Abstract:
Disclosed herein is a polycarbonate-polydimethylsiloxane copolymer resin composition comprising: (A) about 100 parts by weight of a thermoplastic polycarbonate resin; and (B) about 0.1 -30 parts by weight of an organo-siloxane polymer having an epoxy group. The polycarbonate-polysiloxane copolymer resin composition has high impact strength at low temperature and high mechanical strength.
Description

POLYCARBONATE-POLYSILOXANE COPOLYMER RESIN COMPOSITION WITH HIGH IMPACT STRENGTH AT LOW TEMPERATURE AND MECHANICAL STRENGTH AND PROCESS OF PREPARING SAME

Technical Field

The present invention relates to a polycarbonate-polysiloxane copolymer resin composition with high impact strength at low temperature and high mechanical strength. More particularly, the present invention relates to a polycarbonate-polysiloxane copolymer resin composition comprising a polycarbonate resin and an organo-siloxane polymer having an epoxy group.

Background Art

Polycarbonate-polysiloxane copolymers and methods of preparing the same have been widely studied for many years.

In general, polycarbonate-polysiloxane copolymers have been prepared by an interfacial polymerization process. U.S. Patent No. 5,530,083 discloses an interfacial phosgenation process in which an aromatic dihydroxy compound, phosgene and catalyst react with diorganopolysiloxane having terminal hydroxyaryl groups. However, this process has a problem in that an environmentally hazardous chlorinated solvent is used.

U.S. Patent No. 4,994,532 discloses a technique for preparing a polycarbonate-polysiloxane copolymer by melt blending a polydimethylsiloxane having carboxylic acid functional groups with a polycarbonate resin.

Further, U.S. Patent No. 5,194,524 discloses a technique for preparing a copolymer by reaction and extrusion of a siloxane compound having at least one secondary amine group and a polycarbonate resin in a tubular extruder. According to this patent, a polysiloxane having secondary amine functional groups is more effective in the reaction and extrusion than a polysiloxane having primary amine functional groups since a primary amine has relatively low hydrolysis stability. However, the aforementioned melt blending process has a problem in that low temperature impact strength and mechanical strength can not reach satisfactory levels although the process can be performed in a tubular melt extruder and the process is simple.

The present inventors have studied to solve the above problems and developed a polycarbonate-polysiloxane copolymer resin composition having excellent low
temperature impact strength and mechanical strength by blending a polycarbonate resin with an organo-siloxane polymer having an epoxy group, and a method of preparing the same.

[8]

Disclosure of Invention

Technical Problem

[9] An object of the present invention is to provide a polycarbonate-polysiloxane copolymer resin composition excellent in both low temperature impact strength and mechanical strength.

[10] Another object of the present invention is to provide a polycarbonate-polysiloxane copolymer resin composition with an excellent balance of physical properties such as impact resistance, thermal stability, workability, and external appearance characteristics.

[11] A further object of the present invention is to provide a method of preparing the above polycarbonate-polysiloxane copolymer resin composition.

[12] Other objects and advantages of this invention will be apparent from the ensuing disclosure and appended claims.

[13]

Technical Solution

[14] According to the present invention, there is provided a polycarbonate-polysiloxane copolymer resin composition comprising (A) about 100 parts by weight of a thermoplastic polycarbonate resin and (B) about 0.1 to 30 parts by weight of an organo-siloxane polymer having an epoxy group.

[15] In one embodiment, the polycarbonate-polysiloxane copolymer resin composition has an impact strength of about 18 kgf-D/D or more measured at 23 °C and an impact strength of about 15 kgf-D/D or more at -30 °C measured in accordance with ASTM D-256 for 1/4" specimens, respectively, a flexural modulus of about 18,000 Kgfd/Dor more measured in accordance with ASTM D790 using a 1/4" thick specimens, and a brittle fracture ratio of about 45 % or less of a flat plate specimen with dimensions of 2 mm x 50 mm x 200 mm after leaving the specimen alone at -30 °C for 48 hours.

[16] The resin composition may further comprise about 10 parts by weight or less of an impact modifier in order to further improve impact strength.

