

Reactive processing of maleic anhydride-grafted ABS and its compatibilizing effect on PC/ABS blends

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Abstract

Polymer compatibilizer agents are crucial for industrial materials development. Compatibilizer agents may be prepared by melt-grafting in the reactive extrusion process which is cheaper and environmentally friendly. Maleic anhydride-grafted acrylonitrile-butadiene-styrene (ABS-g-MA) has emerged as a relevant compatibilizer agent for immiscible blends, like polycarbonate (PC)/ABS. In this work, ABS-g-MA was prepared by a simple reactive extrusion process using ABS, maleic anhydride (MA) and benzoyl peroxide (BPO). The MA:BPO ratios of 1:0.5 and 1:1 varying the content of MA by 1, 2 and 5 wt% were investigated. The grafting reaction was confirmed through Fourier transform infrared spectroscopy (FT-IR), grafted degree (GD%), thermal and rheological analysis. The effectiveness of the compatibilizer agent was evaluated in PC/ABS blends (70/30 and 85/15 blend ratios). The addition of 5 wt% of ABS-g-MA (5 MA:2.5 BPO) in the PC/ABS blends promoted an expressive reduction of ABS domain sizes and better dispersion in the PC matrix.

Keywords: *ABS-g-MA, melt-grafting, blends, compatibilizer agent, reactive extrusion.*

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1. Introduction

Polymeric compatibilizer agents are used to obtaining new materials by combining the best features of already commercial materials, as polymer blends and polymer composites^[1]. In the specific case of polymer blends, most systems are composed by polymers of different chemical nature, which can cause a weak interface between two different phases and compromises its mechanical properties^[2-5]. An efficient way to overcome this problem is the use of a compatibilizer agent to improve the dispersion and the distribution of the second phase in the matrix, thereby promoting a better interaction between these components^[4-6].

Several types of compatibilizer agents can be used in polymer blends, especially polymers grafted with reactive groups, block copolymers and polymers with polar groups^[7,8]. The first group is popular and used for reactive blending, and can be used in polycarbonate (PC)/acrylonitrile-butadiene-styrene (ABS) blends^[8-10], polyamide 6 (PA6)/ABS^[11,12] and polyethylene (PE)/PA6 blends^[13]. In these cases, the backbone of the compatibilizer agent usually is chemically compatible with the non-polar phase and the grafting group reacts with the other phase, providing

the copolymer formation at the interface^[8]. This process promotes a stronger interface and decreases the interfacial energy^[8] and as a consequence, there are improvements in the mechanical properties of the blends.

In this way, the grafting of maleic anhydride (MA) on the backbone of a rubber or a non-polar polymer is an important type of compatibilizer agent^[6,14]. There are some commercial grades of MA-grafted polymer like polyethylene (PE-g-MA)^[13], polypropylene (PP-g-MA)^[15] and polystyrene (PS-g-MA)^[14]. Among other monomers, used in grafting, MA is preferred due to its high reactivity^[16], thermal stability^[17,18] and difficulty in homopolymerization^[19]. For polymer blends, MA is advantageous because may result in less mechanical properties loss when compared with other types of compatibilizer agent like for example the glycidyl acrylate (GA)^[10] and is more efficient than methyl methacrylate (MMA) requiring smaller quantities in polymer blends compositions^[9].

Several studies have been published^[6] about different ways to prepare these graft polymers using vinyl monomers, like MA, GA, and MMA. However,

the most common method is by chemical initiation^[20], also called free-radical grafting^[14]. Under the industrial technologies available for free-radical grafting there are the solution, emulsion or suspension grafting methods, which can achieve high grafting degree (GD%) levels, but require high costs and some organic solvent, being environmentally dangerous^[6,14]. The solid-state graft technology which is solvent-free and achieves high GD%, nevertheless, requires long reaction times and it is limited to semi-crystalline polymers with high molecular weight. Finally, the most applied technique is the melt-grafting technology that has the advantages of being simple, fast, solvent-free and not limited by polymers melting temperature^[14].

MA melt-grafting by reactive extrusion is a well-known and applied technology in the industry to produce compatibilizer agents^[14], which is still being developed because it is strongly dependent on process parameters, like the temperature of the process and the screw configuration of the extruder, and the grafting levels could be improved by using comonomers and mixed initiators^[21].

