Title: GLASS-FILLED POLYCARBONATE-POLY(ETHYLENE TEREPHTHALATE) COMPOSITION AND ASSOCIATED ARTICLE

Abstract: A composition includes specific amounts of a polycarbonate, poly(ethylene terephthalate), glass fibers, and the flame retardant 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphasphate. Relative to a composition with the related phosphate ester flame retardant bisphenol A bis(diphenyl phosphate), the inventive composition provides improved impact strength while maintaining stiffness, melt flow, heat resistance, and flame retardancy. The composition is useful for fabricating articles including television bezels and notebook computer covers.
GLASS-FILLED POLYCARBONATE-POLY(ETHYLENE TEREPTHALATE) COMPOSITION AND ASSOCIATED ARTICLE

BACKGROUND OF THE INVENTION

[0001] Polycarbonate is an engineering plastic widely used in various applications due to its good heat resistance, impact resistance, and transparency. The self-charring capability of polycarbonate during combustion makes it especially suitable for consumer electronics and electrical applications where halogen-free flame retardants are prohibited. In some specific applications where rigidity is required, such as notebook computer covers and television bezels, glass fiber reinforcement is added to polycarbonate. The use of glass fiber increases rigidity, but also reduces melt flow and impact strength. Melt flow can be improved by blending a polyester, such as poly(ethylene terephthalate), with polycarbonate, but the crystallinity of the polyester limits its content in the blend, as too much polyester causes post-molding warpage in molded parts. Also, acceptable contents of polyester do not compensate for the impact strength loss associated with glass fiber reinforcement. There remains a need for glass-filled polycarbonate compositions exhibiting improved impact strength while maintaining high levels of rigidity, melt flow, and flame retardancy.

BRIEF SUMMARY OF EMBODIMENTS OF THE INVENTION

[0002] One embodiment is a composition comprising: 40 to 50 weight percent of a polycarbonate; 8 to 20 weight percent of a poly(ethylene terephthalate); 5 to 15 weight percent of 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate; and 15 to 35 weight percent of glass fibers having a substantially circular cross-section; wherein all weight percent values are based on the total weight of the composition; and wherein the composition comprises 0 to 1 weight percent of scale-like fillers.

[0003] Another embodiment is an article comprising the composition.

[0004] These and other embodiments are described in detail below.

DETAILED DESCRIPTION OF THE INVENTION

[0005] The present inventors have determined that an improved balance of rigidity, impact strength, melt flow, and flame retardancy is provided by a composition comprising specific amounts of a polycarbonate, a poly(ethylene terephthalate), glass fibers, and 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate. Thus, one embodiment is a composition comprising 40 to 50 weight percent of a polycarbonate; 8 to 20 weight percent
of a poly(ethylene terephthalate); 5 to 15 weight percent of 1,3-phenylene-tetrakis(2,6-
dimethylphenyl)diphosphate; and 15 to 35 weight percent of glass fibers having a
substantially circular cross-section; wherein all weight percent values are based on the total
weight of the composition; and wherein the composition comprises 0 to 1 weight percent of
scale-like fillers.

[0006] The composition comprises a polycarbonate. “Polycarbonate” as used herein
means a polymer or copolymer having repeating structural carbonate units of the formula

\[
* \text{R}^1 \text{O} = \text{C} = \text{O} * 
\]

wherein at least 60 percent of the total number of \( \text{R}^1 \) groups are aromatic. Specifically, each
\( \text{R}^1 \) can be derived from a dihydroxy compound such as an aromatic dihydroxy compound of
the formula

\[
\text{HO} \begin{array}{c} \text{R}^n \text{A} \text{OH} \\ \text{or} \\ \text{HO} \begin{array}{c} \text{R}^p \text{X}^2 \text{X}^2 \text{X}^2 \text{X}^2 \text{OH} \\ \text{R}^q \end{array} \end{array}
\]

