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Compatibilization, processing and properties of post-consumer PET/polyolefin blends

Summary — The possibilities of poly(ethylene terephtalate) and polyolefins recycling by blending together are discussed. Two approaches are presented: use of commercial compatibilizer and formation of compatibilizer during blend preparation. It was found that for blends of recycled PET/PE-HD the most effective compatibilizer was EGMA, which improved the dispersion of the minor phase and the mechanical properties of a blend. Liquid glycidyl methacrylate in the amount 2—4 pph may be used as a component for reactive extrusion of PET/PE-HD, with formation of PE-HD-*g*-GMA during processing.

Key words: polyethylene, poly(ethylene terephtalate), blends of recycled materials, compatibilization, copolymer ethylene/glycidyl methacrylate, mechanical properties, morphology.

A recycling of scrap plastic materials represents a fundamental issue for protection of natural environment. The incinerating of polymers, probably most effective economically way of recycling, is often non accepted for social reasons. Another possibility of management of polymer wastes is material recycling by reprocessing [1].

Industrial scraps are relatively easy to process, because the contamination from other plastics is usually low. Processing of municipal plastic waste is more complicated. The potential application of this material is limited by its poor properties. Analysis of a municipal waste composition shown dominant contents of poly(ethylene terephtalate) (PET) and polyolefins (PE-HD, PP, PE-LD) [2].

Typically, the main effort during recycling concentrates on segregation and reprocessing of a single polymeric material. Unfortunately, a polymer after segregation is not quite pure and in many cases should rather be treated as a blend of non compatible polymers than as a single polymer. In such a situation, phase separation on the microscale level becomes visible, with the size of dispersed phase up even to 20 μm and with weak interfacial adhesion. In the case of PET from municipal waste, up to 15% of polyolefins (mainly PE-HD) is detected. And *vice versa*, in the recycled PE-HD, quite large number of PET inclusions is usually present. Scrapped polymers, due to the reasons mentioned above have poor mechanical properties. The improvement of dispersion, increase of adhesion and acceptable mechanical properties may be obtained by addition of a compatibilizer [3—6].

The mechanical properties of recycled polymers are influenced by thermal degradation during reprocessing, which may be promoted by some kinds of inclusions. The important problem in PET recycling is the elimination of impurities which may catalyze the hydrolysis, such as PVC, NaOH or alkaline detergents left after label removing and washing as well as ester or acidic glues like EVA. Water present in recycled PET must be removed by drying [7].

In order to prevent thermal degradation of polyolefins during processing in high temperatures, stabilizers and antioxidants have to be used since in recycled polymers the activity of still present additives is lower than in virgin polymers.

The large contents of polymeric inclusions in a typical recycled polymer implicate blending as the best possible way of treatment. In the presented studies we examined the possibilities of blending non-completely segregated polymers, such as recycled PET and PE-HD, with formation of a material characterized with acceptable mechanical properties. Recycled polymers — from Polish and Italian sources — were first characterized and next three of them (one PET and 2 types of PE-HD) were selected for preparation of blends. The effectiveness of different compatibilizers using for improving blends properties has been studied. The possibility of reactive mixing with replacement of commercial compatibilizer with a respective monomer was analyzed, too.

EXPERIMENTAL

Materials and samples preparation

Materials (recyclates) used in our study were obtained from recycling companies in Poland and Italy. The homogeneity of part of them was not satisfactory, so all regrinds were first homogenized by extrusion in Brabender single screw extruder (*D* = 19 mm, *L*/*D* = 25), equipped with a mixing screw. All materials were dried before the processing (for compatibilizers see further text).

Blends of recycled polymers were prepared by extrusion in Mapre DS 40 (*D* = 30 mm, *L*/*D* = 33, 250 rpm) co-rotatating twin-screw extruder. Blend components (*i.e.* recyclates and compatibilizers — see further text and Table 4) were dried before processing. Samples for mechanical testing were prepared by injection molding. Battenfeld 30 g injection molder was used. The temperature of injection was 270°C, temperature of mold was kept at room level. The samples were of 100 mm gauge length (ASTM D 638).

Methods

The composition and dispersion of phases in recyclates of PET and polyolefins were studied by following techniques:

— Melting followed by crystallization of averaged samples of polymers were performed with heating/cooling rate 10 deg/min by means of TA 2100 differential scanning calorimeter (DSC). The weight of the samples was in the range 6—9 mg. The same apparatus was used for determination of thermo-oxidative stability of polyolefins by measurement of an oxidation induction time, according to EN 728:1997:E standard.

— The thermogravimetry (TGA) was used for determination of mineral fillers and pigments contents. Samples of 4 mg weight were heated up to 600°C with the rate 10 deg/min in Perkin-Elmer TGS 1 apparatus under the flux of air or nitrogen. The weight loss was determined.

— The chemical composition was studied with using of ATI Mattson Infinity FTIR 60 apparatus. Thin (10—20 μm) samples for these studies were formed by hot pressing at 270°C.

— Measurements of viscosities of PET's in dilute solutions were performed by using Ubbelohde type of viscometer. Details of viscosity and molecular weight determination are described in [7].

— The flow rates (*MFR*) of thermoplastics were studied by using extrusion plastometer, according to ASTM D 1238-95 standard (*T* = 265°C, weight 2.16 kg). For PE-HD also flow at 190°C was determined.

— Morphologies of polymers and blends were examined by means of Jeol scanning electron microscope (SEM). Injected samples were fractured in a liquid nitrogen.

Mechanical properties of polymers and blends were studied using Instron tensile machine, with testing rate 50%/min. The impact strength was determined as Izod test, using "Resil 5.5" (Ceast) instrument. The notched injected samples were used.

