

Description

The present invention relates to a liquid composition, polymerizable by the free-radical polymerization route, to yield organic glasses endowed with a high thermal stability.

The invention relates also to the organic glasses which can be obtained from said composition.

In the sector of the high-transparence organic glasses, those obtained by means of the polymerization of bis(allyl-carbonate) of diethylene glycol are of considerable interest from a commercial viewpoint, owing to their particular mechanical characteristics, and characteristics of chemical and ageing resistance.

See, e.g., F. Strain, "Encyclopaedia of Chemical Processing and Design", 1st ed., Dekker Inc., New York, Volume II, pages 452-foll.; and "Encyclopaedia of Polymer Science and Technology", Vol. I, pages 799-foll., Interscience Publishers, New York, 1964.

However, the products of polymerization of bis(allyl-carbonate) of diethylene glycol suffer from a limitation deriving from the relatively low values of their heat distortion temperature (HDT), of the order of 65°C, what makes them unsuitable in applications wherein high operating temperatures are required.

In order to overcome such a drawback, the use was proposed of copolymers of diethylene glycol bis(allyl-carbonate) containing up to approximately 10% by weight of triallyl cyanurate, such as disclosed, e.g., by H.W. Starkweather et al. in Ind. Eng. Chem., Vol. 47, No. 2, 1955, page 302.

However, if on one hand they show improved heat distortion temperatures, on the other hand such copolymers show worse values of some other characteristics than the polymerizate obtained from diethylene glycol bis(allyl-carbonate) alone.

In particular, the possibility of being polymerized by means of the usual casting method results endangered for such copolymers, owing to the presence of phenomena of cracking during polymerization, or at mould opening time. Said phenomena mainly derive from the high shrinkage during the polymerization step, and from the higher fragility of the polymerizates, deriving from their considerable crosslinking density.

The present Applicant has found now that the above reported drawbacks affecting the prior art can be overcome by means of the liquid composition of the present invention, which can be easily polymerized by free-radical polymerization, with a low shrinkage during polymerization, in order to yield organic glasses endowed with high values of thermal distortion temperature.

This invention, therefore provides a liquid composition polymerizable by free-radical polymerization and with low shrinkage for producing highly thermally stable organic glasses, characterized in that it is obtained by subjecting to a transesterification reaction, at a temperature of from 80°C to 160°C, preferably from 90°C to 130°C, in the presence of an alkaline catalyst, diallyl carbonate (component A) with a mixture of

- an ether linear, or a branched aliphatic diol having from 3 to 10 carbon atoms (component B), and
 - an ether linear, or a branched aliphatic, cycloaliphatic, or heterocyclic polyol having from 4 to 20 carbon atoms and from 3 to 6 hydroxyl groups (component C),
- or, as an alternative, with a mixture of:

- (component B) as defined hereinabove, and
- a cycloaliphatic diol (component C'), the molar ratio of (Component A) to (Component B + Component C), or of (Component A) to (Component B + Component C') being equal to, or greater than 3 : 1, the amount of (Component C) in the (Component B + Component C) mixture being equal to, or lower than 70% by weight, the amount of (Component C') in the (Component B + Component C') mixture being equal to, or lower than 90% by weight, and adding to the thus obtained transesterification reaction product an amount a polymerization initiator of from 1% to 6% by weight relative to the weight of said transesterification reaction product.

According to the preferred form of practical embodiment, the values of the molar ratios of (A)/(B + C) and (A)/(B + C') are kept comprised within a range of from 3/1 to 12/1, and the (C) and (C') components are respectively present in an amount comprised within the range of from 20 to 80% and of from 20 to 80% by weight in the mixture (B + C) and (B + C').

The (B) diols used for the purposes of the present invention are the ether linear or branched aliphatic diols containing from 3 to 10 carbon atoms in their molecule.

Specific examples of diols are diethylene glycol, triethylene glycol, tetraethylene glycol, 1,4-butane-diol, 1,6-hexane-diol, 1,3-propane-diol, neopentyl glycol, dipropylene glycol and 2,2,4-trimethyl-1,3-pentanediol.

Among them, diethylene glycol is preferred.

The (C) polyols, used for the purposes of the present invention, are ether linear or branched aliphatic, cycloaliphatic or heterocyclic polyols, containing from 4 to 20 carbon atoms, and from 3 to 6 hydroxy groups in their molecule.

Specific examples of polyols suitable for the intended purpose are: pentaerythritol, trimethylolpropane, dipentaerythritol, di-trimethylol-propane and tris(hydroxyethyl)isocyanurate.

Among these, pentaerythritol, trimethylolpropane and tris(hydroxyethyl)isocyanurate are preferred.

The (C') component, used for the intended purpose, is selected from cycloaliphatic, monocyclic or polycyclic diols, with 1,4-cyclohexane-di-methanol and 4,8-bis(hydroxy-methyl)tricyclo[5.2.1.0.2.6]decane.

5 The composition according to the present invention is obtained by starting from diallyl-carbonate (A) and from the (B + C) or (B + C') mixture by operating under transesterification conditions. More particularly, the process is carried out by placing the reactants into mutual contact, in the hereinabove stated proportions, and making them react at temperatures comprised within the range of from 80° to 160°C, and preferably of from 90° to 130°C in the presence of a catalyst of alkaline character, with the allyl alcohol which is formed as the reaction byproduct being continuously removed. Suitable catalysts for the intended purpose are hydroxides, carbonates
10 and alkoxides of alkali metal, the organic bases and the basic ion-exchange resins.

Specific examples of catalysts are sodium hydroxide, sodium carbonate, sodium methoxide. The catalyst is advantageously used in an amount equal to at least 1 ppm (part per million parts by weight), relatively to the sum of the weights of (B + C) or (B + C') components, and preferably in amounts comprised within the range of from 0.01 to 0.3% by weight.

15 The reaction is advantageously carried out under such a pressure that the system is made boil at the selected operating temperature, so as to favour the removal of allyl alcohol from the reaction mixture; e.g., pressure values comprised within the range of from 26,66 hPa to 1013,88 hPa (20 to 760 torr) and preferably of from 66,65 hPa to 533,2 hPa (50 to 400 torr) are suitable for the intended purpose.

Under the above specified conditions, the reaction times are generally comprised within the range of from
20 0.5 to 20 hours, and typically are of the order of from 0.5 to 2 hours.

After cooling, the reaction mixture is washed with water, in order to remove the small catalyst amounts, and, after de-mixing and separation of the aqueous phase, the unreacted diallyl carbonate is distilled off, by heating up to temperatures of the order of 120°C, under a decreasing pressure, with end pressure values of the order of 0,1333 hPa to 26,66 hPa (0.1-20 Torr), and preferably of 1,333 hPa to 3,999 hPa (1-3 Torr, with
25 the desired product being obtained as the residue.

The composition is finally submitted, if necessary, to filtration, after a preliminary treatment with activated charcoal.

The composition according to the present invention is liquid at room temperature, and has viscosity values comprised within the range of from $15 \cdot 10^{-6}$ m²/s to $300 \cdot 10^{-6}$ m²/s (15 to 300) cst and density values of the order
30 of 1.1-1.3 g/ml.

The composition of the present invention is a complex mixture containing allyl-carbonates of the (B) component and of the (C) or (C') component, in either monomer or oligomer form, as well as mixed oligomer allyl-carbonates of said (B) and (C) or (C') components, with the relative amounts of said constituents of the composition mainly depending on the preselected ratios of the (A), (B) and (C) or (C') reactants.

35 This composition can be transformed into organic glasses, by means of free-radical polymerization, with the usual "casting" technique.

For that purpose, to the composition one or more polymerization initiator(s) is(are) added, which are soluble in the same composition, and is(are) capable of generating free radicals at temperatures comprised within the range of from 30° to 120°C.

40 Preferred examples of such initiators are di-cyclo-hexyl-peroxy-dicarbonate, di-isopropyl-peroxy-dicarbonate, di-benzoyl-peroxide, di-sec-butyl-peroxy-dicarbonate and sec-butyl-cyclohexyl-peroxy-dicarbonate.

The amount of initiator may generally vary within the range of from 1 to 6 parts by weight per each 100 parts by weight of the composition.

The composition can additionally contain one or more conventional additive(s), such as stabilizers, lubricants, dyes, pigments, U.V.-absorbers, I.R.-absorbers, with the overall amount of such additives being anyway
45 not higher than 1 part by weight per each 100 parts by weight of the same composition.