wherein \( n, p, \) and \( q \) are each independently 0, 1, 2, 3, or 4; \( \text{R}^n \) is independently at each
occurrence halogen, or unsubstituted or substituted \( \text{C}_{1-10} \) hydrocarbyl; and \( \text{R}^p \) is a single bond,
\(-\text{O}, -\text{S}, -\text{O}(\text{O}), -\text{S}(\text{O})_2, -\text{O}(\text{C})_2, \) or a \( \text{C}_{1-18} \) hydrocarbylene, which can be cyclic or acyclic,
aromatic or non-aromatic, and can further comprise one or more heteroatoms selected from
halogens, oxygen, nitrogen, sulfur, silicon, or phosphorous. As used herein, the term
“hydrocarbyl”, whether used by itself, or as a prefix, suffix, or fragment of another term,
refers to a residue that contains only carbon and hydrogen unless it is specifically identified
as “substituted hydrocarbyl”. The hydrocarbyl residue can be aliphatic or aromatic,
straight-chain, cyclic, bicyclic, branched, saturated, or unsaturated. It can also contain
combinations of aliphatic, aromatic, straight chain, cyclic, bicyclic, branched, saturated, and
unsaturated hydrocarbon moieties. As used herein, “substituted” means including at least one
substituent such as a halogen (i.e., F, Cl, Br, I), hydroxyl, amino, thiol, carboxyl, carboxylate,
amide, nitrile, sulfide, disulfide, nitro, \( \text{C}_{1-18} \) alkyl, \( \text{C}_{1-18} \) alkoxy, \( \text{C}_{6-18} \) aryl, \( \text{C}_{6-18} \) aryloxy, \( \text{C}_{7-18} \)
alkylaryl, or \( \text{C}_{7-18} \) alkylaryl oxy. So, when the hydrocarbyl residue is described as
substituted, it can contain heteroatoms in addition to carbon and hydrogen.

[0007] Some illustrative examples of specific dihydroxy compounds include the
following: bisphenol compounds such as 4,4'-dihydroxybiphenyl, 1,6-dihydroxynaphthalene,
2,6-dihydroxynaphthalene, bis(4-hydroxyphenyl)methane, bis(4-
hydroxyphenyl)diphenylmethane, bis(4-hydroxyphenyl)-1-naphthylmethane, 1,2-bis(4-hydroxyphenyl)ethane, 1,1-bis(4-hydroxyphenyl)-1-phenylethane, 2-(4-hydroxyphenyl)-2-(3-hydroxyphenyl)propane, bis(4-hydroxyphenyl)phenylmethane, 2,2-bis(4-hydroxy-3-bromophenyl)propane, 1,1-bis(hydroxyphenyl)cyclopentane, 1,1-bis(4-hydroxyphenyl)cyclohexane, 1,1-bis(4-hydroxyphenyl)isobutene, 1,1-bis(4-hydroxyphenyl)cyclododecane, trans-2,3-bis(4-hydroxyphenyl)-2-butene, 2,2-bis(4-hydroxyphenyl)adamantane, alpha, alpha'-bis(4-hydroxyphenyl)toluene, bis(4-hydroxyphenyl)acetonitrile, 2,2-bis(3-methyl-4-hydroxyphenyl)propane, 2,2-bis(3-ethyl-4-hydroxyphenyl)propane, 2,2-bis(3-n-propyl-4-hydroxyphenyl)propane, 2,2-bis(3-isopropyl-4-hydroxyphenyl)propane, 2,2-bis(3-sec-butyl-4-hydroxyphenyl)propane, 2,2-bis(3-t-butyl-4-hydroxyphenyl)propane, 2,2-bis(3-cyclohexyl-4-hydroxyphenyl)propane, 2,2-bis(3-allyl-4-hydroxyphenyl)propane, 2,2-bis(3-methoxy-4-hydroxyphenyl)propane, 2,2-bis(4-hydroxyphenyl)hexafluoropropane, 1,1-dichloro-2,2-bis(4-hydroxyphenyl)ethylenylene, 1,1-dibromo-2,2-bis(4-hydroxyphenyl)ethylene, 1,1-dichloro-2,2-bis(5-phenoxy-4-hydroxyphenyl)ethylene, 4,4'-dihydroxybenzophenone, 3,3-bis(4-hydroxyphenyl)-2-butanone, 1,6-bis(4-hydroxyphenyl)-1,6-hexanediene, ethylene glycol bis(4-hydroxyphenyl)ether, bis(4-hydroxyphenyl)ether, bis(4-hydroxyphenyl)sulfide, bis(4-hydroxyphenyl)sulfoxide, bis(4-hydroxyphenyl)sulfone, 9,9-bis(4-hydroxyphenyl)fluorine, 2,7-dihydroxypyrène, 6,6'-dihydroxy-3,3,3',3'-tetramethylspiro(bis)indane ("spirobiindane bisphenol"), 3,3-bis(4-hydroxyphenyl)phthalimide, 2,6-dihydroxydibenzo-p-dioxin, 2,6-dihydroxythianthrene, 2,7-dihydroxyphenoxathiin, 2,7-dihydroxy-9,10-dimethylphenazine, 3,6-dihydroxydibenzo furan, 3,6-dihydroxydibenzothiophene, and 2,7-dihydroxy carbazole; resorcinol, substituted resorcinol compounds such as 5-methyl resorcinol, 5-ethyl resorcinol, 5-propyl resorcinol, 5-butyl resorcinol, 5-t-butyl resorcinol, 5-phenyl resorcinol, 5-cumyl resorcinol, 2,4,5,6-tetrafluoro resorcinol, 2,4,5,6-tetrambromo resorcinol, or the like; catechol; hydroquinone; substituted hydroquinones such as 2-methyl hydroquinone, 2-ethyl hydroquinone, 2-propyl hydroquinone, 2-butyl hydroquinone, 2-t-butyl hydroquinone, 2-phenyl hydroquinone, 2-cumyl hydroquinone, 2,3,5,6-tetramethyl hydroquinone, 2,3,5,6-tetra-t-butyl hydroquinone, 2,3,5,6-tetrafluoro hydroquinone, and 2,3,5,6-tetrambromo hydroquinone.

