardness of blends [11].

Also we notice that the Shore hardness increases after UV-RAD this is because the effect of cross linking degree which it increase by UV-RAD.

Melt flow index

Table 2. Show the melt flow index of LDPE with it's blends (PP+LDPE) before and after UV rad.

Table 2. Show the melt flow index of LDPE with it's blends (PP+LDPE) before and after UV

No. of sample	Samples	M.F.I g/10 min , Without UV rad	M.F.I g/10 min , With UV rad
1	LDPE 100%	11	9
2	10 LDPE : 90 PP	1.5	2.76
3	25 LDPE : 75 PP	5.1	2.04

We notice from Table 2 and Fig. (3) there are an decreasing in melt flow index with increasing of PP content, this is because there are an cross linking between the polymeric chain was happened through the curing of LDPE:PP blends as proven by DSC analysis. [Siriporn et. al 2003], while UV rad leads to decreasing of melt flow rate because the cross link efficiency decreased with increasing of PP content. Generally increasing of MFI as (90 LDPE: 10 PP) because the chain scission reaction while MFI decrease to cross linking reaction [12].

DSC Results

Figures (4) and (5) show the DSC analysis of thermal properties of pure LDPE, PP and it's blend with (25%PP:75%LDPE) respectively before and after UV rad. We notice from Fig. (4) the melting point of LDPE is about 109 ^oC and there are an small broad peak at about 60 ^oC, this is because the physical. Ageing effect or annealing. This annealing process happens when polymer with lower molecular weight or branching polymer does not have enough time for full crystallization during the cooling process [13].

The PP curve shows an endothermic melting about 158 ^oC, furthermore on the low temperature side of the endothermic peak, also we notice there are an smooth DSC curve between 110-125 ^oC [14].

Fig. (5) showed the blending of (25%PP:75%LDPE) before and after sample exposure to the UV rad . we notice from red DSC curve (before UV rad), there are two peaks, the first is about 130 ^oC, with endothermic curve, this is due to the existence of small quantity of PE or PE/PP block copolymer the second peak is about 159 ^oC corresponding to the melting point of PP. Also There are three region of recrystallization. Generally, PP crystallizes to the monoclinic α form under usual industrial thermal conditions. While it may be translate to unstable crystalline form (β form) under : (1) presence of additives lead to hinder movement chain mobility; (2) changing the chain structures by shear stress and (3) fast cooling causes not enough time to more stable form [14].

Thermal degradation curve before UV rad refers the blend degraded about 200 ^oC with an crosslinking chain.

Blow DSC curve refers there are an increasing in the thermal effecting temperature of blends, there are three peaks , the first is about 126 ^oC, the second about 156 ^oC, while the third is about 260 ^oC, also there are an changing in recrystallization regions, we notice an increasing in crystalline region this is because the cross-linking and session reactions, LDPE tends to cross-linking reaction while the presences of PP hinder this process by session reaction. UV rad leads to increase of crystallinity regions of LDPE from (4.89 J/g) to (36.9 J/g) by saving the cross-linking chain. Also the thermal degradation temperature increased more than 260 ^oC [15].

Conclusions:

1. Blended of LDPE with polypropylene leads to more economic materials.
2. PP leads to enhancement of LDPE for more application fields especially processing and shaping.
3. UV rad leads to an enhancement in recrystallize regions of blends with increase the withering resistance.

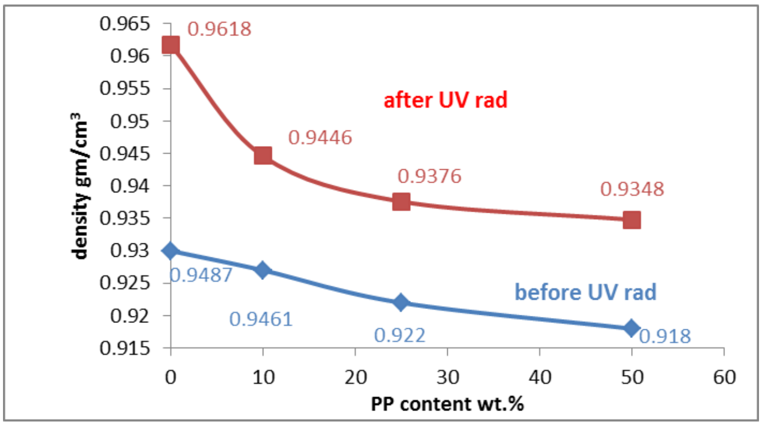

Fig. (1) relationship between density and PP% content of immiscible blends before and after UV rad.