The composition of the present invention containing the initiator, and, possibly, one or more additive(s) selected from the above mentioned additives, is transformed into the relevant organic glass by operating at temperatures comprised within the range of from 30° to 120°C, with polymerization times which can be generally
50 comprised within the range of from 1 to 100 hours.

During the polymerization, small-extent phenomena of shrinkage occur, and the organic glasses obtained have a high thermal distortion temperature (HDT higher than approximately 90°C, when determined by ASTM D-648), and a good set of optical and physical/mechanical characteristics.

The so-obtained organic glasses are particularly useful in protecting shields (e.g., for welders), in sight windows (e.g., in blast furnaces), in windows in the transportation sector and in the civil building sector, in lenses for vehicle lights, in solar and photovoltaic collectors and panels, in substrates for optical disks and in panels
55 for displays.

The following experimental Examples are reported for exemplifying purposes.

In the following examples, liquid polymerizable compositions are prepared by reacting, under transesterification conditions, diallyl-carbonate (A) and a mixture of the hydroxy-compounds.

The (B) diol used in the examples is diethylene glycol (DEG).

The (C) polyols used in the examples are : pentaerythritol (PE) ; tris-hydroxyethyl-isocyanurate (THEIC) ;
5 and trimethylol-propane (TMP).

The (C') cycloaliphatic diol used in the examples is 1,4-cyclohexane-dimethanol.

To the so-obtained liquid compositions, di-cyclohexyl-peroxy-dicarbonate (DCPD) is added as the initiator, in an amount of 5% by weight, of the mixture weight.

The catalyst-containing compositions are transformed by polymerization into flat sheets or neutral lenses, respectively of 3 mm and 2 mm of thickness, by means of the conventional casting technique. According to
10 this technique, the liquid composition, containing the catalyst, is cast into the hollow of a mould constituted by two glass elements, with a spacer gasket of plasticized polyvinyl-chloride or of ethylene-vinyl acetate copolymer (EVA).

The liquid composition is then submitted to polymerization by means of a thermal treatment carried out for
15 72 hours inside a forced air circulation oven at 48°C.

At the end of this treatment, the moulds are opened and the polymerizates are recovered and are left standing at 110°C for a further 2 hours, in order to decompose any possible residues of initiator, and of relieving possible inner stresses.

On the so-obtained sheets, the following characteristics are determined :

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a) Optical Characteristics :

- Refractive index (n_D^{20}) measured by Abbe refractometer (ASTM D-542) ;
- Haze and transmittance at visible wave lengths (%) : measured by using Gardner's Hazegard XL-211
25 (ASTM D-1003) ;
- Yellow index (YI), defined as :

$$30 \quad YI = \frac{100}{Y} \cdot (1.277X - 1.06Z)$$

as determined by means of Gardner's XL-805 colorimeter (ASTM D-1925).

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b) Physical and Mechanical Characteristics

- Density : as determined by means of the hydrostatic balance at the temperature of 25°C (ASTM D-792) ;
- Shrinkage during polymerization, computed by means of the following formula :
- 40 Shrinkage % =

$$45 \quad = \frac{(\text{polymer density} - \text{monomer density})}{\text{polymer density}} \times 100$$

- Rockwell hardness (M), as measured by the Rockwell durometer (ASTM D-785) ;
- Elastic modulus at bending (ASTM D-790) ;
- 50 — Abrasion resistance, Taber method (ASTM D-1044, modified), carried out with a couple of grinding wheels CS-10F and under a load of 500 g on both wheels.

The results are expressed as the ratio of the number of passages necessary for producing a 10% increase in Haze for the sample being tested, to the same parameter for a reference sample of poly-methylmethacrylate (PMMA).

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- On the neutral lenses, the
- Sutherland Abrasion Resistance is determined.

The test consists in carrying out 25 abrasive cycles (50 passages), on the neutral lenses, of a pad of 2/0-

type steel wool of 5.5 cm × 7.5 cm, loaded with a weight of 630 g. The abrasion degree produced is evaluated by means of the visual observation of the number, the length and the depth of the scratches, as compared to a corresponding reference sample based on diethylene glycol bis(allyl-carbonate) homopolymer. The abrasion resistance is expressed by means of a scoring on a scale of from 0 to 10, wherein score 10 is assigned to the scratch-free sample, or to a sample showing from one to three thin, not very deep scratches, and score 0 is assigned to the completely scratched sample (this is the case of diethylene glycol bis(allyl-carbonate) homopolymer, assumed as the reference standard).

Intermediate scores from 1 to 9 are assigned on the basis of the percentage of scratches shown by the tested sample, as compared to the reference standard. For example, if the sample shows a 60% of scratches relatively to the reference standard, its abrasion resistance value is 4; if it shows a 30% of scratches, its assigned score is 7, and so on.

c) Thermal Characteristics

— Heat Distorsion Temperature Under Load

1.82 MPa (HDT), (ASTM D-648)

Example 1

To a three-neck flask with jacket, fitted with a thermometer, a magnetic stirrer and an overhead distillation column with 20 perforated trays, there are charged :

- Trimethylol-propane (TMP) :	60 g (0.447 mol)
- Diethylene glycol (DEG) :	140 g (1.320 mol)
- Diallyl-carbonate (DAC) :	1,254 g (8.835 mol)
- Solution at 30% by weight of sodium methoxide in methanol :	0.20 ml

The reaction is carried out for 45 minutes at a temperature of 98-118°C, and under a pressure of 199.95 hPa (150 torr), with allyl alcohol being distilled off as it forms (total 230 g; purity of 99.0%).

After cooling, the reaction mixture is washed with two portions of 500 ml each, of distilled water.

The excess of diallyl-carbonate is distilled under 1 torr, with increasing temperature up to 120°C.

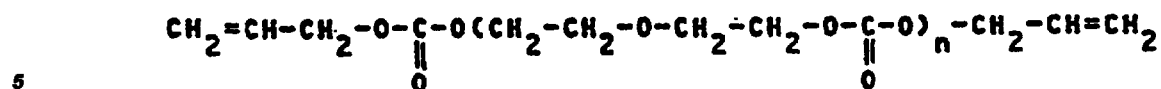
The obtained product is decolorized by contact with 2% by weight of activated charcoal, for 4 hours at 80°C, and is then filtered.

In this way, 500 g is obtained of a liquid product having the following characteristics :

- Viscosity (25°C) :	$34,5 \cdot 10^{-6} \text{ m}^2/\text{s}$ (34.5 cst)
- Density (20°C) :	1.164 g/ml
- Refractive index (n_D^{20}) :	1.4585
- Colour (APHA) :	15

This product is a mixture of both monomer and oligomer diethylene glycol bis(allyl-carbonate), trimethylol-propane tris(allyl-carbonate), and of mixed allyl-carbonates, having the following presumed composition :

— Diethylene glycol bis(allyl-carbonate) :



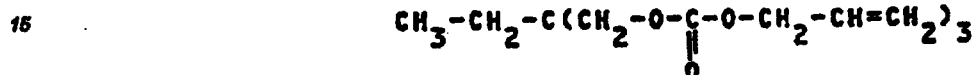
monomer $n=1$ 45.8% by weight;

dimer $n=2$ 10.1% by weight.

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— Trimethylol-propane tris(allyl-carbonate) :

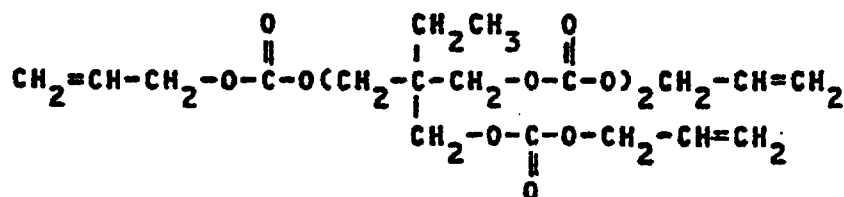
monomer 17.3% by weight;



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dimer 2.4% by weight.

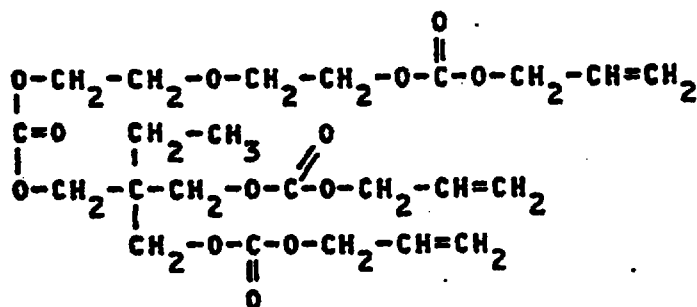
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— Mixed allyl-carbonate : 10.1% by weight

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with the residual percentage being essentially constituted by the higher oligomers of the above disclosed species.