[0008] Specific dihydroxy compounds include resorcinol, 2,2-bis(4-hydroxyphenyl) propane ("bisphenol A" or "BPA"), 3,3-bis(4-hydroxyphenyl) phthalimidine, 2-phenyl-3,3'-bis(4-hydroxyphenyl) phthalimidine (also known as N-phenyl phenolphthalein bisphenol, "PPPBP", or 3,3-bis(4-hydroxyphenyl)-2-phenylisoindolin-1-one), 1,1-bis(4-hydroxy-3-
methylphenyl)cyclohexane (DMBPC), 1,1-bis(4-hydroxy-3-methylphenyl)-3,3,5-
trimethylcyclohexane (isophorone bisphenol), and combinations thereof.

[0009] In some embodiments, at least 90 percent of the total number of R^1 groups in
the polycarbonate have the formula

```
O   
/  
\   
CH3 C \-O
```

In some embodiments, the polycarbonate comprises or consists of bisphenol A polycarbonate
resin.

[0010] More than one polycarbonate can be used. For example, the composition can
comprise a first polycarbonate having a weight average molecular weight of 18,000 to 25,000
atomic mass units and a second polycarbonate having a weight average molecular weight of
27,000 to 35,000 atomic mass units.

[0011] Methods of forming polycarbonates are known, and many are commercially
available from suppliers including SABIC Innovative Plastics, Bayer MaterialScience, and
Mitsubishi Chemical Corp.

[0012] The composition comprises the polycarbonate in an amount of 40 to 50 weight
percent, based on the total weight of the composition. Within this range, the polycarbonate
amount can be 43 to 49 weight percent.

[0013] In addition to the polycarbonate, the composition comprises poly(ethylene
terephthalate), CAS Registry No. 25038-59-9. In some embodiments, the poly(ethylene
terephthalate) has an intrinsic viscosity of 0.6 to 1.2 deciliter per gram, specifically 0.7 to 1.0
deciliter per gram, as measured by Ubbelohde viscometer at 25 °C in a 1:1 weight/weight
mixture of phenol and 1,1,2,2-tetrachloroethane. Poly(ethylene terephthalate) is
commercially available from suppliers including DuPont, DAK Americas LLC, and Foshan
Shunde Shunyan Plastic Co., Ltd.

[0014] The composition comprises the poly(ethylene terephthalate) in an amount of 8
to 20 weight percent, based on the total weight of the composition. Within this range, the
poly(ethylene terephthalate) amount can be 10 to 16 weight percent.

[0015] In addition to the polycarbonate and the poly(ethylene terephthalate), the
composition comprises the flame retardant 1,3-phenylene-tetrakis(2,6-
dimethylphenyl)diphosphate, CAS Registry No. 139189-30-3. As demonstrated in the
working examples below, using 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate
instead of bisphenol A bis(diphenyl phosphate) provides the composition with a substantial
and unexpected increase in impact strength. Methods for synthesizing 1,3-phenylene-
tetrakis(2,6-dimethylphenyl)diphosphate are known, and it is commercially available from
suppliers including Daihachi Co. Ltd. and Go Yen Chemical Industrial Co. Ltd.

[0016] The composition comprises the 1,3-phenylene-tetrakis(2,6-
dimethylphenyl)diphosphate in an amount of 5 to 15 weight percent, based on the total
weight of the composition. Within this range, the 1,3-phenylene-tetrakis(2,6-
dimethylphenyl)diphosphate amount can be 8 to 12 weight percent.

