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(54) **Title**: POLYCARBONATE RESIN COMPOSITION AND FORMED ARTICLE

(57) **Abstract**: Provided is a formed article produced by forming a polycarbonate resin composition, wherein the polycarbonate resin composition contains a polycarbonate resin and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less; in the polycarbonate resin composition, a content of the silica fine particles with respect to a total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or less; and the formed article has, in a range of 20°C to 60°C, a linear expansion coefficient that is 20 x10^{-6}/°C or less and may be a negative value.

DESCRIPTION

POLYCARBONATE RESIN COMPOSITION AND FORMED ARTICLE

Technical Field

[0001] The present invention relates to a polycarbonate resin composition and a formed article, in particular, to a polycarbonate resin composition and a formed article thereof that have a low linear expansion coefficient.

Background Art

[0002] In general, substances expand upon heating. In particular, organic resin materials have high linear expansion coefficients. When components composed of organic resin materials are used in, for example, devices represented by precision optical systems, large dimensional variations of the components in response to temperature change can cause misalignment of the optical systems. When an organic resin material alone is used to produce a component for a precision optical system, it desirably has a linear expansion coefficient of $20 \times 10^{-6}/°C$ or less.

[0003] There is a method for suppressing misalignment of an optical system due to thermal expansion of an organic resin material: a material having a negative linear expansion property (hereafter, referred to as negative

expandability) is disposed around a member composed of the organic resin material to thereby compensate for dimensional variations of the member. Examples of the material having negative expandability include inorganic materials such as zirconium tungstate, lithium-aluminum-silicon oxides, and manganese nitrides.

[0004] There is another method for suppressing misalignment of an optical system due to thermal expansion of an organic resin material by reducing the thermal expansion of the organic resin material. It is well known that thermal expansion of an organic resin material is reduced by adding inorganic fine particles to the organic resin material to decrease the linear expansion coefficient of the organic resin material (PTL 1 and PTL 2).

Citation List

Patent Literature

[0005] PTL 1 Japanese Patent Laid-Open No. 2006-291197

PTL 2 Japanese Patent Laid-Open No. 11-017073

Summary of Invention

Technical Problem

[0006] The above-described material having negative expandability has a low linear expansion coefficient of -25 $\times 10^{-6}/°C$ at the minimum. However, it is difficult to form bulk articles from such materials having negative expandability, compared with general-purpose organic resin

materials.

[0007] According to the methods of adding inorganic fine particles to an organic resin material to decrease the linear expansion coefficient of the organic resin material in PTL 1 and PTL 2, linear expansion coefficients of 20×10^{-6}/°C or less are achieved by adding inorganic fine particles to resins. However, when a thermosetting resin is used as a matrix material, contraction of the resin due to curing at the time of forming results in deformation and misalignment of the formed article. In addition, the forming costs incurred by the curing become high.

[0008] There is an example where inorganic fine particles are added to a thermoplastic resin to decrease the linear expansion coefficient of the resin. However, to decrease the linear expansion coefficient of a thermoplastic resin to 20×10^{-6}/°C or less, from simple calculation in terms of volume fraction, inorganic fine particles need to be added in an amount of about 80% by weight (71 vol%) even by using silica having a low specific gravity as the inorganic fine particles. Addition of a large amount of inorganic fine particles results in severe degradation of bulk formability of the thermoplastic resin and hence it is actually difficult to produce a formed article having a linear expansion coefficient of 20×10^{-6}/°C or less.

[0009] Since there are such problems, even when the

existing method of adding inorganic fine particles to an organic resin material to decrease the linear expansion coefficient of the organic resin material is used, it has been difficult to use the resultant organic resin material in, for example, precision optical systems.

[0010] Accordingly, the present invention provides a polycarbonate resin composition and a formed article thereof that have a low linear expansion coefficient and high formability.

Solution to Problem

[0011] A polycarbonate resin composition includes a polycarbonate resin; and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less, wherein, in the polycarbonate resin composition, a content of the silica fine particles with respect to a total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or less.

[0012] Provided is a formed article produced by forming a polycarbonate resin composition, wherein the polycarbonate resin composition contains a polycarbonate resin and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less; in the polycarbonate resin composition, a content of the silica fine particles with respect to a total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or

less; and the formed article has, in a range of 20°C to 60°C, a linear expansion coefficient that is 20 × 10^{-6}/°C or less and may be a negative value.

