

603960

COMMONWEALTH of AUSTRALIA
Patents Act 1952

APPLICATION FOR A STANDARD PATENT

I/We

Menicon Co., Ltd.

of

21-19, Aoi 3-chome, Naka-ku, Nagoya-shi, Aichi-ken, Japan

hereby apply for the grant of a Standard Patent for an invention entitled:

Ocular lens material

which is described in the accompanying complete specification.

Details of basic application(s):-

<u>Number</u>	<u>Convention Country</u>	<u>Date</u>
16620/1989	Japan	26 January 1989

The address for service is care of DAVIES & COLLISON, Patent Attorneys, of 1 Little Collins Street, Melbourne, in the State of Victoria, Commonwealth of Australia.

DATED this FIFTEENTH day of JANUARY 1990

To: THE COMMISSIONER OF PATENTS

Keith Collison

a member of the firm of
DAVIES & COLLISON for
and on behalf of the
applicant(s)

Davies & Collison, Melbourne

11 5 7 15 1990

APPLICATION ACCEPTED AND AMENDMENTS

ALLOWED 4.9.90

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

DECLARATION IN SUPPORT OF CONVENTION OR NON-CONVENTION APPLICATION FOR A PATENT

Insert title of invention

In support of the Application made for a patent for an invention
entitled:

OCULAR LENS MATERIAL

Insert full name(s) and address(es)
of declarant(s) being the appli-
cant(s) or person(s) authorized to
sign on behalf of an applicant
company.

I ~~was~~ Menicon Co., Ltd. of

21-19, Aoi 3-chome, Naka-ku,
Nagoya-shi, Aichi-ken, Japan

Cross out whichever of paragraphs
1(a) or 1(b) does not apply

1(a) relates to application made
by individual(s)

1(b) relates to application made
by company; insert name of
applicant company.

do solemnly and sincerely declare as follows:-

1. (a) ~~XXXXX~~ ~~XXXXXXXXXXXXXXXXXXXX~~

or (b) I am authorized by
Menicon Co., Ltd.

Cross out whichever of paragraphs
2(a) or 2(b) does not apply

2(a) relates to application made
by inventor(s)

2(b) relates to application made
by company(s) or person(s) who
are not inventor(s); insert full
name(s) and address(es) of inven-
tors.

the applicant..... for the patent to make this declaration on ^{its} ~~their~~ behalf.

2. (a) ~~XXXXX~~ ~~XXXXXXXXXXXXXXXXXXXX~~

or (b) Hiroaki Yanagawa and Naotaka Kamiya of
Menicon Co., Ltd. Kenkyusho, 12-7,
Biwajima 3-chome, Nishi-ku, Nagoya-shi,
Aichi-ken, Japan and - ditto -

State manner in which applicant(s)
derive title from inventor(s)

~~XX~~ the actual inventor(s)..... of the invention and the facts upon which the applicant.....
~~are~~
~~is~~
~~XX~~ entitled to make the application are as follows:-

The applicant would, if a patent were granted
on an application made by the said actual
inventors, be entitled to have the patent
assigned to it.

Cross out paragraphs 3 and 4
for non-convention applications.
For convention applications,
insert basic country(s) followed
by date(s) and basic applicant(s).

3. The basic application..... as defined by Section 141 of the Act ^{was} ~~was~~ made
in JAPAN..... on the 26th day of January, 1989
by Menicon Co., Ltd.
in on the
by
in on the
by

4. The basic application..... referred to in paragraph 3 of this Declaration ^{was} ~~was~~
the first application..... made in a Convention country in respect of the invention the subject
of the application.

Insert place and date of signature.

Declared at JAPAN this 22nd day of December, 1989

Signature of declarant(s) (no
attestation required)

Kyoichi Tanaka

Note Initial all alterations.

Kyoichi Tanaka, President of Menicon Co., Ltd.

DAVIES & COLLISON, MELBOURNE and CANBERRA.

