In situ compatibilization of PBT/ABS blends through reactive copolymers

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Styrene–acrylonitrile–glycidyl methacrylate (SAG) copolymer with ethyltriphenyl phosphonium bromide (ETPB) catalyst has been used successfully as *in situ* compatibilizer to compatibilize the immiscible and incompatible blends of poly(butylene terephthalate) (PBT) and acrylonitrile–butadiene–styrene (ABS). This SAG copolymer contains reactive glycidyl groups that are able to react with PBT end groups (–COOH or –OH) under melt conditions to form SAG-*g*-PBT copolymer. However, the rate of the grafting reaction is slow without the presence of catalyst. The ETPB catalyst is highly efficient: even at a concentration as low as 50 ppm, it is able to promote the grafting reaction to obtain the maximum achievable properties. The compatibilized PBT/ABS blend has smaller phase domain, higher viscosity, and significantly improved mechanical properties compared to the corresponding non-compatibilized blend.

(Keywords: compatibilizer; reactive copolymer; polymer blend)

INTRODUCTION

Physical and chemical interactions across the interface are recognized to be critical in controlling the overall performance in any immiscible polymer blend. Considerable research efforts have focused on methods of reducing interfacial tension and increasing phase adhesion between two immiscible phases. The synthesized block or graft copolymers as compatibilizers have successfully turned several otherwise incompatible blends into compatible and useful blending materials. However, such copolymers usually require a separate preparation step and certain copolymers are difficult to obtain.

Compatibilizers formed *in situ* based on certain types of reactive copolymers have been the subject of great interest as an alternative to the conventional block or graft copolymers to compatibilize incompatible polymer blends. Research activity on reactive compatibilization has been concentrated mostly on polymer blends between nylon and polyolefins (and polyolefin rubbers) functionalized with maleic anhydride (MA) or acrylic acid[1-11], with only a few studies on other systems[12-17].

Recently, *in situ* compatibilized polymer blends based on copolymers containing glycidyl methacrylate (GMA) monomer have attracted great attention because of potentially broad applications. Chung and Carter[18] patented a polymer, claimed to have excellent low temperature impact properties, based on polycarbonate (PC), poly(ethylene terephthalate) (PET), high butadiene content acrylonitrile–butadiene–styrene (ABS) rubber, and styrene–acrylonitrile–glycidyl methacrylate (SAG) copolymer. We believe that the presence of SAG functions as an *in situ* compatibilizer between PET and ABS rubber. Suzuki and Yamamoto briefly reported SAG as a reactive compatibilizer in the polymer blends of poly(butylene terephthalate) (PBT) and ABS[19]. Akkapeddi *et al.* reported using ethylene-*g*-GMA (E-GMA) as a reactive compatibilizer in the blends of PET with PC[20] and with various polyolefins[21]. In a continuous programme to investigate the *in situ* compatibilization of polyblends, we have reported a series of reactive compatibilized blends based on GMA-containing copolymers including the following polymer pairs: polystyrene (PS)/nylon[22], PS/PET[23], high impact polystyrene (HIPS)/PET[24], ABS/phenoxy[25], ABS/nylon[26], ABS/polyacetal[27], polyphenylene oxide (PPO)/PBT[28], and poly(methyl methacrylate) (PMMA)/PBT[29].

PBT is a commodity crystalline polymer with excellent properties in terms of solvent resistance and electric insulation and therefore has wide applications in the automotive and electronic industries. High notch impact sensitivity is the major disadvantage for PBT and rubber-toughened PBT usually requires a large quantity of rubber (>20%) in order to shift the notch impact fracture from brittle into ductile mode. ABS is also a large quantity commodity polymer with excellent low temperature impact strength and is very easy to process. The major disadvantage of ABS is the extremely poor solvent resistance which tends to prohibit its application in areas involving contact with organic solvents.

A polyblend based on PBT and ABS is logically an ideal choice and highly desirable to produce a product with balanced properties of both matrices: better notch impact strength than PBT and better solvent resistance than ABS. Very little literature is currently available on the polymer blends of PBT/ABS and we suspect this is due to the incompatibility of this polymer pair. The incompatibility between PBT and ABS was observed when we initiated the study of this blend without using any compatibilizer[30]. Binsack *et al.* patented a

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high-impact PBT by blending PBT with high rubber content ABS rubber without mentioning any compatibilizer[31]. ABS in this patent basically functions as an impact modifier to toughen PBT rather than as a blend matrix. In this paper, we report SAG-compatibilized polymer blends of PBT and ABS, their specific miscibility, and correlation with their mechanical properties.

EXPERIMENTAL

Materials

PBT was natural grade 1100 from Chang Chun Petrochemical., Ltd. ABS was Magnum, from Dow Chemical Company. The catalyst was ethyltriphenyl phosphonium bromide (ETPB) from Merck. The core–shell rubber was EXL 3330 from Rohm and Haas. The SBS rubber was Kraton D-1101 from Shell Chemical Company. The SBS-X rubber was Kraton G-1901X, MA grafted SBS, from Shell Chemical Company.

SAG copolymers were synthesized through suspension polymerization; the following procedure, as an example, shows the preparation of SAG10 (10 wt% of GMA in SAG). Some 2 g benzoyl peroxide initiator, 0.8 g Irgonox 1010 antioxidant, 130 g styrene 50 g acrylonitrile (from Merck) and 20 g GMA (from Merck) were added to a 2 l five-necked glass reactor. An aqueous solution was prepared by mixing 2 g polyvinyl alcohol in 1200 ml water and adding it to the reactor under agitation (150 rev min^{-1}) and nitrogen purging. The reactant mixture temperature was raised to 75°C and held for 8 h to complete the reaction. The solid SAG product was filtered and washed with plenty of water, and dried in a vacuum oven at 95°C for at least 12 h to obtain the SAG10 powder product.

Melt blending and injection molding

Melt blending was carried out by using a 20 mm Welding Engineers twin-screw extruder with $L/D=48$ and counter-rotating intermeshing screws. The blended and dried pellets were moulded into 3.2 mm standard test specimens by using an Arburg 3 oz injection-moulding machine.

Characterization

Material characterizations including blending, torque measurements, melt flow rate (250°C, 5.0 kg), Fourier transform infra-red spectroscopy (*FT*i.r.), tensile (ASTM-D638), notched Izod impact (ASTM-D256), instrumental falling weight impact (ASTM-D3029) and scanning electron microscopy (SEM) have been described in previous papers[22,23,25,32,33,34].

