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(54) **COMPATIBILIZED
POLYESTER/POLYAMIDE BLENDS**

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(57) **ABSTRACT**

Disclosed are compatibilized polymer blends comprising polyester, polyamide and a compatibilizer. Such compatibilized polymer blends, in preferred embodiments, are fabricated into monolayer or multilayer preforms and/or containers. Containers comprising such blends exhibit good gas barrier properties against gases such as oxygen and carbon dioxide, have a good appearance and may be used as containers for a wide variety of consumer products, including beverages, edibles and cosmetics. In multilayer containers comprising one or more layers of the compatibilized polymer blend and one or more layers of PET or PET-containing copolymers, the present containers have greatly improved impact delamination resistance as compared to those formed using uncompatibilized blends.

COMPATIBILIZED POLYESTER/POLYAMIDE BLENDS

RELATED APPLICATION DATA

[0001] This application claims priority under 35 U.S.C. 119(e) from provisional application Ser. No. 60/366,701 filed Mar. 21, 2002, the disclosure of which is incorporated in its entirety herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to compatibilized polymer blends comprising polyester, polyamide and a compatibilizer. Such compatibilized polymer blends, in preferred embodiments, are fabricated into monolayer or multilayer preforms and/or containers.

[0004] 2. Description of the Related Art

[0005] Thermoplastic polyester containers as produced through stretch blow molding have various excellent properties including good transparency, good mechanical characteristics and good flavor barrier properties, and are sanitary and safe for daily use. Therefore, they have many applications in various fields. However, since their gas barrier properties are not always satisfactory, drinks, foods and others in them could be stored only a relatively short period of time.

[0006] In order to achieve extended shelflife of PET containers by improving barrier and mechanical properties, various methods of combining a thermoplastic polyester with a polyamide or Nylon barrier resin such as MXD6 with good gas barrier properties to give laminated structures have been proposed. Prior to stretch blowing, a preform (parison) is first formed. For forming the preform, various techniques e.g. coinjection molding, coextrusion molding, multi-stage, including multilayer, injection molding, etc. are employed. Of these, multilayer injection molding is characterized by many as a suitable apparatus and method and the preforms produced through it would have a three or five layer structure in which each polyamide layer is sandwiched between PET layers and therefore, even though the moldings have no adhesive resin (Ad) layer between the MXD6 layer and the PET layers they could be suitable multi-layered containers with seemingly good appearance at atmospheric pressures.

[0007] However, when such containers filled with drinks, foods and others are shocked, for example, by dropping them, the PET layers and the MXD6 layer are easily delaminated, thereby causing a serious problem with appearance and performance of the containers. In that situation, coinjected molded containers having adhesive layers between each polyamide and PET layer have been proposed. Alternatively, the PET multilayer container may be overdesigned by the incorporation of more overall weight in the preform/bottle to better resist delamination.

[0008] Such options have been investigated. However, the equipment for producing them is often extremely complicated, and, in addition, controlling the thickness and/or positioning of each layer constituting them is often difficult. Therefore, those containers are inferior to others having no adhesive layer in view of the production costs and the processability.

[0009] Other methods have also been investigated of blending MXD6 with any other resins for increasing the delamination resistance of containers with no Ad layer. For example, in JP-A-1-176554 a method of blending MXD6 with a polyamide-ester type thermoplastic resin, in JP-A-1-182023 a method of blending it with a metal-containing polyester type thermoplastic resin, and in JP-A-3-175032 a method of blending it with a thermoplastic polyurethane is disclosed. However, blending MXD6 with such other resins in producing containers lowers the transparency of the containers produced, and the containers will generally have an extremely bad appearance. In addition, the blending increases the production costs, and, depending on the type of the resins to be blended, there will occur still other problems in that the melt stability of the blends will be poor, acetaldehyde content will be high, and the barrier properties will be inadequate.

SUMMARY OF THE INVENTION

[0010] In accordance with preferred embodiments, there is provided a compatibilized polymer blend, comprising polyamide, PET or a PET-containing copolymer, and at least one compatibilizer. Preferred compatibilizers include modified PET, including IPA modified PET, p-toluene sulfonic acid (pTSA) modified PET, pyromellitic dianhydride (PMDA) modified PET, and maleic anhydride modified PET; PET ionomers, including sulfonated PET, acrylic-modified polyolefin ionomer; and bisphenol-A epoxy resin, preferably of low molecular weight. In a preferred embodiment, a compatibilized polymer blend comprises polyamide, preferably MXD-6, PET or a PET-containing copolymer, and at least one compatibilizer selected from IPA-modified PET and PET ionomer. Although PET ionomers are preferred, other polyester ionomers such as polybutylene terephthalate (PBT) ionomers and polypropylene (PPT) ionomers may also be used. In some embodiments, the compatibilized polymer blend can further comprise at least one antioxidant. In a preferred embodiment, the blend which forms a monolayer preform or container or one layer of a preform or container comprises 15 mole % or less polyamide.

[0011] In a preferred embodiment, the compatibilized polymer blend is formed by a process comprising blending the polyamide, PET or PET-containing copolymer, and compatibilizer in the melt phase; extruding the blend into pellets; and heating said pellets, preferably in an inert atmosphere, to a temperature between the blend's glass transition temperature and melt temperature thereby causing solid state polymerization and/or reactive compatibilization to occur. In some embodiments, the heating step may be omitted.

[0012] In accordance with preferred embodiments, a compatibilized polymer blend is used to form a monolayer or multilayer preform or container. For example, one preferred preform or container is that which comprises a body and a neck finish, wherein at least said body comprises at least a first layer comprising a compatibilized polymer blend, said compatibilized polymer blend comprising polyamide, PET or a PET-containing copolymer, and at least one compatibilizer, preferably IPA-modified PET or PET ionomer. In a preferred embodiment, the polyamide constitutes less than or equal to about 15 mol % of the blend. In accordance with another preferred embodiment, there is provided a multilayer preform or container, comprising a body portion and a

neck finish; wherein at least said body portion comprises at least one layer comprising a compatibilized polymer blend, said compatibilized polymer blend comprising polyamide, PET or a PET-containing copolymer, and at least one compatibilizer, preferably IPA-modified PET or PET ionomer, and at least one layer comprising thermoplastic polyester, preferably PET or PET-containing copolymer. The multi-layer preform or container may further comprise a third layer comprising a thermoplastic polyester, preferably PET or PET-containing copolymer.

[0013] In accordance with a preferred embodiment, there is provided a preform or container comprising a body portion and a neck finish, wherein at least said body portion comprises at least first and second layers, wherein said first layer comprises PET or a PET-containing copolymer; and said second layer comprises a compatibilized polymer blend, said compatibilized polymer blend comprising polyamide, PET or a PET-containing copolymer, and at least one compatibilizer selected from IPA-modified PET and PET ionomers.