(12) PATENT ABRIDGMENT (11) Document No. AU-B-47962/90
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 603960

(54) Title
OCULAR LENS MATERIAL

International Patent Classification(s)
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G02C 007/04

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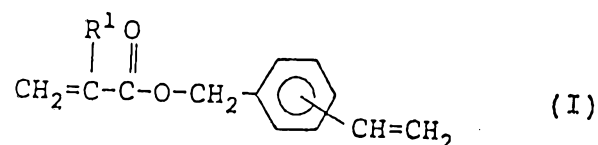
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(57) Claim

1. An ocular lens material, comprising a copolymer of a styrene monomer; with an acrylic monomer and/or a methacrylate monomer; and a cross linking agent of the formula:



wherein R¹ is a hydrogen atom or a methyl group and
wherein the content of the cross linking agent is from
0.5 to 15 parts by weight in 100 parts by weight of the
total copolymer components.

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COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952
COMPLETE SPECIFICATION

NAME & ADDRESS
OF APPLICANT:

Menicon Co., Ltd.
21-19, Aoi 3-chome, Naka-ku
Nagoya-shi
Aichi-ken
Japan

This document contains the
amendments made under
Section 49 and is correct for
printing.

NAME(S) OF INVENTOR(S):

Hiroaki YANAGAWA
Naotaka KAMIYA

ADDRESS FOR SERVICE:

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Patent Attorneys
1 Little Collins Street, Melbourne, 3000.

COMPLETE SPECIFICATION FOR THE INVENTION ENTITLED:

Ocular lens material

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

- 1a-

The present invention relates to a material for ocular lenses (such as contact lenses, intraocular lenses or artificial cornea) having excellent optical properties and high strength. Further, the present invention relates to an ocular lens material useful as a contact lens material which is excellent not only in the optical properties and strength but also in the oxygen permeability.

In the synthesis of a copolymer to be used as an ocular lens material, a cross linking agent has been used to let the copolymer have a cross linked network structure and to make it tough.

However, particularly in the synthesis of a copolymer comprising a styrene monomer, and an acrylic monomer and/or a methacrylic monomer (hereinafter referred to as a (meth)acrylic monomer), particularly a copolymer comprising them in a weight ratio within a range of from 10:90 to 70:30, if the copolymer is synthesized by means of a conventional cross linking agent such as ethylene

glycol dimethacrylate, allyl methacrylate,
trimethylolpropane trimethacrylate or divinyl benzene,
the composition of the polymer tends to be non-uniform
due to the difference in the polymerization rate or in
5 the compatibility during the polymerization process.
Consequently, the resulting material (copolymer) will be
non-uniform, lack in optical transparency and have
turbidity or optical distortion. For example, in a
system wherein a styrene monomer and a (meth)acrylic
10 monomer are copolymerized substantially
stoichiometrically, turbidity will be distinctly formed
if such a conventional cross linking agent is used.

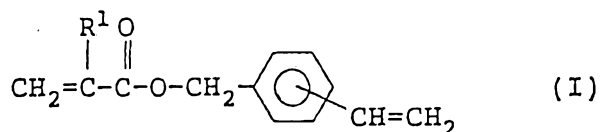
Further, in the case of an ocular lens material
having high oxygen permeability, which has attached an
15 attention as a prospective material for an oxygen
permeable hard contact lens, there is a difficulty such
that when it is attempted to increase the oxygen
permeability, the mechanical strength and the hardness
tend to decrease even if a conventional cross linking
20 agent is used in an optimum amount, and the material
tends to be brittle if the cross linking agent is used
excessively, whereby it tends to be weak against an
impact or other stress.

The present invention has been made to solve the
25 above problems, and the object of the present invention
is to obtain an ocular lens material made of a copolymer
having a cross linked network structure, which is tough

and optically transparent without optical distortion,
particularly an ocular lens material composed of a
styrene monomer and a (meth)acrylic monomer, which is
tough and has excellent mechanical strength and hardness
5 and which is transparent and excellent in the optical
properties without optical distortion.

A further object of the present invention is to
provide an ocular lens material useful as a contact lens
material which is optically transparent without
10 distortion and has a high refractive index and excellent
mechanical strength and hardness and superior durability
against an impact and which has an excellent oxygen
permeability.

The present invention provides an ocular lens
15 material, wherein a cross linking agent of the formula:



wherein R^1 is a hydrogen atom or a methyl group, is used.

20 Now, the present invention will be described in
detail with reference to the preferred embodiments.

The ocular lens material of the present invention is
a copolymer wherein a vinylbenzyl acrylate and/or a
vinylbenzyl methacrylate (hereinafter referred to as a
25 vinylbenzyl (meth)acrylate) of the above formula I is
used as the cross linking agent.