Preparation of compatibilized blends

Characterization of available recycled thermoplastics was necessary before selecting some of them for studies of possibilities of using blending as a way of recycling (see further text). On the base of information about composition, oxidation induction time and mechanical properties PET Rilat and PE-HD Rilae were selected for blends preparation. For improvement of blend properties three compatibilizers were chosen after a careful selection:

— styrene/ethylene/butylene/styrene block copolymer grafted with maleic anhydride, SEBS-*g*-MA (PAB 192, Shell Development Co., equivalent to FG 1901, 1.7 wt. % of maleic anhydride);

— ethylene/glycidyl methacrylate copolymer EGMA (Bondfast 2C, Sumitomo, Japan, 8 wt. % of GMA, or Lotader AX8840, Elf-Atochem, 8 wt. % of GMA);

— PE-HD grafted with maleic anhydride (Polybond 3009, Uniroyal, 4 wt. % of MA).

The blends formed from these components are shown in the Table 1.

Table 1. Composition of blends prepared by extrusion

Blend	Composition, wt. %/wt. %/pph*)
PET/PE-HD Rilac/SEBS-*g*-MA	75/25/0, 5 or 10
PET/PE-HD Rilac/SEBS-*g*-MA	25/75/0, 5 or 10
PET/PE-HD Rilac/EGMA	75/25/0, 5 or 10
PET/PE-HD Rilac/EGMA	25/75/0, 3 or 5
PET/PE-HD Rilac/PE-HD-*g*-MA	75/25/10
PET/PE-HD Rilac/PE-HD-*g*-MA	25/75/10

*) The description 75/25/0, 5 or 10 means that to the total mass of blend with composition 75 wt.% of PET and 25 wt.% of PE-HD was added 0, 5 or 10 pph of compatibilizer.

On the base of the knowledge of properties of compatibilized blends (described below) we assumed that another effective way of reprocessing of non-completely segregated polymers may be mixing with a formation of compatibilizer *in situ*, inside the machine, from liquid monomer, such as glycidyl methacrylate GMA.

Grafting reactions of GMA onto PE-HD Rilae were carried out in a Brabender internal mixer under nitrogen flux using bis[1-(tert-butyl-peroxy)-1-methylethyl]benzene (TBP) (Aldrich product) as radical initiator. Grafting was carried out by melting first the polymer in the mixer at 145°C and adding, at the same temperature, the liquid monomer premixed with initiator. The mixing of the components was then continued at 175°C for 5 min with a speed of 50 rpm. Various amounts of GMA monomer (10—18 wt. %) and TBP peroxide (0.2—0.3 wt. %) were added. Prepared PE-HD-*g*-GMA compatibilizer was used to extrusion of a blend containing 75 wt. % of PET and 25 wt. % of PE-HD-*g*-GMA, in a laboratory extruder. For comparison, a blend of PET/PE-HD Rilae/EGMA 75%/25%/5 pph was extruded, too.

Poor properties of PE-HD-*g*-GMA blend were the reason for selecting another way of GMA addition to the blends. To prevent a strong reaction of GMA with only one polymer (PE-HD) we decided to mix all three components (PET, PE-HD, GMA) together using Brabender mixer (T = 270°C, 30 rpm, t = 20 min) or co-rotating laboratory twin screw extruder. In the second case the controlled amount (up to 10 wt. %) of liquid GMA with dissolved TBP for reaction initiation was fed through the first venting zone to a molten blend.

RESULTS

Recyclates

Four different types of ground PET flakes from beverage bottles were carefully characterized after homogenization. Their compositions and properties are presented in Table 2. More details of analysis can be found in another author's paper [7]. We have found that all PET regrinds contain 0.1—5 wt. % admixture of other polymers. The presence of more than 50—60 ppm of PVC makes PET worthless for advanced application for film forming. Although the individual flakes of recycled PET show almost unchanged properties, the processed regrinds always exhibit worse properties and needs homogenization before use. The differences between PET's studied are mainly the results of different recycling procedures. Admixtures of other polymers always deteriorate tensile properties.

Recycled PE-HD and mixture of PE and PP were acquired from Replastic Co., Italy. PE-HD Rilae was in the form of green pellets from household detergents and cosmetics packagings. Polyolefins mixture (PEM) has been delivered in the form of multicolor flakes from packaging. According to the producer's data there is 5—10% of PET in the PEM mixture. These recyclates are produced by Replastic in large quantities.

PE-LD, PE-HD and PP, all in the form of pellets, were acquired from Ekogeminex company, Pabianice, Poland. Pellets of PE-LD are of grey color. Pellets of PE-HD and PP were black. The polymers were recovered from the stream of plastic packages, collected in the containers at inhabited regions of Łódź. Some amount of plastics originated from technological waste. The segregation according to the type of polymer was performed at a line consisting of grinders, washers, flotation, water cyclones and regranulation extruder.

The DSC curves of melting of polyolefins are presented in Fig. 1a. For all types of PE-HD (Rilae, Ekogeminex, PEM): large peaks of melting at 130—132°C

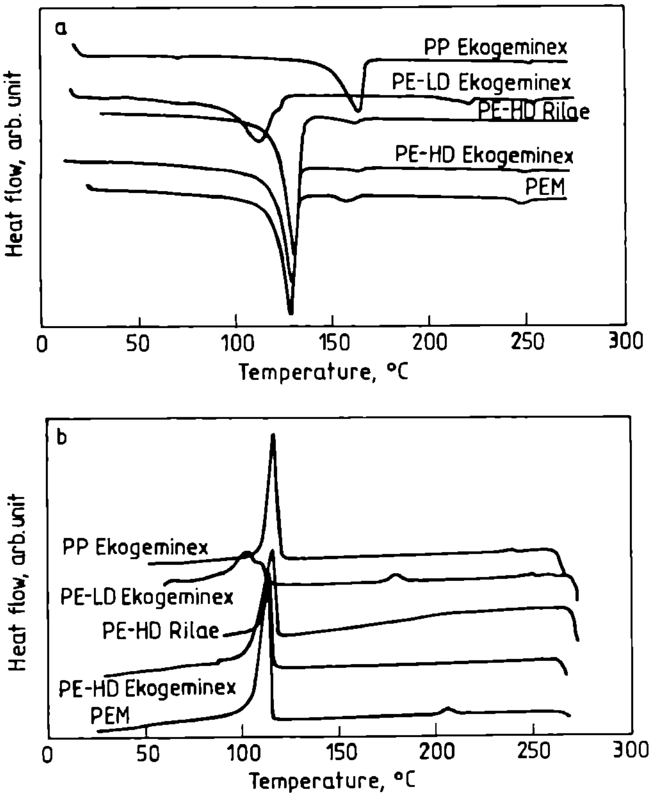

Fig. 1. DSC curves for polyolefins

Table 2. **Properties of examined recyclates of poly(ethylene terephtalates) [7]**