[0014] Containers and preforms made from preferred compatibilized polymer blends exhibit lower haze as compared to those made from non-compatibilized blends. In multilayer containers and preforms, layers made from compatibilized polymer blends according to preferred embodiments may also exhibit greater adhesion to PET than those made from non-compatibilized blends.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Disclosed herein are compatibilized polyester/polyamide blends and containers made therefrom with greatly improved impact delamination resistance, adhesion, color, and clarity. In addition, these containers preferably have one or more of the following properties: excellent gas barrier properties against oxygen, carbon dioxide and other gasses, stable resin melts as well as improved appearance.

[0016] A preferred container is of the type used for beverages. Alternatively, embodiments of the container could take the form of jars, tubs, trays or bottles for holding edibles, cosmetics, and the like. Preferred containers may comprise a single layer or multiple layers. As presently contemplated, one embodiment of a container is formed from a preform comprising a body and a neck finish which is stretch blow molded into a container. However, for the sake of simplicity, these embodiments will be described herein primarily as containers or preforms.

[0017] Furthermore, the containers described herein may be described specifically in relation to a particular component, polyethylene terephthalate (PET), but preferred methods are applicable to many other thermoplastics of the polyester type described herein. Other suitable polyesters include, but are not limited to, polypropylene, polyethylene, polycarbonate, polyamides or acrylics.

[0018] In addition, preferred containers described herein may be described specifically in relation to a particular component, MXD6 or nylon, but preferred methods are applicable to other polyamides, and such description should not be taken to exclude such other polyamides.

[0019] As used herein, the terms substantially or predominantly indicates that the component described is present as

50% or more of the total content. PET is used to describe virgin and/or recycled polyethylene terephthalate polymers, including virgin and/or recycled PET-containing copolymers. IPA modified PET is used to describe PET comprising isophthalic acid (IPA).

[0020] In one embodiment, a container is a single layer comprising a blend of polyamide, polyester, and a compatibilizer. Other embodiments comprise at least one layer of a blend of polyamide, polyester, and a compatibilizer and at least one layer comprising a thermoplastic polyester. For example, a multi-layered container may be prepared by over-molding a polyester resin with a polyamide/polyester-terephthalate/compatibilizer resin mixture. In one embodiment, a container may comprise a first layer of thermoplastic polyester and a second layer comprising a blend of a polyamide, such as MXD6, and PET having an isophthalic acid content of from about 2 to 15 mol % wherein the isophthalic acid acts as a compatibilizer. Further, a blend comprising polyamide/PET/compatibilizer, also referred to herein as a compatibilized polymer blend, may also include an antioxidant to prevent haze and/or color formation inherent with polyamide/PET blends. As presently contemplated, one preferred, process for producing these layers comprises an overmolding process as disclosed in U.S. Pat. No. 6,352, 426 B1 the disclosure of which is incorporated in its entirety herein by reference. Further, these layers may also be produced by any suitable process, including coinjection, injection molding with or without overmolding, and coextrusion.

A. Preferred Materials

1. Preferred Polyesters

[0021] Preferred thermoplastic polyesters include, but are not limited to, condensed polymers that comprise an aromatic dicarboxylic acid or its alkyl ester and a diol. Suitable resins include a polyester resin including or consisting essentially of an ethylene terephthalate component. In one embodiment, it is desirable that the total proportion (mol %) of terephthalic acid units and ethylene glycol units constituting a preferred polyester is at least about 70 mol % relative to the total moles of all constituent units that constitute said polyester, more preferably at least about 90 mol %. Such an embodiment is suitable for most applications, and is especially suitable for hot fill applications. If the total proportion of terephthalic acid units and ethylene glycol units constituting the preferred polyester is smaller than about 70 mol %, the copolyester will be amorphous. When hot filled, stretched containers that comprise such an amorphous copolyester are more susceptible to heat shrinkage, and may have poor heat resistance and lower strength.

[0022] A polyester resin, including, but not limited to those discussed above, may be optionally copolymerized with any other bifunctional compound units except terephthalic acid units and ethylene glycol units, within the range not significantly interfering with the properties needed or desired for the container or preform. In the embodiment discussed above, the proportion (mol %) of the additional units is preferably at most about 30 mol % relative to the total moles of all constituent units that constitute the polyester, more preferably at most 20 mol %, even more preferably at most 10 mol %. Preferred bifunctional compound units that may be in the resin include dicarboxylic acid units,

diol units and hydroxycarboxylic acid units. Other bifunctional compounds are also employable for the purpose, including, for example, aliphatic bifunctional compound units, alicyclic bifunctional compound units and aromatic bifunctional compound units.

[0023] Examples of preferred aliphatic bifunctional compound units, include, but are not limited to, divalent structure units to be derived from aliphatic dicarboxylic acids and their ester-forming derivatives, such as malonic acid, succinic acid, adipic acid, azelaic acid and sebacic acid; from aliphatic hydroxycarboxylic acids and their ester-forming derivatives, such as 10-hydroxyoctadecanoic acid, lactic acid, hydroxyacrylic acid, 2-hydroxy-2-methylpropionic acid and hydroxybutyric acid, and from aliphatic diols such as trimethylene glycol, tetramethylene glycol, hexamethylene glycol, neopentyl glycol, methylpentanediol and diethylene glycol. Neopentyl glycol units are preferred aliphatic bifunctional compound units, since copolyesters comprising the units do not lower the heat resistance of the multi-layered containers comprising them and are easy to produce.

[0024] Examples of alicyclic bifunctional compound units include, but are not limited to, divalent structure units to be derived from alicyclic dicarboxylic acids and their ester-forming derivatives, such as cyclohexanedicarboxylic acid, norbornenedicarboxylic acid and tricyclodecanedicarboxylic acid; alicyclic hydroxycarboxylic acids and their ester-forming derivatives such as hydroxymethylcyclohexanecarboxylic acid, hydroxymethylnorbornenecarboxylic acid and hydroxymethyltricyclodecanecarboxylic acid; and alicyclic diols such as cyclohexanedimethanol, norbornenedimethanol and tricyclodecanedimethanol. Cyclohexanedimethanol units or cyclohexanedicarboxylic acid units are preferred alicyclic bifunctional compound units, since copolyesters comprising them are easy to produce. Further, these units improve the drop-impact strength of the containers and greatly improve the transparency thereof.