The above-mentioned vinylbenzyl (meth)acrylate is a

cross linkable monomer having an acryloyl group or a methacryloyl group (hereinafter referred to as a (meth)acryloyl group) and a vinyl group bonded to a benzene ring, as functional groups. Specific examples thereof include, for example, 4-vinylbenzyl (meth)acrylate and 3-vinylbenzyl (meth)acrylate. These vinylbenzyl (meth)acrylates may be used alone or in combination as a mixture of two or more different types.

Such a vinylbenzyl (meth)acrylate serves to let the copolymer have a cross linked structure so that it will be tough and will have improved mechanical strength and hardness and make an ocular lens material which is uniform and transparent without turbidity and which has excellent optical properties without optical distortion. Further, it provides other cross linking effects such as effects to improve durability such as chemical resistance, heat resistance, solvent resistance or dimension stability and to reduce eluting substances.

Such a vinylbenzyl (meth)acrylate can be prepared, for example, by reacting acrylic acid or methacrylic acid (hereinafter referred to as (meth)acrylic acid) and chloromethylstyrene in the presence of 1,8-diazabicyclo[5.4.0]-7-undecene.

The obtained vinylbenzyl methacrylate is a colorless transparent liquid having an aroma and a boiling point of from 90 to 105°C (under 0.12 mmHg), and the vinylbenzyl acrylate is a colorless transparent liquid having an

aroma and a boiling point of from 80 to 90°C (under 0.10 mmHg). Their structures can be confirmed by a ¹H-NMR spectrum method, an infrared absorption spectrum method, etc.

5 The monomers to be used together with the cross linking agent of the formula I as components of the ocular lens material of the present invention, include a (meth)acrylic monomer, a styrene monomer and other monomers.

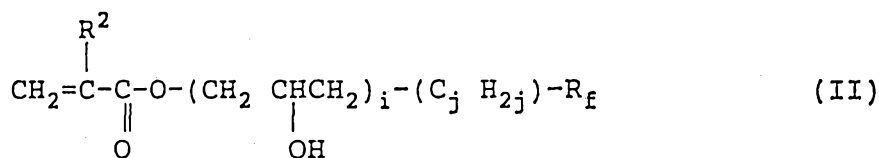
10 Particularly when a copolymer is synthesized by using a (meth)acrylic monomer and a styrene monomer together with the cross linking agent of the formula I, the cross linking agent will be uniformly mixed and polymerized with these monomers, since the (meth)acryloyl group
15 portion of the cross linking agent has good compatibility with the (meth)acrylic monomer, and the vinyl group bonded to the benzene ring i.e. the so-called styrene backbone portion has good compatibility with the styrene monomer. Although there is a difference in the
20 polymerization rate between the (meth)acryloyl group of the (meth)acrylic monomer and the vinyl group of the styrene monomer, the cross linking agent of the formula I polymerizes excellently with the copolymer components (i.e. the (meth)acrylic monomer and the styrene monomer)
25 having functional groups (i.e. the (meth)acryloyl group and the vinyl group) having substantially the same polymerization rates as the two functional groups of the

cross linking agent i.e. the (meth)acryloyl group and the vinyl group bonded to the benzene ring, respectively.

Accordingly, if the cross linking agent of the formula I is used for the preparation of a copolymer of the (meth)acrylic monomer and the styrene monomer, the copolymerization proceeds smoothly to form a cross linked structure, whereby the resulting copolymer will be tough and will have improved mechanical strength and hardness, and it will be a material which is uniform and transparent without turbidity and which has excellent optical properties without optical distortion.

Specific examples of the (meth)acrylic monomer include linear, branched and cyclic alkyl (meth)acrylates such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, tert-butyl (meth)acrylate, isobutyl (meth)acrylate, pentyl (meth)acrylate, tert-pentyl (meth)acrylate, hexyl (meth)acrylate, 2-methylbutyl (meth)acrylate, heptyl (meth)acrylate, octyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, dodecyl (meth)acrylate, stearyl (meth)acrylate, cyclopentyl (meth)acrylate and cyclohexyl (meth)acrylate; silicon-containing (meth)acrylates such as pentamethyldisiloxanylmethyl (meth)acrylate, pentamethyldisiloxanylpropyl (meth)acrylate, methylbis(trimethylsiloxy)silylpropyl (meth)acrylate,