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Example 2

To the same equipment as disclosed in Example 1, there are charged :

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- Tris(hydroxyethyl)isocyanurate (THEIC):

30.0 g (0.115 mol);

- Diethylene glycol (DEG): 70.0 g (0.660 mol);

- Diallyl-carbonate (DAC): 1,320 g (9.30 mol);

- Solution at 30% by weight of sodium methoxide in methanol: 0.15 ml.

The reaction is carried out for 1.5 hours at a temperature of 116-119°C, and under a pressure of 199,95 hPa (150 torr), with allyl alcohol being distilled off as it forms (total 98 g; purity of 98%).

After cooling, the reaction mixture is washed with two portions of 500 ml each, of distilled water.

The excess of diallyl-carbonate is then distilled under 1,333 hPa (1 torr), with increasing temperature up to 120°C.

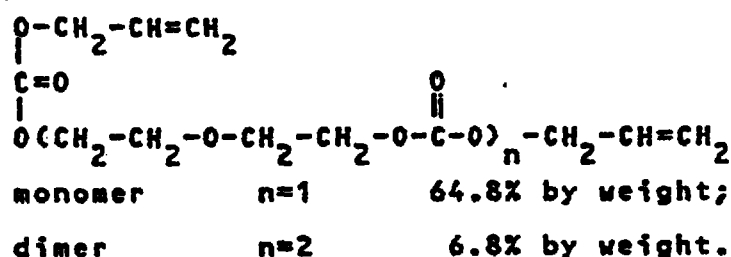
The so obtained product is filtered over decalite.

In this way, 212 g is obtained of a liquid product having the following characteristics :

- Viscosity (25°C)	:	47,06.10 ⁻⁶ m ² /s (47.06 cst)
- Density (20°C)	:	1.195 g/ml
- Refractive index (n _D ²⁰)	:	1.4640
- Colour (APHA)	:	15

This product is a mixture of both monomer and oligomer diethylene glycol bis(allyl-carbonate), tris-(hydroxyethyl)isocyanurate tris(allyl-carbonate), and of mixed allyl-carbonates, having the following presumed composition :

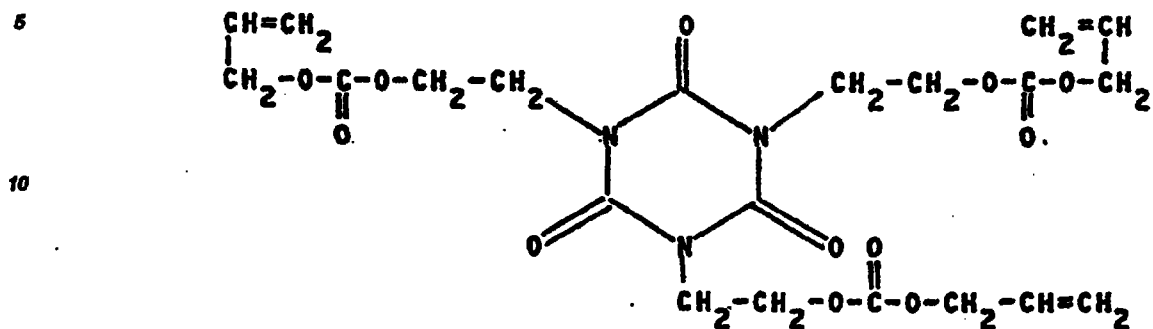
— Diethylene glycol bis(allyl-carbonate) :



— Tris(hydroxyethyl)isocyanurate tris(allyl-carbonate) :

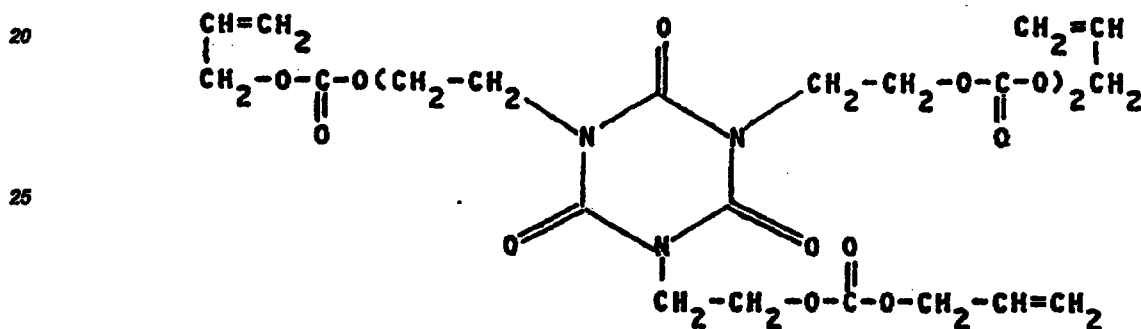
monomer

19.2% by weight;

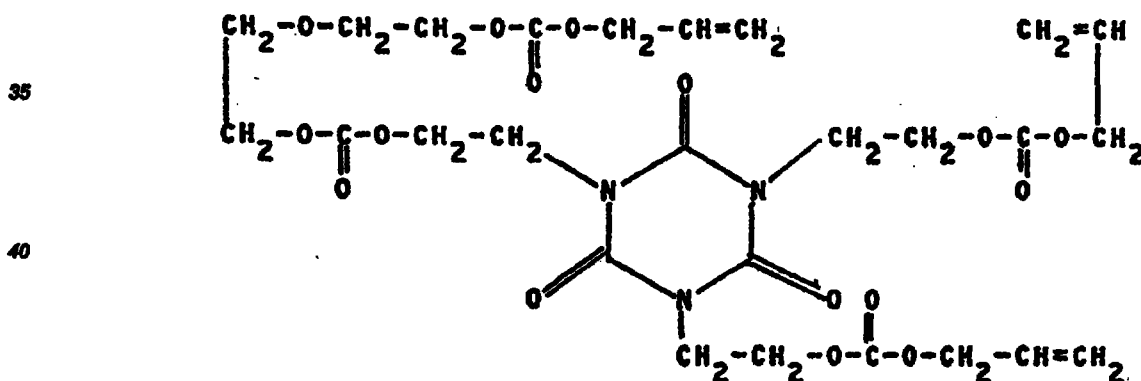


dimer

0.8% by weight.



— Mixed allyl-carbonate : 5.1% by weight



with the residual percentage being essentially constituted by the higher oligomers of the above species.

Example 3

To the same equipment as disclosed in Example 1, there are charged :

- Pentaerythritol: : 45.4 g (0.33 mol);
- Diethylene glycol : 106.1 g (1.00 mol);
- 5 - Diallyl-carbonate : 947 g (6.66 mol);
- Solution at 30% by weight of sodium methoxide in methanol : 0.40 ml.

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The reaction is carried out for 45 minutes at a temperature of 109-118°C, and under a pressure of 199,95 hPa (150 torr), with allyl alcohol being distilled off as it forms (total 218 g ; purity of 90%).

After cooling, the reaction mixture is washed with two portions of 500 ml each, of distilled water.

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The excess of diallyl-carbonate is then distilled under 1,333 hPa (1 torr), with increasing temperature up to 120°C.

The so obtained product is decolorized with 2% by weight of activated charcoal for 4 hours at 80°C and is then filtered.