[0017] In addition to the polycarbonate, the poly(ethylene terephthalate), and the
1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, the composition comprises glass
fibers. Suitable glass fibers include those based on E, A, C, ECR, R, S, D, and NE glasses, as
well as quartz. The glass fibers have a substantially circular cross-section and are therefore
distinguished from glass fibers have other cross-sectional shapes, such as those described in
embodiments, the glass fibers have a diameter of 2 to 30 micrometers, specifically 5 to 25
micrometers, more specifically 8 to 16 micrometers. In some embodiments, the length of the
glass fibers before compounding is 2 to 7 millimeters, specifically 3 to 5 millimeters. The
glass fibers can, optionally, include an adhesion promoter to improve their compatibility with
the polycarbonate and poly(ethylene terephthalate) resins. Adhesion promoters include
chromium complexes, silanes, titanates, zirco-aluminates, propylene maleic anhydride
copolymers, reactive cellulose esters and the like. Suitable glass fiber is commercially
available from suppliers including, for example, Owens Corning, Nippon Electric Glass, PPG,
and Johns Manville.

[0018] The composition comprises the glass fibers in an amount of 15 to 35 weight
percent, based on the total weight of the composition. Within this range, the glass fiber
amount can be 25 to 35 weight percent.

[0019] The composition can, optionally, further comprise one or more additives,
including impact modifiers, flow modifiers, fillers other than the glass fibers (provided that
the below-described limit on scale-like fillers is respected), antioxidants, heat stabilizers,
light stabilizers, ultraviolet (UV) light stabilizers, UV absorbing additives, plasticizers,
lubricants, mold release agents, antistatic agents, anti-fog agents, antimicrobial agents,
colorants (including dyes and pigments), surface effect additives, radiation stabilizers, flame
retardants other than the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, anti-drip
agents (e.g., a PTFE-encapsulated styrene-acrylonitrile copolymer (TSAN)), and
combinations thereof. In general, the additives, when present, are used in a total amount of
less than or equal to 5 weight percent, based on the total weight of the composition. Within
this limit, the additives can be used in a total amount of less than or equal to 2 weight percent,
specifically less than or equal to 1.5 weight percent. When using the composition to form
television bezels, black colorants (including black pigments and dye combinations yielding
black) are particularly useful. When present, the black colorants can be used in an amount of
about 0.2 to 1 weight percent, specifically about 0.3 to about 0.8 weight percent, based on the
total weight of the composition.

[0020] The composition comprises 0 to 1 weight percent of scale-like fillers.
Scale-like fillers include mica, glass flakes, talc, and graphite. In some embodiments, the
composition excludes scale-like fillers. The use of scale-like fillers can cause undesirable
reductions in stiffness and ductility.

[0021] The composition can, optionally, exclude impact modifiers. The exclusion of
impact modifiers is facilitated by the surprising improvement in impact strength associated
with the use of 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate. Impact modifiers
include, for example, natural rubber, fluoroelastomers, ethylene-propylene rubber (EPR),
ethylene-butene rubber, ethylene-propylene-diene monomer rubber (EPDM), acrylate rubbers,
hydrogenated nitrile rubber (HNBR) silicone elastomers, styrene-butadiene-styrene block
copolymers (SBS), styrene-butadiene rubber (SBR), styrene-(ethylene-butene)-styrene block
copolymers (SEBS), acrylonitrile-butadiene-styrene (ABS), acrylonitrile-ethylene-propylene-
diene-styrene (AES), styrene-isoprene-styrene block copolymers (SIS), styrene-(ethylene-
propylene)-styrene block copolymers (SEPS), methyl methacrylate-butadiene-styrene block
copolymers (MBS), and high rubber graft (HRG).

[0022] In a specific embodiment of the composition, it comprises 43 to 49 weight
percent of the polycarbonate, 10 to 16 weight percent of the poly(ethylene terephthalate), 8 to
12 weight percent of the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, and 25 to
35 weight percent of the glass fibers.

[0023] In another specific embodiment of the composition, the polycarbonate
comprises repeat units having the formula

\[
\begin{align*}
\ast & \quad \begin{array}{c}
\text{O} \\
\text{R}^1
\end{array} \\
\text{C} & \quad \text{O} \\
\end{align*}
\]

wherein at least 90 percent of the total number of \( R^1 \) groups have the formula
the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per gram; the glass fibers have a diameter of 8 to 16 micrometers; the composition comprises 43 to 49 weight percent of the polycarbonate, 10 to 16 weight percent of the poly(ethylene terephthalate), 8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, and 25 to 35 weight percent of the glass fibers; and the composition excludes scale-like fillers.

