STUDY OF THE MECHANICAL PROPERTIES OF ABS-HIPS BLENDS WITH SEBS.

F. Parres[1], A. Nadal[1], R. Navarro[1], S. Sánchez-Caballero[1] and M. A. Selles[1]

[1]Department of Mechanical and Materials Engineering, Universitat Politècnica de Valencia, Plz Ferrandiz y Carbonell, s/n; 03801; Alcoy – Alicante (Spain)
e-mail: fraparga@dimm.upv.es

Abstract

The recovery process configuration produces a significant quantity of mixed material that has no commercial value. During styrene waste recovery processes, a mixture of ABS - HIPS is often produced which cannot be sold or used as either HIPS or ABS, but which must be commercialized as a blend with particular characteristics. A binary blend (ABS-HIPS 50% wt) was prepared on a twin-screw extruder at 190-210 ºC. The different properties were then analyzed using tensile strength and impact tests, melt flow index (MFI). The analysis of mechanical properties showed a decrease in elongation at break and impact strength. Moreover, the addition of SEBS to the binary system (ABS-HIPS) allowed us to increase the ductile properties (elongation at break and impact strength), as well as reducing the viscosity.

Keywords: *Polymer, Blend, Recycling, compatibility, interaction*

1. Introduction

The economic viability of polymer waste recovery processes rests on recovery of a large quantity of waste material, and given the great variety of polymers in existence it is not possible to have separate production lines for each type of material, so each line must be used for a range of polymers. This recovery process configuration produces a significant quantity of mixed material that has no commercial value. During styrene waste recovery processes, a mixture of ABS - HIPS is often produced which cannot be sold or used as either HIPS or ABS, but which must be commercialized as a blend with particular characteristics.

Following on from this, the objective of this study is to characterize ABS – HIPS blends and then to use SEBS to add value to these blends. Optimization of the production process requires that the recycling production line does not stop for a moment, and for this reason, when there is a change of material (from HIPS to ABS or vice versa) a certain quantity of each is lost. This change in material in fact means a change from 100% ABS to 100% HIPS, but in reality, the sum of the wasted material is made up of 50% of each.

2. Materials and Methods

Materials

The HIPS, ABS, and SEBS used in the experiment are commercial products HIPS (PS Impact 6541; Total petrochemical, Belgium), ABS (Terluran® GP22, BASF, Germany), and SEBS (Megol® TA, Applicazioni Plastiche Industriali, Italy)

Sample preparation

A binary blend (50%ABS – 50%HIPS wt) was conducted on a conventional extrusion machine, at 190 – 195 – 200 – 210 ºC extrusion temperatures. Finally, ternary blends were prepared by varying the SEBS content, from 0% to 30 % (wt %)

3. Results and Discussion

ABS – HIPS – System

The mechanical properties of any material are fundamental for its use in any particular application. Traction and impact tests are extremely important because they allow us to understand properties such as tensile strength, elongation at break and impact strength.

Table 1. Mechanical properties of ABS, Blend 50%, and HIPS.

	Tensile Strength, MPa	Elongation at break, %	Impact Strength, kJ m^{-2}
ABS	41.47	10.88	20.74
Blend 50%	27.05	8.65	5.25
HIPS	18.51	16.6	8.76

In the study carried out on the ABS-HIPS system, the graph showing tensile strength for the virgin (ABS and HIPS) and the 50% blend show a linear evolution of the values, where the 50% by weight blend has values that fall between those of virgin ABS and HIPS.

This result indicates the compatibility between the elements that form the blend. However, the values for elongation at break and impact strength of the 50% blend are very low; even lower than those of virgin material. While the elongation at break values, indicate a clear compatibility of the compounds, the properties related to ductility show they are not completely compatible (Table 1).

This behaviour has been observed by other authors when analyzing the properties of the blend obtained from recovery of waste materials from the electrical and electronic sectors [1]. The superficial characteristics after the breaking process allow us to more easily understand the mechanical behaviour of the material under test. This breaking process includes both the beginning of the crack and its evolution.