In this way, 380 g is obtained of a liquid product having the following characteristics :

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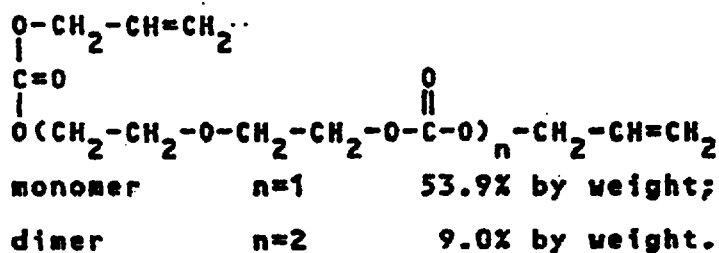
- Viscosity (25°C) : $87,7 \cdot 10^{-6} \text{ m}^2/\text{s}$ (87.7 cst)
- Density (20°C) : 1.1939 g/ml
- Refractive index (n_D^{20}) : 1.4616
- 25 - Colour (APHA) : 5

This product is a mixture of both monomer and oligomer diethylene glycol bis(allyl-carbonate), pentaerythritol tetrakis(allyl-carbonate), and of mixed allyl-carbonates, having the following presumed composition :

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— Diethylene glycol bis(allyl-carbonate) :

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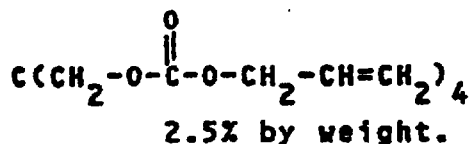
— Pentaerythritol tetrakis(allyl-carbonate) :

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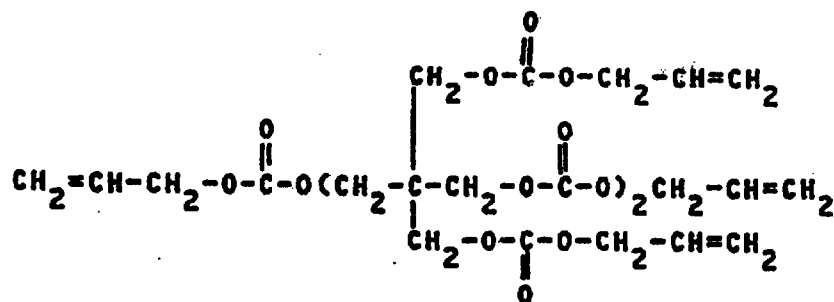
monomer 13.0% by weight;

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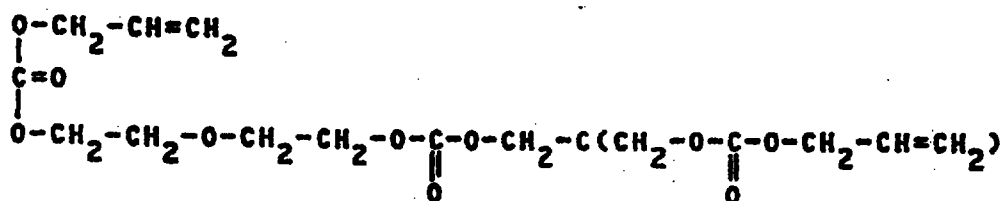
dimer



55



— Mixed allyl-carbonate : 10% by weight



with the residual percentage being essentially constituted by the higher oligomers of the above species.

Example 4

By operating according to as disclosed in Examples 1-3, the polymerizable compositions Nos. 1, 2, 3 and 4 are prepared by reacting diallyl-carbonate (DAC) with mixtures of pentaerythritol (PE) and diethylene glycol (DEG), at various molar ratios (R) of DAC to the sum of (PE + DEG), as shown in following Table 1. In said table, also the characteristics of viscosity (at 25°C); density (g/ml at 20°C) and refractive index (n_D^{20}) in the obtained polymerizable liquid compositions are reported.

65 60 45 40 35 30 25 20 15 10 5

TABLE_1

Composition No.

Mixture { PE (X by weight)
DEG (X by weight)

Ratio of DAC/(PE+DEG)

Viscosity (m²/s at 25°C)

Density (g/ml; 20°C)

n_D²⁰

1	2	3	4
25	25	30	30
75	75	70	70
4/1	5/1	5/1	4/1
73,6.10 ⁻⁶	53,5.10 ⁻⁶	87,7.10 ⁻⁶	110.10 ⁻⁶
1.190	1.183	1.194	1.202
1.4609	1.4598	1.4616	1.4624

The compositions, after the addition of di-cyclohexyl-peroxy-dicarbonate (DCPD) ; 5% by weight in the composition) are submitted to polymerization in the same way as previously set forth and on the hardened compositions, the characteristics reported in Table 2 are determined.

5 Example 5

For comparative purposes, the polymerizable liquid compositions Nos. 5, 6 and 7 according to the prior art are prepared, by mixing triallyl-cyanurate (TAC) and diethylene glycol bis(allyl-carbonate) (BACGD), this latter being the product resulting from the transesterification between diallyl-carbonate and diethylene glycol in the mutual molar ratio of 12/1. The characteristics of these liquid compositions are reported in following Table 3.

TABLE 3

Composition No.	5	6	7
TAC	-	5.5	10.5
BACGD	100	94.5	89.5
Viscosity (m ² /s 25°C)	14.10 ⁻⁶	14,1.10 ⁻⁶	14,2.10 ⁻⁶
Density (g/ml; 20°C)	1.151	1.150	1.148
n _D ²⁰	1.4520	1.4549	1.4576

After the addition of di-cyclohexyl-peroxydicarbonate (DCPD) in an amount of 5% of the weight of the same compositions, said compositions are submitted to polymerization under such conditions as stated in the text, and on the hardened compositions the characteristics as reported in Table 2 are determined.

55 50 45 40 35 30 25 20 15 10 5

TABLE 2

COMPOSITION No.		1	2	3	4	5	6	7
Density,	(g/cm ³)	1.3290	1.3274	1.3317	1.3316	1.3111	1.3112	1.3111
Shrinkage,	%	10.4	10.8	10.3	9.7	12.2	12.3	12.45
n _D ²⁰		1.5016	1.5014	1.5016	1.5015	1.5010	1.5041	1.5070
Haze,	%	0.27	0.26	0.36	0.40	0.16	0.19	0.15
Transmittance at visible wave lengths, %		92.1	91.8	91.7	91.7	93.3	92.5	92.0
Yellow index		2.90	3.20	3.50	3.89	1.20	1.59	2.88
Elastic modulus at bending	(MPa)	2900	2900	3050	3070	2400	2500	2680
Rockwell hardness	(M)	111	112	109	112	97	104	108
Izod impact strength, without notch	(KJ/m ²)	6.0	5.2	4.2	4.9	7.9	7.0	4.0
Taber abrasion resistance	(XPMMA)	-	-	-	-	18	20	25
Sutherland abrasion resistance		8/9	8/9	9/10	9	0	5/6	6
HDT,	°C	108.2	110.8	142.9	121.3	66	73	89.6

Example 6

The polymerizable liquid compositions Nos. 8, 9, and 10 are prepared by starting from diallyl-carbonate (DAC), tris(hydroxyethyl)isocyanurate (THEIC) and diethylene glycol (DEG), as shown in following Table 4.

TABLE 4

Composition No.	8	9	10
Mixture { THEIC (% by weight)	40	50	30
DEG (% by weight)	60	50	70
Ratio of DAC/(THEIC+DEG)	5/1	6/1	12/1
Viscosity (m ² /s; 25°C)	95,7x10 ⁻⁶	187x10 ⁻⁶	48,5x10 ⁻⁶
Density (g/ml; 20°C)	1,220	1,2308	1,1907
²⁰ n _D	ND*	ND*	1,4640

ND* = Not Determined

After the addition of di-cyclohexyl-peroxydicarbonate (DCPD) in an amount of 5% of the weight of the same compositions, said compositions are submitted to polymerization under such conditions as stated in the text, and on the hardened compositions the characteristics as reported in Table 5 are determined.

Example 7

The polymerizable compositions Nos. 11 and 12 are prepared by starting from diallyl-carbonate (DAC), trimethylol-propane (TMP) and diethylene glycol (DEG), as shown in following Table 6.

TABLE 6

Composition No.	11	12
Mixture { TMP (% by weight)	50	30
DEG (% by weight)	50	70
Ratio of DAC/(TMP+DEG)	4/1	5/1
Viscosity (m ² /s; 25°C)	96,1x10 ⁻⁶	34,5x10 ⁻⁶
Density (g/ml; 20°C)	1,1716	1,164
²⁰ n _D	1,4635	1,4585

After the addition of di-cyclohexyl-peroxy-dicarbonate (DCPD) in an amount of 5% of the weight of the same compositions, said compositions are submitted to polymerization under such conditions as stated in the text, and on the hardened compositions the characteristics as reported in Table 5 are determined.