Polymer name/producer	Weight loss in the air — TGMA %	PVC content ppm	Total content of polymeric impurities*), wt. %	Intrinsic viscosity dl/g	Yield stress during tensile test MPa	Elongation at break during tensile test, %
Hanex/GTX Hanex, Sokka, Poland	99	910	0.12	0.8	52	30
Rilat/Replastic Co, Italy	99.7	60	0.21	0.757	56	75
PTM 3/Replastic Co., Italy	99.7	1032	4.30**)	0.792	No yield	6
Ekogeminex/Ekogeminex, Pabianice, Poland	98.3	249	0.7	0.815	No yield	4

*) Including PVC and PET with glue.

**) Including 3.3% PE-HD, 0.3% PE-LD and 0.5% of PP.

and small peaks at 160—162°C are visible. The second peak indicates the polypropylene admixture at the level from 2.5 to 4.6 wt. % as it can be judged from the heat of melting. In the PEM sample also the third peak at 249°C has been registered, which can be ascribed to a fraction of PET at the level of 1.5 wt. %. Typical shape of crystallization curve during cooling (see Fig. 1b) for PE-HD's exhibits a single broad peak at 115—118°C with the long tail extending to even 60°C. Small peak at 211.8°C, related to PET presence, is visible in PEM polyolefin mixture. FTIR spectra of averaged PE-HD samples show the bands typical for PE with small peaks characteristic for $CH-CH_3$ group vibrations.

The melting endotherm of PP Ekogeminex shows a large peak of melting at 164.2°C and a very small peak at 251°C, indicating 0.5 wt. % PET admixture. Crystallization during cooling exhibits one region with the peak at 119°C and small trace of a peak at 247°C. FTIR spectrum of PP sample from Ekogeminex shows bands typical for PP only.

The most complicated melting endotherm was registered for PE-LD Ekogeminex sample with four peaks: a large one at 112°C, a smaller at 220°C, a peak at 254.1°C and the fourth peak at 267.9°C. The second peak indicates Nylon 6 admixture at the level about 7.5 wt. %, the third one — PET from beverage bottles at the concentration of 0.8% and the fourth one — a trace of PET from fibres (melting temperature 270°C). Crystallization during cooling exhibits several regions with the peak at 248.2°C, the second peak at 176.8°C, a shoulder at 110°C, a peak at 96.4°C and a peak at 58.5°C. FTIR spectrum of averaged PE-LD sample shows bands typical for PE with small peaks characteristic for PET and for Nylon 6.

The results of thermogravimetric studies are presented in the Table 3. T_1 represents the start weight loss, *e.g.* beginning of weight change, T_2 equilibrium after the weight loss. In all cases final residues (ashes) at the level of 1.0—2.9 wt. % were observed. Weight loss in the air was only slightly increased as compared to that in nitrogen atmosphere, with exception of PE-HD Ekogeminex, where it was even lower.

Table 3. Thermogravimetric data of recyclates of polyolefins during nitrogen flow and air flow (4 mg samples, gas flow 30 ml/min, rate of heating 10 deg/min, apparatus Perkin Elmer TGS1)

Polymer	T1*) °C Air	T2*) °C Air	Weight loss % Air	T1, °C Nitrogen	T2, °C Nitrogen	Weight loss, % Nitrogen
PEM	260	554	98.7	330	500	98.0
PE-HD Ekogeminex	277	516	97.1	245	507	98.0
PE-HD Rilac	264	496	97.8	355	503	97.5
PE-LD Ekogeminex	260	561	98.5	290	511	97.9
PP Ekogeminex	255	405	99	365	494	98.2

*) T_1 — temperature of beginning of decomposition, T_2 — temperature of end of decomposition.

Oxidation induction time for samples at 200°C was found: 3.9 min for PE-HD Rilae, 7.7 min for PE-HD Ekogeminex, 2.2 min for PEM, 2.5 min for PP Ekogeminex and 2.9 min for PE-LD Ekogeminex. Only for the two first polymers the induction times are acceptable and these polymers may be processed without addition of antioxidants.

Table 4. Tensile properties of injection moulded samples of polyolefin recyclates

Polymer	Yield stress MPa	Yield strain %	Stress at break MPa	Elongation at break %
PEM	20	11	18	23
PE-HD Ekogeminex	21	15	14	230
PE-HD Rilac	23	16	13	85
PE-LD Ekogeminex	11	23	11	107
PP Ekogeminex	30	14	18	80

Mechanical properties of polyolefins characterized in tensile test are presented in Table 4. For all materials yielding was observed. However, elongation to break strongly depended on the type of polyolefin and the lowest value was measured for PEM. It suggests a dependence of mechanical properties on the recycled polymer purity.

Compatibilized blends

The properties of compatibilized blends are summarized below. More details the reader can find in another author's paper, where the role of different type of PE-HD component, *e.g.*, PE-HD Ekogeminex and PE-HD Rilae has been discussed [8]. The influence of extrusion residence time and mixing speed on the properties are presented in above paper, too.

