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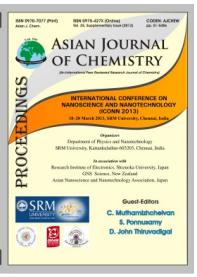

Blending and Characterization of Polyolefin Nanocomposites for Coating Application†

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In the present work nanocomposites comprising ultra high molecular weight high density polyethylene and low density polyethylene grafted by maleic anhydride using reactive extrusion method as the host polymers and organoclay filler were prepared by melt compounding. The dependence of their structure and morphology on the preparation condition was studied by X-ray diffraction and scanning electron microscopy. The blends were studied in three different ratios such as 90:10, 70:30, 50:50 of ultra high molecular weight high density polyethylene and low density polyethylene. The difference in mechanical and thermal properties was observed with the addition of the compatibilizer. Several percentages of compatibilizer were added and 5 % of its addition was found to be optimum. The nanocomposites of these blends were also studied with the addition of nanoclay. The resulting composites were evaluated in terms of mechanical properties, dispersion characteristics and thermal properties. Nanocomposite with 70:30 ratios with 3 % nanoclay showed optimum properties. This composite was uses for coating.

Key Words: Ultra high molecular weight high density polyethylene, Maleic anhydride, Nanoclay, Low density polyethylene.

INTRODUCTION

Polymer nanocomposites are a class of hybrid materials composed of organic matrix in which ironginc particles with nanoscales dimension are imbedded[1-6]. The work presented in this paper focuses on the study of thermoplastic nanocomposites based on blends of low density polyethylene and ultra high molecular weight polyethylene.

EXPERIMENTAL

Ultra high molecular weight polyethylene: Reliance ultra 2504 were purchased from reliance industries Pvt. Ltd. has a density of 0.933 g/cc and melting point of 153 ºC. Low density polyethylene-Reliance 16MA400 were purchased from reliance industries Pvt. Ltd., has a density of 0.915 g/cc and melting point of 103 ºC. Maleic anhydride monomer used in the study, having 99.5 % purity and melting point of 53 ºC, was supplied by S.D. Fine Chem. (India) and was used as received. Dicumyl peroxide was obtained from Hi-Media Laboratories (Mumbai) having a melting temperature of 38 ºC. Chemical reagents used for titration was of AR grade. Cloisite Na^+ was obtained from Southern clay products, The ultra high molecular weight high density polyethylene/low density polyethylene in different compositions (90/10, 70/30 and 50/50 wt %) was melt mixed with 5 wt % maleic anhydride and 1 wt % dicumyl peroxide in the Haake torque rheometer. The direct melt compounding of maleic anhydride grafted ultra high molecular weight high density polyethylene/low density polyethylene with nanoclay (3 wt % concentration) was also carried out and these are referred as maleic anhydride grafted ultra high molecular weight high density polyethylene/low density polyethylene nanocomposites. The melt mixing process was carried out at a rotor speed of 30 rpm and set temperature of 190 ºC. The nanoclay was dried in vacuum oven at 60 ºC over night and was fed along with ultra high molecular weight high density polyethylene/low density polyethylene granules into Haake torque rheometer chamber of 50 mL capacity, preheated to 190 ºC. The rotor speed was maintained at 5 rpm for about 1 min and was then increased gradually to 30 rpm in 60 s and the mixing was continued for 15 min. The molten composites were extracted from the mixer and cooled naturally in air. Ultra high molecular weight polyethylene and low density polyethylene were blended along with the addition of maleic anhydride at 70:30 (w/w) mixing ratio with varying maleic anhydride concentrations. The blend compositions were mixed at 190 ºC in the presence of initiator. After completion of the reaction process the blended material was washed with water to remove any free maleic anhydride. Grafted ultra high molecular weight polyethylene/low density polyethylene was dried under reduced pressure at 80 ºC for 16 h before charac-

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terization. Acid value and percentage of grafting determined using[1-7]. ASTMD 1238 using LLOYD instrument with 5 kg weight, structural anlaysis using FTIR Nicolate 6700, thermal decomposition temperature (heating rate 10 ºC min), melting behaviour and crystallization (10 ºC/min) behaviour was observed using Perkin elemer USA USA model. The dispersion characteristics of polymer/nanoclay composites were studied by X-ray diffractometer. WAX analysis was performed on pressed films approximately 100 µm thick using a SEIFERT diffractometer. Measurements were recorded every 0.02º for 1 s each varying 2θ from 2º to 70º. The interlayer distance of clay was calculated from the (001) peak by using Bragg equation, which is reported. According to ASTM D 638, mechanical properties using the instron instrument. The Izod impact strength using Tinius Olsen impact tester model 104 (6.8 J hammer and 3.5 m/s impact velocity) as per ASTM D-256.