PC/ABS blends are an economical way to improve the balance of mechanical properties of PC^[22,23] and overcome other limitations like being difficult to process due to high melt viscosity and sensitivity to UV degradation^[2,24]. This balance of properties has made the PC/ABS blend largely used in technical applications as automotive parts^[2], and electronic engineering products^[23].

MA grafted-ABS (ABS-g-MA) has been used successfully for PC/ABS blends. Rao et al.^[25] prepared ABS-g-MA by solution process using toluene as solvent, evaluating the effect of monomer and initiator concentrations and time reaction. The grafting reaction occurred onto butadiene regions of the ABS backbone. Balakrishnan et al.^[26] prepared ABS-g-MA by reactive extrusion on a single screw extruder using benzoyl peroxide (BPO) as an initiator and then mixed with PC to verify the efficiency on PC/ABS blends. As a result, an improvement in impact strength and the compatibility of PC/ABS blends were observed with the addition of 2 wt% of MA in this process.

Aiming to improve the %GD through the reactive extrusion process Qi et al.^[21] prepared ABS-g-MA using two initiators (BPO and dicumyl peroxide - DCP) and styrene as a comonomer. The use of DCP as initiator and the use of a comonomer improved the %GD due to the longer half-life of DCP compared to BPO at the temperature utilized, and the presence of styrene with MA could form a charge-transfer complex which is more reactive than the individual monomers^[21].

In this study, ABS-g-MA was produced through reactive melt-grafting method using BPO as the initiator and MA at 1:0.5 and 1:1 MA:BPO ratios and varying the content of MA by 1, 2 and 5 wt%. The effectiveness of the compatibility was verified in different PC/ABS blends (70/30 and 85/15). In addition, the mechanical and morphological properties of the PC/ABS/ABS-g-MA blends were studied.

2. Materials and Methods

2.1 Materials

Acrylonitrile-butadiene-styrene copolymer (ABS) was supplied by TRINSEO (specification Magnum 3404, Switzerland), with a PB content of 20%, MFI of 2.0 g/10 min (230 °C/3.8 kg) and density of 1.05 g/cm³.

Polycarbonate (PC) was supplied by UNIGEL (Durolon IR-2200, Brazil) with a density of 1.20 g/cm³ and a melt flow index (MFI) of 12.0 g/10 min (300 °C/1.2 kg).

Maleic anhydride (MA) was utilized as a monomer and supplied by Sigma-Aldrich (Saint Louis, MO, USA) with 99% purity. As initiator was used benzoyl peroxide (BPO) commercial grade supplied by Dinâmica Química Contemporânea (Indaiatuba, Brazil). Both reagents were used as received.

2.2 Reactive processing of ABS-g-MA

Before the reactive processing, ABS was dried at 80 °C for at least 12 h in a vacuum oven to minimize the hydrolytic degradation during the processing. The reactive extrusion processes to produce ABS-g-MA by melt-grafting were carried out in a co-rotational twin-screw extruder, AX Plásticos, model AX16:40DR (L/D = 40, D = 16 mm), with screw rotation speed set in 80 rpm and feeding in 20 rpm. The temperature profile set was 190/200/200/200/210 °C from the first zone to the die, in these conditions the residence time was near to 2 min. After extrusion, the materials were pelletized and dried on a vacuum oven for 4 h at 80 °C. Table 1 presents the compositions studied with the variation contents of MA and BPO.

2.3. Characterization of the compatibilizer agent - ABS-g-MA

2.3.1 FT-IR Spectroscopy

ABS-g-MA with different MA:BPO ratios were analyzed by Fourier transform infrared spectroscopy (FTIR) using universal attenuated total reflectance (UATR) in a PerkinElmer Frontier equipment and a scan range of 400-4000 cm⁻¹.

2.3.2 Grafting degree (%GD)

The grafting degree of MA in the melt-grafted compatibilizer agents was determined by a back-titration procedure based on the methodology described by Qi et al.^[22]. First, after the reactive extrusion process, the compatibilizer agents were purified by dissolving in 5 mL of acetone and precipitated adding 5 mL of ethanol, twice, to remove the residual reactants (MA and BPO). Then, 0.5 g of each composition

Table 1. Nomenclature and compositions studied.