tris(trimethylsiloxy)silylpropyl (meth)acrylate,
 mono[methylbis(trimethylsiloxy)siloxy]bis-
 (trimethylsiloxy)silylpropyl (meth)acrylate,
 tris[methylbis(trimethylsiloxy)siloxy]silylpropyl
 5 (meth)acrylate, methylbis(trimethylsiloxy)silylpropyl
 glyceryl (meth)acrylate,
 tris(trimethylsiloxy)silylpropylglyceryl (meth)acrylate,
 mono[methylbis(trimethylsiloxy)siloxy]bis-
 (trimethylsiloxy)silylpropylglyceryl (meth)acrylate,
 10 trimethylsilylethyltetramethyldisiloxanylpropylglyceryl
 (meth)acrylate, trimethylsilylmethyl (meth)acrylate,
 trimethylsilylpropyl (meth)acrylate,
 trimethylsilylpropylglyceryl (meth)acrylate,
 pentamethyldisiloxanylpropylglyceryl (meth)acrylate,
 15 methylbis(trimethylsiloxy)silylethyltetramethyl-
 disiloxanylmethyl (meth)acrylate,
 tetramethyltriisopropylcyclotetrasiloxanylpropyl
 (meth)acrylate and
 tetramethyltriisopropylcyclotetrasiloxylbis(trimethyl-
 20 siloxy)silylpropyl (meth)acrylate; fluorine-containing
 (meth)acrylates of the formula II:



25 wherein R^2 is a hydrogen atom or a methyl group, R_f is a
 linear or branched fluoroalkyl group having from 2 to 21

fluorine atoms, i is 0 or 1, and j is an integer of from 0 to 3, such as 2,2,2-trifluoroethyl (meth)acrylate, 2,2,3,3-tetrafluoropropyl (meth)acrylate, 2,2,3,3,3-pentafluoropropyl (meth)acrylate, 2,2,2-trifluoro-1-
5 trifluoromethylethyl (meth)acrylate, 2,2,3,3-tetrafluoro-tert-pentyl (meth)acrylate, 2,2,3,4,4,4-hexafluorobutyl (meth)acrylate, 2,2,3,3,4,4-hexafluorobutyl (meth)acrylate, 2,2,3,4,4,4-hexafluoro-tert-hexyl (meth)acrylate, 2,2,3,3,4,4,4-heptafluorobutyl (meth)acrylate, 2,2,3,3,4,4,5,5-octafluoropentyl (meth)acrylate, 2,3,4,5,5,5-hexafluoro-2,4-bis(trifluoromethyl)pentyl (meth)acrylate, 2,2,3,3,4,4,5,5,5-nonafluoropentyl (meth)acrylate, 2,2,3,3,4,4,5,5,6,6,7,7-dodecafluoroheptyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8-dodecafluorooctyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl (meth)acrylate, 2,2,3,3,4,4,5,5,6,6,7,7,7-tridecafluoroheptyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10-hexadecafluorodecyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-heptadecafluorodecyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11-octadecafluoroundecyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,11-nonadecafluoroundecyl (meth)acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12-eicosafluorodecyl (meth)acrylate, 2-hydroxy-

- 4,4,5,5,6,7,7,7-octafluoro-6-trifluoromethylheptyl
(meth)acrylate, 2-hydroxy-4,4,5,5,6,6,7,7,8,9,9,9-
dodecafluoro-8-trifluoromethylnonyl (meth)acrylate and 2-
hydroxy-4,4,5,5,6,6,7,7,8,8,9,9,10,11,11,11-
5 hexadecafluoro-1-trifluoromethylundecyl (meth)acrylate;
hydroxyl group-containing (meth)acrylates such as
hydroxyethyl (meth)acrylate, hydroxypropyl
(meth)acrylate, hydroxybutyl (meth)acrylate,
dihydroxypropyl (meth)acrylate, dihydroxybutyl
10 (meth)acrylate, diethyleneglycol mono(meth)acrylate,
triethyleneglycol mono(meth)acrylate and dipropylene
glycol mono(meth)acrylate; (meth)acrylic acid; N-
(meth)acryloylpyrrolidone; (meth)acrylamides such as
(meth)acrylamide, N-methyl (meth)acrylamide, N-ethyl
15 (meth)acrylamide, N-hydroxyethyl (meth)acrylamide, N,N-
dimethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide
and N-ethylaminoethyl (meth)acrylamide; aminoalkyl
(meth)acrylates such as aminoethyl (meth)acrylate, N-
methylaminoethyl (meth)acrylate and N,N-
20 dimethylaminoethyl (meth)acrylate; alkoxy group-
containing (meth)acrylates such as methoxyethyl
(meth)acrylate, ethoxyethyl (meth)acrylate and
methoxydiethyleneglycol (meth)acrylate; aromatic group-
containing (meth)acrylates such as benzyl (meth)acrylate;
25 glycidyl (meth)acrylate; tetrahydrofurfuryl
(meth)acrylate; N-(meth)acryloylpiperidine; N-
(meth)acryloylmorpholine; 2-cyanoethyl (meth)acrylate;

