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MECHANICAL CHARACTERIZATION OF SEBS COMPOUNDS WITH PHASE CHANGE MATERIALS (PCM)

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Abstract: SEBS (styrene-ethylene/butylene-styrene) polymers successfully combine elastomeric properties with low processing costs typical of commodity plastics.
This study focuses on a blend from the provider's SEBS extreme hardness (50% Shore-A 5 and 50% Shore-A 90), adding microencapsulated phase change materials (PCMs) with a melting point of 52 ºC to optimize thermal inertia of parts made for uses in childcare products and footwear.
First step is injection of the blend from the provider's extreme hardness without and with PCMs in a relation of 2% and 5% weight. Next step is mechanical characterization of the blends, analyzing hardness, elongation at break and tensile strength. Finally, results are compared in order to determine properties variation.

1. INTRODUCTION.

SEBS (styrene-ethylene/butylene-styrene) polymers successfully combine elastomeric properties with low processing costs typical of commodity plastics. It is remarkable its range of hardness and elastic modulus, excellent resistance to aging, very good processability at low temperatures and resistant to high temperatures.

PCMs are materials with a well-defined melting point and a relatively high heat of fusion. These materials absorb energy to melt, and release heat to crystallize so that, they can be used as energy storage materials. Some aspects such as compatibility, morphology, mechanical performance, influence of particle fillers (including nanoparticles) and additives, etc. have been widely studied in the literature [1-6].

The main objective of this study is the mechanical characterization of a blend from the provider's SEBS extreme hardness (50% Shore-A 5 and 50% Shore-A 90) adding microencapsulated phase change materials (PCMs) with a melting point of 52 ºC to optimize thermal inertia of parts made for uses in childcare products and footwear.

It is possible to find different works regarding SEBS characterization; Wright, T. et. al. (2002) [7] analyze the improvement of properties of SEBS at high temperatures by modifying its chemical composition. In a similar way, Ghosh, S. et al. (1998) [8] discuss the stages of SEBS modification by using different additives and their influence on morphology and mechanical properties.

For the development of this study, we used the SEBS thermoplastic elastomer virgin Megol TA®, injecting standardized test pieces into a mold for tensile tests. For the injection has been used for injection Meteor 270/75 Mateu & Solé ®, by injection and crushed five cycles. The mechanical analysis has been developed using the model traction equipment from the manufacturer Elib-30 IBERTEST,S.L. and Shore A hardness equipment from the manufacturer Baxlo.

2. EXPERIMENTAL

2.1 Materials and preparation of specimens

For the development of this study, we used the SEBS thermoplastic elastomer virgin Megol TA® provider's extreme hardness, from the Italian manufacturer Plastiche Applicazioni Industriali, whose characteristics, within the range of SEBS available, make it unique thanks to its range of hardness and transparency.

Properties provided by the manufacturer are shown in Table 1:

Table 1. Properties of virgin SEBS Megol TA®

Properties	Values
Shore hardness range	5-90 A
Compatibility	PP-PE-EVA
Ageing resistance Ozone (72h - 40°C - 200ppcm)	
Tension = 20 %	Excellent
Weathering	Excellent
Density (g/cm3)	0,88-0,89
Tear strength w.n. (KN/m)	22-44
Tensile modulus 100% elongation (MPa)	1,1-4,2
Tensile modulus 300% elongation (MPa)	1,9-5
Tensile strength (MPa)	6-7,2
Elongation at break (%)	700-550

Phase change materials microcapsules (micro PCMs) with a melting point of 52 ºC, MPCM 52-D were supplied by Microtek Labs (Microtek Laboratories Inc., Dayton, USA). These microcapsules are composed of a paraffin blend core (85-90 wt. %) and a polymer shell (10-15 wt. %) which is stable up to 250 ºC heating thus enabling processing with conventional injection molding at intermediate temperatures. Microcapsules are supplied in powder form with an average diameter of 17-20 μm.