[17] The impact modifier may be a core-shell graft copolymer. In one embodiment, when the core-shell graft copolymer is used as the impact modifier, the polycarbonate-polysiloxane copolymer resin composition has an impact strength of about 75 kgf-D/D or more measured at a room temperature of 23 °C and an impact strength of about 27 kgf-D/D or more measured at a low temperature of -30 °C for a 1/4" thick specimen.
according to ASTM D256, a flexural modulus of about 18,000 kgf/D or more of a 1/4” thick specimen according to ASTM D790, and a brittle fracture ratio of about 10 % or less of a flat plate specimen with dimensions of 2 mm x 50 mm x 200 mm after leaving the specimen alone at -30 °C for 48 hours.

[18] In another exemplary embodiment of the invention, the impact modifier may be an ethylene/alkyl(meth)acrylate copolymer.

[19] Another aspect of the present invention relates to a method for preparing a polycarbonate-polysiloxane copolymer resin composition. In one embodiment, the method comprises melt-blending a thermoplastic polycarbonate resin with an organo-siloxane polymer having an epoxy group, and extruding the melt-blended mixture.

[20] Best Mode for Carrying Out the Invention

[21] A polycarbonate-polysiloxane copolymer resin composition of the present invention comprises (A) a thermoplastic polycarbonate resin and (B) an organo-siloxane polymer having an epoxy group. Hereinafter, the present invention will be described in detail.

[22]

[23] (A) Polycarbonate Resin

[24] The polycarbonate resin of the present invention is prepared by allowing a diphenol represented by the following chemical formula 1 to react with a phosgene, a halogen formate or a carbonic diester.

[25]

[26] [Chemical Formula 1]

[27]

\[
\text{HO} \quad \text{(A)} \quad \text{OH}
\]

wherein A is a single bond, a C-alkylene, a C-alkylidene, a C-cycloalkylidene, -S-, or -SO₂-

[28] The diphenol represented by the chemical formula 1 may include hydroquinone, resorcinol, 4,4’-dihydroxydiphenyl, 2,2-bis-(4-hydroxyphenyl)-propane, 2,4-bis-(4-hydroxyphenyl)-2-methylbutane, 1,1-bis-(4-hydroxyphenyl)-cyclohexane, 2,2-bis-(3-chloro-4-hydroxyphenyl)-propane, 2,2-bis-(3,5-dichloro-4-hydroxyphenyl)-propane, and the like.

[29] In the embodiments, 2,2-bis-(4-hydroxyphenyl)-propane, 2,2-bis-(3,5-dichloro-4-hydroxyphenyl)-propane and 1,1-bis-(4-hydroxyphenyl)-cyclohexane are preferably used, and 2,2-bis-(4-hydroxyphenyl)-propane called ’bisphenol A’ is most preferably used.
In the present invention, it is preferable that the polycarbonate resin has a weight average molecular weight (Mw) of about 10,000 to about 500,000, more preferably about 20,000 to about 100,000.

The polycarbonate resin may be used in the form of a branched chain, and preferably prepared by adding a tri- or more poly-functional compound, e.g., a compound with a tri- or more polyvalent phenol group, of about 0.05 to 2 mol% with respect to the total amount of the diphenol used in the polymerization.

A homopolymer of polycarbonate, a copolymer of polycarbonate, or mixtures thereof may be used in the preparation of resin composition of the present invention.

(B) Organo-Siloxane Polymer Including Epoxy Group

The organo-siloxane polymer used in the preparation of the resin composition of the present invention is at least one siloxane polymer represented by the following chemical formulae 2, 3 or 4 as an organo-siloxane polymer having an epoxy group.

[Chemical Formula 2]

wherein each of R is independently a hydrogen atom, a C\(_1\)-C\(_8\) alkyl group, a C\(_1\)-C\(_6\) aryl group, or a C\(_1\)-C\(_3\) alkyl-substituted C\(_6\)-C\(_8\) aryl group; R is a C\(_1\)-C\(_8\) alkylene group; p is 0 or 1; a representing the number of repeating units is an integer of 1 to 10.

Each of R\(_i\), which are independent from one another, is preferably a hydrogen atom, a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, a sec-butyl group, a t-butyl group, an isobutyl group, an isoamyl group, or a t-amyl group.

R is preferably methylene, ethylene, propylene, isopropylene, butylene, sec-butylene, or t-butylene, and a is most preferably 3 to 6.

[Chemical Formula 3]
wherein each of $R_i$, which are independent from one another, is a hydrogen atom, a $C_1$-$C_4$ alkyl group, a $C_5$-$C_{10}$ aryl group, or a $C_1$-$C_4$ alkyl-substituted aryl group; $R_i$ is a $C_4$-$C_8$ alkylene group; $q$ is 0 or 1; $b$ representing the number of repeating units is an integer of 1 to 10.