Advantageous Effects of Invention

[0013] The present invention provides a polycarbonate resin composition and a formed article thereof that have a low linear expansion coefficient and high formability.

[0014] A formed article according to the present invention can be suitably used as low-expansion members and temperature-compensation members that are used for optical fibers and precision optical devices such as lenses and mirrors.

Description of Embodiments

[0015] Hereinafter, embodiments according to the present invention will be described in detail.

[0016] A polycarbonate resin composition according to the present invention contains a polycarbonate resin and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less, wherein the content of the silica fine particles in the polycarbonate resin composition is 40 vol% or more and 80 vol% or less.

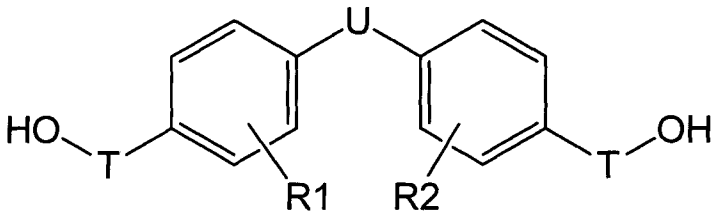
[0017] The type of a polycarbonate resin used in a polycarbonate resin composition according to the present invention is not particularly limited and the polycarbonate resin may be selected from various thermoplastic

polycarbonate resins having a carbonate group. The term "polycarbonate resin" denotes a polymer synthesized by polymerization of at least one diol compound and a carbonic acid ester (carbonate compound) as starting materials. Aromatic polycarbonate resins may be used alone or in combination.

[0018] The diol compound may be an aliphatic compound or an aromatic compound. In view of, for example, heat resistance, a polycarbonate resin having an aromatic component can be used. Examples of the diol compound that can be used include compounds represented by the following general formula (1).

[0019]

[Chem. 1]



(1)

[0020] In the general formula (1), T represents an oxyalkylene group having 2 or more and 12 or less carbon atoms, a poly(oxyethylene) group having 2 or more and 12 or less carbon atoms, or a single bond. Each of R1 and R2 represents a hydrogen atom, an alkyl group having 1 or more and 6 or less carbon atoms, an alkoxy group having 1 or more and 6 or less carbon atoms, or an aryl group having 6 or

more and 12 or less carbon atoms. R1 and R2 may be the same or different from each other. U represents an alkylene group having 1 or more and 13 or less carbon atoms, an alkylidene group having 2 or more and 13 or less carbon atoms, a cycloalkylene group having 5 or more and 13 or less carbon atoms, a cycloalkylidene group having 5 or more and 13 or less carbon atoms, an arylene group having 6 or more and 13 or less carbon atoms, fluorenidene, -O-, -S-, $-SO_2-$, -CO-, or a single bond. R1, R2, T, and U may be different among structural units.

[0021] Specific preferred examples of the diol compound include 2,2-bis(4-hydroxyphenyl)propane (bisphenol A), 2,2-bis(3-methyl-4-hydroxyphenyl)propane, 2,2-bis(3,5-dimethyl-4-hydroxyphenyl)propane, 1,1-bis(4-hydroxyphenyl)-1-phenylethane, and 1,1-bis(4-hydroxyphenyl)cyclohexane; more preferably, 2,2-bis(4-hydroxyphenyl)propane.

[0022] A polycarbonate resin used in the present invention may be synthesized by a publicly known method such as interfacial polymerization or melt polymerization. In this synthesis, agents such as a terminator, a catalyst, and an antioxidant may be used. The polycarbonate resin may be a branched polycarbonate resin synthesized through copolymerization using a polyfunctional compound having a functionality of three or more.

[0023] Examples of the polyfunctional compound include

1,1,1-tris(4-hydroxyphenyl)ethane, 4,4'-[1-[4-[1-(4-hydroxyphenyl)-1-methylethyl]phenyl]ethylidene]bisphenol, 1-[α-methyl-α-(4'-hydroxyphenyl)ethyl]-4-[α',α'-bis(4''-hydroxyphenyl)ethyl]benzene, α,α',α''-tris(4-hydroxyphenyl)-1,3,5-triisopropylbenzene, trimellitic acid, phloroglucin, and isatinbis(o-cresol).