RESULTS AND DISCUSSION

In situ *compatibilization*

A phase compatibilizer (block, graft or random copolymer) tends to reside along the interface but not exclusively; some will dissolve in both blend components. Even without the presence of compatibilizer, a certain degree of mutual solubility still exists in any immiscible polymer pair. The presence of compatibilizer will certainly increase such mutual solubility. Distribution of the compatibilizer molecules in any immiscible polymer blend depends on several factors such as chemical structure, mutual interaction between the compatibilizer and blend components, processing conditions, molecular weight and distribution, and type of copolymer. The compatibilizer distributed within the blend components in order to induce further mutual solubility between components will certainly alter the inherent toughness of these components. Therefore, the toughness of a compatibilized blend may increase or decrease relative to a non-compatibilized blend depending on the competition between the advantages from better phase adhesion and dispersity and the disadvantage from the loss of inherent toughness of the blend components. Therefore, a good compatibilized polymer blend, in terms of better adhesion and finer domain size, does not warrant the improvement of its mechanical toughness, and this point of view has been virtually neglected previously. The styrene–maleic anhydride (SMA) as *in situ* reactive compatibilizer in the polymer blends of PS/nylon is a typical example[22] and many blends reported in the literature show the same phenomenon.

Non-reactive and specific compatibilizers. A non-reactive block or graft copolymer can be considered as a specific compatibilizer because its chemical structure and quantity are unchanged and independent of blending conditions. The choice of a non-reactive copolymer is based on the miscibility of its segments with each of the blend components. A copolymer of the type C–D may compatibilize the immiscible blend pair of A + B provided that C and D are either identical or miscible with A and B, respectively[35].

Reactive, non-specific and in situ*-formed compatibilizers.* A reactive compatibilizer can be considered as a non-specific, *in situ*-formed compatibilizer because the chemical structure and quantity of the copolymers (block or graft) eventually formed will vary with the content of the reactive group, temperature, time mixing efficiency, and catalyst.

When a copolymer containing reactive functional groups C–X is added to a binary blend of A + B during compounding, this added copolymer can react with at least one of the blend components (component B, for example) and the *in situ*-formed copolymer C–X–B (graft or block) will function as compatibilizer for the polyblend of A + B provided C is identical or miscible (or at least partially miscible) with A. This reactive *in situ* compatibilization is applicable only to blend systems in which at least one of the blend components contains certain functional groups (either as chain ends or within the chain) and are able to react with the reactive compatibilizer. Usually the blend components containing chain-end reactive functional groups are more suitable for *in situ* compatibilization; typical examples are $-NH_2$ of nylon, –COOH and –OH of polyester and –OH of PPO. Usually the reactive compatibilizer contains numerous reactive groups per chain and the *in situ*-formed copolymers are the graft type. On rare occasions, the reactive compatibilizer can be a polymer (or copolymer containing chain-end reactive functional group). For example, solid bisphenol-A epoxy resin ($M_n = 5000$) acts as reactive *in situ* compatibilizer for the polymer blend of PC and nylon[36]. When the blend components contain highly reactive functional groups within the main chain, such as –OH in polyvinyl alcohol,

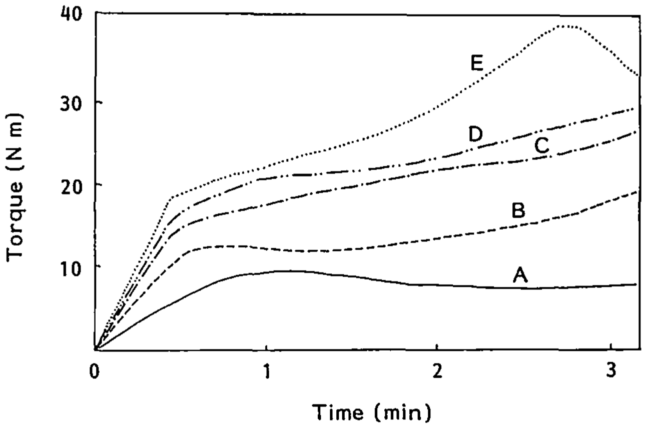
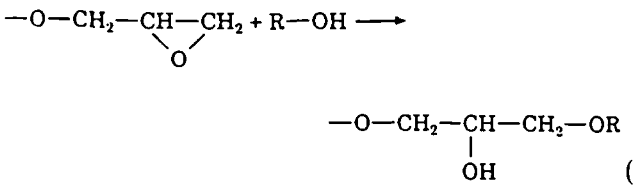


Figure 1 Torque *versus* time of the PBT/SAG10 = 1/1 mixture (245°C, 150 rev min^{-1}) with various concentrations of ETPB catalyst (ppm): A, 0; B, 40; C, 400; D, 1000; E, 2000

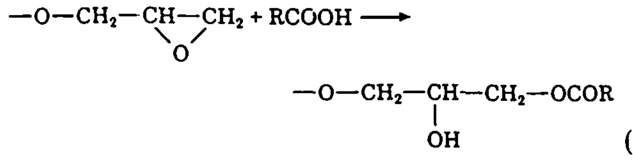
a crosslinked network may form by reacting the reactive compatibilizer. When the blend components contain multiple low reactive functional groups within the main chain, such as the aliphatic -OH in phenoxy resin, the reactive compatibilizer normally cannot react with the aliphatic -OH unless a certain catalyst is present to form the lightly grafted copolymer. Reactive compatibilizer SAG, in the presence of ETPB catalyst, is able to control the degree of graft reaction with the aliphatic -OH in phenoxy resin to form the lightly grafted SAG-*g*-phenoxy copolymer as *in situ* compatibilizer for the polymer blend of ABS and phenoxy resin[25].

In this paper, the reactive copolymer (SAG) itself cannot act as a phase compatibilizer for the polyblends of PBT and ABS. However, the reaction products between the epoxide groups in the SAG copolymer and the PBT end groups (-COOH or -OH) will form various SAG-*g*-PBT copolymers that will function as the non-specific compatibilizer. In order to achieve maximum compatibilization, the S/A monomer ratio in the SA segments in SAG copolymer should match with the S/A monomer ratio in ABS.

An excessively grafted copolymer will result in the highly branched SAG-*g*-PBT comb-like graft copolymers or even a crosslinked network. Such an excessively grafted copolymer has the branched PBT chains effectively shielding the SA segments and its role as a phase compatibilizer is decreased. Besides, the formation of the excessively grafted copolymers will drastically increase the viscosity of the blend and this is certainly undesirable. Therefore, an optimal degree of *in situ* grafting is essential to achieve the greatest performance of the resulting blended product, and this can be accomplished through proper adjustment of the GMA content in SAG, the presence of suitable catalyst, and proper control of the blending conditions. The reaction of SAG copolymer and PBT end groups can be expressed by the following equations:



$$-O-CH_2-\underset{\diagdown O \diagup}{CH-CH_2} + R-OH \longrightarrow -O-CH_2-\underset{OH}{\underset{|}{CH}}-CH_2-OR \qquad (1)$$



$$-O-CH_2-\underset{\diagdown O \diagup}{CH-CH_2} + RCOOH \longrightarrow -O-CH_2-\underset{OH}{\underset{|}{CH}}-CH_2-OCOR \qquad (2)$$

Processability

Without the presence of the compatibilizer, extrusion blending of the incompatible blends of PBT and ABS (at any component ratio) has led to various difficulties such as die swelling and melt fracture. The presence of the SAG compatibilizer has solved most of these problems. When both SAG and ETPB catalyst were used, essentially all the blends resulted in smooth extrusion blending. Therefore, the *in situ* SAG compatibilizer employed in this study, with or without catalyst, is able to convert an incompatible PBT/ABS blend into a compatible one. Higher melt viscosity of the compatibilized blends relative to the non-compatibilized blends is an unavoidable disadvantage.