Each of $R_i$, which are independent from one another, is preferably a hydrogen atom, a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, a sec-butyl group, a t-butyl group, an isobutyl group, an isoamyl group, or a t-amyl group.

$R_i$ is preferably methylene, ethylene, propylene, isopropylene, butylene, sec-butylene, or t-butylene, and $b$ is most preferably 3 to 6.

[Chemical Formula 4]

wherein each of $R_i$, which are independent from one another, is a hydrogen atom, a $C_1$-$C_4$ alkyl group, a $C_5$-$C_{10}$ aryl group, or a $C_1$-$C_4$ alkyl-substituted aryl group; $R_i$ is a $C_4$-$C_8$ alkylene group; and $r$ is 0 or 1.

In the above chemical formula, $c$ and $d$ represent a ratio of repeating units. A ratio of $c$ to $d$ is in a range of about 99.1 : 0.1 to about 50 : 50, preferably about 99.5 : 0.5 to 55 : 45.

Each $R_i$, which are independent from one another, is preferably a hydrogen atom, a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, a sec-butyl group, a t-butyl group, an isobutyl group, an isoamyl group, or a t-amyl group.

$R_i$ is preferably methylene, ethylene, propylene, isopropylene, butylene, sec-butylene, or t-butylene.

An organo-siloxane polymer having an epoxy group used in the preparation of a resin composition of the present invention has a viscosity of about 1 to 50,000 centistocks (cSt), preferably about 1 to 10,000 centistocks, at about 25 °C.

In the present invention, the organo-siloxane polymer (B) having an epoxy group is used in a range of about 0.1 to 30 parts by weight, preferably about 0.2 to 20 parts by
weight, most preferably about 0.5 to 15 parts by weight, with respect to about 100 parts by weight of the polycarbonate resin (A). When such a range is used, excellent mechanical properties can be obtained.

(C) Impact Modifier

In the present invention, an ordinary impact modifier can be optionally included to improve impact strength.

In the present invention, a core-shell graft copolymer may be used as the impact modifier. The core-shell graft copolymer will be described in detail hereinafter.

Core-Shell Graft Copolymer

The core-shell graft copolymer is a core-shell graft copolymer prepared by graft-polymerizing a monomer, which is selected from an aromatic vinyl compound, a vinyl cyanide compound, a C1-C8 alkyl (meth)acrylate ester, maleic anhydride, maleimide, and mixtures thereof, with a rubber polymer.

Specifically, the core-shell graft copolymer is prepared by graft-polymerizing about 5 to 95% by weight of at least one monomer, which is selected from (C-I) styrene, α-methyl styrene, a halogen or C1-C8 alkyl-substituted styrene, a C1-C8 alkyl methacrylate ester, a C1-C8 alkyl acrylate ester, an acrylonitrile, a methacrylonitrile, a maleic anhydride, and a C1-C8 alkyl or phenyl N-substituted maleimide, with about 5 to 95% by weight of one selected from the group consisting of a (C-2) butadiene rubber, an acryl rubber, an ethylene/propylene rubber, a styrene/butadiene rubber, an acrylonitrile/butadiene rubber, isoprene rubber, an ethylene propylene diene monomer (EPDM), a polyorganosiloxane/polyalkyl(meth)acrylate rubber composite, or a mixture thereof.

The C1-C8 alkyl methacrylate ester or the C1-C8 alkyl acrylate ester, as an alkyl ester of methacrylic acid or acrylic acid, is an ester obtained from monohydryl alcohol containing 1 to 8 carbon atoms. Embodiments of the C1-C8 alkyl methacrylate ester or the C1-C8 alkyl acrylate ester include a methyl methacrylate ester, an ethyl methacrylate ester, an ethyl acrylate ester, a methyl acrylate ester and propyl methacrylate ester.

One embodiment of the core-shell graft impact modifier is a mixture form obtained by graft-copolymerizing a butadiene rubber, an acryl rubber or a styrene/butadiene rubber with styrene, acrylonitrile, and optionally an alkyl (meth)acrylate ester monomer.