Morphological observations of all the blends studied (examples see Figs. 2) show the tendency of decreasing of the inclusions mean size with increasing of the compatibilizer content. In the compatibilized blends (Figs. 2b and 2d) the boundaries between minor phase inclusions and the matrix are less visible, surfaces of exposed inclusions and caverns remaining in the matrix are less smooth, which also indicate stronger adhesion in the compatibilized compositions. Mean sizes of minor phase inclusions in selected blends are shown in Fig. 3.

EGMA is more effective for such compatibilization than SEBS-*g*-MA and PE-HD-*g*-MA. Decreasing of mean inclusion size to about 1 μm seems to be very effective and should produce the improvement of mechanical properties.

The compatibilized blends were more viscous than simple PET/PE-HD systems (Fig. 4), as determined by melt flow rate (*MFR*) measurements. The effect of SEBS-*g*-MA and PE-HD-*g*-MA seems to be comparable, how-

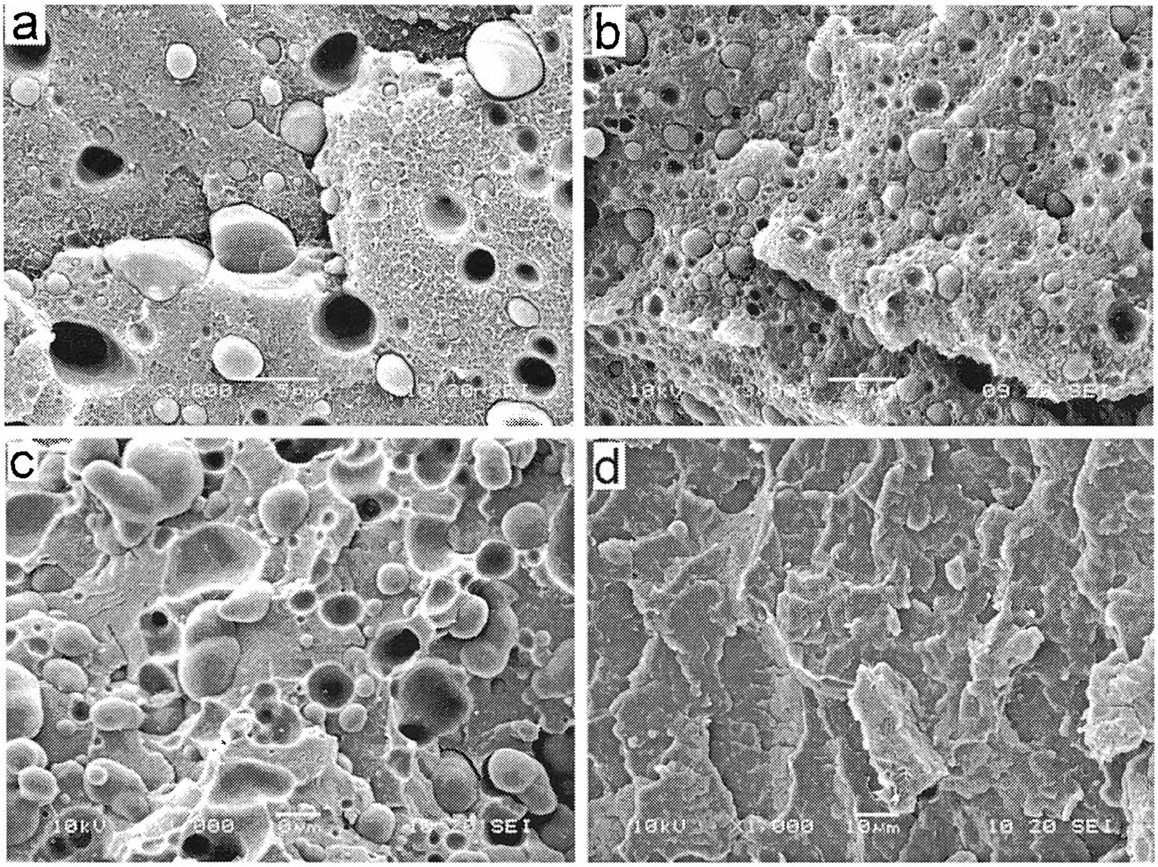

Fig. 2. Exemplary micrographs of blend morphologies: (a) PETPE-HD = 25/75 wt. %, (b) PET/PE-HD = 25/75 wt. % with 10 pph of PE-HD-g-MA, (c) PET/PE-HD = 75/25 wt. %, (d) PET/PE-HD = 75/25 wt. % with 10 pph of PE-HD-g-MA; space bars: 5 µm (a, b) and 10 µm (c, d)

ever, in the blends where EGMA was added, the *MFR* values are low, which indicates chemical reaction between components occurring during blending.

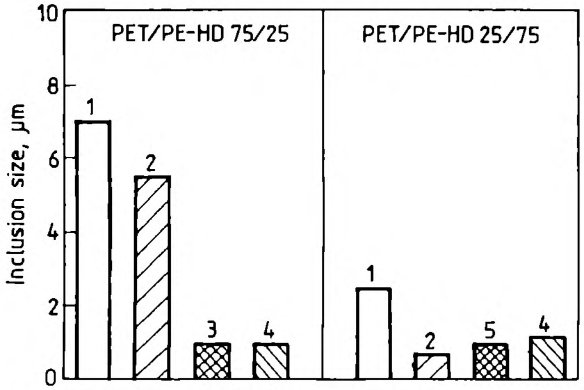

Fig. 3. Mean size of inclusion of dispersed phase, determined from SEM micrographs; 1 — without compatibilizers, 2 — 10 pph SEBS-g-MA, 3 — 10 pph EGMA, 4 — 10 pph PE-HD-g-MA, 5 — 5 pph EGMA

The mechanical properties of compositions prepared were studied during tensile test. For the blends with the PET matrix the beginning of plastic deformation with