Torque versus time

Figure 1 shows the torque *versus* time (in a Brabender Plasticorder 651) by blending the mixtures, PBT/SAG10 = 1/1, with various ETPB catalyst concentrations. Higher catalyst content increases the rate of the grafting reaction, and the molecular weight increase due to the formation of SAG-*g*-PBT is responsible for the higher torque value observed. However, excessive catalyst, at 2000 ppm or higher, caused the torque to decrease after about 2.8 min. This ETPB catalyst may also catalyse degradation of the SAG/PBT blend but at a significantly slower rate than the grafting reaction. Therefore, excessive ETPB catalyst is unnecessary or even harmful in promoting the desired grafting reaction.

Identification of grafting reaction by FT*i.r. and acid titration*

In order to verify the reaction between -COOH end groups of PBT and glycidyl groups of SAG10, a mixture of PBT/SAG10 = 1/1 was melt mixed in a Brabender at 245°C and 60 rev min^{-1}. Samples were taken after 2 and 7 min and analysed by *FT*i.r. and acid titration. *FT*i.r. spectra (*Figure 2*) show that the epoxy characteristic peak (930 cm^{-1}) is decreased slightly from 2 to 7 min while the corresponding acid content (based on PBT) is also decreased from 0.09 to 0.05 meq g^{-1}. Since the total epoxy equivalence in this mixture is much higher than the total PBT end groups (-COOH and -OH), the observed slight reduction of epoxy group is not unexpected. This result indicates that both epoxy groups (from SAG) and -COOH groups (from PBT) decrease simultaneously in response to the anticipated grafting reaction. It is understandable that the graft reaction can also occur through -OH end groups of the PBT, as shown in equation (2), but the rate is expected to be slower owing to the acidity difference. The epoxy groups can also be consumed in other reactions such as hydrolysis[23] and epoxide coupling.

SEM morphologies

Figure 3 illustrates the effect of SAG10 compatibilizer and ETPB catalyst on the resultant phase domains. The non-compatibilized PBT/ABS = 75/25 blend (*Figure 3a*) shows large dispersed holes which are the ABS phase being etched out by tetrahydrofuran solvent. The ABS phase domains become significantly smaller but the phase contrast remains very clear for the blend containing 5 phr (parts per hundred parts resin) of SAG10 reactive compatibilizer (*Figure 3b*). When both SAG10 and ETPB catalyst (100 ppm) are present in the blend, phase contrast nearly disappears (*Figure 3c*). *Figure 3c* and *Figure 4* demonstrate the effect of GMA content in SAG compatibilizers on the resultant morphologies. The blend with higher GMA content in SAG results in finer ABS domains, as would be expected. *Figure 5* shows examples of the rubber-modified blends which result in a similar trend to *Figure 3*. These morphologies clearly demonstrate the improvement of miscibility of PBT/ABS blends due to the presence of SAG compatibilizer and ETPB catalyst.

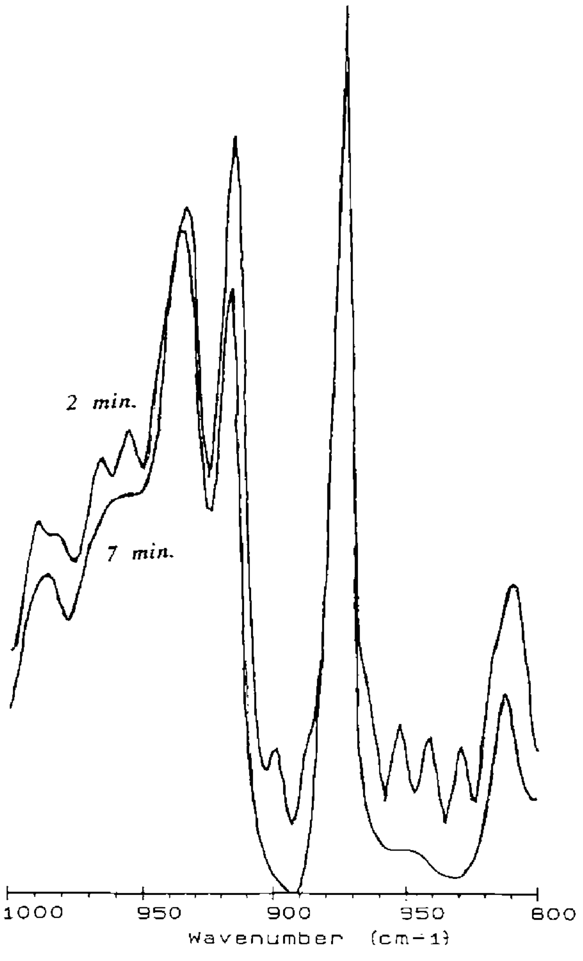


Figure 2 *FTi.r.* spectra of the melt-blended mixture of PBT/SAG10 = 1/1

Melt flow rate

The melt flow rates (MFRs) from all the blends in this study are summarized in *Table 1* and *Figures 6–9*. *Figure 6* illustrates the effect of SAG10 (5 phr) and SAG10 + catalyst (100 ppm) on the resultant MFRs of various blend compositions. The MFR reduction is particularly pronounced for the blend with higher PBT content. *Figure 7* shows the effect of GMA content in SAG copolymer, with or without catalyst (100 ppm), for the PBT/ABS/SAG = 75/25/5 blend. Higher GMA content, with or without catalyst, results in lower MFR as would be expected. At the same GMA level, the blend with catalyst has lower MFR owing to a higher degree of grafting reaction. *Figure 8* demonstrates the very high efficiency of the ETPB catalyst; it takes only 50 ppm (or possibly lower) to approach the minimum obtainable MFR of the PBT/ABS/SAG10 = 75/25/5 blends. *Figure 9* indicates the similar trend when 10 phr of various rubbers are added into the blends. The above MFR results show that SAG compatibilizer and ETPB catalyst promote the desirable grafting reaction and increase the resultant viscosity.