[0024] A polycarbonate resin used in the present invention may contain an additive as long as advantages of the present invention are achieved. Examples of the additive include phosphorus-based thermal stabilizers; thermal stabilizers of hydroxylamines; antioxidants such as hindered phenols; light stabilizers such as hindered amines; ultraviolet absorbing agents such as benzotriazoles, triazines, benzophenones, and benzoates; plasticizers such as phosphates, phthalates, citrates, and polyesters; release agents such as silicones; flame retardants such as phosphates and melamines; antistatic agents such as fatty ester-based surfactants; organic coloring agents; and impact modifiers. These additives may be used alone or in combination.

[0025] The amount of a polycarbonate resin contained in a polycarbonate resin composition according to the present invention is, with respect to the total amount of the polycarbonate resin and the silica fine particles, more than 20 vol% and less than 60 vol%, preferably 40 vol% or more and less than 60 vol%.

[0026] Silica fine particles used in a polycarbonate resin composition according to the present invention may be prepared by a publicly known method as long as the silica fine particles satisfy desired properties. Examples of the method include: a method in which a silica fine-particle powder is placed in high-temperature flame, melted to be liquidized, and then rapidly cooled; a method in which a silicon powder is placed in chemical flame formed with a burner in an oxygen-containing atmosphere so that explosion is caused to produce silica fine particles; and a method by a sol-gel process in which a silicon alkoxide is subjected to hydrolysis and polycondensation in the presence of a catalyst to produce silica fine particles.

[0027] Groups on the surfaces of silica fine particles used in the present invention may be selected from various groups in accordance with a desired value of a linear expansion coefficient or desired dispersibility of the silica fine particles. It is well known that inorganic fine particles are added to an organic resin material to decrease the linear expansion coefficient of the material. The inventor of the present invention has found that the amount of a decrease in the linear expansion coefficient varies depending on the type of groups exposed on the surfaces of the inorganic fine particles. This is probably because the influence of the interaction between a polycarbonate resin

and silica fine particles or between silica fine particles, and the dispersion state and morphology of a polycarbonate resin and silica fine particles, vary depending on the type of groups exposed on the surfaces of the particles.

[0028] The groups exposed on the surfaces of silica fine particles may be publicly known groups. Examples of such groups include alkyl groups such as a methyl group, an ethyl group, a n-propyl group, an i-propyl group, a n-butyl group, an i-butyl group, a t-butyl group, a hexyl group, and a hexadecyl group; halogenated alkyl groups such as a chloromethyl group, a chloropropyl group, a fluoromethyl group, and a fluoropropyl group; a vinyl group; a styryl group; an acrylic group; a methacrylic group; a glycidyl group; an epoxycyclohexyl group; an isocyanate group; an amino group; a ureide group; a mercapto group; a sulfide group; and a hydroxyl group such as a silanol group. One or more groups may be selected from these groups.

[0029] Silica fine particles that have, as a group exposed on the surfaces thereof, at least one of a hexadecyl group, an amino group, and a silanol group have a lower linear expansion coefficient.

[0030] A method of modifying the surfaces of silica fine particles is not particularly limited and may be a publicly known method of surface modification using a silicon-containing compound. This silicon-containing compound is at

least one selected from the group consisting of chlorosilane, alkoxysilanes, silylamine, hydrosilane, and polyorganosiloxane that have at least one group selected from the above-described groups. In this description, the average particle size is a number-average particle size. The particle sizes of the inorganic fine particles are determined from an electron micrograph taken by using a transmission electron microscope.

[0031] When the average primary particle size of silica fine particles is excessively large, the low linear expansion property is not provided. This is probably because the surface area of the fine particles is decreased and the effect of the surface interaction is reduced. In addition, a large particle size causes optical scattering and hence it becomes difficult to apply the polycarbonate resin composition to optical devices. When the particle size is excessively small, the rigidity of the fine particles is reduced and loss of the low linear expansion property may be caused. Accordingly, the silica fine particles have an average primary particle size of 0.5 nm or more and 30 nm or less, preferably 1 nm or more and 20 nm or less.