TABLE_5						
COMPOSITION No.		8	9	10	11	12
Density,	(g/cm ³)	1.3473	1.3516	1.3288	1.3031	1.3077
Shrinkage,	%	9.4	8.9	10.4	10.1	11.0
n _D		1.5080	1.5082	1.5052	1.5010	1.5004
Haze,	%	0.08	0.10	0.10	0.19	0.14
Transmittance at visible wave lengths, %		92.4	92.0	92.7	92.5	93.0
Yellow index		3.5	4.0	2.4	3.2	1.48
Elastic modulus at bending	(MPa)	3380	3300	3160	2950	2510
Rockwell hardness	(M)	104	110	107	109	100
Izod impact strength, without notch	(KJ/m ²)	10	9.6	7.8	4.5	8.6
Taber abrasion resistance	(XPMMA)	16	18	24	27	18
Sutherland abrasion resistance		-	-	-	6	5
HDT,	°C	91	98.3	93.4	131.8	90.0

Example 8

A liquid and polymerizable composition is prepared by starting from :

- 1,4-Cyclohexane-dimethanol 138.7 g (0.96 mol)
- Diethylene glycol 46.2 g (0.44 mol)
- Diallyl-carbonate 795 g (5.6 mol)
- Sodium methoxide, as a solution at 30% by weight of sodium methoxide in methanol 0.30 ml

The reaction is carried out for 1 hour at a temperature of 114-121°C, and under a pressure of 199,95 hPa (150 torr), with allyl alcohol being distilled off as it forms (total 167 g ; purity of 97%).

After cooling, the reaction mixture is washed with two portions, of 500 ml each, of distilled water.

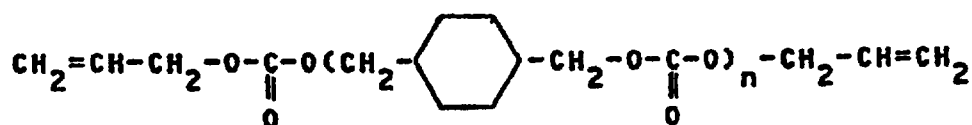
The excess of diallyl-carbonate is then distilled off by operating under a pressure of 1,333 hPa (1 torr), with increasing temperature up to 120°C.

The obtained product is decolorized with 2% by weight of activated charcoal, for 4 hours at 80°C, and is then filtered.

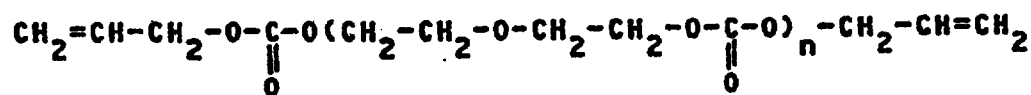
In this way, 360 g is obtained of a liquid product having the following characteristics :

- Viscosity (25°C) : $62,1 \cdot 10^{-6} \text{ m}^2/\text{s}$
- Density (20°C) : 1.124 g/ml
- Refractive index (n_D^{20}) : 1.468
- Colour (APHA) : 5

This product is formed by both monomer and oligomer bis(allyl-carbonates) of cyclohexane-dimethanol, diethylene glycol or mixed allyl-carbonates, having the following presumed distribution :

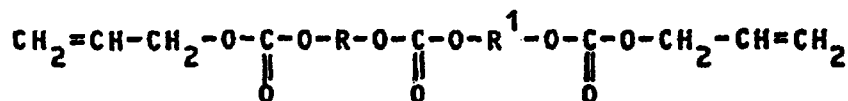


- monomer $n=1$ 45.9% by weight;
- dimer $n=2$ 12.2% by weight;
- trimer $n=3$ 2.8% by weight.

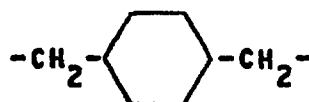


- monomer $n=1$ 18.5% by weight;
- dimer $n=2$ 2.2% by weight;
- trimer $n=3$ 0.2% by weight.

The mixed cyclohexane-dimethanol and diethylene glycol bis(allyl-carbonate) dimer :



wherein R =



is present in an amount of 10.3% by weight, and the relevant trimer is present in an amount of 5.2% by weight.

The mixture contains furthermore an overall amount of 2.7% by weight of higher oligomers than the trimer.

After the addition of di-cyclohexyl-peroxy-dicarbonate (DCPD) in an amount of 5% of its weight, said composition is submitted to polymerization under such conditions as stated in the text, and on the hardened compositions the characteristics as reported in Table 6 are determined.

TABLE 6

Density,	(g/cm ³)	1.2366
Shrinkage,	%	9.1
₂₀ n _D		1.5040
Haze,	%	0.23
Transmittance at visible		
wave lengths,	%	92.7
Yellow index		1.10
Elastic modulus at bending (MPa)		2,320
Rockwell hardness	(M)	108
Izod impact strength,		
without notch	(KJ/m ²)	5.0
Taber abrasion resistance	(XPMMA)	18
HDT,	°C	93.0

Example 9

To a three-neck flask with jacket, fitted with a thermometer, a magnetic stirrer and an overhead distillation column with 20 perforated trays, there are charged :

- 1,4-Cyclohexane-dimethanol	288.4 g (2.00 mol)
- Neopentyl glycol	123.6 g (1.19 mol)
- Diallyl carbonate	1,810 g (12.75 mol)
- Solution at 30% by weight of sodium methoxide in methanol	1.60 ml

The reaction is carried out for 45 minutes at a temperature of 107-116°C, and under a pressure of 199,95 hPa (150 Torr), with allyl alcohol being distilled off as it forms (total 370 g).

After cooling, the reaction mixture is washed with two portions of 1,000 ml each, of distilled water.

The excess of diallyl-carbonate is distilled under 1,333 hPa (1 torr), with increasing temperature up to 120°C.

The obtained product is decolorized by contact with 2% by weight of activated charcoal, for 4 hours at 80°C, and is then filtered.

In this way, 840 g is obtained of a liquid product having the following characteristics :

- Viscosity (m ² /s 25°C)	73.10 ⁻⁶
- Density (g/ml; 20°C)	1.099
- Colour (APHA)	5

This product is a mixture of both monomer and oligomer cyclohexane-dimethanol bis(allyl-carbonate), neopentyl glycol bis(allyl-carbonate), and of mixed allyl-carbonates, having the following approximate composition :

- Cyclohexane-dimethanol bis(allyl-carbonate):

monomer 42% by weight;

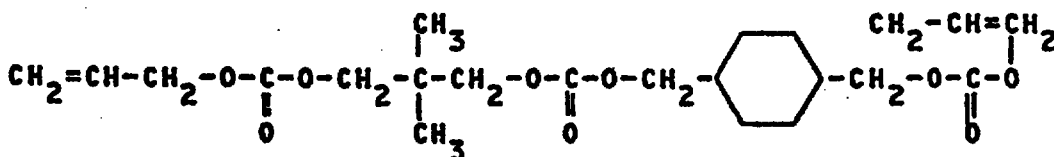
dimer 10% by weight;

- Neopentyl glycol bis(allyl-carbonate):

monomer 19% by weight;

dimer 3% by weight;

- Mixed bis(allyl-carbonate)



10% by weight;

with the residual percentage being essentially constituted by the higher oligomers of the above species.

After the addition of di-cyclohexyl-peroxy-dicarbonate (DCPD) in an amount of 5% of weight of the same composition, the reaction product is submitted to polymerization under such conditions as stated in the text, and on the hardened compositions the characteristics as reported in Table 7 are determined.

TABLE 7

Density,	(g/cm ³)	1.2104
Shrinkage,	%	9.3
20 n _D		1.500
Haze,	%	0.22
Transmittance at visible		
wave lengths,	%	92.7
Yellow index		1.2
Elastic modulus at bending (MPa)		2,400
Rockwell hardness	(M)	112
Izod impact strength,		
without notch	(KJ/m ²)	4.6
Taber abrasion resistance	(xPMMA)	14
HDT,	°C	86.2

In Table 8, the results are reported of the tests of water absorption for long soaking times, as compared to the values measured on the polymer of diethylene glycol bis(allyl-carbonate) (BACGD), taken as the reference standard.

TABLE 8

Weight Change %, Composition		
Soaking Time	of Example 7	BACGD
1 day	0.12	0.27
7 days	0.32	0.65
15 days	0.43	0.96

Claims

Claims for the following Contracting States : AT, BE, CH, DE, FR, GB, GR, LI, LU, NL, SE

1. A liquid composition polymerizable by free-radical polymerization and with low shrinkage for producing highly thermally stable organic glasses, characterized in that it is obtainable by subjecting to a transesterification reaction, at a temperature of from 80°C to 160°C in the presence of an alkaline catalyst, diallyl carbonate (component A) with a mixture of

- an ether linear, or a branched aliphatic diol having from 3 to 10 carbon atoms (component B), and
 - an ether linear, or a branched aliphatic, cycloaliphatic, or heterocyclic polyol having from 4 to 20 carbon atoms and from 3 to 6 hydroxyl groups (component C),
- or, as an alternative, with a mixture of :
- (component B) as defined hereinabove, and
 - a cycloaliphatic diol (component C'), the molar ratio of (Component A) to (Component B + Component

C), or of (Component A) to (Component B + Component C') being equal to, or greater than 3 : 1, the amount of (Component C) in the (Component B + Component C) mixture being equal to, or lower than 70% by weight, the amount of (Component C') in the (Component B + Component C') mixture being equal to, or lower than 90% by weight, and adding to the thus obtained transesterification reaction product an amount

2. Liquid polymerizable composition according to claim 1, wherein the transesterification reaction is carried out with a molar ratio of the (Component A) to the (Component B + Component C) mixture, or of the (Component A) to the (Component B + Component C') mixture, of from 3 : 1 to 12 : 1, the amount of the (Component C) in the (Component B + Component C) mixture being from 20% to 60% by weight, or, as an alternative, the amount of the (Component C') in the (Component B + Component C') mixture being of from 20% to 80% by weight.