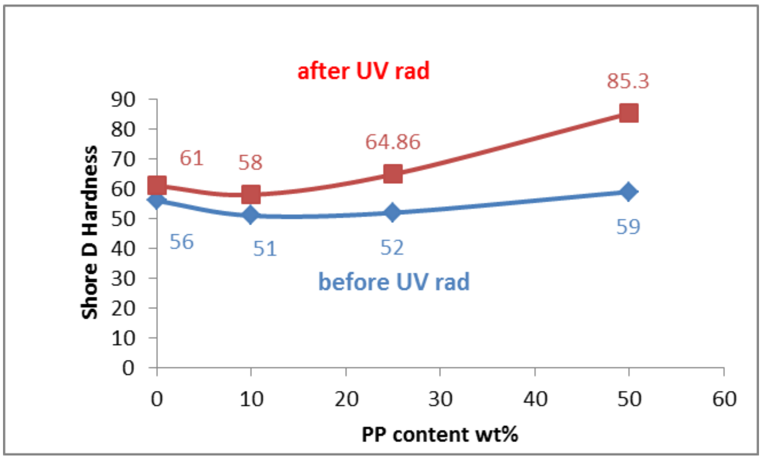

Fig. (2) relationship between Shore D hardness and PP% content of immiscible blends before and after UV rad.

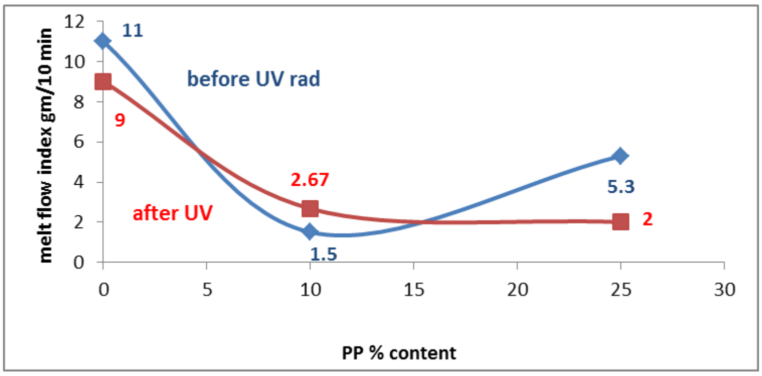

Fig. (3) relationship between melt flow index and PP% content of (PP+LDPE) blends before and after UV rad.