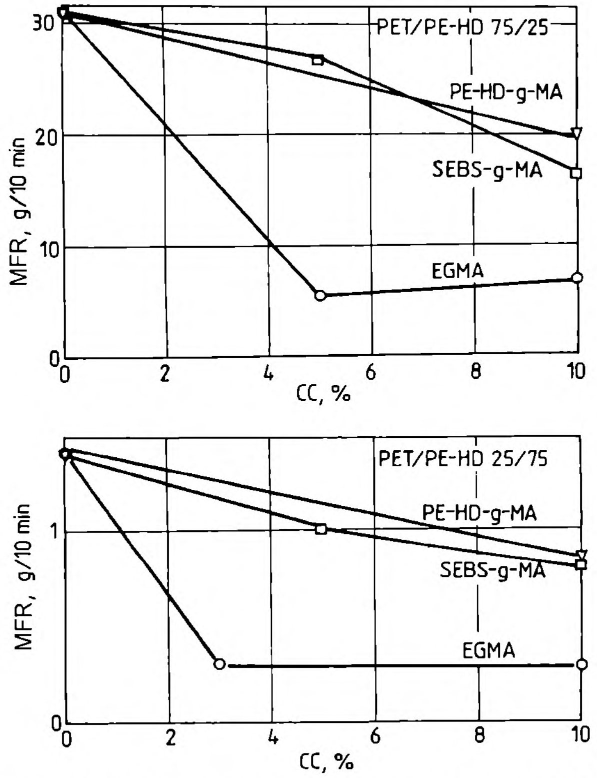

Fig. 4. Effect of compatibilizers type and content (CC) on viscosities of PET/PE-HD blends, characterized by MFR

necking is observed if at least 5 pph of compatibilizer was added. However, to increase the elongation to break behind the necking region, using of 10 pph of compatibilizer is necessary (Fig. 5a).

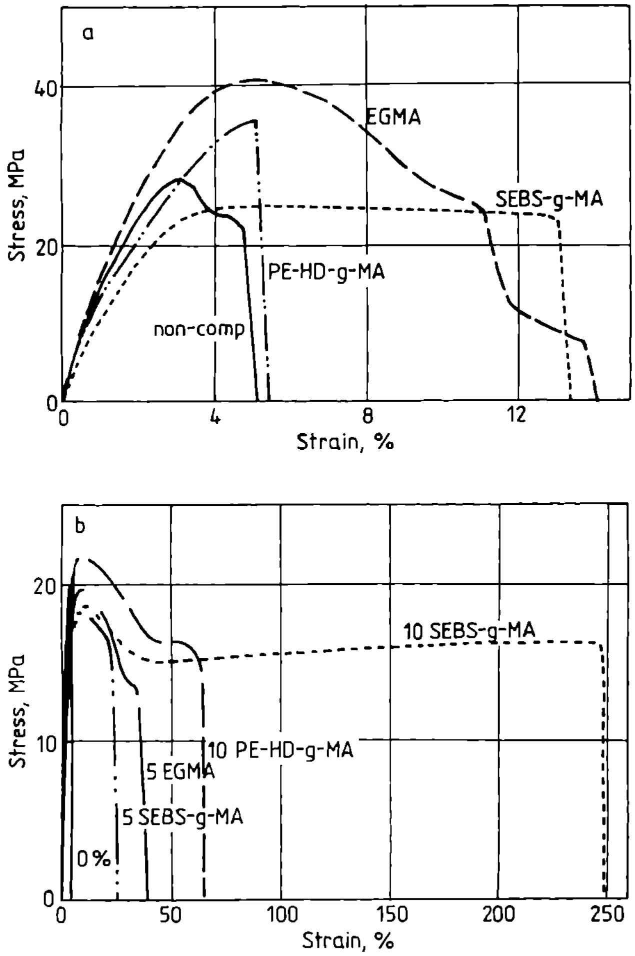

Fig. 5. Tensile properties of the blends with compatibilizer, tested at v = 50%/min (a) PET/PE-HD = 75/25 wt. % with 10 pph of compatibilizers; (b) PET/PE-HD = 25/75 wt. % with different amounts of compatibilizers

It is easier to improve properties of blends with PE-HD matrix (Fig. 5b). An addition of 10 pph of SEBS-*g*-MA leads to deformation to break at level 250%. Also EGMA (tested for 5 pph contents) is here effective. The worst material for compatibilization is PE-HD-*g*-MA, probably due to some internal reactions leading to microgels formation.

The impact properties, measured during the Izod test, are presented in Fig. 6. The effect of compatibilizer addition depends on its type. PE-HD-*g*-MA was completely not effective. SEBS-*g*-MA caused the increasing of absorbed energy when was added at amount of 10 pph. The most effective on the impact strength improvements was EGMA, because even lower contents, *e.g.* 5 pph for the blend with PET matrix (Fig. 6a) and 3 pph for the PE-HD-rich blend (Fig. 6b) resulted in the increase of impact strength.