Tensile elongation

The presence of compatibilizer and catalyst in a blend does not generally cause significant variation of the tensile modulus and strength and those data will not be provided here. Tensile elongation to break is normally considered as tensile toughness. *Figure 10* shows the per cent tensile elongation for similar compositions as shown in *Figure 6*. The presence of 5 phr SAG10 increases the per cent elongation only slightly but this becomes very substantial

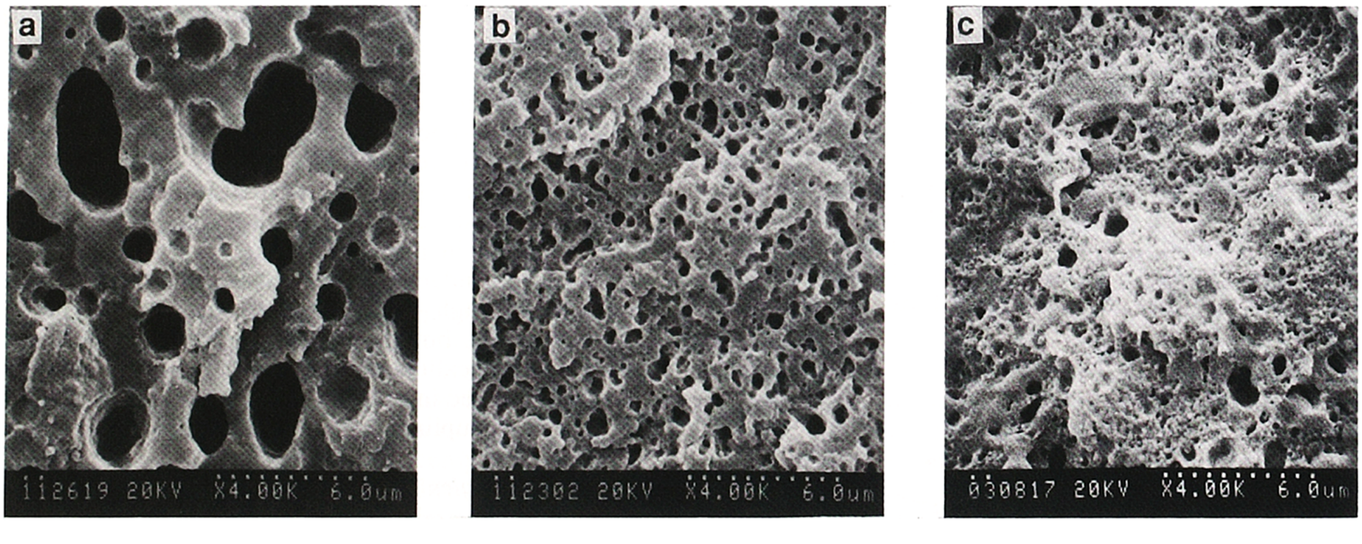


Figure 3 SEM micrographs of the blends: (a) PBT/ABS = 75/25; (b) PBT/ABS/SAG10 = 75/25/5; (c) PBT/ABS/SAG10/ETPB = 75/25/5/0.01

Figure 4 SEM micrographs of the blends: (a) PBT/ABS/SAG0/ETPB = 75/25/5/0.01; (b) PBT/ABS/SAG2/ETPB = 75/25/5/0.01; (c) PBT/ABS/SAG4/ETPB = 75/25/5/0.01

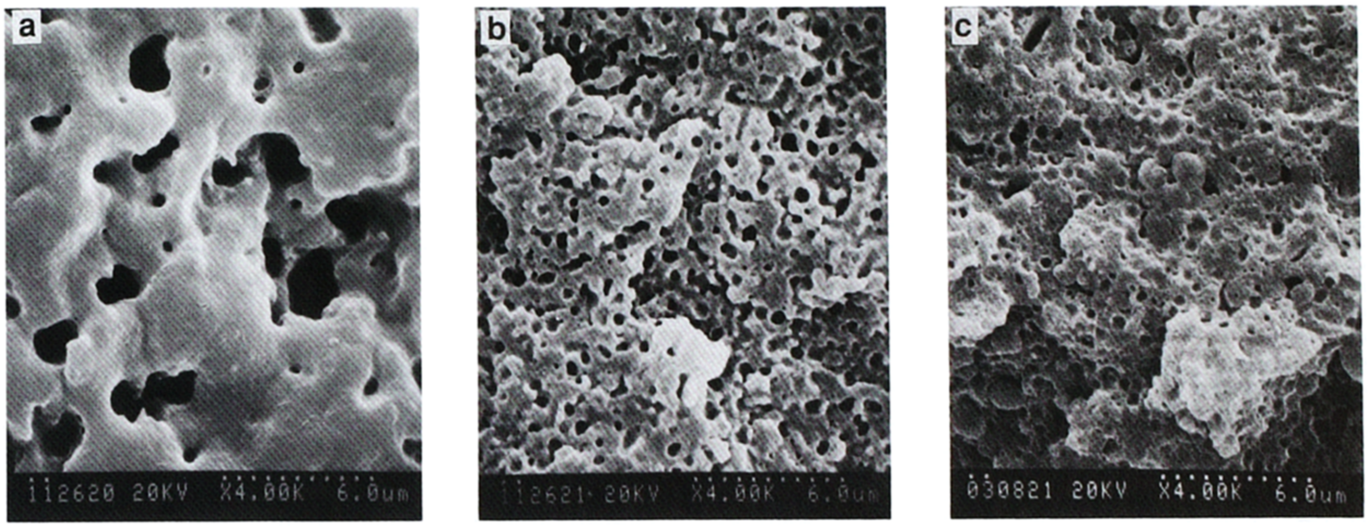


Figure 5 SEM micrographs of the blends: (a) PBT/ABS/EXL-3300 = 75/75/10; (b) PBT/ABS/SAG10/EXL-3330 = 75/25/5/10; (c) PBT/ABS/SAG10/ETPB = 75/25/5/0.01