[0032] In the present invention, the mixing of a polycarbonate resin and silica fine particles may be performed by dissolving the polycarbonate resin in a solvent,

then mixing the resultant solution with the silica fine particles, and removing the solvent. Specifically, the polycarbonate resin is first dissolved in a solvent to prepare a polycarbonate resin solution. The type of the solvent is not particularly limited as long as the polycarbonate resin can be dissolved and mixed therein with the silica fine particles without causing phase separation. Examples of the solvent include aprotic polar solvents such as tetrahydrofuran, dimethylformamide, dimethylacetamide, ethyl acetate, and butyl acetate; and nonpolar solvents such as toluene and xylene. Preferably, solvents having a low boiling point such as tetrahydrofuran and ethyl acetate are used in view of removal of the solvent performed after mixing of a polycarbonate resin and silica fine particles.

[0033] The mixing of the silica fine particles and the polycarbonate resin solution may be performed by mixing the silica fine particles directly with the polycarbonate resin solution, or by mixing a slurry of the silica fine particles (prepared in advance by mixing the silica fine particles with a solvent) with the polycarbonate resin solution. The amount of the solvent is not limited and the solvent may be further added as long as the solvent can be ultimately removed. The solvent may be a single solvent or a combination of two or more solvents. After the polycarbonate resin solution and the silica fine particles

are mixed, the resultant mixed solution can be made uniform with a dispersion apparatus selected from various publicly known apparatuses such as a homogenizer, an ultrasonic treatment apparatus, a roll mill, a ball mill, a vibration ball mill, a bead mill, an attritor, a disc mill, a sand mill, a colloid mill, a jet mill, and a paint shaker.

[0034] The removal of the solvent from the mixed solution of the silica fine particles and the polycarbonate resin can be performed by appropriately adjusting the temperature and the degree of pressure reduction by heating and pressure reduction. The remaining solvent can cause a poor linear expansion coefficient or disadvantages at the time of forming. Accordingly, the amount of the remaining solvent is minimized. Specifically, the solvent is removed such that the content of the remaining solvent with respect to the total mass becomes 0.5% or less, preferably 0.1% or less, still more preferably 0.01%.

[0035] In a polycarbonate resin composition according to the present invention, the content of the silica fine particles with respect to the total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or less, preferably 40 vol% or more and 60 vol% or less. When the content of the silica fine particles is 40 vol% or more, the linear expansion coefficient of the formed article becomes very low. To

decrease the linear expansion coefficient, it is effective to increase the content of the silica fine particles. However, as this content increases, the composition becomes brittle and the formability is degraded. Accordingly, the content can be 80 vol% or less. Even in the cases where the content of the silica fine particles is the same, the linear expansion coefficient may be different depending on the dispersion state of the silica fine particles. In the present invention, the content of the silica fine particles denotes a value determined in the following manner: the formed article is heated to 800°C with a thermogravimetric analysis (TGA) system, the amount of the residue in percent by weight is measured; and this amount is converted into a value in terms of volume.

[0036] A formed article according to the present invention is produced by forming a polycarbonate resin composition, wherein the polycarbonate resin composition contains a polycarbonate resin and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less; and, in the polycarbonate resin composition, the content of the silica fine particles with respect to the total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or less.

[0037] A formed article according to the present invention is produced by forming a polycarbonate resin composition

into a desired shape by, for example, injection molding or heat-press forming in which the composition is pressed under heating. When the temperature at the time of the forming is excessively low, the intended shape is not formed; when the temperature is excessively high, the linear expansion coefficient can become high. Accordingly, the temperature at the time of the forming can be in the range of 150°C to 300°C. The forming pressure is not particularly limited, but it can be 50 MPa or more to achieve the transfer of the shape.

[0038] A formed article according to the present invention has, in a range of 20°C to 60°C, a linear expansion coefficient of 20×10^{-6}/°C or less; this range of the linear expansion coefficient covers both positive and negative values. In particular, a formed article according to the present invention preferably has, in a range of 20°C to 60°C, a linear expansion coefficient of -100×10^{-6}/°C or more and 20×10^{-6}/°C or less, more preferably -100×10^{-6}/°C or more and 0/°C or less. A formed article according to the present invention can have, in a range of 20°C to 60°C, a linear expansion coefficient that is a negative value.

Examples

[0039] Hereinafter, the present invention will be described in further detail with reference to Examples and

Comparative examples. However, the present invention is not restricted to these Examples at all.

