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

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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 º 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 º C.

Tª inyección 165ºC

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**

	R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)
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		R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)
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		R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)
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		R (Mpa)	A%	E (Mpa)	Carrera(mm)	Lo (mm)	Lf (mm)
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):

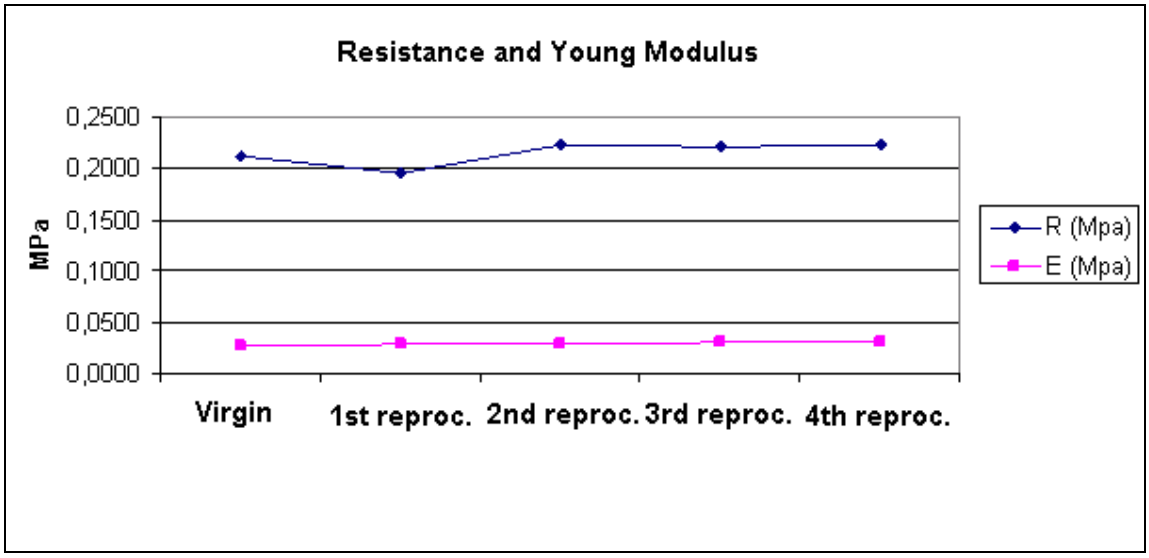

Figure 1: Graph of Resistance and the Young's modulus for the five materials at 165 º C.

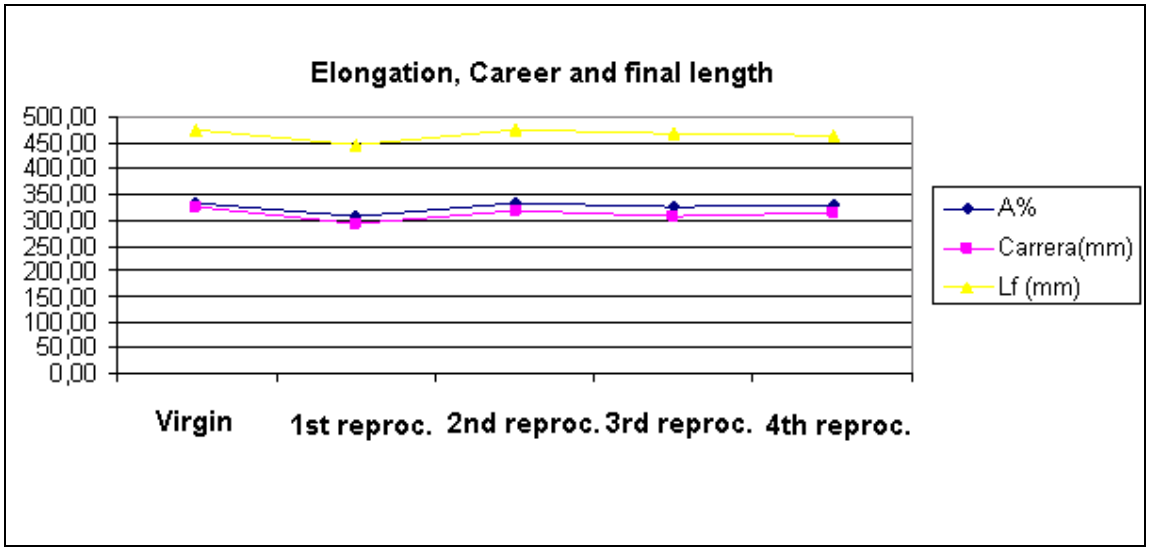

Figure 2: Graph of elongation, Career and final length for the five materials at 165 º C.

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 165ºC.

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

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

1st. Reprocessed	Test tube 1	Test tube 2	
1	11,00	10,00	
2	10,00	8,00	
3	10,00	9,00	
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 º 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 º 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 º 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 º C.

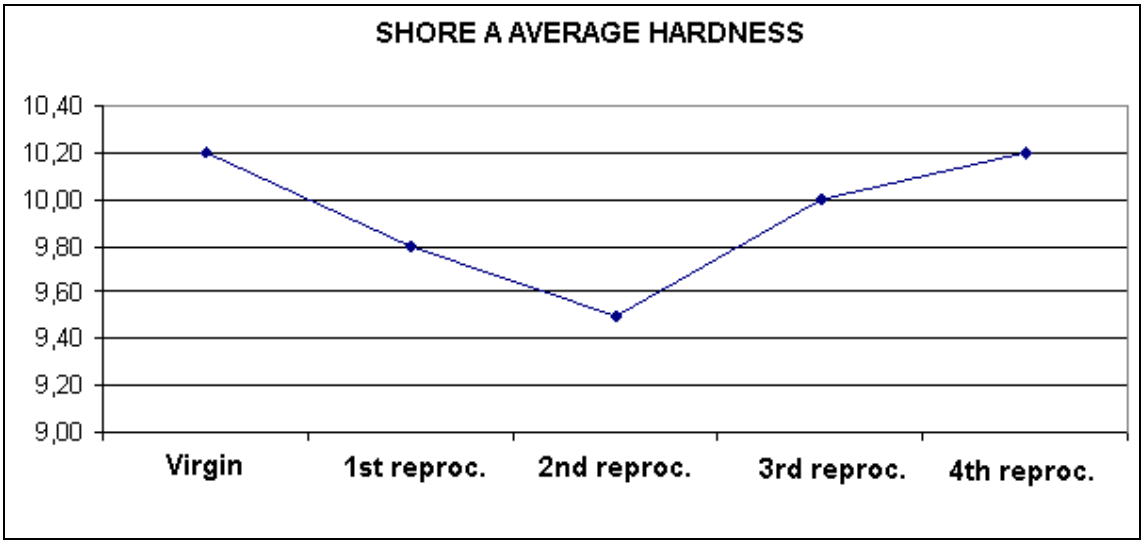

Figure 3: Graph of average Shore A hardness for the five materials at 165 º C.

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

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