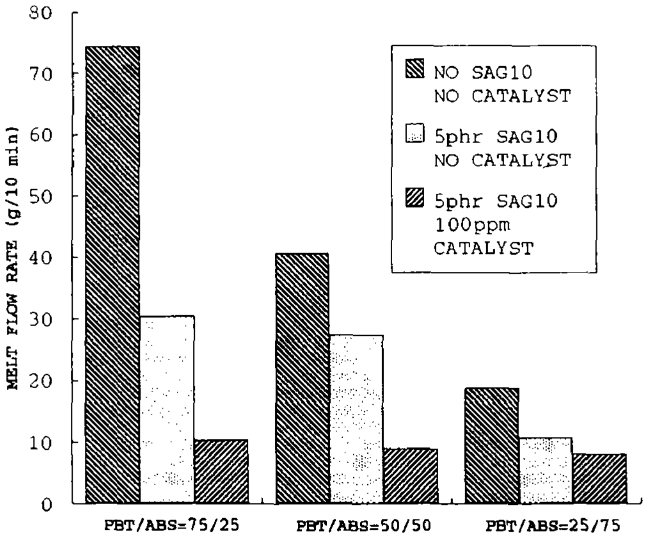


Figure 6 Melt flow rates of various PBT/ABS blends

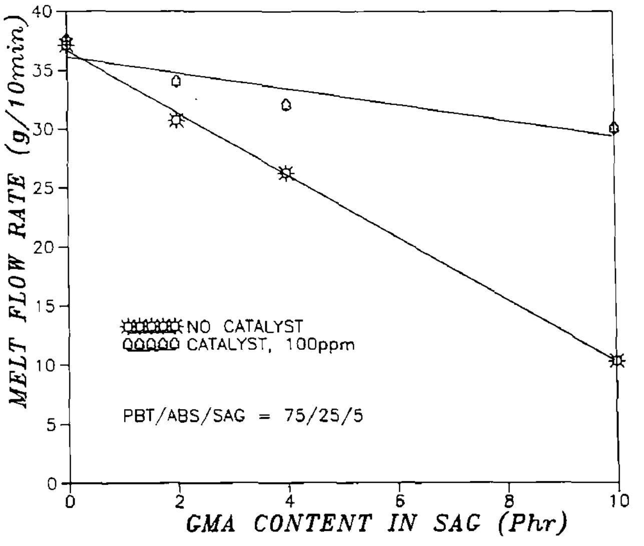


Figure 7 Effect of GMA content in SAG on the resultant melt flow rate

Table 1 Composition and physical properties of the blends used in this study

Blend	PBT	ABS	SAG10	Catalyst	Rubber	Melt flow rate (g/10 min)	Tensile strength (MPa)	Tensile elongation (%)	Notch 120d impact (J m^{-1})	Falling weight impact (J)
	100	0	0	0		81.6	57.5	11.2	16.0	1.1
	0	100	0	0		11.7	40.3	31.2	494.0	43.0
1	75	25	0	0		74.4	53.9	10.1	15.5	1.0
2	50	50	0	0		40.6	44.9	9.3	27.0	2.8
3	25	75	0	0		18.8	41.8	20.4	103.4	21.6
4	75	25	5	0		30.4	53.6	12.0	18.6	1.7
5	50	50	5	0		27.3	44.9	13.4	45.1	5.5
6	25	75	5	0		10.7	42.7	20.6	136.4	22.5
7	75	25	5	0.01		10.3	52.9	24.9	43.0	50.1
8	50	50	5	0.01		13.0	43.8	25.5	79.7	19.5
9	25	75	5	0.01		8.0	39.7	36.4	73.6	37.6
10	75	25	5[a]	0		37.5	53.0	10.6	26.5	1.6
11	75	25	5[a]	0.01		37.1	52.9	10.5	26.2	1.7
12	75	25	5[b]	0		34.0	52.6	10.9	26.9	1.7
13	75	25	5[b]	0.01		30.7	53.3	19.5	46.3	12.4
14	75	25	5[c]	0		32.0	52.8	11.5	27.3	1.6
15	75	25	5[c]	0.01		26.2	51.3	23.8	52.5	21.6
16	75	25	5	0.005		12.5	52.6	25.2	36.9	44.4
17	75	25	5	0.015		9.6	52.8	23.6	48.8	49.5
18	75	25	5	0.020		9.0	52.9	25.6	30.9	51.8
19	75	25	5	0.025		6.3	53.5	29.6	34.0	51.9
20	75	25	5	0.150		17.2	51.2	19.1	26.2	14.5
21	75	25	0	0	10[d]	32.9	44.5	11.7	20.5	4.2
22	75	25	5	0	10[d]	13.9	46.6	13.4	33.2	22.2
23	75	25	5	0	10[d]	4.3	47.8	23.9	88.7	45.8
24	75	25	0	0	10[e]	61.9	37.6	12.4	21.3	1.5
25	75	25	5	0	10[e]	28.3	39.3	20.9	30.9	3.1
26	75	25	5	0.01	10[e]	5.1	42.4	45.7	77.5	44.2
27	75	25	0	0	10[f]	48.9	42.2	10.9	20.6	2.1
28	75	25	5	0	10[f]	25.2	42.1	11.2	21.7	4.1
29	75	25	5	0.01	10[f]	18.6	42.4	29.7	47.3	43.9

[a] SAG0
[b] SAG2
[c] SAG4
[d] EXL 3330
[e] Kraton D-1101
[f] Kraton G-1901-X

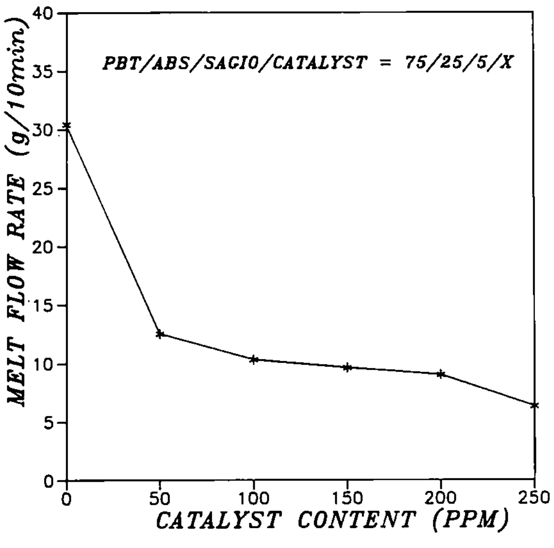


Figure 8 Effect of ETPB catalyst concentration on the resultant melt flow rate

if 100 ppm ETPB is also present. *Figure 11* shows the effect of GMA content in SAG, with and without the presence of 100 ppm ETPB catalyst, on the resultant tensile elongation. Again, the blends containing SAG alone have minimum effect on tensile elongation. With the presence of 100 ppm ETPB catalyst, the per cent elongation is increased with the increase of GMA content but approaches a maximum at about 4 phr. *Figure 12* shows the effect of the catalyst concentration on tensile elongation where only 50 ppm catalyst is really required to approach the maximum obtainable tensile elongation. *Figure 13* shows the per cent tensile elongation for the rubber-modified blends where a similar trend to that in *Figure 9* is also obtained. From these tensile elongation data, it is clear that the presence of both SAG compatibilizer and ETPB catalyst are essential to significantly improve the tensile toughness of the blends.

Notch Izod impact

Figure 14 shows the notch Izod impact strength for the same blends as in *Figure 10*; the trend is almost identical to the results from *Figure 10* except for the PBT/ABS = 25/75 blends. The presence of 100 ppm ETPB catalyst in the PBT/ABS/SAG10 = 25/75/5 blend actually decreases its Izod impact toughness and the reason is not very clear at present. Usually the data were obtained from an average of four or five specimens, so the possibility of experimental error can be ruled out. *Figure 15* shows the effect of GMA content in SAG and the trend is very similar to the tensile elongation shown in *Figure 11*. The effect of catalyst concentration on the

