

VIRGIN AND REPROCESSED SEBS COMPARATIVE BY MECHANICAL CHARACTERIZATION

D. JUAREZ, M. A. PEYDRO, REIG, M.J., SEGUÍ V.J.

Instituto de Tecnología de Materiales, Universidad Politécnica de Valencia, Alcoy (Spain)

djuarez@mcm.upv.es

Keywords: SEBS, Thermoplastic, Reprocessing, Injection, Mechanical properties.

Abstract: SEBS plastic is a SBS that has been subjected to a hydrogenation process, by eliminating the polybutadiene chain. The new rubber has a high resistance to the environment, temperature, UV radiation, etc.. without losing the properties of a thermoplastic, making them very useful in applications where a normal SBS does not work.

This study focuses on the mechanical characterization of virgin SEBS and its reprocessed (by successive injection cycles), making a comparison of behavior, because the possible uses of this material.

1. INTRODUCTION.

SEBS is a thermoplastic material which combines successfully the properties of an elastomer (rubber) with low costs of processing thermoplastics.

The main representative of these compounds with the characteristics of thermoplastic elastomer is SEBS (Styrene - ethylene - butadiene - styrene). The excellent resistance to aging of all compounds based on SEBS is due to the absence of the double chain in the polymeric structure. Flexibility in the formulation of the polymer allows the production of wide ranges of hardness for different applications in industry.

Its main features are:

Remarkable range of hardness and elastic modulus.

- Excellent resistance to aging.
- Wide range of colors with white base.
- Very good processability at low temperatures.
- Resistant to high temperatures.

Regarding the characteristics of processing that indicates the manufacturer:

- Thermoplastic Material.
- Excellent processing characteristics using conventional methods.
- Reduced cycle times.
- Access to more sophisticated processing techniques: hot camera, co injection, co extrusion, etc.
- Simple Recycling.

The reprocessing and recycling of thermoplastic materials [3-8] is very interesting for the conservation of the environment, because it reduces the disposal of waste and makes better use of the material, especially when the price of the raw material is high, as is the case of SEBS.

Injection molding is one of the different manufacturing processes that use this type of material, which is of great importance for the quantity of products that are made daily.

The main objective of this study is the mechanical characterization of SEBS virgin and its reprocessed (by repeated cycles of injection), by a comparison of behavior, because of the possible uses that will give a temperature of 165 ° C (recommended by the manufacturer).

For the development of this study, we used the SEBS thermoplastic elastomer virgin Megol, exactly DP1261/s Cristallo E251 ®. The following material has been used reprocessed from the crushed of sprues and previously injected 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

For the development of this study, we used the SEBS thermoplastic elastomer virgin Megol, exactly DP1261/s Cristallo E251 ®, from the Italian manufacturer Plastiche Applicazioni Industriali, whose characteristics, within the range of SEBS available, make it unique thanks to its low hardness and transparency.

Next step has been using Megol DP1261/s Cristallo E251 reprocessing parts from sprues and standardized test pieces previously injected into a mold for tensile tests, using blades from the ground due to the impossibility of carrying it out through a traditional mill.

The injection was carried out by injection into a Meteor 270/75 Mateu & Solé ® machine. There were five injection cycles and ground, as indicated below, sufficient to determine the behavior of the material after reprocessing.

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.

3. RESULTS AND DISCUSSION

The reprocessing of the material has been carried out for five consecutive injection processes, in a prepared pan shaped pieces for tensile test pieces. The experiment began with the virgin material and after each injection parts and sprues were crushed to return to reprocessing.

After each injection, enough material was removed to make a proper investigation and hard drive. Experimentation has led to a total of five cycles of injection, spending thirty-five specimens tensile tests and fifty hardness testing.

The following tables, Tables 1 to 5 show the results obtained in the traction equipment Elib-30 model with the five materials injected to 165 ° C.

Tª inyección 165°C

Ensayos de Tracción	
Lo entre estrangulamientos:110mm	Velocidad:50mm·min-1

Virgen	R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)
SEBS Virgen 1	0,2150	341,82	0,0265	335,47	150	486
SEBS Virgen 2	0,2464	368,18	0,0281	364,41	150	515
SEBS Virgen 3	0,1857	297,27	0,0280	286,01	150	437
SEBS Virgen 4	0,2419	366,36	0,0275	361,96	150	513
SEBS Virgen 5	0,2046	322,73	0,0277	314,05	150	465
SEBS Virgen 6	0,2092	328,18	0,0281	316,63	150	471
SEBS Virgen 7	0,1844	305,45	0,0276	288,49	150	446
Medias	0,2125	332,86	0,0276	323,86		476,14

Table 1. Resistance values, Young's modulus, elongation, and Final Longitude Race for the virgin material.