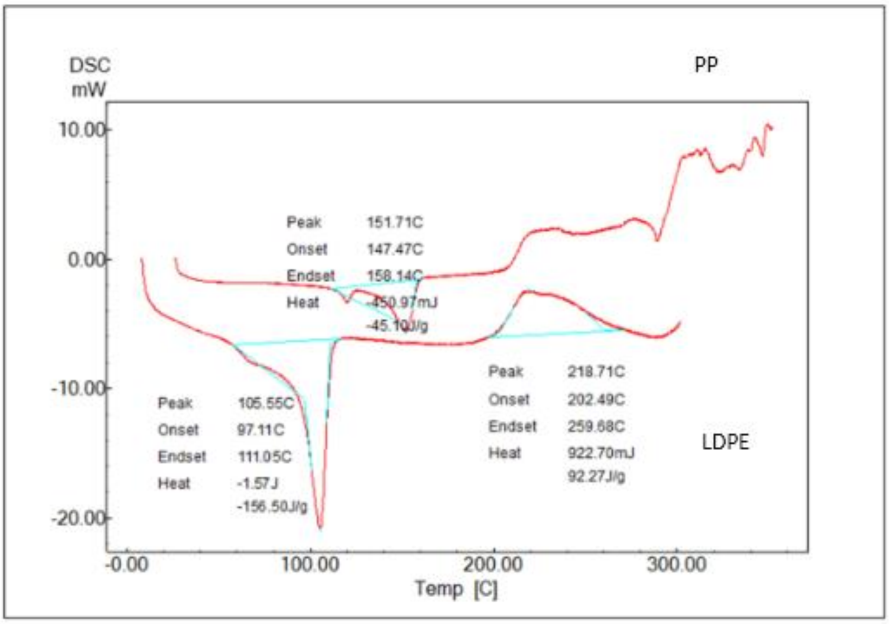

Fig. (4) DSC curve of pure (PP) & (LDPE)

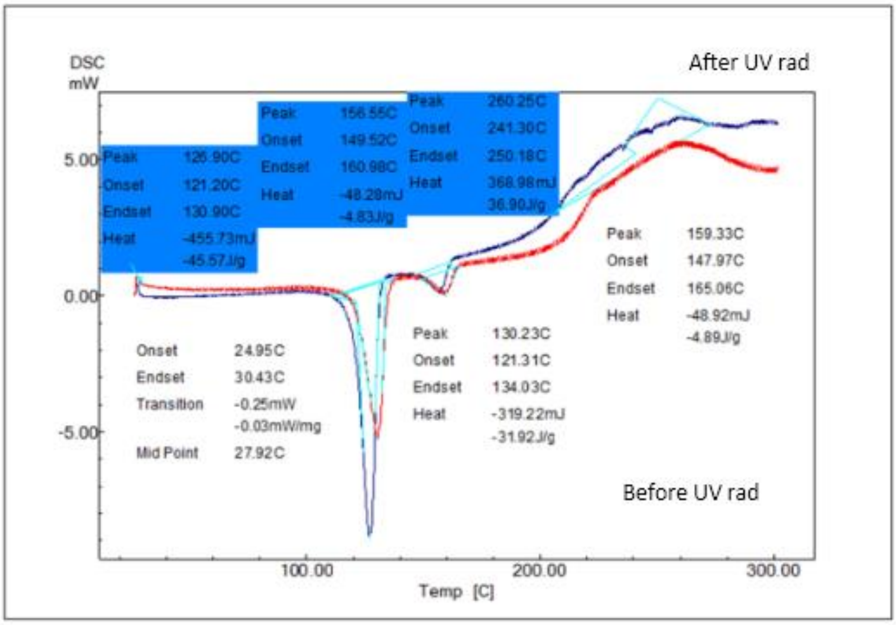

Fig (5) DSC curve of (25% PP+ 75%LDPE) blend before and after UV rad.

References:

[1] D. Nwabunma and Th. Kyu, " Polyolefin Blends", ISBN: 978-0-471-79058-7, Jan. (2008).

[2] D. G. Dikobe and A. S. Luyt, " Comparative study of the morphology and properties of PP/LLDPE/wood powder and MAPP/LLDPE/wood powder polymer blend composites", EXPRESS Polymer Letters Vol.4, No.11 PP, (729–741), (2010).

[3] L. Utraki, " Commercial Polymer Blends", Springer – Verlag, PP (80-90), USA. (1998).

[4] J. Li and R. Shanks," Time-dependent Morphology of Polyethylene – Polypropylene Blends", Chinese Jour. of Poly. Sci., Vol. 20, No. 6, PP(497-508). (2002).

[5] A. V. Shenoy and D. R. Saini, "Thermoplastic Melt Rheology and Processing", Marcel Dekker Inc., New York. (1996).

[6] Das, P K, DesLauriers, P J, Fahey, R, Wood, F K & Coruforth, F J, "Photostabilization of poly(p-phenylene sulfide), Polymer Degradarion and Stability", pp (1 – 10), (1994).

[7] I. Z. Liang and J. N. Ness, "Investigation on the melt flow properties of polyethylene and polypropylene blends", Polymer Testing, Vol. 16, PP (379-389), (1997).