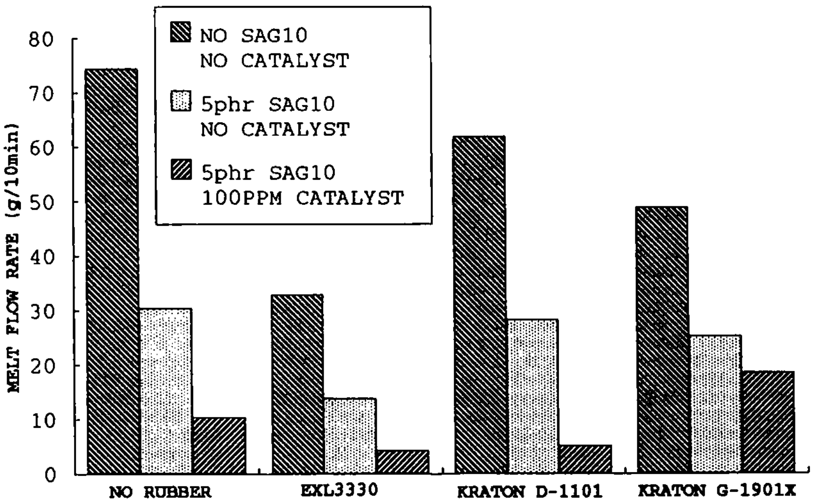


Figure 9 Melt flow rates of various rubber-modified PBT/ABS blends

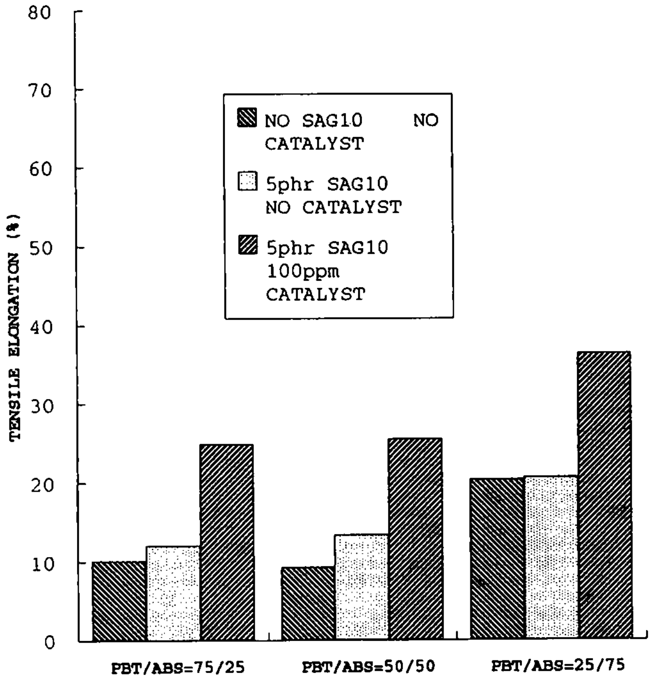


Figure 10 Tensile elongation of various PBT/ABS blends

resultant Izod impact toughness (*Table 1*) indicates that a catalyst content of over 250 ppm in the blend actually decreases the Izod impact strength. The blends with catalyst concentration between 100 and 150 ppm result in the highest impact strength. *Figure 16* shows a similar improvement for the rubber-modified blends as for those blends without rubber and the results are self-explanatory.

Instrumental falling weight impact

Figure 17 illustrates the typical load–time curves from the instrumental falling weight impact tests of various PBT/ABS blends. The non-compatibilized blend fails in brittle mode and has the lowest impact energy (curve A, *Figure 17*). The presence of 5 phr SAG10 in the blend increases the fracture energy only slightly (curve B, *Figure 17*). The blend containing both SAG10 and ETPB catalyst results in ductile fracture and has extremely high fracture energy (curve C, *Figure 17*). *Figure 18* shows that the

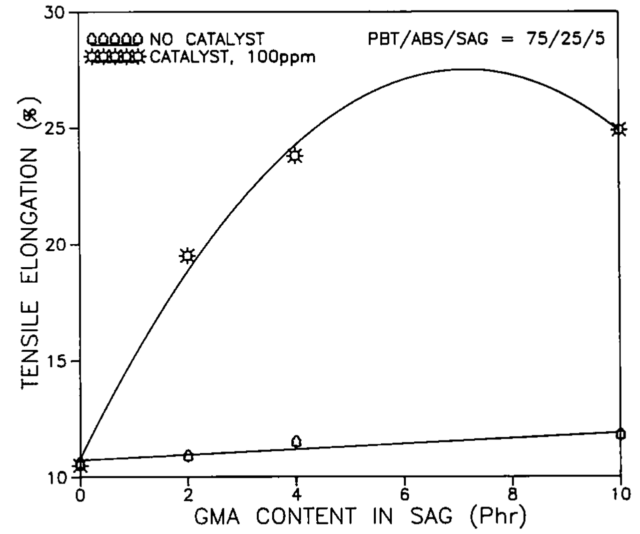


Figure 11 Effect of GMA content in SAG on the resultant tensile elongation

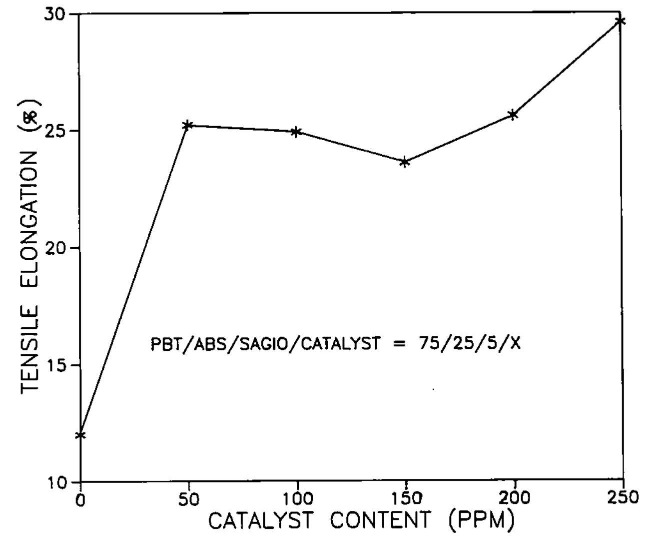


Figure 12 Effect of ETPB catalyst concentration on the resultant tensile elongation