[0025] The cyclohexanedimethanol unit as referred to herein is meant to indicate at least one divalent unit selected from 1,2-cyclohexanedimethanol units, 1,3-cyclohexanedimethanol units and 1,4-cyclohexanedimethanol units. The cyclohexanedicarboxylic acid unit also referred to herein is to indicate at least one divalent unit selected from 1,2-cyclohexanedicarboxylic acid units, 1,3-cyclohexanedicarboxylic acid units and 1,4-cyclohexanedicarboxylic acid units. Of the alicyclic bifunctional compound units noted above, more preferred are 1,4-cyclohexanedimethanol units and 1,4-cyclohexanedicarboxylic acid units, since they are easily available and since copolyesters comprising them and even moldings from such copolyesters could have higher drop-impact strength.

[0026] Preferred aromatic bifunctional compound units may be any of aromatic dicarboxylic acid units, aromatic hydroxycarboxylic acid units and aromatic diol units. Examples include, but are not limited to, divalent units to be derived from aromatic dicarboxylic acids except terephthalic acid and their ester-forming derivatives, such as isophthalic acid (IPA), phthalic acid, biphenyldicarboxylic acid, diphenyl ether-dicarboxylic acid, diphenyl sulfone-dicarboxylic acid, diphenyl ketone-dicarboxylic acid, sodium sulfoisophthalate, 2,6-naphthalenedicarboxylic acid, 1,4-naphthalenedicarboxylic acid and 2,7-naphthalenedicarboxylic acid; aromatic hydroxycarboxylic acids and their

ester-forming derivatives, such as hydroxybenzoic acid, hydroxytoluic acid, hydroxynaphthoic acid, 3-(hydroxyphenyl)propionic acid, hydroxyphenylacetic acid and 3-hydroxy-3-phenylpropionic acid, and aromatic diols such as bisphenol compounds and hydroquinone compounds. At least one of isophthalic acid units, phthalic acid units, naphthalenedicarboxylic acid units and 4,4'-biphenyldicarboxylic acid units are preferred as the aromatic dicarboxylic acid units for bifunctional compound units, since copolyesters comprising them are easy to produce and since the monomer costs for them are low.

[0027] In particular, isophthalic acid (IPA) is advantageous in that the moldability of copolyesters comprising IPA is good. Further these IPA copolyesters exhibit a broad range of molding conditions resulting in good moldings and a low percentage of failed moldings. In addition, the acid is further advantageous in that it retards the crystallization rate of the copolyesters comprising it thereby preventing the whitening of the copolyester molding.

[0028] Naphthalenedicarboxylic acid is also advantageous in that it increases the glass transition point of copolyesters comprising it and even increases the heat resistance of containers comprising the copolyesters. In addition, naphthalenedicarboxylic acid-copolymerized polyesters absorb UV rays, and are therefore preferably used in producing containers that are desired to be resistant to UV rays. For the purpose of protecting the contents of containers from UV rays, it is desirable that the thermoplastic polyester to be used for producing the containers has a naphthalenedicarboxylic acid component in an amount of from 0.1 to 15 mol %, more preferably from 1.0 to 10 mol %, but also including about 0.5, 2, 3, 4, 5, 6, 7, 8, 9, 10.5 mol % relative to the sum total of all dicarboxylic acid components constituting it. 2,6-naphthalenedicarboxylic acid component is preferred as naphthalenedicarboxylic acid, since copolyesters comprising it are easy to produce and since the monomer cost for it is low.

[0029] Examples of suitable aromatic bifunctional compound units include, but are not limited to, diol units to be derived from 2,2-bis(4-(2-hydroxyethoxy)phenyl)propane, 2-(4-(2-(2-hydroxyethoxy)ethoxy)phenyl)-2-(4-(2-hydroxyethoxy)phenyl)propane, 2,2-bis(4-(2-(2-hydroxyethoxy)ethoxy)phenyl)propane, bis(4-(2-hydroxyethoxy)phenyl)sulfone, (4-(2-hydroxyethoxy)ethoxy)phenyl)-(4-(2-hydroxyethoxy)phenyl)sulfone, 1,1-bis(4-(2-hydroxyethoxy)phenyl)cyclohexane, 1-(4-(2-(2-hydroxyethoxy)ethoxy)ethoxy)phenyl)-1-(4-(2-hydroxyethoxy)phenyl)-cyclohexane, 1,1-bis(4-(2-(2-hydroxyethoxy)ethoxy)phenyl)cyclohexane, 2,2-bis(4-(2-hydroxyethoxy)-2,3,5,6-tetrabromophenyl)propane, 1,4-bis(2-hydroxyethoxy)benzene, 1-(2-hydroxyethoxy)-4-(2-(2-hydroxyethoxy)ethoxy)benzene or 1,4-bis(2-(2-hydroxyethoxy)ethoxy)benzene. Of those diol units mentioned above, preferred are 2,2-bis(4-(2-hydroxyethoxy)phenyl)propane units, bis(4-(2-hydroxyethoxy)phenyl)sulfone units and 1,4-bis(2-hydroxyethoxy)benzene units, since polyester resins comprising any of those diol units are easy to produce while having good melt stability. Further, moldings from such resins have good color tone and good impact resistance.

[0030] Suitable polyester resins for the thermoplastic polyester layer of certain embodiments may have one or

more bifunctional compound units including, but not limited to, those mentioned above. Resins containing such monomers in addition to terephthalic acid are referred to herein as PET-containing copolymers. Preferred polyester resins may contain a small amount of diethylene glycol units from diethylene glycol, which is a dimer of an ethylene glycol component and is formed as a minor by-product in the process of producing the polyester resin. Because of potential problems involving factors such as glass transition point, heat resistance, mechanical strength and color tone of moldings such as bottles, it is preferred that the proportion of the diethylene glycol units in the polyester resin be kept relatively low. Accordingly, in a preferred embodiment, the proportion of the diethylene glycol units in the polyester resin is smaller than 3 mol %, including 1 and 2 mol %, relative to the total moles of all constituent units of the polyester resin.