Another embodiment of the core-shell graft impact modifier is obtained by graft-copolymerizing a rubber polymer, in which a polyorganosiloxane/polyalkyl(meth)acrylate rubber blends with a butadiene rubber, an acryl rubber, or a
When preparing the graft impact modifier, it is preferable that rubber particles have a particle diameter range of about 0.05 to 4 D in order to improve impact resistance and surface characteristics of molded articles.

A method for preparing the graft impact modifier is already well known to those skilled in the art, and the graft impact modifier may be prepared by an emulsion polymerization process, a suspension polymerization process, a solution polymerization process, or a bulk polymerization process. Preferably, an emulsion or bulk polymerization process is performed using a polymerization initiator by injecting the aforementioned monomer in the presence of a rubber polymer.

In the present invention, a linear impact modifier such as an ethylene/alkyl(meth)acrylate copolymer may be used besides the core-shell graft impact modifier. The linear impact modifier will be described in detail as follows.

**Linear Impact Modifier**

The ethylene/alkyl(meth)acrylate copolymer is represented by the following chemical formula 5.

[Chemical Formula 5]

\[
\begin{align*}
\left( \overset{H_2}{C - C} \right)_m \left( \overset{H_2}{C - C} \right)_n \\
\overset{\text{R}_7}{\overset{\text{C - O}}{\text{R}_8}}
\end{align*}
\]

where \( R \) is a hydrogen atom or a methyl group; \( R \) is a \( C_{\text{7}} \) alkyl group; and \( m \) and \( n \) are polymerization degrees, and a ratio of \( m \) to \( n \) is about 300 : 1 to 10 : 90.

Preferably, \( R \) is a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, a sec-butyl group, a t-butyl group, an isobutyl group, an isoamyl group, or a t-amyl group.

The ethylene/alkyl(meth)acrylate copolymer may be a random copolymer, a block copolymer, a multi-block copolymer, a graft copolymer, or a mixture thereof. The ethylene/alkyl (meth) acrylate copolymer may be prepared by one of ordinary skill in the art.

In the present invention, a mixture of the core-shell graft copolymer and the
ethylene/alkyl(meth)acrylate copolymer may be used.

In the present invention, it is preferable in terms of the mechanical strength to use the impact modifier preferably in a range of not more than about 10 parts by weight, more preferably about 0.1 to 7 parts by weight, most preferably about 0.5 to 5.5 parts by weight.

A polycarbonate-polysiloxane copolymer resin composition of the present invention may include general additives such as flame retardants, flame retardant aids, lubricants, releasing agents, nucleating agents, antistatic agents, stabilizers, reinforcing agents, inorganic fillers, pigments and dyes according to respective uses in addition to the foregoing components. One of the additives may be used solely, or a mixture of at least two thereof may also be used. An added inorganic additive may be used in a range of about 0 to 60 parts by weight, preferably about 1 to 40 parts by weight with respect to about 100 parts by weight of basic resin components (A)+(B).

A polycarbonate-polysiloxane copolymer of the present invention is prepared by melt-blending the thermoplastic polycarbonate resin with the organo-siloxane polymer having an epoxy group and then by extruding the melt-blended material. The melt-blended material is preferably extruded at a temperature of about 200 to 300 °C, most preferably about 250 to 280 °C. The extrusion has a form of a pellet. The pellet is molded in an ordinary manner and applicable to internal and external parts of electrical and electronic appliances such as a television set, a washing machine, a telephone, an audio, a video player, a CD player, or the like.

The present invention will be more understood by the following examples. However, the following examples are only for illustrative purposes of the present invention and do not intend to limit the scope of the present invention defined by the appended claims.

Mode for the Invention

Examples

Specifications of respective components used in the examples and comparative examples as follows.

(A) Polycarbonate resin
A bisphenol-A-based polycarbonate with a weight average molecular weight (Mw) of 22,500 was used.

(B) Organo-siloxane polymer
(B-I) In a structural formula such as the aforementioned chemical formula 3, an organo-siloxane polymer was used, wherein \( b = 4, R_3 \) is a methyl group, \( R_4 \) is methylene; \( q = 0 \), with a dynamic viscosity measured at 25 \(^\circ\)C is 15 centistrokes (cSt).

(B-2) KF-96 produced by Shinetsu Corporation in Japan was used as a poly-dimethylsiloxane, and an organo-siloxane polymer without a functional group was used, with a dynamic viscosity measured at 25 \(^\circ\)C is 100 centistrokes (cSt).