3. Liquid polymerizable composition according to claim 1, wherein the (Component B) diol is selected from diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, 1,4-butanediol, 1,6-hexanediol, 1,3-propanediol, neopentyl glycol, and 2,2,4-trimethyl-1,3-pentanediol.

4. Liquid polymerizable composition according to claim 1, wherein the (Component C) polyol is selected from : pentaerythritol, trimethylolpropane, di-pentaerythritol, di-trimethylolpropane, and tris(hydroxyethyl)isocyanurate.

5. Liquid polymerizable composition according to claim 1, wherein (Component C') is 1,4-cyclohexane-dimethanol, or 4,8-bis(hydroxymethyl)tricyclo-[5.2.0^{2,9}] decane.

6. Liquid polymerizable composition according to claim 1, wherein said alkaline catalyst is selected from the alkali metal hydroxides, carbonates and alkoxides, the organic bases, and the basic ion-exchange resins.

7. Liquid polymerizable composition according to claim 1, wherein the polymerization initiator is selected from di-cyclohexyl-peroxy dicarbonate, dibenzoyl peroxide, di-sec.butyl peroxy dicarbonate, and sec.butyl-cyclohexyl peroxy dicarbonate.

8. Use of a liquid polymerizable composition according to claim 1, for preparing organic optical glasses.

9. Organic optical glasses obtained by casting into moulds and polymerizing a liquid polymerizable composition according to any of claims 1 to 7.

Claims for the following Contracting State : ES

1. Process for preparing a liquid composition polymerizable by free-radical polymerization and with low shrinkage for producing highly thermally stable organic glasses, characterized by comprising the steps of subjecting to a transesterification reaction, at a temperature of from 80°C to 160°C in the presence of an alkaline catalyst, diallyl carbonate (component A) with a mixture of

— an either linear, or a branched aliphatic diol having from 3 to 10 carbon atoms (component B), and
— an either linear, or a branched aliphatic, cycloaliphatic, or heterocyclic polyol having from 4 to 20 carbon atoms and from 3 to 6 hydroxyl groups (component C),
or, as an alternative, with a mixture of :

— (component B) as defined hereinabove, and

— a cycloaliphatic diol (component C'), the molar ratio of (Component A) to (Component B + Component C), or of (Component A) to (Component B + Component C') being equal to, or greater than 3 : 1, the amount of (Component C) in the (Component B + Component C) mixture being equal to, or lower than 70% by weight, the amount of (Component C') in the (Component B + Component C') mixture being equal to, or lower than 90% by weight, and adding to the thus obtained transesterification reaction product an amount a polymerization initiator of from 1% to 6% by weight relative to the weight of said transesterification reaction product.

2. Process according to claim 1, wherein the transesterification reaction is carried out with a molar ratio of the (Component A) to the (Component B + Component C) mixture, or of the (Component A) to the (Component B + Component C') mixture, of from 3 : 1 to 12 : 1, the amount of the (Component C) in the (Component B + Component C) mixture being from 20% to 60% by weight, or, as an alternative, the amount of the (Component C') in the (Component B + Component C') mixture being of from 20% to 80% by weight.

3. Process according to claim 1, wherein the (Component B) diol is selected from diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, 1,4-butanediol, 1,6-hexanediol, 1,3-propanediol, neopentyl glycol, and 2,2,4-trimethyl-1,3-pentanediol.

4. Process according to claim 1, wherein the (Component C) polyol is selected from pentaerythritol, trimethylolpropane, di-pentaerythritol, di-trimethylolpropane, and tris(hydroxyethyl)isocyanurate.

5. Process according to claim 1, wherein (Component C') is 1,4-cyclohexane-dimethanol, or 4,8-bis(hydroxymethyl)tricyclo-[5.2.0^{2,9}] decane.



C), or of (Component A) to (Component B + Component C') being equal to, or greater than 3 : 1, the amount of (Component C) in the (Component B + Component C) mixture being equal to, or lower than 70% by weight, the amount of (Component C') in the (Component B + Component C') mixture being equal to, or lower than 90% by weight, and adding to the thus obtained transesterification reaction product an amount

2. Liquid polymerizable composition according to claim 1, wherein the transesterification reaction is carried out with a molar ratio of the (Component A) to the (Component B + Component C) mixture, or of the (Component A) to the (Component B + Component C') mixture, of from 3 : 1 to 12 : 1, the amount of the (Component C) in the (Component B + Component C) mixture being from 20% to 60% by weight, or, as an alternative, the amount of the (Component C') in the (Component B + Component C') mixture being of from 20% to 80% by weight.

3. Liquid polymerizable composition according to claim 1, wherein the (Component B) diol is selected from diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, 1,4-butanediol, 1,6-hexanediol, 1,3-propanediol, neopentyl glycol, and 2,2,4-trimethyl-1,3-pentanediol.

4. Liquid polymerizable composition according to claim 1, wherein the (Component C) polyol is selected from : pentaerythritol, trimethylolpropane, di-pentaerythritol, di-trimethylolpropane, and tris(hydroxyethyl)isocyanurate.

5. Liquid polymerizable composition according to claim 1, wherein (Component C') is 1,4-cyclohexane-dimethanol, or 4,8-bis(hydroxymethyl)tricyclo-[5.2.0.0^{2,6}] decane.

6. Liquid polymerizable composition according to claim 1, wherein said alkaline catalyst is selected from the alkali metal hydroxides, carbonates and alkoxides, the organic bases, and the basic ion-exchange resins.

7. Liquid polymerizable composition according to claim 1, wherein the polymerization initiator is selected from di-cyclohexyl-peroxy dicarbonate, dibenzoyl peroxide, di-sec.butyl peroxy dicarbonate, and sec.butyl-cyclohexyl peroxy dicarbonate.

8. Use of a liquid polymerizable composition according to claim 1, for preparing organic optical glasses.

9. Organic optical glasses obtained by casting into moulds and polymerizing a liquid polymerizable composition according to any of claims 1 to 7.

Claims for the following Contracting State : ES

1. Process for preparing a liquid composition polymerizable by free-radical polymerization and with low shrinkage for producing highly thermally stable organic glasses, characterized by comprising the steps of subjecting to a transesterification reaction, at a temperature of from 80°C to 160°C in the presence of an alkaline catalyst, diallyl carbonate (component A) with a mixture of

— an either linear, or a branched aliphatic diol having from 3 to 10 carbon atoms (component B), and
— an either linear, or a branched aliphatic, cycloaliphatic, or heterocyclic polyol having from 4 to 20 carbon atoms and from 3 to 6 hydroxyl groups (component C),
or, as an alternative, with a mixture of :

— (component B) as defined hereinabove, and

— a cycloaliphatic diol (component C'), the molar ratio of (Component A) to (Component B + Component C), or of (Component A) to (Component B + Component C') being equal to, or greater than 3 : 1, the amount of (Component C) in the (Component B + Component C) mixture being equal to, or lower than 70% by weight, the amount of (Component C') in the (Component B + Component C') mixture being equal to, or lower than 90% by weight, and adding to the thus obtained transesterification reaction product an amount a polymerization initiator of from 1% to 6% by weight relative to the weight of said transesterification reaction product.

2. Process according to claim 1, wherein the transesterification reaction is carried out with a molar ratio of the (Component A) to the (Component B + Component C) mixture, or of the (Component A) to the (Component B + Component C') mixture, of from 3 : 1 to 12 : 1, the amount of the (Component C) in the (Component B + Component C) mixture being from 20% to 60% by weight, or, as an alternative, the amount of the (Component C') in the (Component B + Component C') mixture being of from 20% to 80% by weight.