[0031] Polyester resins used in accordance with a preferred embodiment may be optionally copolymerized with polyfunctional compound units, including, but not limited to, those preferably derived from at least one polyfunctional compound having at least three groups selected from carboxyl groups, hydroxyl groups and their ester-forming groups. In one embodiment, the proportion of the polyfunctional compound units in the polyester resin are no more than 0.5 mol % relative to the total moles of all constituent units of the polyester. The polyfunctional compounds from which the polyfunctional compound units are derived may be any of polyfunctional compounds, including, but not limited to those having at least three carboxyl groups only, those having at least three hydroxyl groups only, and those having at least three carboxyl and hydroxyl groups in total. Suitable polyfunctional compound units, include, but are not limited to, those derived from aromatic polycarboxylic acids such as trimellitic acid, trimellitic acid, 1,2,3-benzenetricarboxylic acid, pyromellitic acid and 1,4,5,8-naphthalenetetracarboxylic acid; aliphatic polycarboxylic acids such as 1,3,5-cyclohexanetricarboxylic acid; aromatic polyalcohols such as 1,3,5-trihydroxybenzene; aliphatic or alicyclic polyalcohols such as trimethylolpropane, pentaerythritol, glycerin and 1,3,5-cyclohexanetriol; aromatic hydroxycarboxylic acids such as 4-hydroxyisophthalic acid, 3-hydroxyisophthalic acid, 2,3-dihydroxybenzoic acid, 2,4-dihydroxybenzoic acid, 2,5-dihydroxybenzoic acid, 2,6-dihydroxybenzoic acid, protocatechuic acid, gallic acid and 2,4-dihydroxyphenylacetic acid; aliphatic hydroxycarboxylic acids such as tartaric acid and malic acid; and their ester-forming derivatives.

[0032] A preferred polyester resin for the thermoplastic polyester layer of a preferred embodiment may comprise at least one polyfunctional compound unit such as, but not limited to, those mentioned above. Of those mentioned above, a preferred polyester resin preferably comprises at least one polyfunctional compound unit to be derived from trimellitic acid, pyromellitic acid, trimellitic acid, trimethylolpropane and pentaerythritol, in view of the ease of producing the polyesters and the costs for their production. In addition, embodiments comprising such polyfunctional compound units may further comprise monofunctional compound units to be derived from at least one of monofunctional compounds such as, but not limited to, monocarboxylic acids, monoalcohols and their ester-forming derivatives. In embodiments including such monofunctional compound units, it is desirable that the proportion of the monofunc-

tional compound units is at most about 5 mol %, more preferably at most about 1%, but also including about 2, 3, and 4%, relative to the total moles of all constituent units of the resin. Where the resin contains two or more different monofunctional compound units, the proportion indicates the total of all those units. Monofunctional compounds can be used to retard gellation when used at preferred concentrations. This is because gelling of the resin that satisfies the requirement is retarded in many cases. If the proportion of the monofunctional compound units is larger than about 5 mol %, the polymerization rate in producing the polyester resin, through melt or solid-phase polymerization, may be low which further unfavorably lowers the producibility of said polyester resin. In embodiments including monofunctional compound units, these units function as blocking compound units to block the terminal groups of the molecular chain or the terminal groups of the branched chains in the polyester resin, whereby the polyester resin is prevented from being too crosslinked and from being gelled. Preferred monofunctional compound units are not specifically defined, but preferably include, but are not limited to, those derived from at least one of monocarboxylic acids, monoalcohols and their ester-forming derivatives. Suitable monofunctional compound units, include, but are not limited to, units derived from monofunctional compounds, for example, aromatic monocarboxylic acids such as benzoic acid, o-methoxybenzoic acid, m-methoxybenzoic acid, p-methoxybenzoic acid, o-methylbenzoic acid, m-methylbenzoic acid, p-methylbenzoic acid, 2,3-dimethylbenzoic acid, 2,4-dimethylbenzoic acid, 2,5-dimethylbenzoic acid, 2,6-dimethylbenzoic acid, 3,4-dimethylbenzoic acid, 3,5-dimethylbenzoic acid, 2,4,6-trimethylbenzoic acid, 2,4,6-trimethoxybenzoic acid, 3,4,5-trimethoxybenzoic acid, 1-naphthoic acid, 2-naphthoic acid, 2-biphenylcarboxylic acid, 1-naphthalenacetic acid and naphthalenacetic acid; aliphatic monocarboxylic acids such as n-octanoic acid, n-nonanoic acid, myristic acid, pentadecanoic acid, stearic acid, oleic acid, linolic acid and linolenic acid; ester-forming derivatives of those monocarboxylic acids; aromatic alcohols such as benzyl alcohol, 2,5-dimethylbenzyl alcohol, 2-phenethyl alcohol, phenol, 1-naphthol and 2-naphthol; and aliphatic or alicyclic monoalcohols such as pentadecyl alcohol, stearyl alcohol, polyethylene glycol monoalkyl ethers, polypropylene glycol monoalkyl ethers, polytetramethylene glycol monoalkyl ethers, oleyl alcohol and cyclododecanol.

[0033] A preferred polyester resin may comprise at least one monofunctional compound units such as, but not limited to, those mentioned above. Of the monofunctional compound units mentioned above, those to be derived from one or more monofunctional compounds selected from benzoic acid, 2,4,6-trimethoxybenzoic acid, 2-naphthoic acid, stearic acid and stearyl alcohol are preferred for the polyesters for use in accordance with preferred embodiments, in view of the ease in producing the polyesters and of the costs for their production.

[0034] In view of its moldability, it is desirable that the thermoplastic polyester of a preferred embodiment comprises or consists essentially of an ethylene terephthalate component, otherwise known as polyethylene terephthalate or PET. The PET used in accordance with preferred embodiments may be copolymerized with suitable amounts of one or more comonomer components. It is desirable that the thus-copolymerized polyester resin contains a comonomer component in an amount of from 1 to 6 mol %, relative to

the total moles of all constituent units of the polyester, including about 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 and 5.5 mol %. In consideration of the degree of copolymerization with diethylene glycol that may be produced as a by-product in the process of producing the resin, some other comonomers may be added to the resin so as to make the resin copolymerized with them within the range noted above. Such other comonomers are not specifically defined, for which any of the monomers mentioned above are usable. Some preferred monomers include, but are not limited to, neopentyl glycol, cyclohexanedimethanol (CHDM), cyclohexanedicarboxylic acid, isophthalic acid (IPA), and naphthalenedicarboxylic acid (NDC).

