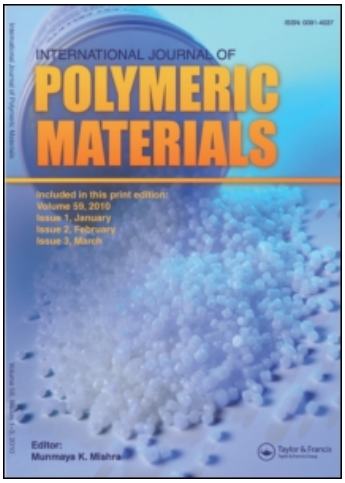

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Preparation and Properties of Styrene-Ethylene-Buthylene-Styrene Hot Melts

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Hot melt-type adhesives were prepared by mixing Styrene-Ethylene-Buthylene-Styrene (SEBS) rubber with various tackifying resins. Thermal and peeling properties measured on the resulting blends show that it is indeed possible to produce a working SEBS-based solvent-free adhesive by properly combining the properties of the corresponding components in the formulation.

Keywords: Hot melt adhesives; Styrene-Ethylene-Buthylene-Styrene rubbers formulations

INTRODUCTION

Adhesives and adhesion are two very important issues in today's science and technology for a number of reasons: first, because many of the very basic mechanisms and interactions taking place in the adhesion phenomenon are not well understood yet. Second, because of the extremely important practical applications that adhesives have in most areas. In particular, hot melts and related materials represent a

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rather attractive field of research and technological development. This is due, among other reasons, to the fact that they constitute solvent-free adhesion systems, which, besides, the scientific relevance from the standpoint of the fundamental physico-chemistry involved, represent an important ecological issue [1]. In this present work, hot melts adhesives were prepared by using SEBS (Styrene-Ethylene-Buthylene-Styrene) rubber modified with tackifying resins in various proportions. This commercially-available elastomer was chosen due to its great resistance to degradation. DSC, TGA and DMA were employed for characterizing the materials prepared. Also, peeling, loop tack and shear tests were performed according to the standards of the Pressure Sensitive Tape Council.

EXPERIMENTAL

The formulations prepared are described in Table I. As can be noticed there, every composition contains a commercial SEBS (Exxon Co.), two low molecular weight resins (Hercules Inc.) and a stabilizer to prevent oxidation. All four components in the proper composition were blended in a standard mixer (Rheometrix 600). TGA was carried out in a Dupont V41. C, series 2000 and DSC in a Dupont V4.0B series 2100.

TABLE I Description of the hot melts prepared

Component	*Formulation* 1 *% weight*	*Formulation* 2 *% weight*	*Formulation* 3 *% weight*	*Formulation* 4 *% weight*
Kraton GX 1657 (SEBS)	44.83	34.84	34.84	44.84
Regalrez 1085 Solid Resin	54.72	19.87	38.33	24.22
Regalrez 1018 Liquid Resin	00.00	44.94	26.48	30.49
Irganox 1010 Stabilizer	00.45	00.35	00.35	00.45
Total % Weight	100.00	100.00	100.00	100.00
Total % resin	55.00	65.00	65.00	55.00

RESULTS AND DISCUSSION

The results of the TGA experiments are summarized in Table II, where the corresponding degradation temperatures are listed. As can be observed there, the highest degradation temperature achieved (235°C) corresponds to the composition with the highest SEBS content. However, the presence of the solid resin 1085 also seems to play an important role. By comparing the measured degradation temperature to the resin content, one can observe that here exists a resin content value, around 30% wt., where the degradation temperature shows a minimum. It is important to point out here that all the measured degradation temperatures were smaller than the mixing temperatures; therefore, a possible degradation during the mixing process can be ruled out.

Table III contains the results of the DSC analysis. In this case, the more total resin is added, the higher the Tg obtained. It is interesting to notice that in the literature a second glass transition temperature for SEBS is expected at around 100°C, corresponding to the polystyrene blocks. In the present report, only one Tg was found in each case, probably due to the low styrene content (13%) of the SEBS employed. Figure 1 shows schematically the effect of adding solid resin on the Tg of the blend. The linear dependence experimentally observed can be explained by using the so-called Fox correlation [2].