- benzophenone polymerizable ultraviolet absorbers such as 2-hydroxy-4-(meth)acryloyloxybenzophenone, 2-hydroxy-4-(meth)acryloyloxy-5-tert-butylbenzophenone, 2-hydroxy-4-(meth)acryloyloxy-2',4'-dichlorobenzophenone and 2-
- 5 hydroxy-4-(2'-hydroxy-3'-(meth)acryloyloxypropoxy)benzophenone; benzotriazole type polymerizable ultraviolet absorbers such as 2-(2'-hydroxy-5'-(meth)acryloyloxyethylphenyl)-2H-benzotriazole, 2-(2'-hydroxy-5'-(meth)acryloyloxyethylphenyl)-5-chloro-2H-benzotriazole,
- 10 2-(2'-hydroxy-5'-(meth)acryloyloxypropylphenyl)-2H-benzotriazole and 2-(2'-hydroxy-5'-(meth)acryloyloxypropyl-3'-tert-butylphenyl)-5-chloro-2H-benzotriazole; salicylic acid derivative type
- 15 polymerizable ultraviolet absorbers such as phenyl 2-hydroxy-4-(meth)acryloyloxymethylbenzoate; polymerizable ultraviolet absorbers such as 2-cyano-3-phenyl-3-(3'-(meth)acryloyloxyphenyl)propenoic acid methyl ester; azo type polymerizable dyes such as 1-phenylazo-4-
- 20 (meth)acryloyloxynaphthalene, 1-phenylazo-2-hydroxy-3-(meth)acryloyloxynaphthalene, 1-naphthylazo-2-hydroxy-3-(meth)acryloyloxynaphthalene, 1-(α -anthrylazo)-2-hydroxy-3-(meth)acryloyloxynaphthalene, 1-(4'-(phenylazo)phenyl)azo)-2-hydroxy-3-
- 25 (meth)acryloyloxynaphthalene, 1-(2',4'-xylylazo)-2-(meth)acryloyloxynaphthalene, 1-(o-tolylazo)-2-(meth)acryloyloxynaphthalene, 2-(m-(meth)acryloylamide-