RESULTS AND DISCUSSION

Fig. 1 showed the FTIR spectra of ultra high molecular weight polyethylene/low density polyethylene under different conditions. Grafting of maleic anhydride is expected to result in the presence of carboxylic group and hence the peak corresponding to this group expected to appear at 1714 cm^{-1} in the FTIR spectrum, corresponding to low density polyethylene has a very small peak at 1714 cm^{-1}. Ultra high molecular weight polyethylene/low density polyethylene g-maleic anhydride exhibit sharp peaks at 1714 cm^{-1} indicating presence of carbonyl peaks. However, intensity of peak for ultra high molecular weight polyethylene/low density polyethylene is compared to that of grafted ultra high molecular weight polyethylene/low density polyethylene. Acid value and per cent grafting were calculated according to the reference[7]. The optimum 5 % male anhydride were calculated the percentage of grafting 4 % by quantitative methods[7].

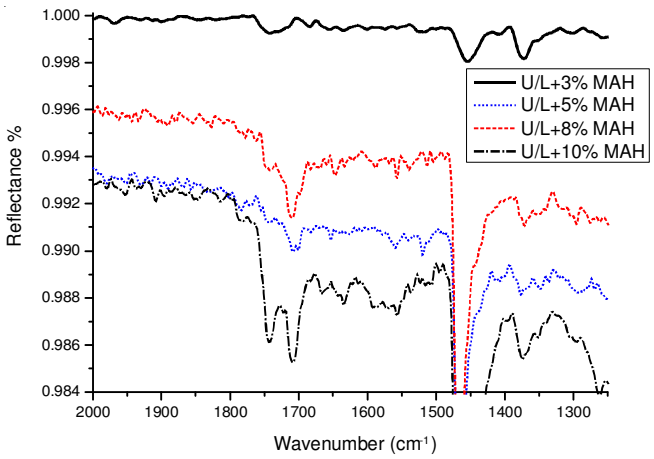

Fig. 1. FTIR spectra of UMHDPE/LDPE g Maleic anhydride

The mechanical properties of the maleic anhydride ultra high molecular weight high density polyethylene/low density polyethylene nanocomposties such as tensile strength and elongation at break have been evaluated such as 13.87 and 9.88. By the addition of nanoclay (closite Na^+) which resulted in the decreasing tensile strength with the increase in nanoclay content. The decrease in the tensile properties could be due to the immiscibility of the polymer blends with the addition of nanoclay. The decrease in tensile strength could be due to the weak interfacial interaction between nancolay and polymer. These observations suggest that the composition of clay (closite Na^+) has a strong influence on the structural and physical of maleic anhydride grafted ultra high molecular weight high density polyethylene/low density polyethylene blends. Considering the composition analysis, 3 % nanoclay addition showed optimum. The impact strength decrease by 50 % when the nanoclay was added to the nanocomposites having maleic anhydride. This was due to the immiscibility of polymer and nanoclay. With the increase in concentration of nanoclay added the impact strength kept on decreasing but for 3 % addition it showed improved impact strength compared to other concentration loadings. The interfacial interaction between the two disparate phases in the 3 % concentration increase the impact strength compared to other concentrations.

The abrasion strength of the blend of varying composition was determined and value 0.0048, 0.0041 and 0.0042. The nanoclay addition of 3 wt % showed better abrasion behaviour due to crosslinking of nanoclay on polymer matrix compared to other concentration. When the nanoclay concentration was increased the nanoclay forms agglomerated and with abrasion strength of 3 wt % nanoclay was optimized.

The heat deflection temperature of the nancompostes prepared with different concentration of clay and found that the heat deflection temperature depends on the aspect ratio of dispersed nancolay particles. The dispersion of nanoclay in the polymer matrix due to good reinforcement of clay particles. The melt flow index of the blend with varying compositon ultra high molecular weight high density polyethylene/low density polyethylene g-maleic anhydride 0.25, ultra high molecular weight high density polyethylene/low density polyethylene grafted nanocomposite 1.3 and 5 % 0.078, 0.063 and 0.189 respectively.