TABLE II Degradation temperatures of hot melts prepared

Formulation	*Degradation temperature*
1	235°C
2	193°C
3	183°C
4	187°C

TABLE III Tg of components utilized and of hot melts prepared

Component	*Tg.°C (Reported)*	*Formulation*	*Tg. °C (Measured)*
SEBS	−55	1	−31
Solid Resin	32	2	−33
Liquid Resin	−22	3	−28
		4	−34

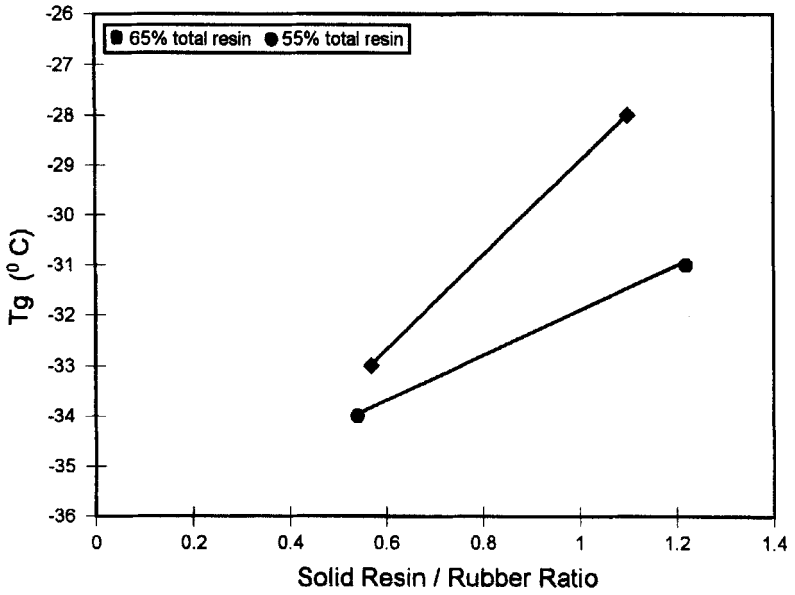

FIGURE 1 Effect of solid resin/rubber ratio on Tg of the blends.

Table IV summarizes the results of the peel, loop tack and shear modulus tests performed, and Figures 2–4 represent graphically the same results.

As a general trend, the peeling force increases when the solid resin content is increased, reaching a maximum and then decreasing. This is probably so because, as the shear modulus increases, the material becomes harder and the adhesion improves. However, a corresponding increase in Tg makes that, when Tg goes above room temperature, the material no longer is capable of flowing adequately on the surface and thus the adhesion capability decreases. From Figure 3, it can be

TABLE IV Summary of properties of hot melts prepared

Test value	*Formulation* 1	*Formulation* 2	*Formulation* 3	*Formulation* 4
Peel	290 g/in.	406 g/in	611 g/in.	494 g/in.
Loop Tacks	1.4 g/in	69.2 g/in	12.4 g/in	56.1 g/in
Shear	> 100 hours	10 min.	23 min.	285 min.

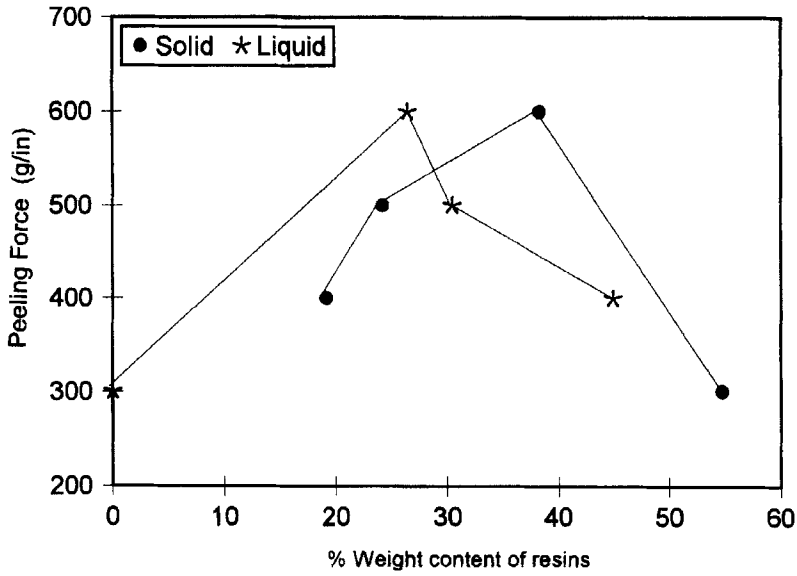

FIGURE 2 Effect of weight content of resins on the peeling force of the hot melts.