Example 1

[0040] A polycarbonate resin (Panlite AD5503 [product name], manufactured by Teijin Chemicals Ltd.) was added in a proportion of 5 wt% to a tetrahydrofuran solvent. The polycarbonate resin was dissolved in the solvent by an ultrasonic treatment at room temperature to prepare a polycarbonate resin-tetrahydrofuran solution.

[0041] Subsequently, 0.6 g of silica fine particles (AEROSIL RA200H [product name], average primary particle size: 12 nm; fine-particle surface group: amino group; manufactured by NIPPON AEROSIL CO., LTD.) were added to 10 g of the polycarbonate resin-tetrahydrofuran solution. An appropriate amount of tetrahydrofuran was further added such that AEROSIL RA200H was sufficiently immersed in the solution. The resultant solution was sufficiently mixed by an ultrasonic treatment.

[0042] After the resultant solution was naturally dried to a certain degree to evaporate tetrahydrofuran, it was heated in a vacuum-heating furnace at about 250°C for 4 hours to remove the solvent. Thus, a polycarbonate resin composition was obtained.

[0043] This composition was formed by heat-pressing.

Novec-EGC1720 [product name] (manufactured by Sumitomo 3M Limited) serving as a release agent was dropped on a surface of a mold for press forming having a diameter of 15 mm and sufficiently wiped off. This mold for press forming was charged with the polycarbonate resin composition. The mold was placed in a heat-pressing machine and heated to 250°C. After temperatures at the upper and lower surfaces of the heat-pressing machine reached 250°C, the mold was pressed under a load of 110 MPa; while the mold was slowly cooled to 100°C, the load was allowed to decrease naturally; at 100°C, the load was completely removed and the composition was released from the mold to provide a coin-shaped formed article.

Example 2

[0044] A polycarbonate resin composition was produced under the same conditions as in Example 1 except that the amount of the silica fine particles added in Example 1 was changed to 0.9 g. The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 1.

Comparative example 1

[0045] A polycarbonate resin composition was produced under the same conditions as in Example 1 except that the

amount of the silica fine particles added in Example 1 was changed to 0.3 g. The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 1.

Comparative example 2

[0046] A polycarbonate resin composition was produced under the same conditions as in Example 1 except that the amount of the silica fine particles added in Example 1 was changed to 1.5 g. The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 1. The resultant formed article had many cracks and were brittle. Accordingly, it was impossible to measure the linear expansion coefficient.

Example 3

[0047] A polycarbonate resin composition was produced under the same conditions as in Example 1 except that the silica fine particles in Example 1 were changed to AEROSIL R816 [product name] (average primary particle size: 12 nm; fine-particle surface group: hexadecyl group; manufactured by NIPPON AEROSIL CO., LTD.) and the amount of the silica fine particles added was changed to 0.8 g. The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 1.

Example 4

[0048] A polycarbonate resin composition was produced under the same conditions as in Example 3 except that the amount of the silica fine particles added in Example 3 was changed to 1.1 g. The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 3.

Example 5

[0049] A polycarbonate resin composition was produced under the same conditions as in Example 1 except that the silica fine particles in Example 1 were changed to AEROSIL 200 [product name] (average primary particle size: 12 nm; fine-particle surface group: silanol group; manufactured by NIPPON AEROSIL CO., LTD.) and the amount of the silica fine particles added was changed to 0.8 g. The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 1.

Comparative example 3

[0050] A polycarbonate resin composition was produced under the same conditions as in Example 5 except that the silica fine particles in Example 5 were changed to AEROSIL OX50 [product name] (average primary particle size: 40 nm;

fine-particle surface group: silanol group; manufactured by NIPPON AEROSIL CO., LTD.). The resultant polycarbonate resin composition was formed and evaluated under the same conditions as in Example 1.

Evaluation of linear expansion coefficient

[0051] Each formed article was subjected to a three-cycle temperature load in a range of 0°C to 80°C with a TMA (TMA Q400 [product name], manufactured by TA Instruments) and a linear expansion coefficient in the thickness direction in a range of 20°C to 60°C was calculated. The displacement was measured with an expansion probe.