1Reprocesado	R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)						
SEBS 1Reprocesado 1	0,2052	315,45	0,0285	305,47	150	457						
SEBS 1Reprocesado 2	0,2019	318,18	0,0284	304,91	150	460						
SEBS 1Reprocesado 3	0,1722	280,00	0,0284	264,00	150	418						
SEBS 1Reprocesado 4	0,1828	298,18	0,0280	281,47	150	438						
SEBS 1Reprocesado 5	0,1907	299,09	0,0287	285,28	150	439						
SEBS 1Reprocesado 6	0,2285	344,55	0,0285	334,97	150	489						
SEBS 1Reprocesado 7	0,1835	288,18	0,0292	272,87	150	427						
Medias	0,1950	306,23	0,0285	292,71		446,86	Variaciones	-8,23%	-8,00%	3,20%	-9,62%	-6,15%

Table 2. Resistance values, Young's modulus, elongation, and Final Longitude Race for the 1st reprocessed material.

2Reprocesado	R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)						
SEBS 2Reprocesado 1	0.2429	354.55	0.0295	344.79	150	500						
SEBS 2Reprocesado 2	0.2176	320.00	0.0297	309.15	150	462						
SEBS 2Reprocesado 3	0.2112	319.09	0.0295	305.67	150	461						
SEBS 2Reprocesado 4	0.2319	351.82	0.0285	341.05	150	497						
SEBS 2Reprocesado 5	0.2361	347.27	0.0291	338.10	150	492						
SEBS 2Reprocesado 6	0.2193	320.00	0.0305	307.79	150	462						
SEBS 2Reprocesado_7	0.1935	300.00	0.0292	285.88	150	440						
Medias	0,2218	330,39	0,0294	318,92		473,43	Variaciones	4,39%	-0,74%	6,46%	-1,53%	-0,57%

Table 3. Resistance values, Young's modulus, elongation, and Final Longitude Race for the 2nd reprocessed material.

3Reprocesado	R (Mpa)	A%	E (Mpa)	Carrera (mm)	Lo (mm)	Lf (mm)						
SEBS 3Reprocesado 1	0.2327	330.00	0.0308	319.22	150	473						
SEBS 3Reprocesado 2	0.1786	273.64	0.0308	255.91	150	411						
SEBS 3Reprocesado 3	0.1897	297.27	0.0295	279.61	150	437						
SEBS 3Reprocesado 4	0.2232	329.09	0.0300	316.00	150	472						
SEBS 3Reprocesado 5	0.2187	320.00	0.0302	307.17	150	462						
SEBS 3Reprocesado 6	0.2397	332.73	0.0318	320.41	150	476						
SEBS 3Reprocesado_7	0.2654	400.00	0.0322	348.26	150	550						
Medias	0,2211	326,10	0,0308	306,65		468,71	Variaciones	4,09%	-2,03%	11,27%	-5,31%	-1,56%

Table 4. Resistance values, Young's modulus, elongation, and Final Longitude Race for the 3rd reprocessed material.

4Reprocesado	R (Mpa)	A%	E (Mpa)	Carrera (mm)	Lo (mm)	Lf (mm)						
SEBS 4Reprocesado 1	0.2393	333.64	0.0312	324.30	150	417						
SEBS 4Reprocesado 2	0.2270	320.00	0.0316	306.45	150	462						
SEBS 4Reprocesado 3	0.2295	332.73	0.0301	321.29	150	476						
SEBS 4Reprocesado 4	0.2259	348.18	0.0308	336.15	150	493						
SEBS 4Reprocesado 5	0.1883	293.64	0.0295	276.26	150	433						
SEBS 4Reprocesado 6	0.2089	319.09	0.0293	304.08	150	461						
SEBS 4Reprocesado_7	0.2358	349.09	0.0291	338.43	150	494						
Medias	0,2221	328,05	0,0302	315,28		462,29	Variaciones	4,54%	-1,44%	9,35%	-2,65%	-2,91%

Table 5. Resistance values, Young's modulus, elongation, and Final Longitude Race for the 4th reprocessed material.