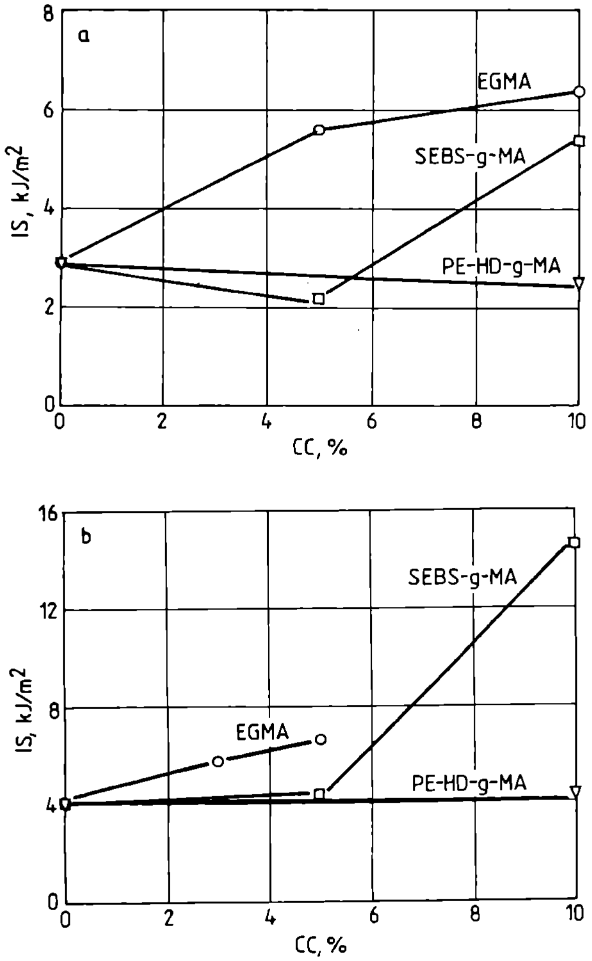

Fig. 6. Effect of compatibilizers type and content (CC) on impact strength (IS) of blends measured by the Izod test; (a) PET/PE-HD = 75/25 wt. %, (b) PET/PE-HD = 25/75 wt. %

The analysis of mechanical properties of blends suggests the possible application for the film forming, after optimization of EGMA compatibilizer content. The 4 pph of EGMA was found as an optimum value and the film from the blend PET/PE-HD/EGMA (75%/25%/4 pph) was prepared at the industrial line in Terplast, Sieradz. The received tape was smooth and of acceptable properties. The details of processing and properties can be found in [9].

Blends prepared by reactive extrusion

Commercial compatibilizers are expensive. Due to this fact, the reactive extrusion, with the formation of compatibilizer *in situ* during processing, seems to be an attractive alternative. In the above described studies, the copolymer of ethylene and glycidyl methacrylate (GMA) acted the best way. So PE-HD-*g*-GMA, formed by grafting of GMA monomer onto PE-HD, was selected for our studies. Our results of FTIR analysis by method described by Pazzagli and Pracella [10] indicated that the amount of grafted GMA increased with the increasing of initial amount, up to a value of about 8 wt. % of grafted GMA. Prepared PE-HD-*g*-GMA's, of different contents of grafted GMA, were blended with PET using laboratory extruder.

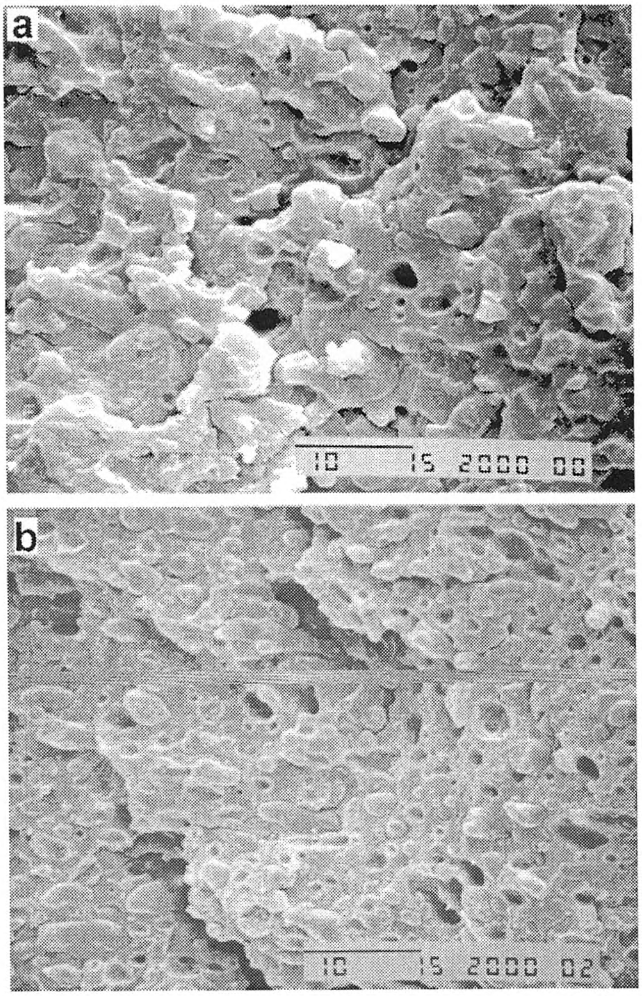

Fig. 7. SEM micrographs of fractured surfaces of blends PET/PE-HD-g-GMA 75/25 wt. % with different content of grafted GMA: (a) 2.5 wt. %; (b) 8 wt. % (scale bar — 10 mm)

The morphological analysis of PET/PE-HD-*g*-GMA (Fig. 7) demonstrates a better dispersion of the polyolefin component in comparison to non-compatibilized blend (Fig. 2c). The mean size of PE-HD inclusions in non-compatibilized blend is 7 μm, the average inclusion in PET/PE-HD-*g*-GMA blend containing 2 wt. % of GMA is reduced to 4 μm and in the blend containing 8 wt. % GMA bonded is as low as 2 μm.

The tensile tests show brittle behavior of the PET/PE-HD-*g*-GMA (75/25) blend, with elongation to break of only 5%. Another blend, PET/PE-HD Rilae/EGMA (75/25/5), prepared for comparison, deforms with the neck and shows the elongation to break at 16%. Poor tensile properties of the blend with PE-HD-*g*-GMA were probably the result of a network formation during reactive mixing of GMA with PE-HD.