2. Preferred Polyamides

[0035] Preferred polyamides are preferably selected from the group of partially aromatic polyamides and can be formed from isophthalic acid, terephthalic acid, cyclohexanedicarboxylic acid, meta- or para-xylylene diamine, 1,3- or 1,4-cyclohexane(bis)methylamine, aliphatic diacids with 6 to 12 carbon atoms, aliphatic amino acids or lactams with 6 to 12 carbon atoms, aliphatic diamines with 4 to 12 carbon atoms, and other generally known polyamide forming diacids and diamines can be used. Preferred polyamides may also contain small amounts of trifunctional or tetrafunctional comonomers such as trimellitic anhydride, pyromellitic dianhydride, or other polyamide forming polyacids and polyamines known in the art. Preferred partially aromatic polyamides include, but are not limited to, poly(m-xylylene adipamide), poly(hexamethylene isophthalamide), poly(hexamethylene adipamide-co-isophthalamide), poly(hexamethylene adipamide-co-terephthalamide), and poly(hexamethylene isophthalamide-co-terephthalamide). One preferred partially aromatic polyamide is poly(m-xylylene adipamide) having a number average molecular weight of 7,000 to 39,000, including 9,000, 11,000, 13,000, 15,000, 17,000, 19,000, 21,000, 23,000, 25,000, 27,000, 29,000, 31,000, 33,000, 35,000 and 37,000, and/or an inherent viscosity of 0.6 to 0.9 dL/g, also including 0.65, 0.7, 0.75, 0.8, and 0.85 dL/g. Preferred aliphatic polyamides include, but are not limited to, poly(hexamethylene adipamide) and poly(caprolactam). The most preferred low molecular weight aliphatic polyamide is poly(hexamethylene adipamide) having a number average molecular weight of 13,000 to 16,000, but also including 13,500, 14,000, 14,500, 15,000 and 15,500, and/or an inherent viscosity of 0.7 to 0.9 dL/g, but also including 0.75, 0.8, and 0.85 dL/g.

[0036] Aliphatic and partially aromatic polyamides of preferred embodiments used in conjunction with polyester, uniformly decrease the acetaldehyde concentration in articles formed from such blends. Partially aromatic polyamides, however, are preferred over the aliphatic polyamides where clarity and dispersibility are crucial.

[0037] Polyamides are generally prepared by melt phase polymerization from a diacid-diamine complex which may be prepared either in situ or in a separate step. In either method, the diacid and diamine are used as starting materials. Alternatively, an ester form of the diacid may be used, preferably the dimethyl ester. If the ester is used, the reaction should be carried out at a relatively low temperature, generally 80 to 120° C., until the ester is converted to an amide. The mixture is then heated to the polymerization temperature. In the case of polycaprolactam, either caprolactam or

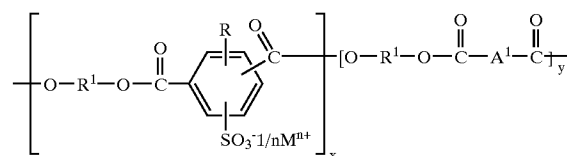
6-aminocaproic acid can be used as a starting material and the polymerization may be catalyzed by the addition of adipic acid/hexamethylene diamine salt which results in a nylon 6/66 copolymer. When the diacid-diamine complex is used, the mixture is heated to melting and stirred until equilibration. The molecular weight is controlled by the diacid-diamine ratio. An excess of diamine produces a higher concentration of terminal amino groups which are available to react with acetaldehyde. If the diacid-diamine complex is prepared in a separate step, excess diamine is added prior to the polymerization. The polymerization can be carried out either at atmospheric pressure or at elevated pressures.

[0038] As presently contemplated a preferred polyamide is MXD6 available from Mitsubishi Gas Chemical (Japan).

3. Preferred Compatibilizers

[0039] Preferred compatibilizers include, but are not limited to, polyester ionomers, preferably PET ionomers, IPA modified PET, p-toluene sulfonic acid (pTSA) modified PET, pyromellitic dianhydride (PMDA) modified PET, and maleic anhydride modified PET. Other preferred compatibilizers include acrylic modified polyolefin type ionomer and low molecular weight bisphenol-A epoxy resin-E44 which may be added directly to a PET/polyamide blend. Further, trimellitic anhydride (TMA) may be added to the polyamide, transesterified, mixed with PET and then coupled using a bifunctional coupler such as, but not limited to, diphenylmethane-4,4'-diisocyanate (MDI), diphenylmethane-4,4'-diisopropylurethane (DU), or bisoxazoline (BOX). When compatibilizers are used, preferably one or more properties of the polyamide/polyester blends are improved, such properties including, color, haze, and adhesion between a layer comprising a blend and a layer comprising polyester.

[0040] Preferred polyester ionomers include those disclosed in U.S. Pat. No. 6,500,895 B1, the disclosure of which is hereby incorporated by reference in its entirety. The ionomers disclosed therein comprise repeating units having the formula:



[0041] wherein R is hydrogen, halogen, alkyl having from one to about twenty carbons, or aryl having from one to about twenty carbons; M is a metal; n=1-5; R¹ is an alkylene radical having from one to about twelve carbon atoms; A¹ is a 1,2-phenylene, 1,3-phenylene, or 1,4-phenylene radical; and the mole fraction, x, of sulfonate-substituted units, is about 0.1 to about 50 percent of the sum of x and y, with about 0.2 to about 20 mole percent being preferred, about 0.5 to about 10 mole percent being more preferred, and about 1 to about 5 mole percent being even more preferred. Preferably R is hydrogen. Preferably R¹ is alkylene having from one to about six carbon atoms; more preferably R¹ is ethylene or butylene. M is preferably an alkali or alkaline earth metal; M is more preferably sodium or potassium.

[0042] Preferred PET ionomers include sulfonated PET. A preferred sulfonated PET is Crystar® available from E.I. du Pont de Nemours and Company, Wilmington, Del., USA. In embodiments comprising PET ionomers, they may be used in concentrations of about 0.01 weight % to about 15 weight % of the total blend, preferably about 1 weight % to about 10 weight %, also including about 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, and 14 weight %. In other embodiments, other PET ionomer compatibilizers may be used in similar quantities.

[0043] A preferred modified PET-type compatibilizer is IPA modified PET. In one embodiment, IPA modified PET preferably comprises from about 1 mole % to about 6 mole % IPA of the total blend, including about 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 and 5.5 mol %. In other embodiments, modified PET compatibilizers may be used in similar quantities.

[0044] Another preferred ionomer-type compatibilizer is a methacrylic acid modified olefinic ionomer. A preferred methacrylic acid modified olefinic ionomer is Surlyn® also available from E.I. du Pont de Nemours and Company. In embodiments comprising methacrylic acid modified olefinic ionomers, they may be used in concentrations of about 0.01 weight % to about 15 weight % of the total blend, preferably about 1 weight % to about 10 weight %, also including about 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, and 14 weight %. In other embodiments, other compatibilizers may be used in similar quantities.

4. Preferred Performance Enhancing Additives

[0045] Many other ingredients can be added to the compositions of preferred embodiments to enhance the performance properties of preferred blends. For example, crystallization aids, impact modifiers, surface lubricants, denesting agents, stabilizers, antioxidants, ultraviolet light absorbing agents, metal deactivators, colorants such as titanium dioxide and carbon black, nucleating agents such as polyethylene and polypropylene, phosphate stabilizers, fillers, and the like, can be included herein. Additives of these types and the use thereof are well known in the art and do not require extensive discussions. Therefore, only a limited number will be referred to, it being understood that any of these compounds can be used so long as they do not interfere or hinder the present invention.