[0024] The composition is useful for molding articles, including television bezels and notebook computer covers. Suitable methods of forming such articles include single layer and multilayer sheet extrusion, injection molding, blow molding, film extrusion, profile extrusion, pultrusion, compression molding, thermoforming, pressure forming, hydroforming, vacuum forming, and the like. Combinations of the foregoing article fabrication methods can be used.

[0025] All of the compositional variations described above apply as well to the article comprising the composition.

[0026] All ranges disclosed herein are inclusive of the endpoints, and the endpoints are independently combinable with each other. Each range disclosed herein constitutes a disclosure of any point or sub-range lying within the disclosed range.

[0027] The invention includes at least the following embodiments.

[0028] Embodiment 1: A composition comprising: 40 to 50 weight percent of a polycarbonate; 8 to 20 weight percent of a poly(ethylene terephthalate); 5 to 15 weight percent of 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate; and 15 to 35 weight percent of glass fibers having a substantially circular cross-section; wherein all weight percent values are based on the total weight of the composition; and wherein the composition comprises 0 to 1 weight percent of scale-like fillers.

[0029] Embodiment 2: The composition of embodiment 1, wherein the polycarbonate comprises repeat units having the formula

\[
\begin{align*}
\text{O} & \quad \text{R}^1 \quad \text{O} \\
\text{C} & \quad \text{O} 
\end{align*}
\]

wherein at least 60 percent of the total number of \( \text{R}^1 \) groups are aromatic.

[0030] Embodiment 3: The composition of embodiment 2, wherein \( \text{R}^1 \) is the residue
of a dihydroxy compound having the formula

\[
\begin{align*}
&\quad \text{(R\textdegree)}_n \\
\quad \text{or} \\
&\quad \text{(R\textdegree)}_p \\
\quad \text{or} \\
&\quad \text{(R\textdegree)}_q
\end{align*}
\]

wherein n, p, and q are each independently 0, 1, 2, 3, or 4; R\textdegree is independently at each occurrence halogen, or unsubstituted or substituted C\textsubscript{1-16} hydrocarbyl; and X\textdegree is a single bond, -O-, -S-, -S(O)-, -S(O)\textsubscript{2}-, -C(O)-, or C\textsubscript{1-18} hydrocarbylene, which can be cyclic or acyclic, aromatic or non-aromatic, and can further comprise one or more heteroatoms selected from halogens, oxygen, nitrogen, sulfur, silicon, or phosphorous.

[0031] Embodiment 4: The composition of embodiment 2, wherein at least 90 percent of the total number of R\textdegree groups have the formula

\[
\begin{align*}
&\quad \text{CH}_3 \\
\quad \text{CH}_3 \\
&\quad \text{O}
\end{align*}
\]

[0032] Embodiment 5: The composition of any of embodiments 1-4, comprising a first polycarbonate having a weight average molecular weight of 18,000 to 25,000 atomic mass units and a second polycarbonate having a weight average molecular weight of 27,000 to 35,000 atomic mass units.

[0033] Embodiment 6: The composition of any of embodiments 1-5, wherein the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per gram as measured by Ubbelohde viscometer at 25 °C in a 1:1 weight/weight mixture of phenol and 1,1,2,2-tetrachloroethane.

[0034] Embodiment 7: The composition of any of embodiments 1-6, wherein the glass fibers have a diameter of 8 to 16 micrometers.

[0035] Embodiment 8: The composition of any of embodiments 1-7, comprising 25 to 35 weight percent of the glass fibers.


[0037] Embodiment 10: The composition of any of embodiments 1-9, excluding impact modifiers.

[0038] Embodiment 11: The composition of any of embodiments 1-10, comprising 43 to 49 weight percent of the polycarbonate, 10 to 16 weight percent of the poly(ethylene...
terephthalate), 8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-
dimethylphenyl)diphosphate, and 25 to 35 weight percent of the glass fibers.

[0039] Embodiment 12: The composition of embodiment 1, wherein the
carbonate comprises repeat units having the formula

\[
\begin{array}{c}
\text{O} \\
\text{R}^1 \text{O} \text{C} \text{O} \\
\end{array}
\]

wherein at least 90 percent of the total number of \( R^1 \) groups have the formula

\[
\begin{array}{c}
\text{O} \\
\text{C} \\
\end{array}
\]

wherein the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per
gram; wherein the glass fibers have a diameter of 8 to 16 micrometers; wherein the
composition comprises 43 to 49 weight percent of the polycarbonate, 10 to 16 weight percent
of the poly(ethylene terephthalate), 8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-
dimethylphenyl)diphosphate, and 25 to 35 weight percent of the glass fibers; and wherein the
composition excludes scale-like fillers.