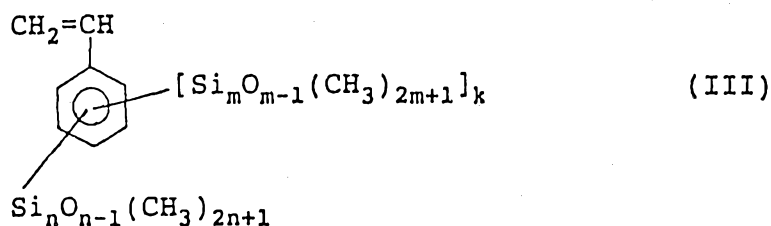
anilino)-4,6-bis(1'-(o-tolylazo)-2'-naphthylamino)-1,3,5-triazine, 3-(meth)acryloylamide-4-phenylazophenol, 3-(meth)acryloylamide-4-(8'-hydroxy-3',6'-disulfo-1'-naphthylazo)phenol, 3-(meth)acryloylamide-4-(1'-phenylazo-2'-naphthylazo)phenol, 3-(meth)acryloylamide-4-(p-tolylazo)phenol and 4-phenylazo-7-(meth)acryloylamide-1-naphthol; anthraquinone type polymerizable dyes such as 1,5-bis((meth)acryloylamino)-9,10-anthraquinone, 1-amino-4-(3'-(meth)acryloylaminophenylamino)-9,10-anthraquinone-2-sulfonic acid, 1-amino-4-(3'-(meth)acryloylaminobenzylamino)-9,10-anthraquinone-2-sulfonic acid, 2-(3'-(meth)acryloylamide-anilino-4-(3'-(3''-sulfo-4''-aminoanthraquinone-1''-yl)-amino-anilino)-6-chloro-1,3,5-triazine and 2-(3'-(meth)acryloylamide-anilino)-4-(3'-(3''-sulfo-4''-aminoanthraquinone-1''-yl)-amino-anilino)-6-hydradino-1,3,5-triazine; nitro-type polymerizable dyes such as o-nitroanilinomethyl (meth)acrylate; phthalocyanine type polymerizable dyes such as (meth)acryloyl-modified tetraamino copper phthalocyanine and (meth)acryloyl-modified (dodecanoyl-modified tetraamino copper phthalocyanine); and polymerizable ultraviolet absorptive dyes such as 2,4-dihydroxy-3-(p-(meth)acryloyloxymethylphenylazo)benzophenone, 2,4-dihydroxy-5-(p-(meth)acryloyloxymethylphenylazo)benzophenone, 2,4-dihydroxy-3-(p-

- (meth)acryloyloxyethylphenylazo)benzophenone,
2,4-dihydroxy-5-(p-
- (meth)acryloyloxyethylphenylazo)benzophenone,
2,4-dihydroxy-3-(p-
- 5 (meth)acryloyloxypropylphenylazo)benzophenone,
2,4-dihydroxy-5-(p-
- (meth)acryloyloxypropylphenylazo)benzophenone,
2,4-dihydroxy-3-(o-
- (meth)acryloyloxymethylphenylazo)benzophenone,
10 2,4-dihydroxy-5-(o-
- (meth)acryloyloxymethylphenylazo)benzophenone,
2,4-dihydroxy-3-(o-
- (meth)acryloyloxyethylphenylazo)benzophenone,
2,4-dihydroxy-5-(o-
- 15 (meth)acryloyloxyethylphenylazo)benzophenone,
2,4-dihydroxy-3-(o-
- (meth)acryloyloxypropylphenylazo)benzophenone,
2,4-dihydroxy-5-(o-
- (meth)acryloyloxypropylphenylazo)benzophenone,
20 2,4-dihydroxy-3-(p-(N,N-
- di(meth)acryloyloxyethylamino)phenylazo)benzophenone,
2,4-dihydroxy-5-(p-(N,N-
- di(meth)acryloyloxyethylamino)phenylazo)benzophenone,
2,4-dihydroxy-3-(o-(N,N-
- 25 di(meth)acryloyloxyethylamino)phenylazo)benzophenone,
2,4-dihydroxy-5-(o-(N,N-
- di(meth)acryloyloxyethylamino)phenylazo)benzophenone,

2,4-dihydroxy-3-(p-(N-ethyl-N-(meth)acryloyloxyethylamino)phenylazo)benzophenone,
2,4-dihydroxy-5-(p-(N-ethyl-N-(meth)acryloyloxyethylamino)phenylazo)benzophenone,
5 2,4-dihydroxy-3-(o-(N-ethyl-N-(meth)acryloyloxyethylamino)phenylazo)benzophenone,
2,4-dihydroxy-5-(o-(N-ethyl-N-(meth)acryloyloxyethylamino)phenylazo)benzophenone,
2,4-dihydroxy-3-(p-(N-ethyl-N-(meth)acryloylamino)phenylazo)benzophenone,
10 2,4-dihydroxy-5-(p-(N-ethyl-N-(meth)acryloylamino)phenylazo)benzophenone,
2,4-dihydroxy-3-(o-(N-ethyl-N-(meth)acryloylamino)phenylazo)benzophenone, and
15 2,4-dihydroxy-5-(o-(N-ethyl-N-(meth)acryloylamino)phenylazo)benzophenone. These
(meth)acrylic monomers may be used alone or in
combination as a mixture of two or more different kinds.

In the above specific examples, a (meth)acrylate
20 means an acrylate and/or a methacrylate. The same
applies to other (meth)acrylic derivatives.