Evaluation of content of silica fine particles

[0052] The content of the silica fine particles denotes a value determined in the following manner: a formed article is heated to 800°C with a thermogravimetric analysis (TGA) system, the amount of the residue in percent by weight is measured; and this amount is converted into a value in terms of volume. The content of the silica fine particles was measured with a TGA (TGA Q500 [product name], manufactured by TA Instruments). In the conversion of the content of the silica fine particles from wt% (percent by weight) to vol% (percent by volume), the specific gravity of the polycarbonate resin used was 1.20 and the specific gravity

of the silica fine particles used was 2.00. In the evaluation, each formed article was cut into a suitable size.

[0053] The evaluation results of the formed articles in Examples and Comparative examples are summarized in Table 1 below.

[0054]

[Table 1]

	Main surface group	Average primary particle size (nm)	Content of silica fine particles (vol%)	Linear expansion coefficient ($\times 10^{-6} \cdot °C^{-1}$)
Example 1	Amino	12	43.4	-43
Example 2	Amino	12	49.4	0
Comparative example 1	Amino	12	29.6	55
Comparative example 2	Amino	12	87.2	Unmeasurable due to forming defect
Example 3	Hexadecyl	12	59.3	-94
Example 4	Hexadecyl	12	66.0	-12
Example 5	Silanol	12	62.6	-12
Comparative example 3	Silanol	40	60.9	22

[0055] From the results in Table 1, it has been demonstrated that, when a polycarbonate resin composition contains silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less in a content of 40 vol% or more and 80 vol% or less, the formed article of the polycarbonate resin composition has a linear expansion coefficient of 20 $\times 10^{-6}$/°C or less in a range of 20°C to 60°C.

Industrial Applicability

[0056] A formed article according to the present invention produced by forming a polycarbonate resin composition has a

very low linear expansion coefficient of 20 × 10^{-6}/°C or less in a range of 20°C to 60°C and hence can be used as low-expansion members and temperature-compensation members that are used for optical fibers and precision optical devices such as lenses and mirrors.

[0057] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0058] This application claims the benefit of Japanese Patent Application No. 2011-133501, filed June 15, 2011, which is hereby incorporated by reference herein in its entirety.

CLAIMS

[1] A formed article produced by forming a polycarbonate resin composition, wherein

the polycarbonate resin composition contains a polycarbonate resin and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less,

in the polycarbonate resin composition, a content of the silica fine particles with respect to a total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or less, and

the formed article has, in a range of 20°C to 60°C, a linear expansion coefficient that is 20×10^{-6}/°C or less and may be a negative value.

[2] The formed article according to Claim 1,

wherein the formed article has a linear expansion coefficient of -100×10^{-6}/°C or more and 0/°C or less in the range of 20°C to 60°C.

[3] The formed article according to Claim 1,

wherein the formed article has a linear expansion coefficient that is a negative value in the range of 20°C to 60°C.

[4] The formed article according to any one of Claims 1 to 3,

wherein the formed article is formed by press forming.

[5] A polycarbonate resin composition comprising:

a polycarbonate resin; and silica fine particles having an average primary particle size of 0.5 nm or more and 30 nm or less,

wherein, in the polycarbonate resin composition, a content of the silica fine particles with respect to a total amount of the polycarbonate resin and the silica fine particles is 40 vol% or more and 80 vol% or less.

[6] The polycarbonate resin composition according to Claim 5,

wherein the silica fine particles have, on surfaces of the silica fine particles, at least one of a hexadecyl group, an amino group, and a silanol group.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/062731

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. C08L69/00(2006.01)i, C08K3/36(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)

Int.Cl. C08L69/00, C08K3/36

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2012
Registered utility model specifications of Japan 1996-2012
Published registered utility model applications of Japan 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-335870 A (Idemitsu Petrochemical CO.,LTD) 2003.11.28, claim 3,10,[0008],[0012],[0013],[0020] Family:none	1-6
X A	JP 2009-67823 A (Sumitomo Electric Industries, LTD) 2009.04.02, [0026],fig.2 Family:none	1,4-6 2-3
A	JP 2006-299126 A (Nissan Motor Company Limited) 2006.11.02, Whole document Family:none	1-6

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15.06.2012	26.06.2012

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/062731

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2006/051699 A1 (Konica-Minolta OPTO,Inc) 2006.05.18, Whole document Family:none	1-6