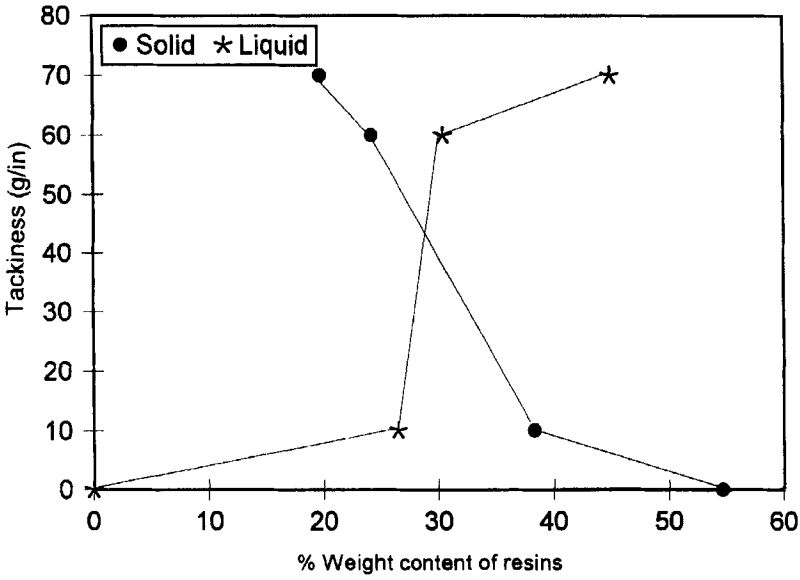

FIGURE 3 Effect of weight content of resins on the tackiness of the hot melts.

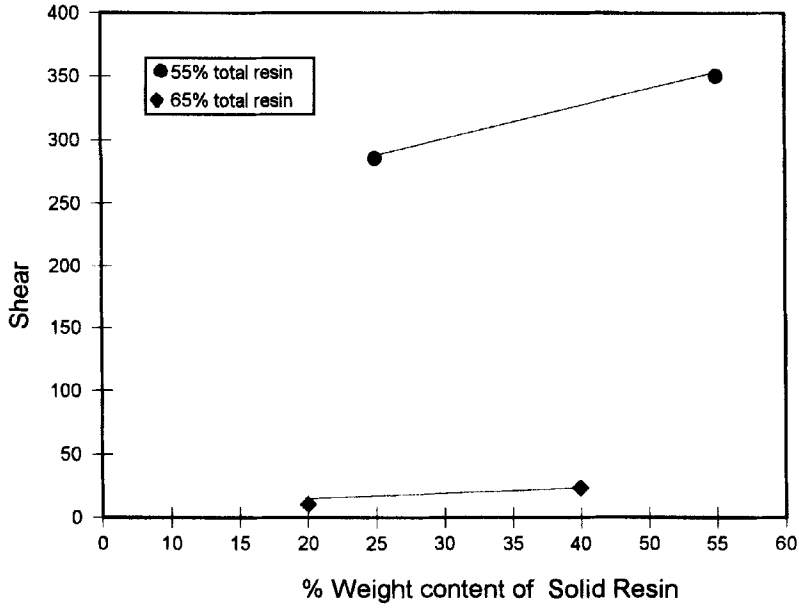

FIGURE 4 Effect of weight content of solid resin on shear of the blends.

observed that the tacking increases that the tacking increases as the amount of liquid resin increases too. This is obviously due to the better flow capacity of the blend. However, a saturation point is reached when, due to miscibility problems, the mixing is not perfect and a second phase is likely to be formed. The use of solid resin has the opposite effect. This means that the more solid resin added, the higher the viscosity and the poorer the loop tacking [3, 4].

Figure 4 shows the effect of solid resin content on the shear, for two different contents of liquid resin (55% and 65%). The results indicate that, for the same liquid resin content, the addition of more solid resin results on an increase of the shear. However, the use of less liquid resin (55%) has a considerable effect also. This can be understood by recalling that, the more liquid resin added, the less viscous the blend, resulting this in a higher flow capacity, producing thus less adhesion to the substrate.

CONCLUSION

The feasibility of producing SEBS-based hot melts with competitive characteristics for adhesion applications was demonstrated. The combined use of tackifing resins both in solid and in liquid state seems to be the appropriate way to control the final behavior of these hot melts, specially in terms of the corresponding loop tack, shear and peeling properties. A careful mixing of the appropriate liquid–solid resin relationships allows to produce adequate materials through the changes on the chemical and physical characteristics, such as the resulting Tg and the specific segregation behavior.

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