Specific examples of the styrene monomer include, for
example, silicon-containing styrene derivatives of the
formula III:



- 5 wherein k is 0 or 1, m is an integer of from 1 to 15 and n is an integer of from 1 to 15, such as
- tris(trimethylsiloxo)silylstyrene,
- bis(trimethylsiloxo)methylsilylstyrene,
- (trimethylsiloxo)dimethylsilylstyrene,
- 10 trimethylsilylstyrene,
- tris(trimethylsiloxo)siloxanyldimethylsilylstyrene,
- [bis(trimethylsiloxo)methylsiloxanyl]dimethylsilyl-
- styrene, pentamethyltrisiloxanylstyrene,
- heptamethyltrisiloxanylstyrene,
- 15 nonamethyltetrasiloxanylstyrene,
- pentadecamethylheptasiloxanylstyrene,
- heneicosamethyldecasiloxanylstyrene,
- heptacosamethyltridecasiloxanylstyrene,
- hentriacontamethylpentadecasiloxanylstyrene,
- 20 trimethylsiloxo·pentamethyltrisiloxo·methylsilylstyrene,
- tris(pentamethyltrisiloxo)silylstyrene,
- (tris·trimethylsiloxo)siloxanyl·bis(trimethylsiloxo)-
- silylstyrene,
- bis(heptamethyltrisiloxo)methylsilylstyrene,
- 25 tris(methylbis·trimethylsiloxo·siloxo)silylstyrene,
- trimethylsiloxo·bis(tris·trimethylsiloxo·siloxo)-

silylstyrene,
heptakis(trimethylsiloxy)trisiloxanylstyrene,
nonamethyltetrasiloxylundecylmethylpentasiloxylmethyl-
silylstyrene, tris(tris(trimethylsiloxy)siloxy)silyl-
5 styrene,
(tristrimethylsiloxyhexamethyl)tetrasiloxyl(tris(trimethylsiloxy)siloxy)trimethylsiloxy-silylstyrene,
nonakis(trimethylsiloxy)tetrasiloxanylstyrene,
bis(tridecamethylhexasiloxyl)methylsilylstyrene,
10 heptamethylcyclotetrasiloxanylstyrene,
heptamethylcyclotetrasiloxylbis(trimethylsiloxy)-
silylstyrene and
tripropyltetramethylcyclotetrasiloxanylstyrene; fluorine-
containing styrene derivatives such as o-fluorostyrene,
15 m-fluorostyrene, p-fluorostyrene, trifluorostyrene,
perfluorostyrene, p-trifluoromethylstyrene, o-
trifluoromethylstyrene and m-trifluoromethylstyrene; and
styrene derivatives such as o-methylstyrene, m-
methylstyrene, p-methylstyrene, p-ethylstyrene, o-
20 hydroxystyrene, m-hydroxystyrene, p-hydroxystyrene,
trimethylstyrene, tert-butylstyrene, perbromostyrene,
dimethylaminostyrene and α-methylstyrene. These styrene
monomers may be used alone or in combination as a mixture
of two or more different types.

25 Further, vinyl monomers containing a vinyl group
other than the above-mentioned styrene monomers, may be
used as equivalent to the styrene monomers. Specific

examples of such vinyl monomers include, for example, vinyl lactams, such as N-vinylpyrrolidone, α -methylene-N-methylpyrrolidone and N-vinylcaprolactam; 4-vinylpyridine; hetero ring type N-vinyl monomers such as

5 N-vinylimidazole, N-vinylpiperidone, N-vinylpiperidine and N-vinylsuccinimide; azo type polymerizable dyes such as 2-(m-vinylanilino)-4-((p-nitrophenylazo)-anilino)-6-chloro-1,3,5-triazine, 2-(1'-(o-tolylazo)-2'-naphthyloxy)-4-(m-vinylanilino)-6-chloro-1,3,5-triazine,

10 2-(p-vinylanilino)-4-(1'-(o-tolylazo)-2'-naphthylamino)-6-chloro-1,3,5-triazine, N-(1'-(o-tolylazo)-2'-naphthyl)-3-vinylphthalic acid monoamide, N-(1'-(o-tolylazo)-2'-naphthyl)-6-vinylphthalic acid monoamide, 3-vinylphthalic acid-(4'-(p-sulfophenylazo)-1'-naphthyl)monoester, 6-