Composition	ABS (wt%)	MA (wt%)	BPO (wt%)
C1	98.5	1	0.5
C2	98	1	1
C3	97	2	1
C4	96	2	2
C5	92.5	5	2.5
C6	90	5	5

was dissolved in 50 mL of acetone and 5 mL of ethanol. NaOH (1.0 mol/L) solution was added with 0.5 mL of Yamada Universal indicator. After 30 min with mechanical stirring, these solutions were back titrated with 0.1 mol/L of HCL. Then, the quantity of MA grafted was calculated as a percentage of ABS by the following:

$$\%GD = \frac{(V_{RABS} - V_S) \times 10^{-3} \times C_{HCl} \times MW_{MA}}{2W_s} \times 100 \quad (1)$$

Where VRABS is the volume (mL) of HCl solution consumed with neat ABS as a reference, VS is the volume consumed by the sample (mL), CHCl is constant and corresponds to 0.1 mol/L of HCl titration solution, MWMA is the molecular weight of MA, also a constant used as 98.06 g/mol and Ws is the weight of each sample (g).

2.3.3 Rheological characterization

The rheological behavior of the compositions were evaluated in a rotational controlled stress rheometer from TA Instruments, model ARG2. The steady-state viscosity was evaluated as a function of the shear rate in an inert nitrogen atmosphere at a temperature of 210 °C, using parallel-plates geometry with 25 mm of diameter and gap of 1 mm. The delay before measurement was determined from stress overshoot experiments performed at 210 °C and 0.01 s⁻¹ until constant stress was attained.

2.4 Melt flow index (MFI)

MFI values of the compositions were analyzed according to the ASTM D1238 standard^[27], a Hebert Lambert plastometer was utilized at 200 °C and a load of 5 kg.

2.4.1 Differential Scanning Calorimetry (DSC)

The glass transition (T_g) of SAN phase of ABS for the compositions were analyzed by DSC. The tests were performed in a TA Instruments equipment, model Q2000 under nitrogen atmosphere. Samples were sealed in an aluminum DSC pan and heated from room temperature to 220 °C at 10 °C/min, followed by an isothermal at 220 °C for 3 min, a cooling cycle to 30 °C at 10 °C/min and a second heating cycle up to 220 °C also at 10 °C/min.

2.4.2 Thermogravimetric Analysis (TGA)

Thermogravimetric analysis (TGA) of the compositions were performed on a Netzsch model Iris® TG 209 F1 equipment from room temperature to 800 °C at a heating rate of 20 °C/min, under nitrogen atmosphere.

2.4. Effectiveness of the compatibilizer agent in PC/ABS blends

The effectiveness of the ABS-g-MA as a compatibilizer agent was verified for PC/ABS blends. PC/ABS blends with different blend ratios (70/30 and 85/15) were prepared using 5 wt% of each ABS-g-MA produced replacing neat ABS. All blends were produced using an AX Plásticos, model AX16:40DR co-rotational twin-screw extruder with screw rotation speed set in 80 rpm and feeding in 20 rpm with the temperature profile of 225/235/245/245/255 °C from the first section to the die. The blends were pelletized and dried on a vacuum oven for 4 h at 80 °C.

Specimens for Izod impact strength tests were pressed into 3.2 mm thick plates in a hydropneumatic press (MH Equipamentos Ltda, model PR8HP) at 260 °C with a pressure of 5 bar for 7 min.

2.5. Characterization of the PC/ABS blends

2.5.1 Impact Izod test

Izod impact strength tests were performed on a CEAST/Instron Izod impactor test machine (model 9050) according ASTM D256-06^[28]. All the test specimens were notched using a manual notched machine (CEAST/Instron) and the tests were performed using a 5.5 J hammer, the largest hammer available for testing, five samples of each composition were tested.

MINITAB®17 statistical software was used to the Izod impact strength data. First, the data distribution was analyzed by Anderson-Darling test for each composition, then the Levene test was used to evaluate the homogeneity between variances of different compositions^[29]. Analyses of variance one-way (ANOVA) were performed to compare the mean size distributions and mean impact strength among the groups, followed by post-HOC Tukey HSD test to compare each pair at $\alpha = 0.05$ ^[29,30].