Identical blends were studied by Pracella *et al.* [11] where the compatibilizing effect of grafting GMA onto PE-HD was estimated by means of tensile-impact strength measurements. Two blends of PET/PE-HD-*g*-GMA (75/25) containing 2 and 2.5 wt. % of grafted GMA respectively were studied by authors of [11]. For comparison with those blends the blends of PET/PE-HD (75/25) compatibilized with EGMA (5 pph) and without compatibilizer were also tested by them. The tensile-impact test showed that strength of the PET/PE-HD (75/25) blend was 38.7 kJ/m^2. Both PET/PE-HD-*g*-GMA blends show the values of tensile-impact strength about twice (*e.g.* 78.1 and 75.8 kJ/m^2) of that found for the non-compatibilized blend, but lower with respect to the blend with 5 pph EGMA (101.4 kJ/m^2) [11]. The variation of tensile-impact strength of the blends correspond to the variation of particle size, *i.e.* the tensile-impact strength increases with the better dispersion of PE-HD.

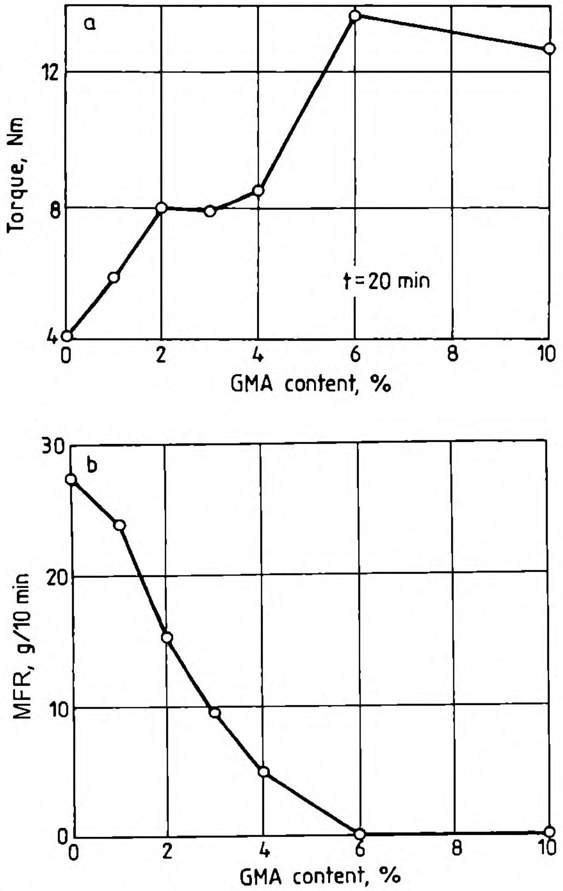

Fig. 8. Torque after 20 min of mixing (a) and melt flow rate (MFR) (b) for the blend PET/PE-HD = 75/25 wt. % as a function of GMA concentration

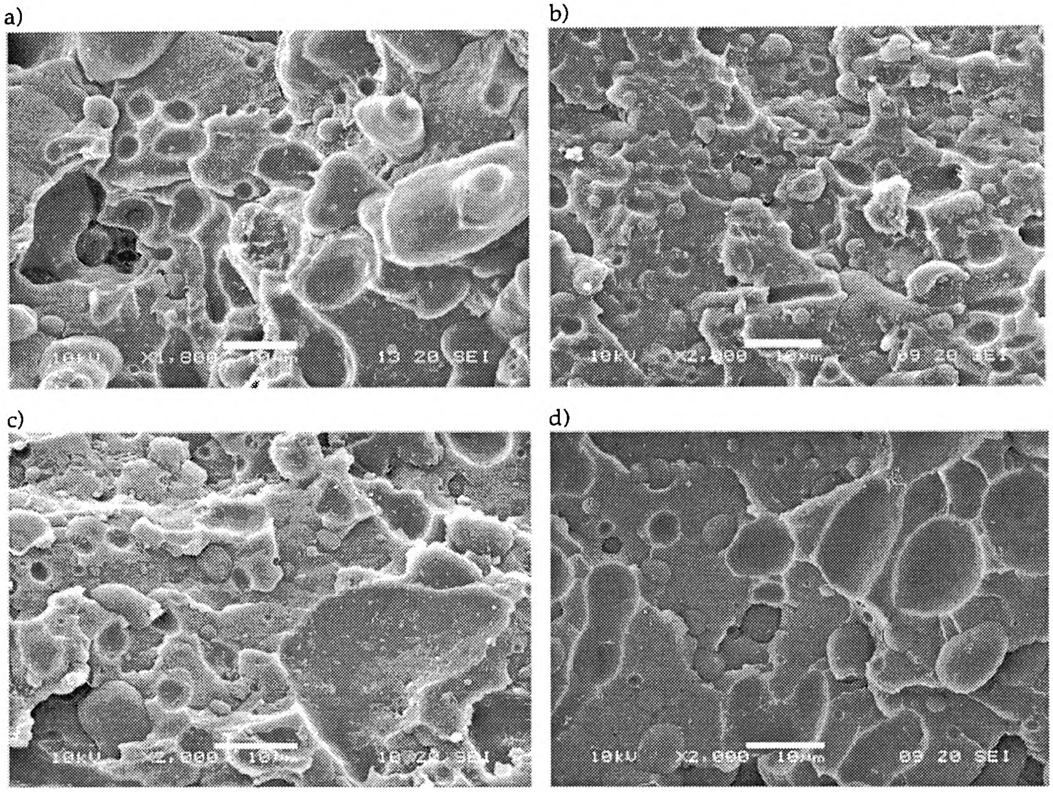

Fig. 9. SEM micrographs of fractured surface of the blends PET/PE-HD = 75/25 wt. % with different concentrations of GMA, prepared at internal mixer (scale bar — 10 μm); content of GMA: (a) 0 wt. %, (b) 3 wt. %, (c) 6 wt. %, (d) 10 wt. %

These results suggest that one-step mixing, with all components added together is more promising. A set of blends with PET/PE-HD Rilae (75/25) and 1 to 10 pph of GMA was prepared in the Brabender mixer. The torque was measured during mixing and the results after 20 min of mixing are presented in Fig. 8a. The increase of torque levels at 6 pph of GMA indicates that bigger amount of GMA is not effectively consumed and remains unreacted in the blend. Also the *MFR* values of prepared blends (Fig. 8b) were close to zero (at tested conditions) for the contents of GMA at 6 pph and more. So low values demonstrate the network formation in the blend.