[0046] In applications where a clear, colorless resin is desired, the slight yellow color generated during processing can be masked by addition of a blue dye. The colorant can be added to either component of the blend during polymerization or added directly to the blend during compounding. If added during blending, the colorant can be added either in pure form or as a concentrate. The amount of a colorant depends on its absorptivity and the desired color for the particular application. A preferred colorant is 1-cyano-6-(4-(2-hydroxyethyl)anilino)-3-methyl-3H-dibenzo(F,I,J)-isoquinoline-2,7-dione used in an amount of from 2 to 15 ppm, but also including 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14 ppm.

[0047] Desirable additives also include impact modifiers and antioxidants. Examples of typical commercially available impact modifiers well-known in the art and useful herein include ethylene/propylene terpolymers, styrene based block copolymers, and various acrylic core/shell type impact modifiers. The impact modifiers may be used in conventional amounts from 0.1 to 25 weight percent of the

overall composition and preferably in amounts from 0.1 to 10, but also including, 1, 2, 3, 4, 5, 6, 7, 8, and 9, weight percent of the composition.

[0048] Examples of typical commercially available antioxidants useful herein include, but are not limited to, hindered phenols, phosphites, diphosphites, polyphosphites, and mixtures thereof. Combinations of aromatic and aliphatic phosphite compounds may also be included. Irgafos XP60 FF (Ciba Geigy) is a preferred antioxidant/processing aid to minimize haze and/or color formation normally associated with polyamide/PET blends.

[0049] For improved gas barrier properties, nanocomposites may also be added. These nanocomposites or nanoparticles are tiny particles of materials which enhance the barrier properties of a material by creating a more tortuous path for migrating oxygen or carbon dioxide. One preferred type of nanoparticulate material is a microparticulate clay-based product available from Southern Clay Products. Preferably these are added to the polyamide prior to compatibilization of the polyamide with the PET.

B. Preparation of the Polyamide, Polyester, Compatibilizer Blend

[0050] A preferred process for preparing polyamide/polyester/compatibilizer blends according to preferred embodiments involves preparing the polyester, polyamide, and compatibilizer respectively, by processes as mentioned previously. The polyester, polyamide, and compatibilizer are dried in an atmosphere of dried air or dried nitrogen, or under reduced pressure. The polyester, polyamide, and compatibilizer are mixed and subsequently melt compounded, for example, in a single or twin-screw extruder. Melt temperatures should be at least as high as the melting point of the polyester and are typically in the range of 260-310° C. Preferably, the melt compounding temperature is maintained as low as possible within said range. After completion of the melt compounding, the extrudate is withdrawn in strand form, and recovered such as by cutting or pelleting. Instead of melt compounding, the polyester and polyamide may be dry-blended and over-molded or draw-formed into plastic articles or preforms.

[0051] In a preferred embodiment, the pellets or cuttings prepared by melt compounding described above then undergo solid state polymerization (SSP). A preferred SSP process comprises heating the pellets or cuttings, preferably under an inert atmosphere, thereby causing solid state polymerization and/or reactive compatibilization to occur. SSP advantageously increases the molecular weight and melt viscosity of the blend. Increased melt viscosity results in improved control of the layers in multilayer injection processes. In addition, when SSP follows melt compounding, the residence time for the mixing portion of the melt compounding may be reduced as the compatibilization process continues during SSP. A preferred temperature for SSP is above the glass transition point of the materials but below the melting point of the materials, preferably above 100° C.

C. Preferred Containers

[0052] The blends of preferred embodiments serve as excellent starting materials for the production of moldings of all types. As presently contemplated, preferred embodiments may be monolayer or multilayer containers produced by

overmolding, such as by using the process noted supra. Other embodiments may also be produced by other suitable processes such as coinjection or extrusion. Specific applications include various packaging applications such as thermoformed or injection molded trays, lids and cups; injection stretch blow-molded bottles, film and sheet; extrusion blow-molded bottles and multilayer articles. Examples of package contents include, but are not limited to, food, beverages, and cosmetics.

[0053] PET blends with MXD6 are known in the industry and are utilized for oxygen and carbon dioxide barrier enhancement. Published literature shows that improved oxygen barrier properties can be obtained with increasing amounts of MXD6, but this increase also produces significant haze formation.

[0054] MXD6 can be used as a blend in PET or as an inner layer in a multilayer container. These MXD6/PET containers will extend the shelf life of oxygen sensitive food products such as orange juice, tea, beer, etc. In addition, MXD6 can be used to reduce the carbon dioxide permeability of the container or bottle to extend the shelf life of carbonated beverages.

[0055] Although barrier properties of PET bottles made with MXD6/PET blends will provide the desired shelf life, the associated haze and/or color problems preclude the general use of blends in the industry. As the amount of MXD6 increases the haze of blended bottles increases dramatically as compared to multilayer bottles of the same or similar compositions. The advantages of using a blend versus a multilayer structure include the use of monolayer injection molding equipment and relatively few concerns with delamination as with multilayer bottles. However, MXD6 use in the PET bottle industry is primarily with multilayer technology due to clarity and recycling concerns. Thus there is a need in the industry to develop a blend system of PET with MXD6 that minimizes haze and/or color formation and allows for the use of simplified injection molding systems (monolayer or overmolding systems). In addition, blends are preferably compatible with recycle streams.

EXAMPLE 1

[0056] In this example two layer 0.5 liter bottles were made from 24 gram overmolded preforms. The overmold resin content was 25% of the total weight of the preform/bottle. The inner layer was a standard PET bottle grade resin such as C93 resin from Dow Chemical. The following blends were made and injected as the outer layer in these PET 2 layer preforms;

Blend	% Haze in Bottle
6% MXD6 in PET	15%
6% MXD6 with IPA modified PET (SKF)	7%
6% MXD6 with IPA modified PET (SKF) and 0.25% XP antioxidant from Ciba Geigy	5.75%

[0057] Thus, the use of IPA modified PET, where IPA represents 2-5 mole % of the total blend content, achieved at least a 50% drop in the Haze. The use of an antioxidant/processing aid such as Irgafos XP further reduced the haze

by 17.8% to produce a bottle with 62% less haze versus the standard MXD6/PET blend. The presence of the antioxidant or stabilizer/processing aid is thought to prevent oxidation of the MXD6 at PET processing conditions. The IPA modified PET resin is believed to compatibilize the MXD6 with the PET. This compatibilization also reduces haze and/or color formation.

[0058] Another compatibilizer that can be used with the polyamide/PET blend is a PET ionomer comprising sulfonated PET.