[8] A. Dhoble, B. Kulshreshtha, S. Ramaswami and D.A. Zumbrunnen, "Mechanical properties of PP-LDPE blends with novel morphologies produced with

a continuous chaotic advection blender", Polymer, Vol. 46 PP(2244–2256), (2005).

[9] N. Saleh, N. A. Mohammed and Weam A.Abed, "Studing of Some Phisical Properties and Morphology of Blends of Hdpe /Lldpe after and before Exposure to UV Light", Eng. & Tech. Journal ,Vol.27, No.4, (2009).

[10] P. Zamotaev , I. Chodak , O. Mityukhin and I. Chorvath, "Photoinduced crosslinking of polyolefine blends. I. Crosslinking of LDPE, PP, and LDPE/PP blends", Journal of Applied Polymer Science, Vol. 56, Issue 8, pages 935–946, (23 May 1995).

[11] Sihama E. Salih1, Abdullkhaliq F. Hamood1 & Alyaa H. Abd alsalam, "Comparison of the Characteristics of LDPE : PP and HDPE : PP Polymer Blends", Modern APPlied Science; Vol. 7, No. 3, (2013).

[12] P. C. Lodi, B. S. Bueno, O. M. Vilar "Evaluation of Geomembrane UV Degradation Using Melt Flow Index and Oxidative Induction Time Tests", Proceeding of the 4th Asian Regional Conference Geosynthetics , June 17-20 Shanghai-China. (2008).

[13] I. Borovanska, R Krastev, R Benavente, M. Pradas, A. Valle´s Lluch, V.Samichkov and M. Iliev, "Ageing effect on morphology, thermal and mechanical properties of impact modified LDPE/PP blends from virgin and recycled materials", Journal of Elastomers & Plastics, PP (427–447) ,Vol. 46(5), (2014).

[14] AT No. 86, "DSC Measurement of Polypropylene", Hitachi High Tech. Science Corporation (2008).

[15] Sh. Luzuriaga, "Utilization of Compatiplization and Restablization Methods in The Recycling of Commingled Municipal Plastic Waste", Masaryk University in Brno, (2009).

تأثير الاشعة فوق البنفسجية على الخصائص الحرارية والميكانيكية لخلائط (PP/LDPE)

بلقيس محمد الدباغ[1] ، هناء جواد الشمري[3] ، عدنان رعد احمد[3]

[1] قسم العلوم التطبيقية ، الجامعة التكنولوجية ، بغداد ، العراق

[2] قسم المواد ، كلية الهندسة ، جامعة بابل ، بابل ، العراق

[3] قسم الفيزياء ، كلية التربية للعلوم الصرفة ، جامعة تكريت ، تكريت ، العراق

الملخص

تم في هذا البحث دراسة تاثير اشعة UV على بعض الخواص الميكانيكية (شور D , الكثافة) وكذلك على بعض الخواص الحرارية مثل معامل الانسياب الانصهاري وكذلك تحليل الخواص الحرارية من درجات الانصهار ودرجات التبلور باستخدام المسعر الحراري التفاضلي للبولي اثيلين واطئ الكثافة وخلائطه من البولي بروبلين (LDPE/PP) بنسب خلط مختلفة. اثبتت النتائج نقصان كثافه الخليط مع زياده محتوى البولي بروبلين، وكذلك نقصان كثافه الخليط بعد تعرضه لأشعة UV لمدة (15 hr) ، صلادة شور تقل بعد اول نسبه من الخلط PP (10%) ثم تبدا بالزيادة بزيادة محتوى البولي بروبلين، كما ان اشعة UV تؤدي الى زيادة صلادة شور ، معامل الانسياب الانصهاري يقل بعد تعرض الخليط الى اشعة UV ، كما لوحظ هناك تغير في مناطق ودرجات تبلور الخليط بعد التعرض لأشعة UV ، حيث لوحظ هناك زيادة في مناطق تبلور الخليط وزياده في درجات التفكك الحراري للخليط.