Morphological characterization with scanning electron microscopy (SEM)

The morphology of the PC/ABS blends were analyzed using a FEI Inspect S50 scanning electron microscope operating at 15 keV. The samples of each blend composition were taken immediately at the exit of the extruder die to verify the formation of phases during the extrusion process. These samples were cryogenically fractured with liquid nitrogen, to preserve the morphology, perpendicularly to flow direction and the surfaces were coated with a thin gold layer. To obtain the average and distribution of ABS domains sizes the SEM images were analyzed with the software Image J. First, one image of each blend composition was selected on the same amplified magnitude (10000x), 50 ABS domains^[11] were selected and measured a minimum of ten times each. Then these data were compiled to create a normal size distribution.

3. Results and Discussions

3.1. Characterization of ABS-g-MA

Figure 1A shows the FTIR spectra of ABS and the compatibilizer agents (C1 – C6). For all compositions, it is possible to observe the main ABS characteristics bands. The band at 2238 cm⁻¹ corresponding the C≡N stretch of acrylonitrile^[20,31], the bands at 1494 cm⁻¹ and 1602 cm⁻¹ are associated to styrene ring modes and bands at 911 and 966 cm⁻¹ are associated to C-H in plane bending in polybutadiene (PB)^[31,32]. The bands at 759 and 700 cm⁻¹ are correlated to bends of C-H styrene rings and 1453 cm⁻¹ indicating the scissoring mode of CH₂ bonds. And some general peaks like 3200-3000 cm⁻¹ which are associated to aromatic the C-H stretches and 3000-2800 cm⁻¹ to the aliphatic ones^[31]. For the ABS-g-MA curves (C1 to C6) it is possible to observe a new absorbance band at 1780 cm⁻¹

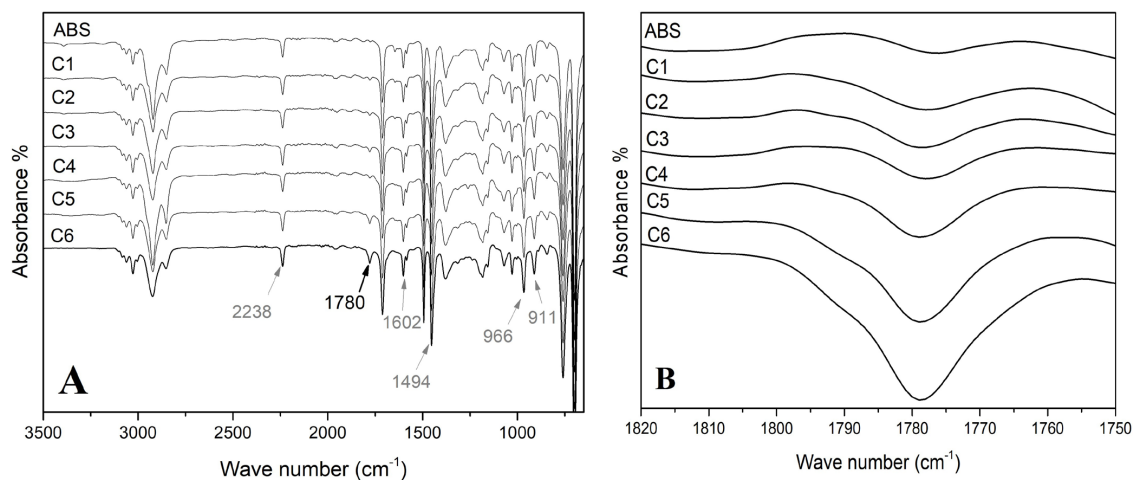


Figure 1. FTIR spectra (A) spectra of ABS and ABS-g-MA (C1 to C6) and (B) detail of 1780 cm⁻¹ peak for all composition.

which corresponds to the C=O stretching from anhydride indicating that MA was grafted in the ABS backbone^[20,32]. This peak also increases with the concentration of MA and BPO^[32], as is shown in Figure 1B. As shown by Braga *et al.*^[33] the C=O stretching band from MA is located at 1709 cm⁻¹. The new absorption band observed in the compatibilizer agents is located at 1780 cm⁻¹ and refers to C=O stretching from anhydride. This shift in the wavelength means that MA was covalently bonded to the ABS backbone, and that the grafting reaction was effective^[34,35] suggested by some authors the MA was preferentially grafted onto PB segments of ABS backbone^[32].