3. Process according to claim 1, wherein the (Component B) diol is selected from diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, 1,4-butanediol, 1,6-hexanediol, 1,3-propanediol, neopentyl glycol, and 2,2,4-trimethyl-1,3-pentanediol.

4. Process according to claim 1, wherein the (Component C) polyol is selected from pentaerythritol, trimethylolpropane, di-pentaerythritol, di-trimethylolpropane, and tris(hydroxyethyl)isocyanurate.

5. Process according to claim 1, wherein (Component C') is 1,4-cyclohexane-dimethanol, or 4,8-bis(hydroxymethyl)tricyclo-[5.2.0.0^{2,6}] decane.



6. Process according to claim 1, wherein said alkaline catalyst is selected from the alkali metal hydroxides, carbonates and alkoxides, the organic bases, and the basic ion-exchange resins.

7. Process according to claim 1, wherein the polymerization initiator is selected from di-cyclohexyl-peroxy dicarbonate, dibenzoyl peroxide, di-sec.butyl peroxy dicarbonate, and sec.butyl-cyclohexyl peroxy dicarbonate.

8. Process for preparing organic optical glasses comprising the steps of casting into moulds and polymerizing a liquid polymerizable composition prepared according to the process as defined in any of claims 1 to 7.

10 Patentansprüche

Patentansprüche für folgenden Vertragsstaaten : AT, BE, CH, DE, FR, GB, GR, LI, LU, NL, SE

1. Flüssige, durch freiradikalische Polymerisation und mit geringem Schrumpfen zu organischen Gläsern mit hoher thermischer Stabilität polymerisierbare Zusammensetzung, dadurch gekennzeichnet, daß sie dadurch erhältlich ist, daß bei einer Temperatur von 80°C bis 160°C und in Gegenwart eines alkalischen Katalysators Diallylcarbonat (Komponente A) mit einem Gemisch aus

— einem entweder linearen oder verzweigten aliphatischen Diol mit 3 bis 10 Kohlenstoffatomen (Komponente B) und

— einem entweder linearen oder einem verzweigten aliphatischen, cykloaliphatischen oder heterocyclischen Polyol mit 4 bis 20 Kohlenstoffatomen und 3 bis 6 Hydroxylgruppen (Komponente C), oder, als Alternative, mit einem Gemisch aus

— (Komponente B) gemäß vorstehender Definition und

— einem cykloaliphatischen Diol (Komponente C') einer Umesterungsreaktion unterworfen wird, wobei das Molverhältnis von (Komponente A) zu (Komponente B + Komponente C) oder von (Komponente A) zu (Komponente B + Komponente C') gleich oder größer als 3 : 1 ist, und die Menge an (Komponente C) im Gemisch (Komponente B + Komponente C) gleich oder niedriger als 70 Gew.-% ausmacht und die Menge an (Komponente C') im Gemisch (Komponente B + Komponente C') gleich oder niedriger als 90 Gew.-% ausmacht, und daß zu dem solcherart erhaltenen Umesterungsreaktionsprodukt eine Menge eines Polymerisationsinitiators von 1 bis 6 Gew.-%, bezogen auf das Gewicht des Umesterungsreaktionsproduktes, zugesetzt wird.

2. Flüssige polymerisierbare Zusammensetzung nach Anspruch 1, worin die Umesterungsreaktion mit einem Molverhältnis von (Komponente A) zu dem Gemisch (Komponente B + Komponente C) oder von (Komponente A) zu dem Gemisch (Komponente B + Komponente C') von 3 : 1 bis 12 : 1 ausgeführt wird, wobei die Menge der (Komponente C) im Gemisch (Komponente B + Komponente C) von 20 bis 60 Gewichtsprozent beträgt oder als Alternative die Menge der (Komponente C') im Gemisch (Komponente B + Komponente C') von 20 bis 80 Gew.-% ausmacht.

3. Flüssige polymerisierbare Zusammensetzung nach Anspruch 1, worin das (Komponente B)-Diol unter Diethylenglykol, Triethylenglykol, Tetraethylenglykol, Dipropylenglykol, 1,4-Butandiol, 1,6-Hexandiol, 1,3-Propan-diol, Neopentylglykol und 2,2,4-Trimethyl-1,3-pentandiol ausgewählt wird.

4. Flüssige polymerisierbare Zusammensetzung nach Anspruch 1, worin das (Komponente C)-Polyol unter Pentaerythrit, Trimethylolpropan, Dipentaerythrit, Ditrime-thylolpropan und Tris(hydroxyethyl)isocyanurat ausgewählt wird.

5. Flüssige polymerisierbare Zusammensetzung nach Anspruch 1, worin die (Komponente C') 1,4-Cyclohexan-dimethanol oder 4,8-Bis(hydroxymethyl)tricyclo-[5.2.0^{2,5}]dekan ist.

6. Flüssige polymerisierbare Zusammensetzung nach Anspruch 1, worin der alkalische Katalysator unter den Alkalimetallhydroxiden, -carbonaten und -alkoxiden, den organischen Basen und den basischen Ionenaustauschharzen ausgewählt wird.

7. Flüssige polymerisierbare Zusammensetzung nach Anspruch 1, worin der Polymerisationsinitiator unter Dicyclohexylperoxydicarbonat, Dibenzoylperoxid, Di-sec.butylperoxydicarbonat und sec.Butylcyclohexylperoxydicarbonat ausgewählt wird.

8. Verwendung einer flüssigen polymerisierbaren Zusammensetzung nach Anspruch 1 zur Herstellung von organischen optischen Gläsern.

9. Organische optische Gläser, erhältlich durch Gießen einer flüssigen polymerisierbaren Zusammensetzung nach einem der Ansprüche 1 bis 7 in Formen und Polymerisieren.



Patentansprüche für folgende Vertragsstaat : ES

1. Verfahren zur Herstellung einer flüssigen, durch freiradikalische Polymerisation und mit geringem Schrumpfen zu organischen Gläsern von hoher thermischer Stabilität polymerisierbaren Zusammensetzung, dadurch gekennzeichnet, daß bei einer Temperatur von 80°C bis 160°C in Gegenwart eines alkalischen Katalysators Diallylcarbonat (Komponente A) mit einem Gemisch aus

— einem entweder linearen oder verzweigten aliphatischen Diol mit 3 bis 10 Kohlenstoffatomen (Komponente B) und

— einem entweder linearen oder einem verzweigten aliphatischen, cykloaliphatischen oder heterocyclischen Polyol mit 4 bis 20 Kohlenstoffatomen und 3 bis 6 Hydroxylgruppen (Komponente C), oder, als Alternative, mit einem Gemisch aus

— (Komponente B) gemäß vorstehender Definition und

— einem cykloaliphatischen Diol (Komponente C') einer Umesterungsreaktion unterworfen wird, wobei das Molverhältnis von (Komponente A) zu (Komponente B + Komponente C) oder von (Komponente A) zu (Komponente B + Komponente C') gleich oder größer als 3 : 1 ist, und die Menge an (Komponente C) im Gemisch (Komponente B + Komponente C) gleich oder niedriger als 70 Gew.-% ausmacht und die Menge an (Komponente C') im Gemisch (Komponente B + Komponente C') gleich oder niedriger als 90 Gew.-% ausmacht, und daß zu dem solcherart erhaltenen Umesterungsreaktionsprodukt eine Menge eines Polymerisationsinitiators von 1 bis 6 Gew.-%, bezogen auf das Gewicht des Umesterungsreaktionsproduktes, zugesetzt wird.

2. Verfahren nach Anspruch 1, worin die Umesterungsreaktion mit einem Molverhältnis von (Komponente A) zu dem Gemisch (Komponente B + Komponente C) oder von (Komponente A) zu dem Gemisch (Komponente B + Komponente C') von 3 : 1 bis 12 : 1 ausgeführt wird, wobei die Menge der (Komponente C) im Gemisch (Komponente B + Komponente C) von 20 bis 60 Gewichtsprozent beträgt oder als Alternative die Menge der (Komponente C') im Gemisch (Komponente B + Komponente C') von 20 bis 80 Gew.-% ausmacht.

3. Verfahren nach Anspruch 1, worin das (Komponente B)-Diol unter Diethylenglykol, Triethylenglykol, Tetraethylenglykol, Dipropylenglykol, 1,4-Butandiol, 1,6-Hexandiol, 1,3-Propandiol, Neopentylglykol und 2,2,4-Trimethyl-1,3-pentandiol ausgewählt wird.