[0059] In accordance with a preferred embodiment, the compatibilized polymer blend is used to form a monolayer preform or container such as by injection molding. Preferred monolayer preforms or containers comprise a compatibilized polymer blend comprising a polyamide such as MXD6, PET or a PET-containing copolymer, and at least one compatibilizer. In some embodiments, said compatibilized polymer blend further comprises an antioxidant. As discussed above, PET may include one or more of the following: virgin PET, recycled PET, and post-consumer PET. Suitable compatibilizers include one or more of the following: PET ionomers, IPA modified PET, p-toluene sulfonic acid (pTSA) modified PET, pyromellitic dianhydride (PMDA) modified PET, maleic anhydride modified PET, acrylic-modified polyolefin ionomer, and bisphenol-A epoxy resin. Preferred compatibilizers comprise IPA modified PET and PET ionomers. In one embodiment, IPA modified PET comprises from about 1 mole % to about 6 mole % IPA of the total blend, also including about 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 and 5.5 mole %. Preferred PET ionomers comprise sulfonated PET. In some monolayer embodiments the compatibilized polymer blend is disposed about the neck and body of the preform or container while in other embodiments at least the body of the container or preform comprises the compatibilized polymer blend.

[0060] In accordance with a preferred embodiment, the compatibilized polymer blend is used to form a multilayer preform or container such as by processes described above. Preferred multilayer preforms or containers comprise at least one layer of a compatibilized polymer blend comprising a polyamide such as MXD6, PET or a PET-containing copolymer, and at least one compatibilizer and at least one layer of a thermoplastic polyester, preferably as PET or a PET-containing copolymer. In certain embodiments, the first layer of the container or preform comprises the compatibilized polymer blend with the second layer of PET adhered directly to said first layer. In other embodiments, said preform or container comprises one or more compatibilized polymer blend layers and one or more PET layers. In some embodiments, said compatibilized polymer blend further comprises an antioxidant. Suitable compatibilizers include one or more of the following: PET ionomers, IPA modified PET, p-toluene sulfonic acid (pTSA) modified PET, pyromellitic dianhydride (PMDA) modified PET, maleic anhydride modified PET, acrylic-modified polyolefin ionomer, and bisphenol-A epoxy resin. Preferred compatibilizers comprise IPA modified PET and PET ionomers. In one embodiment, IPA modified PET comprises from about 1 mole % to about 6 mole % IPA of the total blend, also including about 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 and 5.5 mole %. Preferred PET ionomers comprise sulfonated PET. Said thermoplastic layer may include one or more of the following: virgin PET, recycled PET, and post-consumer PET. In

some multilayer embodiments the compatibilized polymer blend is disposed about the neck and body of the preform or container while in other embodiments at least the body of the container or preform comprises the compatibilized polymer blend.

[0061] In accordance with some embodiments, concentrates of the compatibilized polymer blends may be used. The use of concentrates allows for processing flexibility. Preferred concentrates may have a majority of either polyamide or PET or a PET-containing copolymer. In one embodiment, concentrates can then be diluted with PET or PET recycle resin at desired quantities and injection molded as a monolayer or multilayer structure with reduced haze and/or color. Preferably the final content of polyamide, such as MXD6, in the finished blend following dilution is less than or equal to 15 mole % of the total blend, but also including about 1, 3, 5, 7, 9, and 12 mole %, based on cost versus performance concerns. In other embodiments, the concentrates may also be used without further dilution, such as by using coextrusion or coinjection, in applications where the polyamide/PET/compatibilizer layer is sandwiched between other layers of the container.

[0062] For example, preferred MXD6/PET/compatibilizer blends where the PET contains IPA and/or a PET ionomer can be utilized via a concentrate. Exemplary concentrates include the following wherein the percentages below refer to the percent of the total concentrate (which are not to be taken as limiting on the invention):

[0063] 80 weight % MXD6, 0.25-0.4 weight % Irgafos XP, and 19.75-19.60 weight % IPA modified PET with an IPA range of 1.5-40 mole %

[0064] 80 weight % MXD6 with 20 weight % IPA polymer (100 mole % IPA content).

[0065] MXD6 with 0.1-10.0 weight % PET ionomer and PET copolymer with an IPA content of 1.5-40 mole %

[0066] MXD6 with 0.1-10.0 weight % PET ionomer

[0067] The percentages above should not be taken to limit the invention, for example where 1.5-40 mole % IPA is indicated, this also includes 5, 10, 15, 20, 25, 30 and 35 mole % IPA. Further, 0.1-10.0 weight % PET ionomer also includes, 1, 2, 3, 4, 5, 6, 7, 8, and 9 weight % PET ionomer of the total concentrate. In other embodiments, concentrates may have higher percentages of polyamide and/or higher IPA both as concentrates and when diluted.

[0068] In accordance with a preferred embodiment the concentrates are blended with polyester, preferably PET, so that the polyamide concentration of the final blend used on the container is equal to or less than 15 mole % of the total blend, including about 1, 3, 5, 7, 9, and 12 mole %. In other embodiments utilizing concentrates, other compatibilizers may be used in similar concentrations.

[0069] The concept of blending polyamides such as MXD6, with compatibilizers such as PET ionomers or IPA, promotes compatibilization leading to improved adhesion. For example, the blend of MXD6 with high IPA PET & Irgafos XP will allow the MXD6 to adhere to PET in coinjection or coextrusion without impacting the performance of the MXD6.

[0070] In the case of overmolded preforms, such blends allow for better recycling and compatibility of the total container. When the concentrate is blended with PET prior to forming the bottle, the polyamide/PET/compatibilizer blend content is diluted and thus becomes more compatible with PET as compared to a straight blend of polyamide and PET. Another advantage of an overmolding process is that the blend can be molded in the body of the preform and not in the neck finish where it is not needed, thus further reducing the amount of polyamide in the recycling stream.

[0071] The various methods and techniques described above provide a number of ways to carry out the invention. Of course, it is to be understood that not necessarily all objectives or advantages described may be achieved in accordance with any particular embodiment described herein. Thus, for example, those skilled in the art will recognize that the apparatus may be made and the methods may be performed in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objectives or advantages as may be taught or suggested herein.

[0072] Furthermore, the skilled artisan will recognize the interchangeability of various features from different embodiments. Similarly, the various features and steps discussed above, as well as other known equivalents for each such feature or step, can be mixed and matched by one of ordinary skill in this art to perform methods in accordance with principles described herein.

[0073] Although the invention has been disclosed in the context of certain embodiments and examples, it will be understood by those skilled in the art that the invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses and obvious modifications and equivalents thereof. Accordingly, the invention is not intended to be limited by the specific disclosures of preferred embodiments herein, but instead by reference to claims attached hereto.