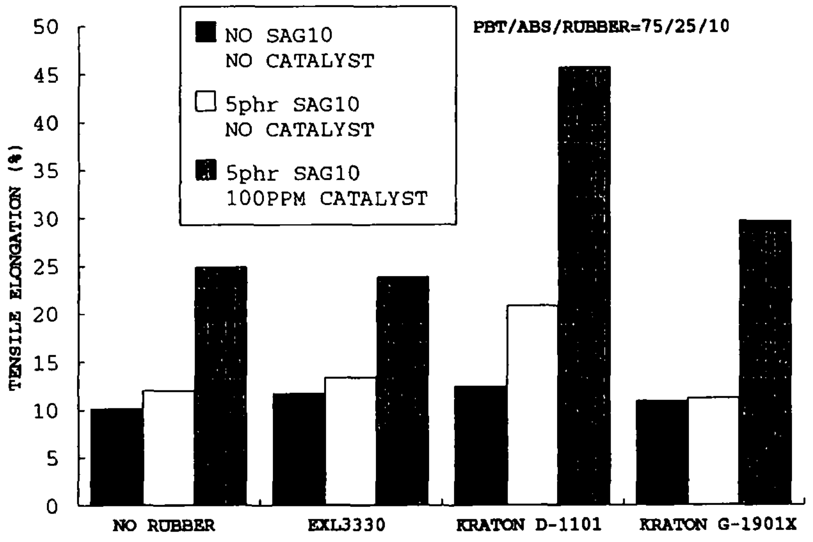


Figure 13 Tensile elongation of various rubber-modified PBT/ABS blends

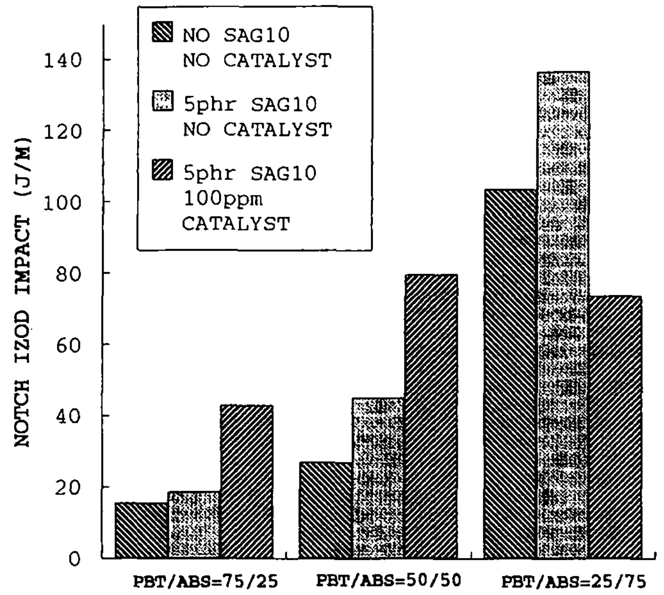


Figure 14 Notch Izod impact strengths of various PBT/ABS blends

improvement of the falling weight impact is most dramatic for the blend with higher PBT content. The blend with higher ABS content (PBT/ABS = 25/75) is already fairly tough even without the presence of any compatibilizer, because the tough ABS matrix is the major component in the blend. *Figure 19* shows the effect of GMA content, with and without catalyst, on the resultant falling weight impact toughness and the results are self-explanatory. *Figure 20* shows the effect of catalyst concentration on the resultant falling weight impact toughness. Again, the results indicate that only 50 ppm catalyst is really needed to approach the maximum achievable value. *Figure 21* clearly demonstrates the importance of the catalyst presence to achieve very tough rubber-modified blends. With the presence of SAG reactive compatibilizer alone, rubber-modified blends are still brittle in the falling weight impact tests. The presence of both SAG compatibilizer and ETPB catalyst is necessary to alter those rubber-modified PBT/ABS blends from brittle to ductile fracture in the falling weight tests.

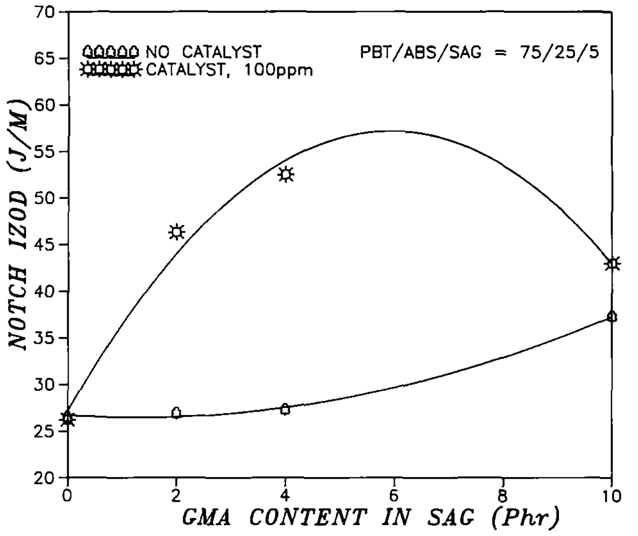


Figure 15 Effect of GMA content in SAG on the resultant Izod impact strength

CONCLUSIONS

The polymer blend of PBT/ABS is incompatible but is of definite commercial interest. This incompatible blend can be converted into a compatible one by incorporating SAG copolymer, which functions as an *in situ* reactive compatibilizer. The SAG itself in the blend does not function as a compatibilizer, but will become one after reacting with PBT end groups during melt blending. SAG reactive compatibilizer alone is not enough to bring the mechanical properties of the PBT/ABS blends up to their maximum achievable level; the presence of a small amount of ETPB catalyst is essential to this blend system. Processability improvement is also very substantial with the aid of the reactive compatibilizer and catalyst. Rubber toughening of PBT/ABS blends does not improve the toughness of the blends unless the SAG compatibilizer and ETPB are also added. Relative to MA-containing

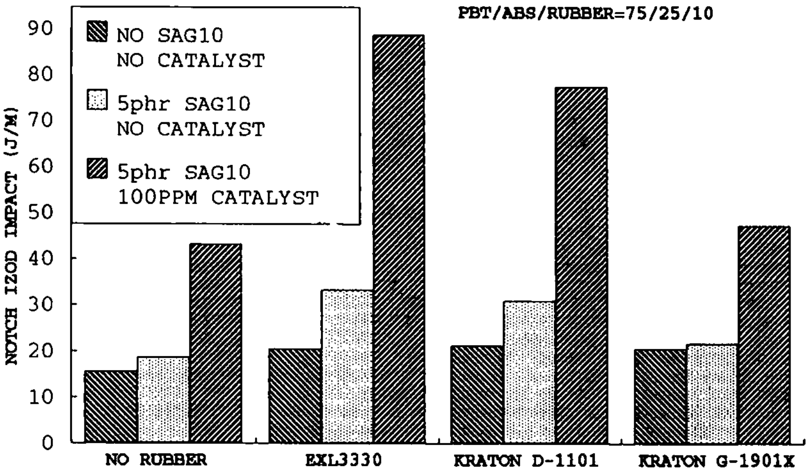


Figure 16 Notch Izod impact strength of various rubber-modified PBT/ABS blends

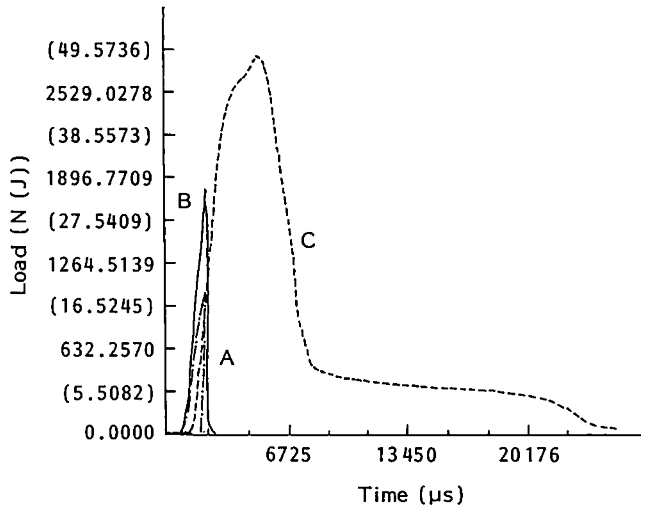


Figure 17 Instrumental falling weight impact load–time curves of various PBT/ABS blends: A, PBT/ABS/SAG10=75/25/0; B, PBT/ABS/SAG10=75/25/5; C, PBT/ABS/SAG10=75/25/5+catalyst (100 ppm)