Once carried out the tensile tests with 35 samples and analyzed the data, we have proceeded to its graphical representation (Figures 1 and 2):

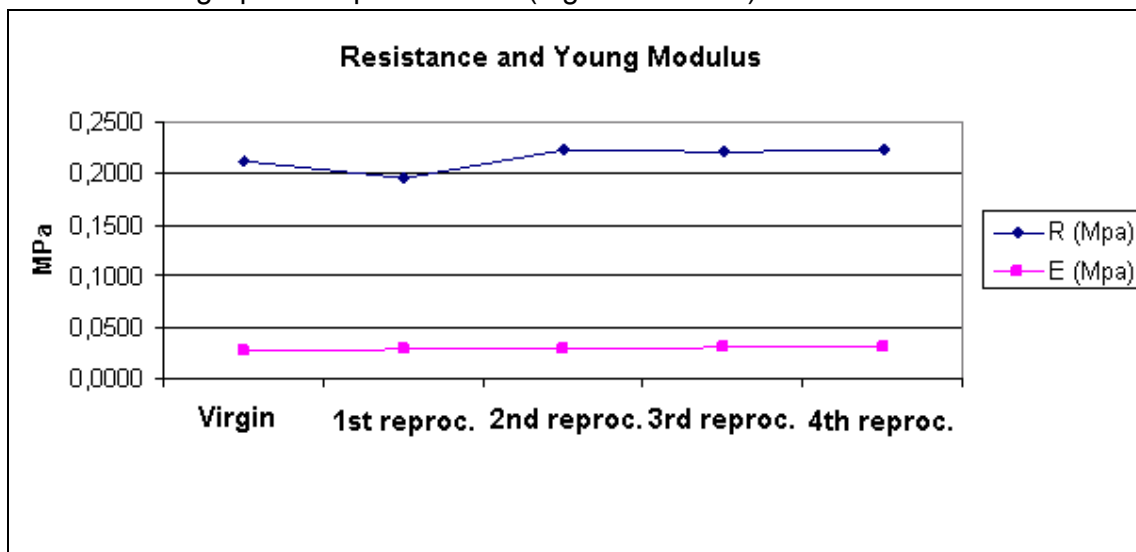


Figure 1: Graph of Resistance and the Young's modulus for the five materials at 165 ° C.

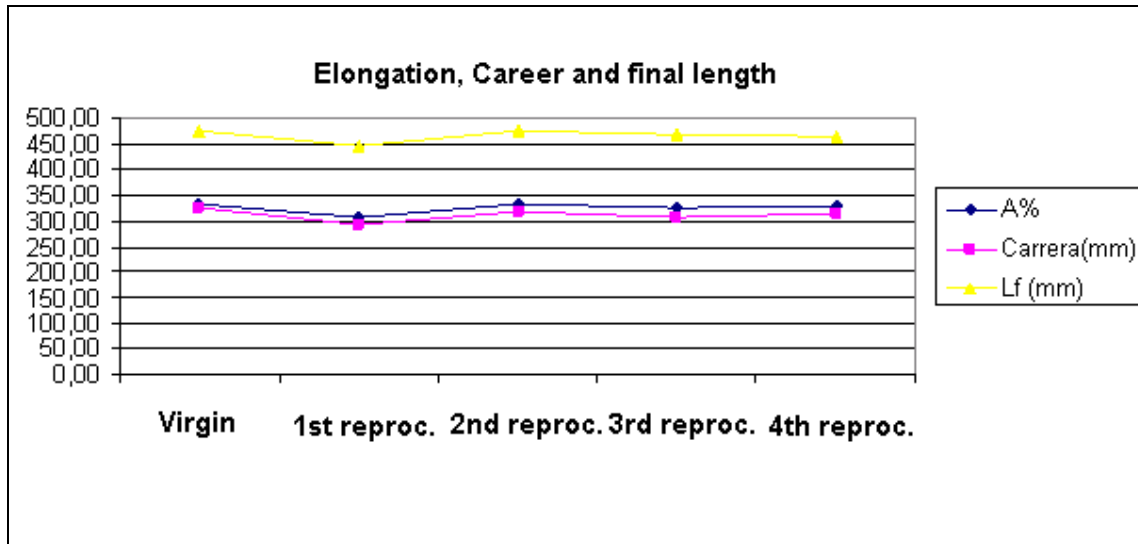


Figure 2: Graph of elongation, Career and final length for the five materials at 165 ° C.

Similarly, in the following tables, tables 6 to 10 show the results obtained in the Shore A hardness equipment from the manufacturer Baxlo with the five materials injected to 165°C.

Virgin	Test tube 1	Test tube 2	
	10,00	10,00	
1	9,00	10,00	
2	11,00	11,00	
3	10,00	11,00	
4	10,00	10,00	
5	10,00	10,00	
Averages	10,00	10,40	10,20

Table 6. Shore A hardness values for virgin material injected to 165 ° C.