What is claimed is:

1. A preform or container, comprising

a body and a neck finish,

wherein at least said body comprises at least a first layer comprising a compatibilized polymer blend, said compatibilized polymer blend comprising polyamide, PET or a PET-containing copolymer, and at least one compatibilizer selected from IPA-modified PET and PET ionomers.

2. The preform or container of claim 1, wherein the container or preform comprising compatibilized polymer blend exhibits lower haze than a container or preform made from a non-compatibilized blend of polyamide and polyester.

3. The preform or container of claim 1, wherein said preform is a monolayer preform and the neck finish comprises said compatibilized polymer blend.

4. The preform or container of claim 1 wherein said IPA modified PET comprises from about 1 mole % to 6 mole % IPA.

5. The preform or container of claim 1, wherein said compatibilizer is a PET ionomer comprising sulfonated PET.

6. The preform or container of claim 1, wherein the PET or a PET-containing copolymer comprises recycled or post-consumer resin.

7. The preform or container of claim 1 wherein said at least one layer further comprises at least one antioxidant.

8. The preform or container of claim 1, wherein the PET or a PET-containing copolymer comprises recycled or post-consumer resin.

9. The preform or container of claim 1, further comprising a second layer directly adhered to the first layer, said second layer comprising PET or a PET-containing copolymer.

10. The preform or container of claim 9, wherein the PET or a PET-containing copolymer of the first and/or second layers comprises recycled or post-consumer resin.

11. The preform or container of claim 1, wherein the polyamide constitutes less than or equal to about 15 mol % of the blend.

12. A preform or container, comprising:

a body portion and a neck finish, wherein at least said body portion comprises at least a first and second layers, wherein

said first layer comprises a polyester; and

said second layer comprises a compatibilized polymer blend, said compatibilized polymer blend comprising:

polyamide;

PET or a PET-containing copolymer; and

at least one compatibilizer selected from IPA-modified PET and PET ionomers.

13. The preform or container of claim 12, wherein the container or preform comprising compatibilized polymer blend exhibits lower haze than a container or preform made from a non-compatibilized blend of polyamide and polyester.

14. The preform or container of claim 12, wherein said PET or a PET-containing copolymer comprises recycled or post-consumer materials.

15. The preform or container of claim 12 wherein said IPA modified PET comprises from about 1 mole % to 6 mole % IPA.

16. The preform or container of claim 12, wherein said compatibilizer is a PET ionomer comprising sulfonated PET.

17. The preform or container of claim 12 wherein said compatibilized polymer blend further comprises at least one antioxidant.

18. The preform or container of claim 12 wherein said compatibilized blend is substantially polyamide in content by mole %.

19. The preform or container of claim 18 further comprising a third layer comprising PET or PET-containing copolymer wherein the second layer comprising said compatibilized polymer blend lies between said third layer and said first layer.

20. The preform or container of claim 12 wherein said compatibilized blend is substantially PET or PET-containing copolymer in content by mole %.

21. The preform or container of claim 20 wherein said compatibilized polymer blend comprises equal to or less than 15 mole % of the polyamide.

22. The preform or container of claim 20 wherein said compatibilized polymer blend is made by a process in which a concentrate of the blend is diluted with PET or PET-containing copolymer.

23. The preform or container of claim 12, wherein the preform or container has an interior surface and an exterior surface and the first layer forms the interior surface.

24. The preform or container of claim 12 wherein said compatibilized polymer blend is made by a process in which a concentrate of the blend is diluted with PET or PET-containing copolymer.

25. A compatibilized polymer blend, comprising:

a compatibilized blend comprising polyamide, PET or a PET-containing copolymer, and at least one compatibilizer,

wherein the blend is formed by a process comprising:

blending the polyamide, PET or PET-containing copolymer, and compatibilizer in the melt phase;

extruding the blend into pellets; and

heating said pellets in an inert atmosphere to a temperature between the blend's glass transition temperature and melt temperature thereby causing solid state polymerization and/or reactive compatibilization to occur.

26. The compatibilized polymer blend of claim 25, wherein said compatibilizer is selected from IPA-modified PET and PET ionomers.

27. The compatibilized polymer blend of claim 25, wherein said IPA modified PET comprises from about 1 mole % to 6 mole % IPA.

28. The compatibilized polymer blend of claim 25, wherein said compatibilizer is selected from IPA modified PET, p-toluene sulfonic acid (pTSA) modified PET, pyromellitic dianhydride (PMDA) modified PET, and maleic anhydride modified PET.

29. The compatibilized polymer blend of claim 25, wherein said compatibilizer is an acrylic-modified polyolefin ionomer or a bisphenol-A epoxy resin.

30. The compatibilized polymer blend of claim 25, wherein said compatibilizer comprises a PET ionomer comprising sulfonated PET.

31. The compatibilized polymer blend of claim 25, wherein said blend further comprises at least one antioxidant.

32. A container or preform comprising a first layer comprising the compatibilized polymer blend of claim 25.

33. The container or preform of claim 32, wherein the first layer comprises no more than about 15 mole % polyamide.

34. The container or preform of claim 33, wherein the compatibilizer comprises IPA-modified PET and PET ionomers.

35. The container or preform of claim 33, wherein the container or preform comprising compatibilized polymer blend exhibits lower haze than a container or preform made from a non-compatibilized blend of polyamide and polyester.

36. The container or preform of claim 32, further comprising a second layer comprising polyester directly adhered to said first layer.

37. The container or preform of claim 36, wherein said polyester comprises PET or PET-containing copolymer.

38. The container or preform of claim 36, further comprising a third layer comprising polyester wherein said first layer is sandwiched between said second and third layers and said first layer is substantially polyamide in content by mole %.

39. The container or preform of claim 38, wherein the polyester of the second and/or third layer comprises PET or PET-containing copolymer.

40. A compatibilized polymer blend, comprising
polyamide;

PET or a PET-containing copolymer; and

at least one compatibilizer selected from IPA-modified PET and PET ionomer;

wherein the polyamide constitutes less than or equal to about 15 mol % of the blend.

41. The compatibilized polymer blend of claim 40, wherein said compatibilizer is IPA-modified PET which comprises from about 1 mole % to 6 mole % IPA.

42. The compatibilized polymer blend of claim 40, wherein said compatibilizer is a PET ionomer comprising sulfonated PET.

43. The compatibilized polymer blend of claim 40, wherein said blend further comprises at least one antioxidant.

44. The compatibilized polymer blend of claim 40, wherein the blend forms at least a portion of the body of a container or preform.

45. The preform or container of claim 44, wherein the container or preform comprising compatibilized polymer blend exhibits lower haze than a container or preform made from a non-compatibilized blend of polyamide and polyester.

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