4. Verfahren nach Anspruch 1, worin das (Komponente C)-Polyol unter Pentaerythrit, Trimethylolpropan, Dipentaerythrit, Ditrimehtylolpropan und Tris(hydroxyethyl)isocyanurat ausgewählt wird.

5. Verfahren nach Anspruch 1, worin die (Komponente C') 1,4-Cyclohexandimethanol oder 4,8-Bis(hydroxymethyl)tricyclo-[5.2.0.0^{2,6}]dekan ist.

6. Verfahren nach Anspruch 1, worin der alkalische Katalysator unter den Alkalimetallhydroxiden, -carbonaten und -alkoxiden, den organischen Basen und den basischen Ionenaustauschharzen ausgewählt wird.

7. Verfahren nach Anspruch 1, worin der Polymerisationsinitiator unter Dicyclohexylperoxydicarbonat, Dibenzoylperoxid, Di-sec.butylperoxy-dicarbonat und sec.Butyldicyclohexylperoxydicarbonat ausgewählt wird.

8. Verfahren zur Herstellung von organischen optischen Gläsern, welches die Stufen des Gießens einer flüssigen polymerisierbaren Zusammensetzung, hergestellt nach dem Verfahren, wie in einem der Ansprüche 1 bis 7 definiert, in Formen und des Polymerisierens der Zusammensetzung umfaßt.

Revendications

Revendications pour les Etats Contractants suivants : AT, BE, CH, DE, FR, GB, GR, LI, LU, NL, SE

1. Composition liquide polymérisable par polymérisation radicalaire, et avec un faible retrait, pour la production de verres organiques très stables thermiquement, caractérisée en ce que l'on peut l'obtenir en soumettant à une réaction de transestérification, à une température de 80°C à 160°C, en présence d'un catalyseur alcalin, du carbonate de diallyle (constituant A) avec un mélange d'un diol aliphatique linéaire ou ramifié, ayant de 3 à 10 atomes de carbone (constituant B) et d'un polyol aliphatique, linéaire ou ramifié, cycloaliphatique ou hétérocyclique, ayant de 4 à 20 atomes de carbone et de 3 à 6 groupes hydroxyle (constituant C), ou, en variante, avec un mélange du constituant B défini précédemment et d'un diol cycloaliphatique (constituant C'),

le rapport molaire du constituant A à la somme des constituants B et C ou du constituant A à la somme des constituants B et C' étant égal ou supérieur à 3 : 1, la proportion de constituant C dans le mélange constituant B + constituant C étant égale ou inférieure à 70% en poids, la proportion du constituant C' dans le mélange constituant B + constituant C' étant égale ou inférieure à 90% en poids,



et en ajoutant au produit de la réaction de transestérification ainsi obtenu une proportion d'un amorceur de polymérisation de 1% à 6% en poids par rapport au poids dudit produit de la réaction de transestérification.

2. Composition liquide polymérisable selon la revendication 1, pour laquelle on réalise la réaction de transestérification avec un rapport molaire du constituant A au mélange constituant B + constituant C ou du constituant A au mélange constituant B + constituant C' de 3 : 1 à 12 : 1, la proportion du constituant C dans le mélange constituant B + constituant C étant de 20% à 60% en poids, ou, en variante, la proportion du constituant C' dans le mélange constituant B + constituant C' étant de 20% à 80% en poids.

3. Composition liquide polymérisable selon la revendication 1, pour laquelle le diol (constituant B) est choisi parmi le diéthylèneglycol, le triéthylèneglycol, le tétraéthylèneglycol, le dipropylèneglycol, le 1,4-butanediol, le 1,6-hexanediol, le 1,3-propanediol, le néopentylglycol et le 2,2,4-triméthyl-1,3-pentanediol.

4. Composition liquide polymérisable selon la revendication 1, pour laquelle le polyol (constituant C) est choisi parmi le pentaérythritol, le triméthylolpropane, le dipentaérythritol, le ditriméthylolpropane et l'isocyanurate de tris(hydroxyéthyle).

5. Composition liquide polymérisable selon la revendication 1, pour laquelle le constituant C' est le 1,4-cyclohexanediméthanol ou le 4,8-bis(hydroxyméthyl)tricyclo-[5.2.0^{2,5}]décane.

6. Composition liquide polymérisable selon la revendication 1, pour laquelle ledit catalyseur alcalin est choisi parmi les hydroxydes, carbonates et alcoolates de métal alcalin, les bases organiques et les résines échangeuses d'ions basiques.

7. Composition liquide polymérisable selon la revendication 1, pour laquelle l'amorceur de polymérisation est choisi parmi le peroxy dicarbonate de dicyclohexyle, le peroxyde de dibenzoyle, le peroxy dicarbonate de di(sec.butyle) et le peroxy dicarbonate de sec.butyle et de cyclohexyle.

8. Utilisation d'une composition liquide polymérisable selon la revendication 1, pour la préparation de verres optiques organiques.

9. Verres optiques organiques obtenus par coulage dans un moule et polymérisation d'une composition liquide polymérisable selon l'une quelconque des revendications 1 à 7.

Revendications pour l'Etat Contractant suivant : ES

1. Procédé de préparation d'une composition liquide polymérisable par polymérisation radicalaire, et avec un faible retrait, pour la production de verres organiques très stables thermiquement, caractérisé en ce qu'il comprend les étapes consistant à soumettre à une réaction de transestérification, à une température de 80°C à 160°C, en présence d'un catalyseur alcalin, du carbonate de diallyle (constituant A) avec un mélange d'un diol aliphatique linéaire ou ramifié, ayant de 3 à 10 atomes de carbone (constituant B) et d'un polyol aliphatique, linéaire ou ramifié, cycloaliphatique ou hétérocyclique, ayant de 4 à 20 atomes de carbone et de 3 à 6 groupes hydroxyle (constituant C), ou, en variante, avec un mélange du constituant B défini précédemment et d'un diol cycloaliphatique (constituant C'),

le rapport molaire du constituant A à la somme du constituant B et du constituant C ou du constituant A à la somme du constituant B et du constituant C' étant égal ou supérieur à 3 : 1, la proportion de constituant C dans le mélange constituant B + constituant C étant égale ou inférieure à 70% en poids, la proportion de constituant C' dans le mélange constituant B + constituant C' étant égale ou inférieure à 90% en poids, et à ajouter au produit de la réaction de transestérification ainsi obtenu une proportion d'un amorceur de polymérisation de 1% à 6% en poids par rapport au poids dudit produit de la réaction de transestérification.

2. Procédé selon la revendication 1, dans lequel on effectue la réaction de transestérification avec un rapport molaire du constituant A au mélange constituant B + constituant C ou du constituant A au mélange constituant B + constituant C' de 3 : 1 à 12 : 1, la proportion du constituant C dans le mélange constituant B + constituant C étant de 20% à 60% en poids, ou, en variante, la proportion du constituant C' dans le mélange constituant B + constituant C' étant de 20% à 80% en poids.

3. Procédé selon la revendication 1, dans lequel le diol (constituant B) est choisi parmi le diéthylèneglycol, le triéthylèneglycol, le tétraéthylèneglycol, le dipropylèneglycol, le 1,4-butanediol, le 1,6-hexanediol, le 1,3-propanediol, le néopentylglycol et le 2,2,4-triméthyl-1,3-pentanediol.

4. Procédé selon la revendication 1, dans lequel le polyol (constituant C) est choisi parmi le pentaérythritol, le triméthylolpropane, le dipentaérythritol, le ditriméthylolpropane et l'isocyanurate de tris(hydroxy-éthyle).

5. Procédé selon la revendication 1, dans lequel le constituant C' est le 1,4-cyclohexanediméthanol ou le 4,8-bis(hydroxyméthyl)tricyclo[5.2.0^{2,5}]décane.

6. Procédé selon la revendication 1, dans lequel ledit catalyseur alcalin est choisi parmi les hydroxydes, les carbonates et les alcoolates de métal alcalin, les bases organiques et les résines échangeuses d'ions basiques.



7. Procédé selon la revendication 1, dans lequel l'amorceur de polymérisation est choisi parmi le peroxydicarbonate de dicyclohexyle, le peroxyde de dibenzoyle, le peroxy dicarbonate de di(sec.butyle) et le peroxydicarbonate de sec.butyle et de cyclohexyle.

5 8. Procédé de préparation de verres optiques organiques, comprenant les étapes consistant à couler dans un moule et à polymériser une composition liquide polymérisable, préparée selon le procédé tel que défini dans l'une quelconque des revendications 1 à 7.

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