Next step has been injecting Megol TA® extreme hardness virgin materials blend in a relation 50%-50% without and with PCMs in a relation of 2% and 5% weight.

2.2 Methods and Measurements.

The injection was carried out by injection into a Meteor 270/75 Mateu & Solé ® machine.

The mechanical analysis has been developed using the model traction equipment from the manufacturer Elib-30 IBERTEST,SL and Shore A hardness equipment from the manufacturer Baxlo. All samples were tested at room temperature using a crosshead rate of 50 mm min-1 with a load cell of 100 N. A minimum of ten samples were tested and average values of elongation at break (ductile mechanical property) and tensile strength (resistance mechanical property) were calculated.

3. RESULS AND DISCUSSION.

The experiment began with the injection of the Megol TA® extreme hardness virgin materials blend in a relation 50%-50% without and with PCMs in a relation of 2% and 5% weight.

Experimentation has led to a total of three cycles of injection, spending twenty-one specimens tensile tests and nine hardness testing.

Mechanical characterization testing general conditions for commercial SEBS Megol TA® are shown in table 2:

Table 2- Mechanical characterization testing general conditions for commercial SEBS Megol TA®

Temperature	Room temperature (20-24 ºC)
Crosshead ratio	50 mm / min^{-1}
Load cell	100 N
Minimum specimens tensile tests	10

Table 3 and figure 1 show the results obtained in the traction equipment Elib-30 model with the three materials injected at 185 ºC.

Table 3- Tensile strength for commercial Megol TA® SEBS + PDM 52D blends

SEBS 50% A5 + 50% A-90 +% PCM	Tensile Strength (Mpa)	Standard Desviation	(%)
0% PCM	1,66	± 0,04	(± 2,21%)
2% PCM	1,76	± 0,05	(± 2,73%)
5% PCM	1,74	± 0,04	(± 2,04%)

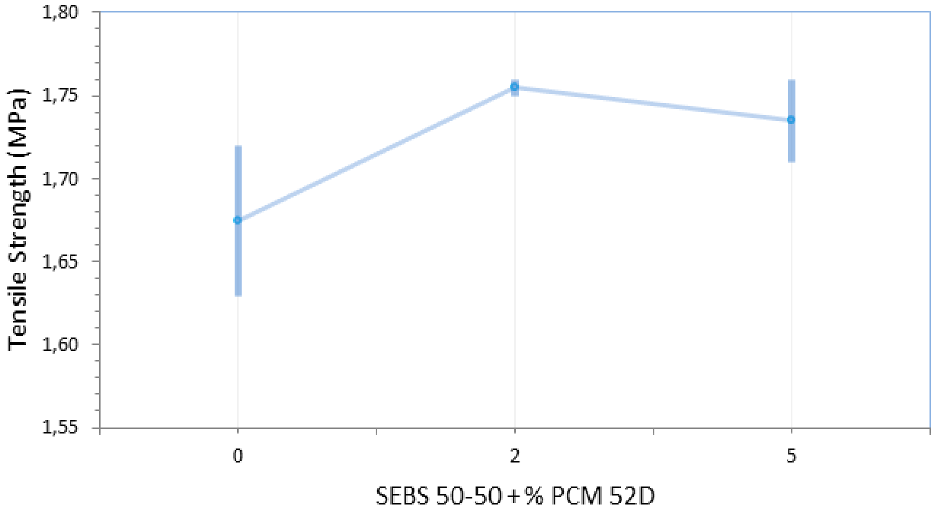

Figure 1 Tensile strength of Megol TA® SEBS + PDM 52D blends.

Table 4 and figure 2 show the elongation at break results obtained.