The efficiency of the reactive extrusion process could be associated with grafting degree of MA (%GD) determined by back-titration method and exhibited in Figure 2. For an ease understand of the results, the compositions could be divided into two groups: First, C1, C3 and, C5 which were prepared with 1:0.5 MA:BPO ratio and second, C2, C4, and C6 with 1:1 MA:BPO ratio. First, the %GD increased with the MA concentration comparing composition into each group. This might be associated with the increase in the number of molecules diffusing in the reaction medium (the molten polymer), therefore increasing the probability of grafting reaction onto the polymer back-bone^[32]. Then, an analogous behavior was observed for the initiator concentration when comparing compositions with 1:0.5 MA:BPO and 1:1 MA:BPO. It may be explained by an increase of free radicals formed from thermal decomposing of BPO^[32]. However, even working with high contents of MA and BPO (5 wt% of each component) the grafting degree is still less than 2.0 wt%, as supported the literature on similar process conditions^[14]. Another side effect of high initiator and monomer content is polymer chains scissions^[21]. In order to understand this effect, the MFI was measured, and the rheological behavior was analyzed.

MFI for ABS-g-MA of all compositions is also shown in Figure 2. It was found that the MFI of ABS-g-MA was higher than the neat ABS resin (around 2.0 g/10min). The MFI of the compatibilizer agents increased with BPO and MA content. The presence of higher levels of BPO has a

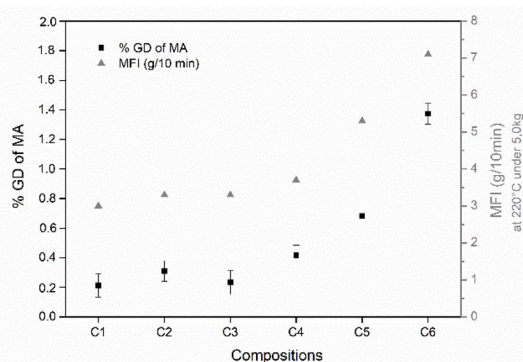


Figure 2. Grafting degree of MA (%GD) and MFI of ABS-g-MA compositions.

greater influence on MFI values and the MFI behavior could explain some thermal degradation of ABS under processing conditions. Moreover, a lubricant effect caused by a residual amount of MA and BPO can increase MFI value. A decrease in MFI can occur if the grafting reaction was predominant than chain scission^[32].

The rheological behavior under low shear rates (0.01 - 1.0 s⁻¹) conditions is commonly used as an indirect way to understand some structural modifications on polymers. At this range of shear rates, a Newtonian behavior is expected for the majority of the thermoplastics and in this analysis the viscosity values for the first Newtonian plateau (η_0) will be considered as those measured at 0.01 s⁻¹^[33]. Figure 3 shows the viscosity as function of the shear rate of the samples at 210 °C.

Comparing the rheological behavior of ABS pellet and the processed ABS it is possible to conclude that the processing conditions applied had no significant influence on the material molecular structure. For the ABS-g-MA compositions (C1 to C6) the η_0 were lower than ABS. The extension of the Newtonian plateau for all samples is small, restricted to very low shear rates and the greater the MA and BPO contents (samples C5 and C6) the smaller the

plateau extension. Thus ABS and ABS-g-MA presented a pseudo-plastic behavior even at low shear rates. Agreeing to MFI results, the viscosity reduction may be associated with molecular weight reduction, due to ABS chain scissions^[34] and a possible lubricant effect of a residual amount of BPO and MA molecules.

Table 2 presents the values of glass transition temperature (T_g) of SAN present in ABS for first and second heating. First, comparing T_g values between the heating cycles is clearly observed that the T_g is higher in the second heat cycle for all compositions. It might indicate the presence of some molecule acting as a plasticizer which exudates on the first heating cycle^[24], and on the present context, could be non-reacted BPO and MA molecules or some molecules with little molecular weight formed between them.