1st. Reprocessed	Test tube 1	Test tube 2	
	11,00	10,00	
1	10,00	8,00	
2	10,00	9,00	
3	10,00	10,00	
4	10,00	10,00	
5	10,00	10,00	
Averages	10,20	9,40	9,80

Table 7. Shore A hardness values for first reprocessed material injected to 165 ° C.

2nd. Reprocessed	Test tube 1	Test tube 2	
1	10,00	9,00	
2	9,00	9,00	
3	9,00	10,00	
4	9,00	10,00	
5	10,00	10,00	
Averages	9,40	9,60	9,50

Table 8. Shore A hardness values for second reprocessed material injected to 165 ° C.

3rd. Reprocessed	Test tube 1	Test tube 2	
1	10	9	
2	11	10	
3	9	8	
4	11	11	
5	11	10	
Averages	10	10	10

Table 9. Shore A hardness values for third reprocessed material injected to 165 ° C.

4th. Reprocessed	Test tube 1	Test tube 2	
1	11,00	11,00	
2	10,00	10,00	
3	9,00	9,00	
4	11,00	11,00	
5	9,00	11,00	
Averages	10,00	10,40	10,20

Table 10. Shore A hardness values for fourth reprocessed material injected to 165 ° C.

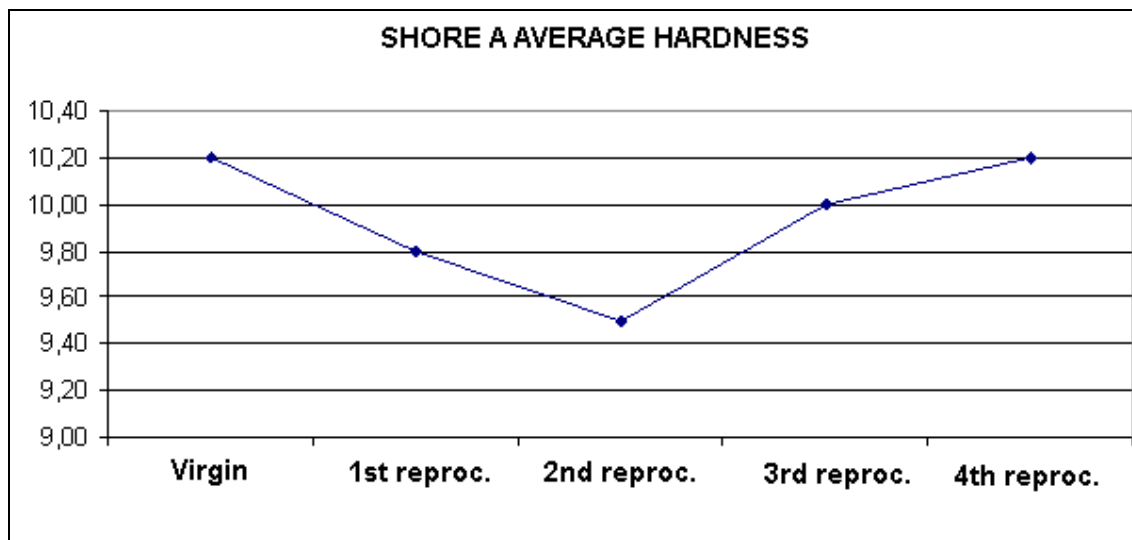


Figure 3: Graph of average Shore A hardness for the five materials at 165 ° C.

4. CONCLUSIONS.

The variation of the resistance and Young's modulus is minimum and there is a slightly increasing trend with advancing the reprocessing cycle.

Regarding the shore A hardness, rarely varies.

5. REFERENCES

- [1] M.J. Reig, V.J. Segui, S. Ferrandiz, J.D. Zamanillo, An evaluation of processability by injection molding of ABS/PC blends obtained from recycled materials, J. Polym. Eng. 27 (2007) 29 – 54
- [2] Nam, G. J., Kim, K. Y., and Lee, J. W. (2005). "The effect of SEBS on interfacial tension and rheological properties of LDPE/PS blend." Journal of Applied Polymer Science, 96 (3), 911.
- [3] Nadal Gisbert A.V. et al. Análisis de la Influencia en las propiedades mecánicas y térmicas de las mezclas de materiales termoplásticos reciclados con G.T.R (Ground Tyre Rubber). 1º Internat. Congress of Energy and Environment Engineering. Portalegre (Portugal) (2005).
- [4] Tjong, S. C., Xu, S. A., et col. (2002). "Mechanical behavior and fracture toughness evaluation of maleic anhydride compatibilized short glass fiber/SEBS/polypropylene hybrid composites." Composites Science and Technology, 62 (6), 831.