The morphology of the blends (Fig. 9) strongly depends on the amount of GMA used. With its increase a better dispersion is observed, however, at the level of 6 pph (Fig. 9c) the morphology is more coarse again, with well visible large structures of cured PE-HD.

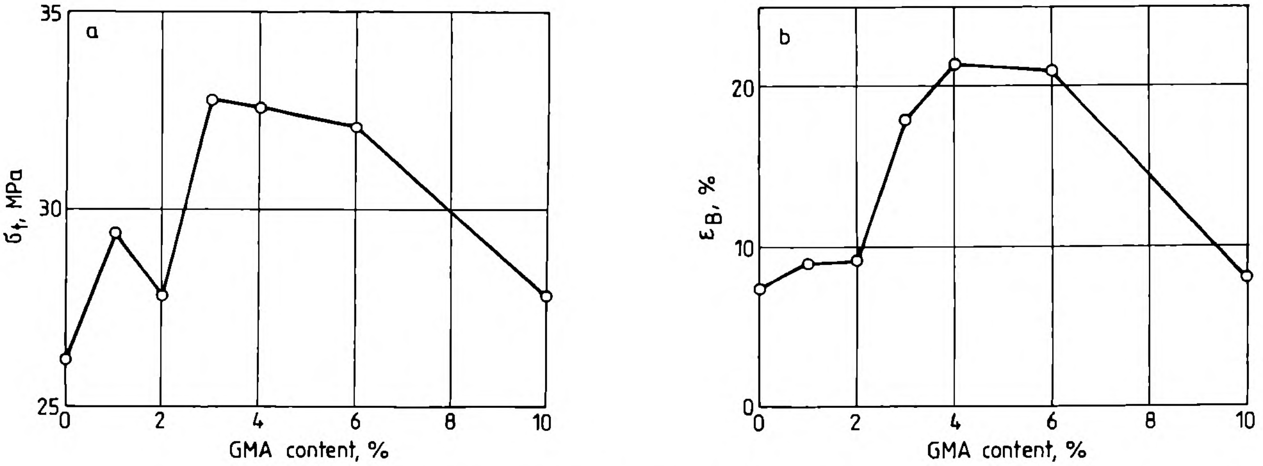

Fig. 10. Mechanical properties of the PET/PE-HD = 75/25 wt. % blends compatibilized with different concentrations of GMA, prepared at internal mixer: (a) tensile strength (σ_t), (b) elongation at break (ε_B)

Tensile properties of the blends as a function of GMA applied are presented in Fig. 10. The maximum of strength and elongation at break were registered for the composition containing 4 pph of GMA. A blend containing 10 pph of GMA showed as poor properties as the non-compatibilized blend.

Similar blends, with the same range of GMA content, were prepared at the twin screw extruder, with the aim to study the processability (see Experimental). At the concentration of 10 pph of GMA an instant formation of a thick gel was observed. The problems with the uniform flow of the extrudate were solved by decreasing the amount of GMA, first to 4 pph and then to 2 pph only. Finally, a uniform material was received from the extruder die. The residence time was 7 min, with the yield of 1 kg/h; the temperature distribution in the extruder was 250—270°C.

However, the mechanical properties of the extruded blend were poor (the tensile strength at 25.5 MPa, elongation at break at 4%), which is a result of the presence of significant amount of microgels. That is because at the temperature above 185°C the reaction is very fast and is accomplished before GMA and peroxide have a chance to be well distributed within the melt. The reaction is intense and undergoes locally with the formation of a gel.

CONCLUSIONS

The blend formation is a possible way of recycling of non-completely segregated polymers. Final properties of such blend strongly depends on the quality of the components. The level and type of impurities in these components are of significant meaning. The analysis of typical recycled poly(ethylene terephtalates) and polyolefins shown that the level of admixtures is from 15 ppm up to 15 wt. %. In PET usually polyolefin admixture is present and, opposite, in PE-HD there are visible PET's inclusions. The level of another polymeric impurities is much lower, however for PET even the presence of low amount of PVC is undesirable. Polyolefins, used for blends formation, often show too low contents of stabilizers and antioxidants, which decreases oxidation induction time below acceptable value of approximately 5 min.

The blends from scrapped polymers needs compatibilization for mechanical properties improvement. Two possible ways were studied: a) addition of commercial compatibilizer; b) *in situ* formation of compatibilizer made of monomer (glycidyl methacrylate), during blending. Advantages of first method are easier processing and better final properties of a blend. In the case of blends made of recycled PET with recycled PE-HD, the addition of about 5 wt. % of compatibilizer was necessary. We found that the most effective as compatibilizer was EGMA copolymer, less SEBS-*g*-MA and the worst was PE-HD-*g*-MA. The relation between decreasing of dispersed phase size, increase of adhesion and improvement of mechanical (tensile and impact) properties was observed.

Disadvantage of using of the commercial compatibilizer is high price, so the second way (b), with *in situ* formation of compatibilizer, seems to be attractive. We tested a two step process, with functionalization of one polymer (PE-HD) and next mixing with the second one (PET), however the results were not satisfactory and the alternative route by mixing all components together in the extruder (or in the internal mixer) was selected.

The optimum level of GMA in the blends of PET/PE-HD Rilae 75/25 has been found. The best mechanical properties were observed when 2 pph of GMA was added to the extruded blend and 4 pph GMA to the blend prepared in the mixer. Too large amount of GMA leads to the crosslinking in the melt and deterioration of the mechanical properties.

The processability of these blends for film forming was good, also the mechanical properties of produced film were acceptable for simple applications. The cost evaluated for this process is in favor over the application of EGMA, however, the residue of unreacted GMA may cause problems with successful application.

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