[0040] Embodiment 13: An article comprising a composition comprising: 40 to 50
weight percent of a polycarbonate; 8 to 20 weight percent of a poly(ethylene terephthalate); 5
to 15 weight percent of 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate; and 15 to 35
weight percent of glass fibers having a substantially circular cross-section; wherein all weight
percent values are based on the total weight of the composition; and wherein the composition
comprises 0 to 1 weight percent of scale-like fillers.

[0041] Embodiment 14: The article of embodiment 13, wherein the article is a
television bezel.

[0042] Embodiment 15: The article of embodiment 13 or 14, wherein the
polycarbonate comprises repeat units having the formula

\[
\begin{array}{c}
\text{O} \\
\text{R}^1 \text{O} \text{C} \text{O} \\
\end{array}
\]

wherein at least 90 percent of the total number of \( R^1 \) groups have the formula
wherein the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per gram; wherein the glass fibers have a diameter of 8 to 16 micrometers; wherein the composition comprises 43 to 49 weight percent of the polycarbonate, 10 to 16 weight percent of the poly(ethylene terephthalate), 8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, and 25 to 35 weight percent of the glass fibers; and wherein the composition excludes scale-like fillers.

[0043] The invention is further illustrated by the following non-limiting examples.

EXAMPLE 1, COMPARATIVE EXAMPLE 1

[0044] Components used to prepare the compositions are summarized in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1</td>
<td>Bisphenol A polycarbonate resin (CAS Reg. No. 25971-63-5) having a weight average molecular weight of about 22,000 atomic mass units; obtained as LEXAN™ ML5221 Resin from SABIC Innovative Plastics.</td>
</tr>
<tr>
<td>PC2</td>
<td>Bisphenol A polycarbonate resin (CAS Reg. No. 25971-63-5) having a weight average molecular weight of about 30,000 atomic mass units; obtained as LEXAN™ ML5721 Resin from SABIC Innovative Plastics.</td>
</tr>
<tr>
<td>PET</td>
<td>Poly(ethylene terephthalate) resin (CAS Reg. No. 25038-59-9) having an intrinsic viscosity of 0.80 to 0.86 deciliter per gram measured by Ubbelohde viscometer at 25 °C in a 1:1 weight/weight mixture of phenol and 1,1,2,2-tetrachloroethane; obtained as BG-03-80 from Foshan Shunde Shunyan Plastic Co., Ltd.</td>
</tr>
<tr>
<td>DMPPD</td>
<td>Tetrakis(2,6-dimethylphenyl) m-phenylene diphosphate (CAS Reg. No. 139189-30-3); obtained as PX200 from Daihachi Co. Ltd.</td>
</tr>
<tr>
<td>BPADP</td>
<td>Bisphenol A bis(diphenyl phosphate) (CAS Reg. No. 5945-33-5), obtained as CR741 from Daihachi Co. Ltd.</td>
</tr>
<tr>
<td>Glass fiber</td>
<td>Surface-treated glass fiber having a diameter of about 13 micrometers and a pre-compounding length of about 4 millimeters; obtained as</td>
</tr>
</tbody>
</table>
Additives
A mixture of monozinc phosphate, mold release agent, antidripping agent, hindered phenol antioxidant, phosphite antioxidant, carbon black pigment, and auxiliary colorants.

[0045] Compositions were prepared as follows. All components except glass fiber were dry-blended, then added to the feed throat of a Toshiba SE37 twin-screw extruder having a 37 millimeter screw diameter and operating at 200 rotations per minute. Glass fibers were added downstream. The extruder temperature profile from feed throat to die was 100 °C / 200 °C / 250 °C / 250 °C / 260 °C / 260 °C / 260 °C / 265 °C / 265 °C / 260 °C. The extruded was pelletized and dried for six hours at 120 °C before molding. Test articles were prepared in accordance with ASTM standards using a FANUC S2000i 150 ton injection molding machine operating with a barrel temperature of 260 °C and a mold temperature of 80 °C.