(B-3) X-22-160AS produced by Shinetsu Corporation in Japan was used as a siloxane polymer containing a carbinol group, and an organo-siloxane polymer was used, with a dynamic viscosity measured at 25 \(^\circ\)C is 35 centistrokes (cSt).

(C) Impact modifier

Metablen C223A produced by MRC Corporation was used as a MBS-based core-shell graft impact modifier.

Examples 1-2 and Comparative Examples 1-3

The components as shown in Table 1 added with an antioxidant and a heat stabilizer were mixed in a conventional mixer and the mixture was extruded through a twin screw extruder with \( L/D=35 \) and \( \Phi=45 \) mm in pellets. The resin pellets were molded into test specimens using a 10 oz injection molding machine at 280-300 \(^\circ\)C.

The physical properties of the test specimens were measured as follow and were shown in Table 1 below.

Methods for measuring physical properties

1. Izod Impact Strength at room temperature: Room temperature notched izod impact strength was measured on a specimen with a thickness of 1/4" according to ASTM D256 after leaving the specimen alone at a temperature of 23 \(^\circ\)C and a relative humidity of 50 % for 48 hours.

2. Izod Impact Strength at low temperature: Low temperature notched izod impact strength was measured on a specimen with a thickness of 1/4" according to ASTM D256 after leaving the specimen alone at a temperature of -30 \(^\circ\)C for 48 hours.

3. Flexural Modulus: The flexural modulus was measured on a specimen with a thickness of 1/4" at a speed of 2.8 mm/min according to ASTM D790 after leaving the specimen alone at a temperature of 23 \(^\circ\)C and a relative humidity of 50 % for 48 hours.

4. Brittle Fracture Ratio at low temperature: Low temperature brittle fracture ratio was measured on a specimen with dimensions of 2 mm x 50 mm x 200 mm by colliding with a sphere falling from a gate after leaving the flat plate specimen along at a temperature of -30 \(^\circ\)C for 48 hours.
It can be seen from the results of the Table 1 that compositions of Examples 1 and 2 prepared by reaction and extrusion of a polycarbonate resin composition and an organo-siloxane polymer having an epoxy group according to the present invention simultaneously satisfy excellent low temperature impact strength and high flexural modulus as compared with compositions of Comparative Examples 1 to 3 prepared using an organo-siloxane polymer without a functional group and an organo-siloxane polymer substituted with another functional group.

According to the present invention, it will be easily understood by those skilled in the art that simple modifications and changes can be made thereto. Also, such modifications and changes are encompassed within the scope of the present invention.
Claims

[1] A polycarbonate-polysiloxane copolymer resin composition with high impact strength at low temperature and high mechanical strength, comprising:
(A) about 100 parts by weight of a thermoplastic polycarbonate resin; and
(B) about 0.1–30 parts by weight of an organo-siloxane polymer having an epoxy group.

[2] The polycarbonate-polysiloxane copolymer resin composition of claim 1, wherein said organo-siloxane polymer having an epoxy group (B) is at least one represented by the following Chemical Formulae 2, 3 and 4:

[Chemical Formula 2]

wherein \( R_i \) is independently a hydrogen atom, a \( \text{C}-\text{C} \) alkyl group, a \( \text{C}-\text{C} \) aryl group, or a \( \text{C}-\text{C} \) alkyl-substituted \( \text{C}-\text{C} \) aryl group; \( R_i \) is a \( \text{C}-\text{C} \) alkylene group; and \( p \) is 0 or 1; a representing the number of repeating units is an integer of 1 to 10;

[Chemical Formula 3]

wherein \( R_j \) is independently a hydrogen atom, a \( \text{C}-\text{C} \) alkyl group, a \( \text{C}-\text{C} \) aryl group, or a \( \text{C}-\text{C} \) alkyl-substituted aryl group; \( R_j \) is a \( \text{C}-\text{C} \) alkylene group; \( q \) is 0 or 1; \( b \) representing the number of repeating units is an integer of 1 to 10;

[Chemical Formula 4]

wherein \( R_k \) is independently a hydrogen atom, a \( \text{C}-\text{C} \) alkyl group, a \( \text{C}-\text{C} \) aryl group, or a \( \text{C}-\text{C} \) alkyl-substituted aryl group; \( R_k \) is a \( \text{C}-\text{C} \) alkylene group; and
r is 0 or 1; c and d represent a ratio of repeating units, a ratio of c to d is in a range of about 99.1 : 0.1 to about 50 : 50.