Comparing the T_g values it was observed a decrease in T_g with the MA content. One hypothesis is that MA grafting reactions and the degradation of ABS occur simultaneously during reactive extrusion and both events affect the T_g value. MA grafted on ABS chains could increase T_g making it more rigid^[24,32]. However, the short MA branches^[8] and more chain ends^[24] resultant from the chains scissions decrease the T_g value. Even some authors had observed the opposite behavior for the T_g ^[32], but for ABS-g-MA prepared on the solvent approach which is less susceptible to degradation

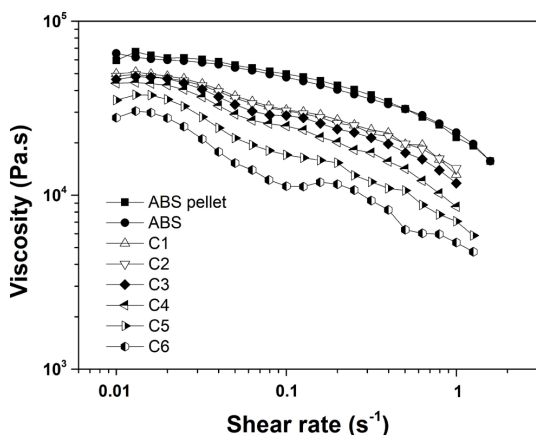


Figure 3. Viscosity curve as a function of the shear rate obtained by deformational rheometry of non-processed ABS (ABS pellet), processed ABS (ABS) and ABS-g-MA (C1 – C6) compositions.

of ABS^[14], so that supports a possible degradation process on higher contents of BPO and MA.

The TGA results are expressed in terms of the temperature of 10, 50 and 90% mass loss and temperature of maximum degradation rate (T_{max}), presented in Table 2.

For ABS-g-MA (C4 to C6), it is possible to observe a mass loss before the main degradation step, which is probably associated with residual molecules of MA and BPO. This mass loss increases gradually with the reactant's content. T_{10} for ABS-g-MA was lower than for ABS and decreases gradually for C4 to C6, this may be explained by the presence of residual molecules and a possible reduction in molecular weight by oxidative chain scissions on reactive extrusion, supporting the MFI and DSC results.

3.2. Effectiveness of ABS-g-MA as compatibilizer agent for PC/ABS blends.

The Izod impact strength values of PC/ABS blends with different blend ratios are shown in Table 3. During the impact test two different specimen failures were observed according to ASTM D256-06 standard. For the most composition occurred a partial break (P), which the specimen had an incomplete break higher than 90% of the sample length and still supporting itself vertically. On the other hand, for other compositions, the specimens had failed by a complete break (C) been separated into two parts^[36].

The ANOVA results for impact strength proved a statistical difference between groups (p-value of 0.000 and F-Value of 228.64)^[29,30,34,35], so the different compositions were classified in statistically different groups by the post-HOC Tukey test exhibited in Table 3.

The addition of ABS increases the PC toughness for both PC/ABS blend ratios (70/30 and 85/15) with a synergistic effect, higher to PC/ABS (85/15), agreeing with Greco et al.^[37] results for PC/ABS blends with ratios between 15-30 wt% of ABS. The higher impact strength for 85/15 than 70/30 ratio was explained for Lee et al.^[36] as a change in the main toughening mechanism. The addition of compatibilizer agents C2 and C5 did not significantly change the impact strength in comparison with the non-compatibilized blends for both blend ratios. The compatibilizers C1, C3, and C4 significantly decreased the impact strength of PC/ABS (85/15), which may be associated with a non-homogeneous morphology^[10].

Table 2. Values of glass transition (T_g) of SAN phase of ABS on first and second heating. TGA analysis results in terms of the temperature of 10, 50 and 90% mass loss and temperature of maximum degradation rate.

Sample	DSC		TGA			DTG
	1 st	2 nd	$T_{10\%}$	$T_{50\%}$	$T_{90\%}$	T_{max}
	T_g^* (°C)	T_g^* (°C)	(°C)	(°C)	(°C)	(°C)
ABS pellets	108	111	395	423	458	421
ABS	115	114	389	417	448	415
C1	107	109	393	416	447	414
C2	102	109	388	416	446	415
C3	105	108	391	417	448	416
C4	99	106	383	414	445	413
C5	84	101	380	414	447	413
C6	86	102	360	409	455	409

The addition of C6 as a compatibilizer agent for PC/ABS (70/30) and PC/ABS (85/15) resulted in the lowest impact strength, comparable with the values of the neat materials PC and ABS. C6 is the ABS-*g*-MA with higher content of MA grafted and the degradation by severing chain scissions suffered during the melt-graft process probably generates a weaker interface on PC/ABS blends.