[0046] The following procedures were used for property testing. Melt flow rate (MFR) values (expressed in units of grams per 10 minutes) were determined according to ASTM D 1238-04 using Procedure B, 260 °C, and 2.16 kilogram load. Flexural modulus (Flex. Mod.) values (expressed in units of megapascals), were determined at 23 °C according to ASTM D790-07 using test bars having dimensions 127 × 12.7 × 3.2 millimeters and a test rate of 1.3 millimeters per minute. Notched Izod impact strength (NII) values (expressed in units of joules/meter), were determined at 23 °C according to ASTM D 256-10 using test bars having dimensions 63.5 × 12.7 × 3.2 millimeters. Heat deflection temperature (HDT) values (expressed in °C), were determined according to ASTM D 648-07 using test bars having dimensions 127 × 12.7 × 3.2 millimeters, and a loading fiber stress of 1.82 megapascals.

[0047] Flame retardancy of injection molded flame bars was determined according to Underwriter’s Laboratory Bulletin 94 “Tests for Flammability of Plastic Materials, UL 94”, 20 mm Vertical Burning Flame Test. Before testing, flame bars with a thickness of 1.5 millimeters were conditioned at 23°C and 50% relative humidity for at least 48 hours. In the UL 94 20 mm Vertical Burning Flame Test, a set of five flame bars was tested. For each bar, a flame was applied to the bar then removed, and the time required for the bar to self-extinguish (first afterflame time, t1) was noted. The flame was then reapplied and removed, and the time required for the bar to self-extinguish (second afterflame time, t2) and the post-flame glowing time (afterglow time, t3) were noted. To achieve a rating of V-0, the
afterflame times t1 and t2 for each individual specimen must have been less than or equal to 10 seconds; and the total afterflame time for all five specimens (t1 plus t2 for all five specimens) must have been less than or equal to 50 seconds; and the second afterflame time plus the afterglow time for each individual specimen (t2 + t3) must have been less than or equal to 30 seconds; and no specimen can have flamed or glowed up to the holding clamp; and the cotton indicator cannot have been ignited by flaming particles or drops. To achieve a rating of V-1, the afterflame times t1 and t2 for each individual specimen must have been less than or equal to 30 seconds; and the total afterflame time for all five specimens (t1 plus t2 for all five specimens) must have been less than or equal to 250 seconds; and the second afterflame time plus the afterglow time for each individual specimen (t2 + t3) must have been less than or equal to 60 seconds; and no specimen can have flamed or glowed up to the holding clamp; and the cotton indicator cannot have been ignited by flaming particles or drops. To achieve a rating of V-2, the afterflame times t1 and t2 for each individual specimen must have been less than or equal to 30 seconds; and the total afterflame time for all five specimens (t1 plus t2 for all five specimens) must have been less than or equal to 250 seconds; and the second afterflame time plus the afterglow time for each individual specimen (t2 + t3) must have been less than or equal to 60 seconds; and no specimen can have flamed or glowed up to the holding clamp; but the cotton indicator can have been ignited by flaming particles or drops. Compositions not achieving a rating of V-2 were considered to have failed.

[0048] Compositions and results are summarized in Table 2, where component amounts are in weight percent based on the total weight of the composition. Example 1 and Comparative Example 2 differ only in the flame retardant type. Example 1 uses tetrakis(2,6-dimethylphenyl) m-phenylene diphosphoramide (DMPPD), and Comparative Example 1 uses Bisphenol A bis(diphenyl phosphate) (BPADP). The property results for the two compositions are similar except that Example 1 with DMPPD has a substantially higher notched Izod impact strength.

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<th>COMPOSITIONS</th>
<th>Example 1</th>
<th>Comparative Example 1</th>
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**PROPERTIES**

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<td>HDT (°C)</td>
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<td>UL 94 Rating</td>
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CLAIMS

1. A composition comprising:
   40 to 50 weight percent of a polycarbonate;
   8 to 20 weight percent of a poly(ethylene terephthalate);
   5 to 15 weight percent of 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diposphate;

   and

   15 to 35 weight percent of glass fibers having a substantially circular cross-section;
   wherein all weight percent values are based on the total weight of the composition;

   and

   wherein the composition comprises 0 to 1 weight percent of scale-like fillers.

2. The composition of claim 1, wherein the polycarbonate comprises repeat units having the formula

   \[
   \begin{array}{c}
   \text{O} \\
   \text{R}^1 \text{O} \text{C} \text{O} \\
   \text{O}
   \end{array}
   \]

   wherein at least 60 percent of the total number of \( R^1 \) groups are aromatic.