[3] The polycarbonate-polysiloxane copolymer resin composition of claim 2, wherein said R₁, R₃ and R₅ of said organic siloxane polymer having an epoxy group (B) are independently a hydrogen atom, methyl, ethyl, propyl, isopropyl, butyl, sec-butyl, t-butyl, isobutyl, isoamyl, or t-amyl.

[4] The polycarbonate-polysiloxane copolymer resin composition of claim 2, wherein said R₂, R₄ and R₆ of said organic siloxane polymer having an epoxy group (B) are methylene, ethylene, propylene, isopropylene, butylene, sec-butylen, or t-butylen.

[5] The polycarbonate-polysiloxane copolymer resin composition of claim 2, wherein the ratio of c to d of said organic siloxane polymer having an epoxy group is about 99.5 : 0.5 to about 55 : 45.

[6] The polycarbonate-polysiloxane copolymer resin composition of claim 1, where in said organic siloxane polymer having an epoxy group (B) has a viscosity of about 1-50,000 cSt at 25 °C.

[7] The polycarbonate-polysiloxane copolymer resin composition of claim 1, wherein said polycarbonate-polysiloxane copolymer resin composition has an impact strength of about 18 kgf-D/D or more measured at 23 °C and an impact strength of about 15 kgf-D/D or more at -30 °C measured in accordance with ASTM D-256 for 1/4" specimens, respectively, a flexural modulus of about 18,000 Kgf/D/D or more measured in accordance with ASTM D790 using a 1/4" thick specimens, and a brittle fracture ratio of about 45 % or less of a flat plate specimen with dimensions of 2 mm x 50 mm x 200 mm after leaving the specimen alone at -30 °C for 48 hours.

[8] The polycarbonate-polysiloxane copolymer resin composition of claim 1, further comprising about 10 or less parts by weight of the impact modifier (C).

[9] The polycarbonate-polysiloxane copolymer resin composition of claim 8, wherein said impact modifier (C) is a core-shell graft copolymer prepared by graft-polymerizing a monomer selected from the group consisting of an aromatic vinyl compound, a vinyl cyanide compound, a C₁-C₈ alkyl (meth)acrylate ester, maleic anhydride, maleimide, and mixtures thereof with a rubber polymer.

[10] The polycarbonate-polysiloxane copolymer resin composition of claim 9, wherein said core-shell graft copolymer is prepared by graft-polymerizing about 5 to 95 % by weight of at least one monomer selected from styrene, α-methyl styrene, a halogen- or C₁-C₈ alkyl-substituted styrene, a C₁-C₈ alkyl methacrylate ester, a C₁-C₈ alkyl acrylate ester, an acrylonitrile, a methacrylonitrile, a maleic anhydride, and a C₁-C₄ alkyl- or phenyl N-substituted maleimide with about 5 to
95% by weight of at least one selected from the group consisting of a butadiene rubber, an acryl rubber, an ethylene/propylene rubber, a styrene/butadiene rubber, an acrylonitrile/butadiene rubber, an isoprene rubber, an ethylene propylene diene monomer (EPDM), a polyorganosiloxane/polyalkyl(meth)acrylate rubber composite and mixtures thereof.

[11] The polycarbonate-polysiloxane copolymer resin composition of claim 10, wherein said polycarbonate-polysiloxane copolymer resin composition has an impact strength of about 7.5 kgf-D/D or more measured at 23°C and an impact strength of about 27 kgf-D/D or more at -30°C measured in accordance with ASTM D-256 for 1/4” specimens, respectively, a flexural modulus of about 18,000 Kgf/D or more measured in accordance with ASTM D790 using a 1/4” thick specimens, and a brittle fracture ratio of about 10% or less of a flat plate specimen with dimensions of 2 mm x 50 mm x 200 mm after leaving the specimen alone at -30°C for 48 hours.

