MANIFESTATION OF GRAFTED POLYMERS IN ENHANCING BLEND COMPATIBILITY OF POLYMERS

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Abstract : Ethylene Vinyl Acetate rubbers (EVA) are recognized for their excessive temperature durability, mechanical strength, super compression set, exact abrasion and wear resistance, low temperature flexibility, low permeability to gases, vibration damping and oil-water resistance. By addition of small proportions of Thermoplastic Polyurethane (TPU) to EVA an enhancement can be acquired in the tensile strength, elongation at break, tear strength and compression set. Additionally improved mechanical properties may additionally be accomplished barring compromising with the other vital bodily houses of EVA such as its low density. In this paper utilization of TPU grafted EVA (EVA-g-TPU) as a compatibilizer for the guidance of EVA/TPU combination has been implemented. Graft addition reaction of EVA-g-MAH with TPU might also result in the formation of the EVA/TPU with top-quality properties and compatibility. Use has been made of an EVA with 28% vinyl content in this case. The blending can be achieved on a twin screw extruder. The characterization of the blend will be based on Fourier Transform Infrared Radiation (FTIR) Spectroscopy. The received closing combination is estimated to be in the form of EVA / EVA – g – TPU / TPU. Similarly the blend of Fluoroelastomer (FKM) with Polypropylene (PP) has been carried out using a compatibilizer in the form of maleated EPDM (Ethylene Propylene Diene Copolymer), which is again a grafted copolymer.

***IndexTerms* - Ethyl Vinyl Acetate copolymer, Thermoplastic Polyurethane, Compatibilizer, Maleated EPDM.**

1. INTRODUCTION

Two or more polymers are blended preferentially so as to either to enhance some of the technical properties of the base polymer so as to make them viable for use in a particular field or for the reduction of compound cost or in order to ease the processing of the polymer. Polymers are manipulated and modified so as to make them appropriate for a specific application which is currently facing some problem. Hence the implication of the blend must be clarified properly before the modification.

Polymers that are miscible with each other are easy to blend but the real challenge is to blend those polymers together who do not possess any sort of affinity towards each other. There are in general five different methods employed for blending viz., melt mixing, solution mixing, latex mixing, partial block or graft copolymerisation and by preparation of interpenetrating polymer networks.

2. CASE STUDIES

Here in this paper, two case studies have been included which involves the use of a grafted copolymer as a compatibilizer in order to blend the two fellow polymers together. The first case study is that of a blend of Ethylene Vinyl Acetate (EVA) with Thermoplastic Poyurethane (TPU) [1] and the second one of a Fluoroelastomer with Polypropylene.

2.1 Ethyl Vinyl Acetate Rubber (EVA) with Thermoplastic Polyurethane (TPU)

This blending aims at increasing the physical properties of EVA foams such as tensile strength, tear strength, peel strength and compression set. The main properties that EVA manifests are flexibility, transparency, excellent low temperature flexibility, chemical resistance and high friction coefficient. Whereas TPU along with elasticity and transparency also provides with resistance against oil and grease, better sustainability to abrasion and easier processing. By blending both these polymers one can aim to obtain a mediocre property range between the two, which would be highly advantageous to be used in the mid soles of athletic sport shoes [2].

But the issues that one has to overcome are: (i) poor compatibility of the two polymers, (ii) possibility of phase separation on using an unidentical third party compatibilizer, and (iii) tendency of TPU to pull out of the polymer matrix due to interfacial slip[3].

It was well understood that all these problems arose because both EVA and TPU were incompatible and the bridge i.e. the compatibilizer used does not match in structure with either EVA or TPU. Hence a simple solution to this was to develop a compatibilizer that would resemble the base polymers more or less so as the chances of phase separation might be minimized. So the outcome was to use an EVA grafted with TPU [4,5] as a bridge between EVA and TPU such that the final blend would seem to be like EVA / EVA-g-TPU / TPU. This compatibilizer can be prepared by mixing maleated EVA along with 4,4’ diamino diphenyl methane (MDA) in the mixing process of EVA and TPU. This can be made possible as the only unidentical material used in maleic anhydride whose Hansen solubility parameter lies in between EVA and TPU. The values typically are 15.1, 10.6 and 13.6 $(cal/cm^3)^{1/2}$ respectively for EVA, TPU and maleic anhydride.

The mixing stage can be bifurcated as:
Step 1: Maleated EVA and MDA reacts to form an intermediate maleic acid grafted EVA.
Step 2: The intermediate reacts with TPU to form the compatibilizer EVA-g-TPU.
Step 3: Final blending is carried out in order to obtain a blend in the form EVA / EVA-g-TPU / TPU.

2.2 Fluoroelastomer (FKM) with Polypropylene (PP)

This blend aims to improve the chemical resistance and durability of the existing chemical hoses. The chemistry and the logic behind this blend formation is very much similar to that of the above case study. Both polymers FKM and PP exhibit opposite polarity effect and hence are incompatible. But by making use of a grafted copolymer the blending can be made possible. In this case the intermediate or the compatibilizer used is maleated EPDM (Ethylene Propylene Diene Monomer Rubber).

The use of maleated EPDM facilitates the blending as it possesses two polar heads which would be able to mix with both FKM as well as PP. The steps involved in the making of maleated EPDM involves [6]:

1. Dissolution of EPDM.
2. Breaking down of molecular chains of EPDM.
3. Addition of liquid graft coagent with vigorous stirring.
4. Extraction of unreacted substituents.
5. Leaching and drying.

Figure 1: Grafting reaction being carried out

Figure 2: Maleated EPDM

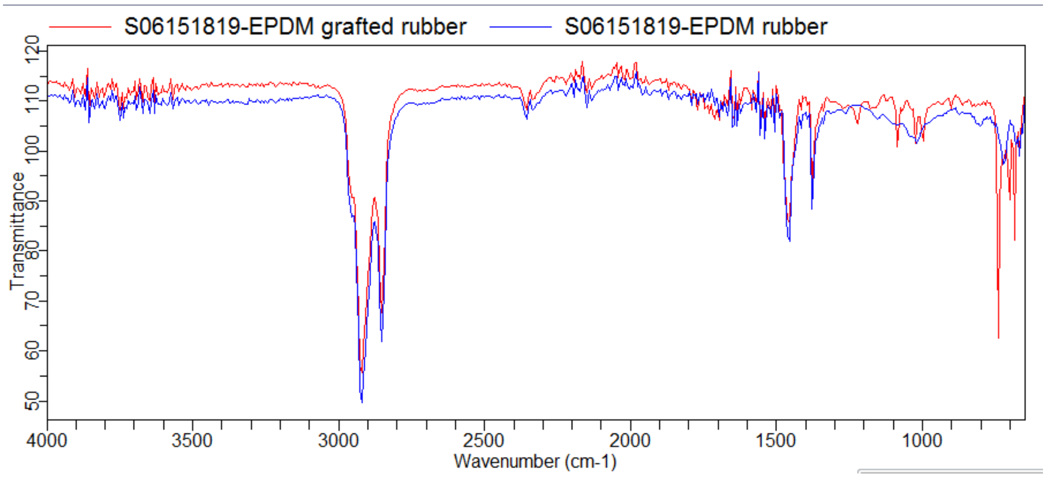

Figure 3: FTIR curve suggesting that proper grafting has occurred

3. CONCLUSION

By making use of a grafted copolymer that either comprises the base polymer itself or another polymer that has proven affinity to the base polymers one can reduce the problems of phase separation and interfacial slipping to a major extent.

4. ACKNOWLEDGEMENT

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