3. The composition of claim 2, wherein \( R^1 \) is the residue of a dihydroxy compound having the formula

   \[
   \begin{array}{c}
   \text{HO} \\
   \text{Cyclic or acyclic, aromatic or non-aromatic, and can further comprise one or more heteroatoms selected from halogens, oxygen, nitrogen, sulfur, silicon, or phosphorous.}
   \end{array}
   \]

4. The composition of claim 2, wherein at least 90 percent of the total number of \( R^1 \) groups have the formula

   \[
   \begin{array}{c}
   \text{O} \\
   \text{C} \\
   \text{O}
   \end{array}
   \]

5. The composition of claim 1, comprising a first polycarbonate having a weight average molecular weight of 18,000 to 25,000 atomic mass units and a second polycarbonate having a
weight average molecular weight of 27,000 to 35,000 atomic mass units.

6. The composition of claim 1, wherein the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per gram as measured by Ubbelohde viscometer at 25 °C in a 1:1 weight/weight mixture of phenol and 1,1,2,2-tetrachloroethane.

7. The composition of claim 1, wherein the glass fibers have a diameter of 8 to 16 micrometers.

8. The composition of any of claims 1-7, comprising 25 to 35 weight percent of the glass fibers.

9. The composition of any of claims 1-7, excluding scale-like fillers.

10. The composition of any of claims 1-7, excluding impact modifiers.

11. The composition of any of claims 1-7, comprising 43 to 49 weight percent of the polycarbonate,

10 to 16 weight percent of the poly(ethylene terephthalate),

8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, and

25 to 35 weight percent of the glass fibers.

12. The composition of claim 1,

wherein the polycarbonate comprises repeat units having the formula

\[
\begin{array}{c}
\text{O} \\
\text{R}^1 \\
\text{O} \\
\text{C} \\
\text{O} \\
\end{array}
\]

wherein at least 90 percent of the total number of \( R^1 \) groups have the formula

\[
\begin{array}{c}
\text{O} \\
\text{C} \\
\text{O} \\
\end{array}
\]

wherein the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per gram;

wherein the glass fibers have a diameter of 8 to 16 micrometers;

wherein the composition comprises

43 to 49 weight percent of the polycarbonate,

10 to 16 weight percent of the poly(ethylene terephthalate),

8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, and

25 to 35 weight percent of the glass fibers; and
wherein the composition excludes scale-like fillers.

13. An article comprising a composition comprising:
40 to 50 weight percent of a polycarbonate;
8 to 20 weight percent of a poly(ethylene terephthalate);
5 to 15 weight percent of 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate;

and

15 to 35 weight percent of glass fibers having a substantially circular cross-section;
wherein all weight percent values are based on the total weight of the composition;

and

wherein the composition comprises 0 to 1 weight percent of scale-like fillers.

14. The article of claim 13, wherein the article is a television bezel.

15. The article of claim 13 or 14,
wherein the polycarbonate comprises repeat units having the formula

\[
\begin{array}{c}
\text{O} \\
\text{R}^1 \text{O} \text{C} \text{O} \\
\text{O}
\end{array}
\]

wherein at least 90 percent of the total number of \( R^1 \) groups have the formula

\[
\begin{array}{c}
\text{O} \\
\text{C} \\
\text{CH}_3
\end{array}
\quad
\begin{array}{c}
\text{C} \\
\text{O} \\
\text{CH}_3
\end{array}
\]

wherein the poly(ethylene terephthalate) has an intrinsic viscosity of 0.7 to 1.0 deciliter per gram;

wherein the glass fibers have a diameter of 8 to 16 micrometers;

wherein the composition comprises

43 to 49 weight percent of the polycarbonate,
10 to 16 weight percent of the poly(ethylene terephthalate),
8 to 12 weight percent of the 1,3-phenylene-tetrakis(2,6-dimethylphenyl)diphosphate, and
25 to 35 weight percent of the glass fibers; and

wherein the composition excludes scale-like fillers.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

C08L 69/00(2006.01); C08L 67/02(2006.01); C08K 3/32(2006.01); C08K 7/14(2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C08L; C08K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

CPRSABS,DWPLS,SIPOABS,CNKI; POLYCARBONATE, TEREPHTHALATE, PC, PET, FIBER, DIPHOSPHATE, FLAME RETARDANT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
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  "O" document referring to an oral disclosure, use, exhibition or other means
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  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "G" document member of the same patent family

Date of the actual completion of the international search: 05 July 2014

Date of mailing of the international search report: 14 July 2014

Name and mailing address of the ISA/Authorized officer

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Authorized officer: HE,Fang

Facsimile No. (86-10)62019451 Telephone No. (86-10)62084472

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