The micrographs of the blends are shown in Figure 4. For all blends, it is possible to observe ABS domains on a PC matrix which are marked by interface lines.

Comparing PC/ABS (70/30) non-compatible blend (Figure 4A) with the compatibilized blend using C3 (Figure 4B) and C5 (Figure 4C) as compatibilizer agents it is possible to note a gradual reduction on the size of ABS domains. Moreover, a more homogeneous and thinner

dispersion for C5 is observed and is in accordance with other works^[9]. However, for the PC/ABS blend using C6 as compatibilizer agent (Figure 4D) it is possible to observe that the ABS domains increase, suggesting a coalescence of ABS domains with a heterogeneous form.

Blends morphologies are strongly correlated to the content of each polymer^[5]. Comparing the two blend ratios (70/30 and 85/15), the PC/ABS (85/15) presents a thinner dispersion and size of the ABS domains. Increasing the content of the higher viscosity phase (PC) causes a change in the viscosity ratio between the disperse phase and the matrix^[5]. For PC/ABS blend (85/15) the addition of C3 as a compatibilizer agent results in an increase in the size of ABS domains, which may be correlated with the lower impact strength for blends PC/ABS (85/15) with the addition of

Table 3. Impact strength test for PC/ABS blends and neat materials (PC and ABS).

	Impact strength (J/m) Mean (SD)	Fracture type	p- value Anderson–Darling test	Groups*
PC	73.8 (3.1)	Complete break	0.494	F
ABS	124.8 (0.9)	Complete break	0.102	EF
B70	428.8 (28.1)	Partial Break	0.505	B
B70C1	436.6 (23.4)	Partial Break	0.139	B
B70C2	427.4 (14.8)	Partial Break	0.873	B
B70C3	358.2 (11.1)	Partial Break	0.109	CD
B70C4	319.4 (27.3)	Partial Break	0.187	BC
B70C5	403.8 (14.4)	Partial Break	0.364	B
B70C6	150.5 (5.3)	Complete break	0.350	F
B85	533.0 (25.7)	Partial Break	0.178	A
B85C1	445.0 (20.8)	Partial Break	0.056	B
B85C2	514.4 (28.9)	Partial Break	0.248	A
B85C3	138.0 (50.1)	Complete break	0.238	E
B85C4	90.4 (6.3)	Complete break	0.520	D
B85C5	522.3 (19.0)	Partial Break	0.160	A
B85C6	70.1 (31.0)	Complete break	0.064	F

*By post-HOC Tukey's test, mean values which do not share letters are significantly different from others. **P-value Levene test 0.336.