[12] The polycarbonate-polysiloxane copolymer resin composition of claim 8, wherein said impact modifier (C) is an ethylene/alkyl(meth)acrylate copolymer represented by the following chemical formula 5:

\[
\begin{align*}
\text{Chemical Formula 5} &= \text{(H}_2\text{H})_m\text{(H}_2\text{C})_n\text{R}_7\text{O}_{\text{R}_8} \\
\text{where } R_7 &\text{ is a hydrogen atom or a methyl group; } R_8 \text{ is a C}_1\text{C}_{12} \text{ alkyl group; and } \\
m \text{ and } n \text{ are polymerization degrees, and a ratio of } m \text{ to } n \text{ is about } 300 : 1 \text{ to } 10 : 90.
\end{align*}
\]

[13] The polycarbonate-polysiloxane copolymer resin composition of claim 8, further comprising an additive selected from the group consisting of flame retardants, flame retardant aids, lubricants, releasing agents, nucleating agents, antistatic agents, stabilizers, reinforcing agents, inorganic fillers, pigments, dyes and mixtures thereof.

[14] A molded article produced from the polycarbonate-polysiloxane copolymer resin composition as defined in any one of claims 1-13.

polymer having an epoxy group represented by the following Chemical
Formulae 2, 3 and 4; and
extruding the melt-blended mixture:

[Chemical Formula 2]

\[
\begin{array}{c}
\text{\( R_1 \)} \left( \text{\( \text{O}_p \)} \right) \text{\( \text{Si-O} \)} \left( \text{\( \text{Si-O} \)} \right)_{a} \text{\( \text{Si-O} \)} \left( \text{\( \text{O}_p \)} \right) \text{\( \text{R}_2 \)}} \quad \text{CH} \quad \text{CH}_2
\end{array}
\]

wherein \( R_1 \) is independently a hydrogen atom, a \( \text{C}_1 \text{-C}_8 \) alkyl group, a \( \text{C}_1 \text{-C}_6 \) aryl group, or a \( \text{C}_1 \text{-C}_{15} \) alkyl-substituted \( \text{C}_1 \text{-C}_6 \) aryl group; \( R_2 \) is a \( \text{C}_1 \text{-C}_8 \) alkylene group; \( p \) is 0 or 1; \( a \) representing the number of repeating units is an integer of 1 to 10;

[Chemical Formula 3]

\[
\begin{array}{c}
\text{H}_2\text{C} \quad \text{CH} \quad \text{R}_4 \quad \left( \text{\( \text{O}_q \)} \right) \text{\( \text{Si-O} \)} \left( \text{\( \text{Si-O} \)} \right)_{b} \text{\( \text{Si-O} \)} \left( \text{\( \text{O}_q \)} \right) \text{\( \text{R}_4 \)}} \quad \text{CH} \quad \text{CH}_2
\end{array}
\]

wherein \( R_3 \) is independently a hydrogen atom, a \( \text{C}_1 \text{-C}_8 \) alkyl group, a \( \text{C}_1 \text{-C}_6 \) aryl group, or a \( \text{C}_1 \text{-C}_{15} \) alkyl-substituted aryl group; \( R_4 \) is a \( \text{C}_1 \text{-C}_8 \) alkylene group; \( q \) is 0 or 1; \( b \) representing the number of repeating units is an integer of 1 to 10;

[Chemical Formula 4]

\[
\begin{array}{c}
\text{R}_5 \quad \left( \text{\( \text{O}_r \)} \right) \text{\( \text{Si-O} \)} \left( \text{\( \text{Si-O} \)} \right)_{c} \text{\( \text{Si-O} \)} \left( \text{\( \text{O}_d \)} \right) \text{\( \text{R}_5 \)}} \quad \text{CH} \quad \text{CH}_2
\end{array}
\]

wherein \( R_5 \) is independently a hydrogen atom, a \( \text{C}_1 \text{-C}_8 \) alkyl group, a \( \text{C}_1 \text{-C}_6 \) aryl group, or a \( \text{C}_1 \text{-C}_{15} \) alkyl-substituted aryl group; \( R_5 \) is a \( \text{C}_1 \text{-C}_8 \) alkylene group; and \( r \) is 0 or 1; \( c \) and \( d \) represent a ratio of repeating units, a ratio of \( c \) to \( d \) is in a range of about 99.1 : 0.1 to about 50 : 50.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

C08L 69/00(2006.01)i

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)

IPC 8 C08L 69/00

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

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Further documents are listed in the continuation of Box C

☑ See patent family annex

Date of the actual completion of the international search

25 MARCH 2008 (25 03 2008)

Date of mailing of the international search report

25 MARCH 2008 (25.03.2008)

Name and mailing address of the ISA/KR

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Facsimile No 82-42-472-7140

Authorized officer

KIM Rahn
Telephone No 82-42-481-5543

Form PCT/ISA/210 (second sheet) (April 2007)
**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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