Thermal decomposition temperature ultra high molecular weight high density polyethylene/low density polyethylene grafted maleic anhydride and it 1,3 and 5 wt %, there no significant difference in onset decomposition temperature due to the partially immiscible blend of nanocom-posites such as the above same formulation 435.56, 418.14, 427.21 and 426.360 ºC respectively and the melting and crystallization behaviour to form two melting point and two crystallization point there is not significant different and also one of the main agreement the blend polymer partially immicible blend and thermodynamically not feasible reaction. The degree of crystallinity increased at around 22, 20, 20 and 20 % the above same formulation by calculating the ratio enthalpy fusion and enthalpy fusion of 100 % crystallinity materials. The ultra high molecular weight high density polyethylene/low density polyethylene enthalpy fusion of 100 % crystallinity 285 J/g as given in Table-1.

The WXRD pattern over the 2θ range between 1 and 11 of the Closite Na^+ and of some of the composites prepared by melt compounding in the brabender mixed are shown in Fig. 2. When the XRD analysis, exfoliation is achieved when the individual montmorillonite platelets no longer exhibit an XRD deflection. Generally, we can assume that the absence of clay

TABLE-1
DSC ANALYSIS OF GRAFTER UHMHDPE/LDPE NANOCOMPOSITES

Sample identification	ΔHf enthalpy of fusion	Melting (ºC)	Crystallization (ºC)	Xc = ΔH f/ΔH f × 100
U/L MAH	58.2	108.0, 139.4	89.9, 115.7	0.20
U/L MAH + 1 %	64.82	106.8, 136.6	90.9, 116.6	0.22
U/L MAH + 3 %	58.72	108.2, 137.2	89.6, 114.2	0.20
U/L MAH + 5 %	59.41	106.5, 135.0	90.7, 115.6	0.20

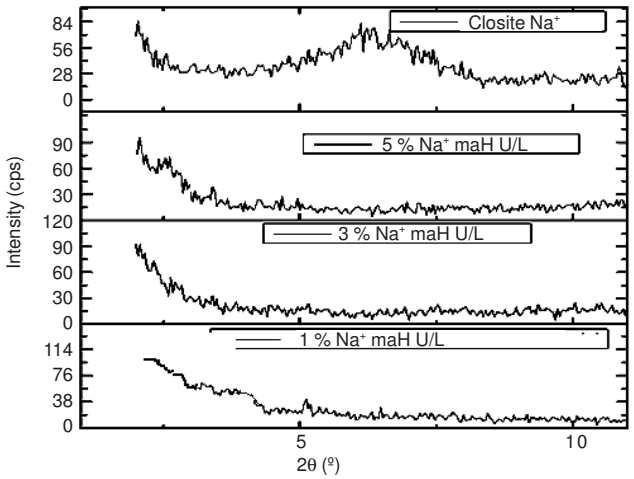

Fig. 2. XRD analysis of ultra high molecular weight high density polyethylene/low density polyethylene grafted nanocomposites

peaks in the XRD spectra indicate that the platelets are at least 70 angstroms apart. When this condition is achieved, the promized surface area is exposed and high aspect ratios gained. The scanning electron microscoy analysis images of broken impact specimen were taken along a direction normal to the material flow during the mold filling process. The morphology of ultra high molecular weight high density polyethylene/low density polyethylene-g-maleic anhydride and its with Nanocomposite at optimum composition are shown in Fig. 3(a, b) respectively, it shows the SEM micrographs of the blends prepared by compression moulding [Fig.3 (a and b)] shows micrograph of ultra high molecular weight high density polyethylene/low density polyethylene-g-maleic anhydride with Nanocomposite. As shown in Fig. 3(a) partially miscible of the ultra high molecular weight high density

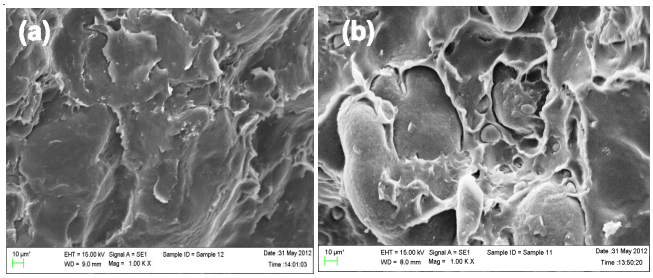

Fig. 3. (a, b), Scanning electron microscopy; a) the UMHDPE/low density polyethylene grafted 5 % maleic anhydride; b) 3 % UMHDPE/low density polyethylene grafted maleic anhydride Nanocomposite

polyethylene/low density polyethylene-g-maleic anhydride and its nanocomposite 3 % optimum composition nano particle -polymer interaction.

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