*** ANOVA results p-Value = 0.000, F-Value = 228.64, S = 22.9979J/m, and R²=98.62%.

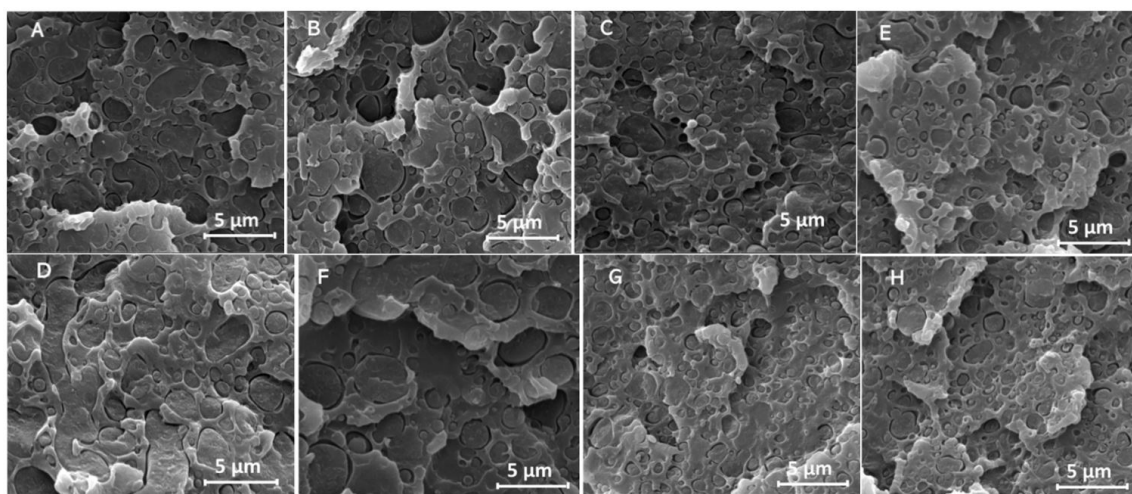


Figure 4. SEM micrographs of fractured surfaces of (A) PC/ABS (70/30), (B) PC/ABS/C3(70/25/5), (C) PC/ABS/C5(70/25/5), (D) PC/ABS/C6(70/25/5), (E) PC/ABS (85/15), (F) PC/ABS/C3(85/10/5), (G) PC/ABS/C5(85/10/5) and (H) PC/ABS/C6(85/10/5) with magnification of 15000x.

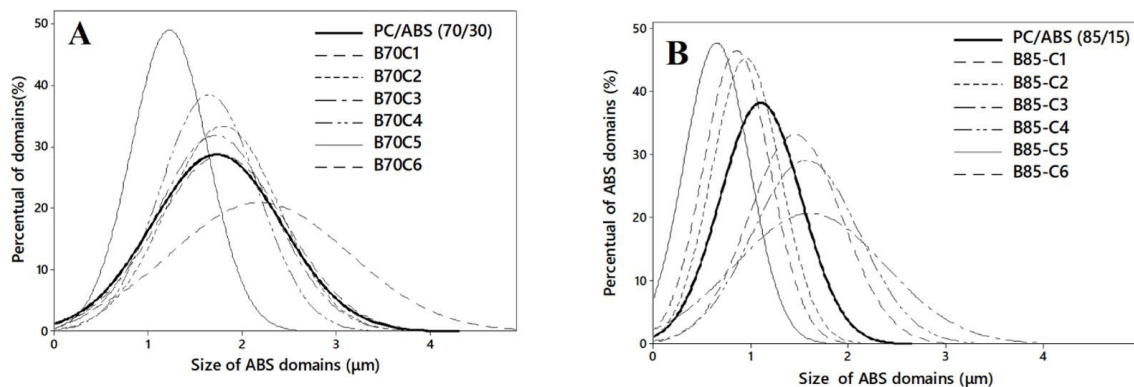


Figure 5. Size ABS domains distribution for PC/ABS with different blend ratio e ABS-g-MA composition (A) 70/30 and (A)85/15.

C3 and C4. A better dispersion and distribution of the ABS phase was observed for the PC/ABS blends that use C5.

Figure 5 shows the effect of compatibilizer addition in size distributions of ABS domains in blends PC/ABS (70/30) (Figure 5A) and PC/ABS (85/15) (Figure 5B), respectively. The distributions of the blend are represented in bold lines. Looking at both different blends compositions the thinner dispersion of PC/ABS (85/15) is confirmed quantitatively, agreeing with the qualitative analyses.

According to the Izod impact test, the compositions of ABS-g-MA (C2 and C5) could be used for PC/ABS blends of both blend ratio. However, based on the sizes distribution is observed that the addition of C5 as compatibilizer agent is promoted the thinnest and narrowest distribution for both PC/ABS blends compositions, indicating that it may be the best compatibilizer agent for that system.

4. Conclusions

Maleic anhydride was successfully melt grafted into ABS by a reactive extrusion process. The effectiveness of the ABS-g-MA as a compatibilizer agent has been confirmed for PC/ABS blends with different blend ratios (70/30 and 85/15). FTIR spectra of ABS-g-MA of all compositions showed a new characteristic band at 1780 cm^{-1} confirming the graft reaction of MA onto the ABS chain. Grafting degree analysis indicated a proportional increase with the MA and BPO content, MFI and rheological behavior suggested a reduction in the molecular weight of ABS due to chain scissions. For the PC/ABS blends, the Izod impact tests confirmed that ABS improved the PC impact strength and that ABS-g-MA compatibilizer agents C2 and C5 could be used for both blend ratios. The morphologies analyzed by SEM and qualitative analyzes of size ABS domains distribution suggests that ABS-g-MA composition C5 might be the best compatibilizer agent for PC/ABS blends.

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