Table 4- Elongation at break for commercial Megol TA® SEBS + PDM 52D blends

SEBS 50% A5 + 50% A-90 +% PCM	% elongation	Standard Desviation	(%)
0% PCM	228,54	± 28,26	(± 12,07%)
2% PCM	193,56	± 38,24	(± 20,42%)
5% PCM	206,31	± 32,48	(± 15,74%)

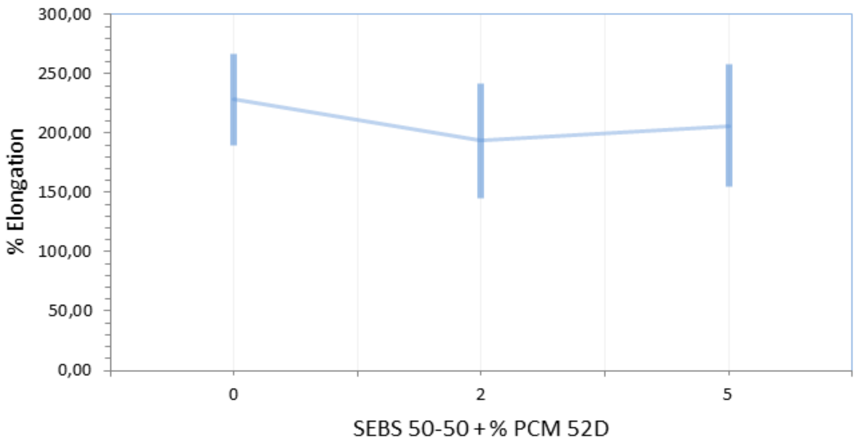

Figure 2 Elongation of Megol TA® SEBS blends.

Table 5 and figure 3 show the hardness results obtained.

Table 5- Shore A hardness for commercial Megol TA® SEBS + PDM 52D blends

SEBS 50% A5 + 50% A-90 +% PCM	Shore A Hardness Average	Standard Desviation	(%)
0% PCM	60,50	± 1,13	(± 1,91%)
2% PCM	56,00	± 1,11	(± 2,01%)
5% PCM	60,00	± 0,71	(± 1,18%)

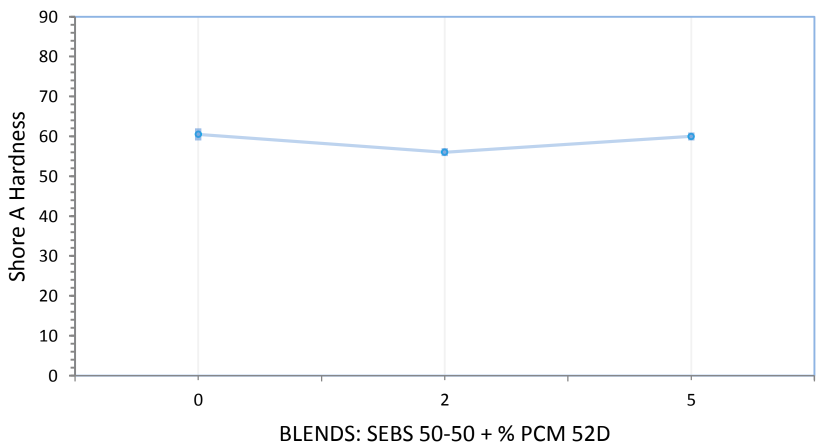

Figure 3 Shore A hardness of Megol TA® SEBS + %PCM 52D blends.

4. CONCLUSIONS

We studied the mechanical effects of processing blends from the provider's SEBS extreme hardness (50% Shore-A 5 and 50% Shore-A 90) adding microencapsulated phase change materials (PCMs) with a melting point of 52 ºC to optimize thermal inertia of parts made for uses in childcare products and footwear.

It has been used the thermoplastic elastomer Megol TA® SEBS, injecting a blend in a relation 50%-50% without and with PCMs in a relation of 2% and 5% weight. Next step is mechanical characterization of the blend, analyzing hardness, elongation at break and tensile strength.

Results show good miscibility between the virgin materials and PCM, obtaining values for tensile strength and Shore A hardness very close to the original ones (no PCM) added.

5. References

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