When we observe the break sections of virgin material (ABS and HIPS) and the 50% blend, we can see some differences in the way the break occurs and develops. Firstly, both virgin materials show a break section that is completely perpendicular to the stresses applied, while on the other hand, the break section of the ABS - HIPS blend occurs initially as a fan shaped crack before developing perpendicular to the stresses applied (Fig. 1). The reason for the loss of ductile mechanical properties could be due to a heterogeneous distribution of the two materials in the blend in the injected piece.

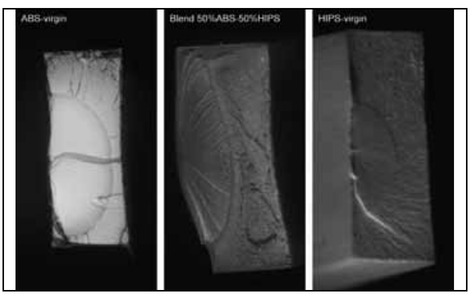

Fig. 1. Micrographs of the break sections obtained from the tensile strength test on the various samples.

ABS – HIPS – SEBS System

The elastic character of SEBS must bring improved ductile properties to the ABS – HIPS system. One of the first effects that can be observed in Table 2 is a decrease in tensile strength as the percentage of SEBS increases.

Table 2. Mechanical properties of Blends in function of SEBS content.

	Tensile Strength, MPa	Elongation at break, %	Impact Strength, kJ m^{-2}
Blend 50%	27.05	8.65	5.25
10% SEBS	24.04	12.41	8.51
20% SEBS	18.10	22.98	11.37
30% SEBS	11.13	27.71	13.18

This decrease is lighter for a SEBS content of 10%, and after this the tensile strength declines more rapidly reaching a loss of 60% for a 30% SEBS content. Although there is a loss in tensile strength, the recovery of high elongation at break and impact strength values more than compensate for this loss (Table 2).

On analyzing the results from the addition of SEBS to the ABS – HIPS blend, we conclude that the ideal percentage of SEBS is 10%, which causes a 10% decrease in tensile strength but a 50% increase in both elongation at break and impact strength values.

We found the reason for this recovery of ductile properties in the break sections of the samples, where the incorporation of SEBS to the ABS – HIPS blend causes a radical change in the break surface. Where previously we saw a fairly rough area, the addition of SEBS causes a peak which increases in size with the addition of more SEBS. The presence of this peak indicates the capacity of plastic deformation which is recovered with the presence of SEBS in the blend (Fig. 2).

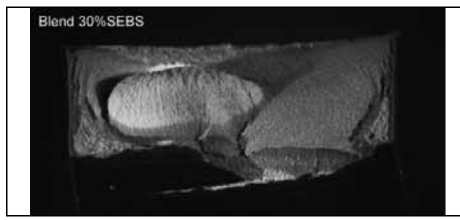

Fig. 2. Micrographs of the break surfaces after the traction tests of blend with 30% SEBS content.

4. Conclusions

Our results suggest that the compatibility between ABS and HIPS is only partial and that a significant loss of ductile properties is produced in the 50% by weight blend of the two materials. The addition of SEBS allows us to recover the ductile properties of the ABS – HIPS blend, with some loss of tensile strength. Analyzing the break surfaces allowed us to understand more easily the results obtained in the mechanical characterization as we saw an increase in plastic deformation when the percentage of SEBS is higher.

References

[1] LB Brennan, DH Isaac, JC Arnold. Recycling of Acrylonitrile–Butadiene–Styrene and High-Impact Polystyrene from Waste Computer Equipment. *Journal Of Applied Polymer Science,* 86, (2002) 572 - 578

Acknowledgements

To the VIDI of the Universitat Politecnica de Valencia for the help granted to the project: “Ternary systems research applied to polymeric materials for the upgrading of waste styrene”, Ref: 20091056 within the program of First Projects of Research (PAID 06-09) where this work is framed.