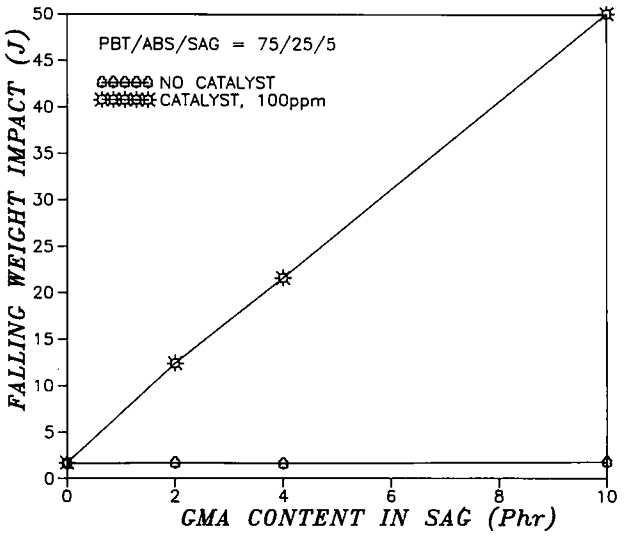


Figure 19 Effect of GMA content in SAG on the resultant falling weight impact energy

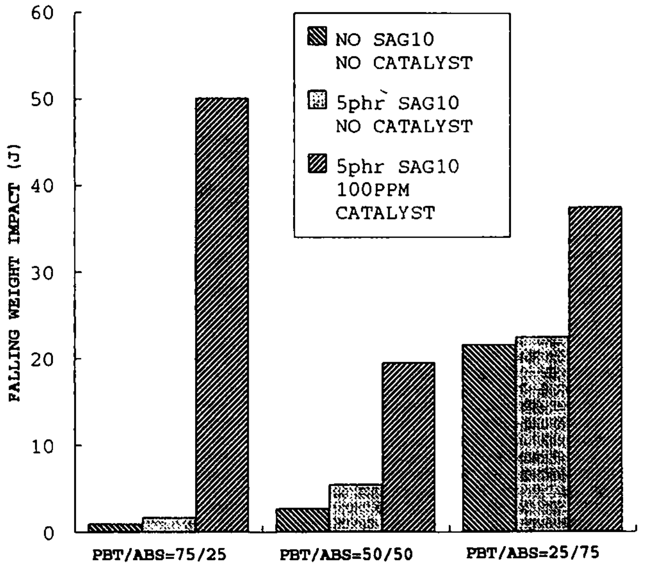


Figure 18 Falling weight impact energies of various PBT/ABS blends

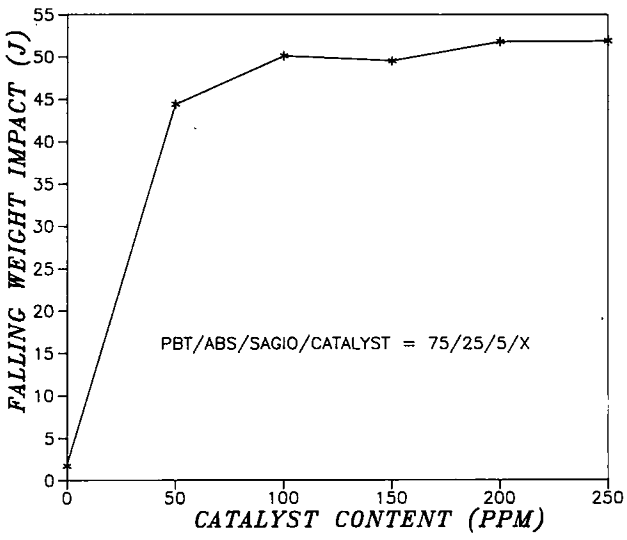


Figure 20 Effect of ETPB catalyst concentration on the resultant falling weight impact energy

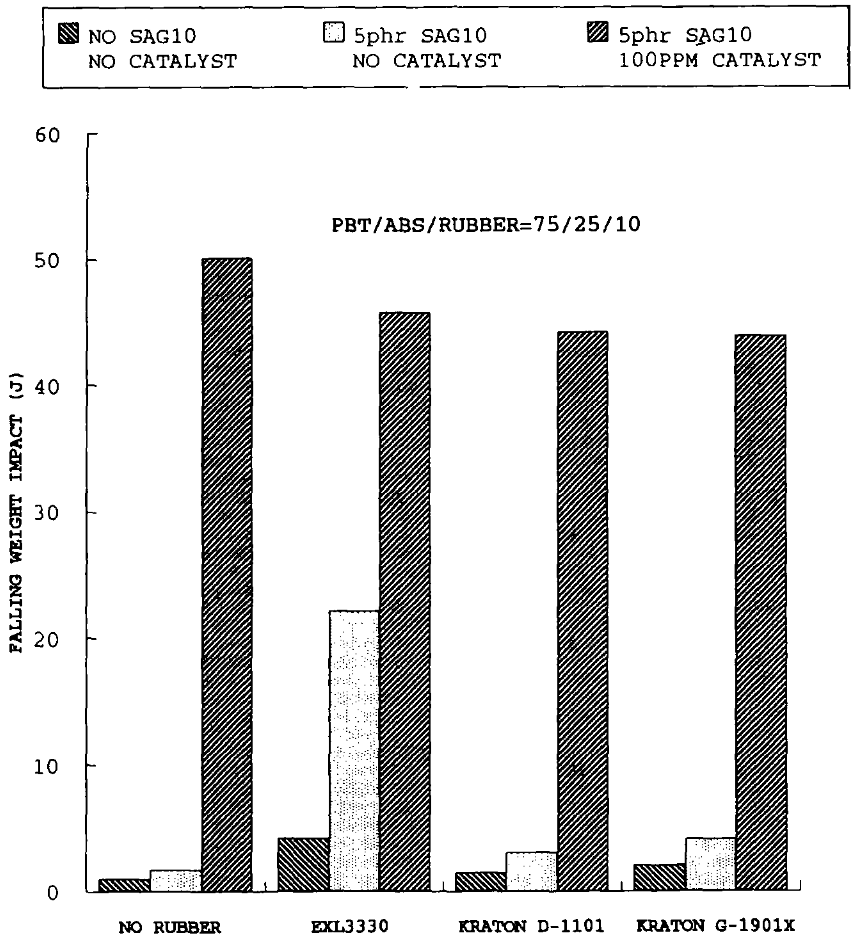


Figure 21 Falling weight impact energies of various rubber-modified PBT/ABS blends

counterparts, the GMA-containing copolymers offer much broader applications because the glycidyl groups are able to react with polymers with -OH, -COOH and $-NH_2$ functional groups, either as chain ends or within the main chain. We will continue to report many other reactive *in situ* compatibilized polymer blends based on GMA-containing copolymers (block or graft) and rubbers.

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