15 vinylphthalic acid-(4'-(p-sulfophenylazo)-1'-naphthyl)monoester, 2-amino-4-(m-(2'-hydroxy-1'-naphthylazo)anilino)-6-isopropenyl-1,3,5-triazine, 2-amino-4-(N-methyl-p-(2'-hydroxy-1'-naphthylazo)anilino)-6-isopropenyl-1,3,5-triazine, 2-amino-4-(m-(4'-hydroxy-1'-phenylazo)anilino)-6-isopropenyl-1,3,5-triazine,

20 2-amino-4-(N-methyl-p-(4'-hydroxyphenylazo)anilino)-6-isopropenyl-1,3,5-triazine, 2-amino-4-(m-(3'-methyl-1'-phenyl-5'-hydroxy-4'-pyrazolylazo)anilino)-6-isopropenyl-1,3,5-triazine, 2-amino-4-(N-methyl-p-(3'-methyl-1'-phenyl-5'-hydroxy-4'-pyrazolylazo)anilino)-6-isopropenyl-

25 1,3,5-triazine and 2-amino-4-(p-phenylazoanilino)-6-isopropenyl-1,3,5-triazine; anthraquinone type

polymerizable dyes such as 1-(4'-vinylbenzoylamide)-9,10-
anthraquinone, 4-amino-1-(4'-vinylbenzoylamide)-9,10-
anthraquinone, 5-amino-1-(4'-vinylbenzoylamide)-9,10-
anthraquinone, 8-amino-1-(4'-vinylbenzoylamide)-9,10-
5 anthraquinone, 4-nitro-1-(4'-vinylbenzoylamide)-9,10-
anthraquinone, 4-hydroxy-1-(4'-vinylbenzoylamide)-9,10-
anthraquinone, 1-(3'-vinylbenzoylamide)-9,10-
anthraquinone, 1-(2'-vinylbenzoylamide)-9,10-
anthraquinone, 1-(4'-isopropenylbenzoylamide)-9,10-
10 anthraquinone, 1-(3'-isopropenylbenzoylamide)-9,10-
anthraquinone, 1-(2'-isopropenylbenzoylamide)-9,10-
anthraquinone, 1,4-bis-(4'-vinylbenzoylamide)-9,10-
anthraquinone, 1,4-bis-(4'-isopropenylbenzoylamide)-9,10-
anthraquinone, 1,5-bis-(4'-vinylbenzoylamide)-9,10-
15 anthraquinone, 1,5-bis-(4'-isopropenylbenzoylamide)-9,10-
anthraquinone, 1-methylamino-4-(3'-vinylbenzoylamide)-
9,10-anthraquinone, 1-methylamino-4-(4'-
vinylbenzoyloxyethylamino)-9,10-anthraquinone, 1-amino-4-
(3'-vinylphenylamino)-9,10-anthraquinone-2-sulfonic acid,
20 1-amino-4-(4'-vinylphenylamino)-9,10-anthraquinone-2-
sulfonic acid, 1-amino-4-(2'-vinylbenzylamino)-9,10-
anthraquinone-2-sulfonic acid, 1-(β -
ethoxycarbonylallylamino)-9,10-anthraquinone, 1-(β -
carboxyallylamino)-9,10-anthraquinone, 1,5-di-(β -
25 carboxyallylamino)-9,10-anthraquinone, 1-(β -
isopropoxycarbonylallylamino)-5-benzoylamide-9,10-
anthraquinone, 2,4-bis-((4''-methoxyanthraquinone-1''-

yl)-amino)-6-(3'-vinylanilino)-1,3,5-triazine and 2-(2'-vinylphenoxy-(4-(4'-(3''-sulfo-4''-aminoanthraquinone-1''-yl-amino)-anilino)-6-chloro-1,3,5-triazine; and polymerizable ultraviolet absorptive dyes such as 2,4-
5 dihydroxy-3-(p-styrenoazo)benzophenone, 2,4-dihydroxy-5-(p-styrenoazo)benzophenone and phenyl 2-hydroxy-4-(p-styrenoazo)benzoate. These vinyl monomers may be used alone or in combination as a mixture of two or more different types.

10 A conventional cross linking agent may also be used as an assistant for the ocular lens material of the present invention, taking into accounts the types and amounts of the copolymer components or the nature of the desired copolymer. Specific examples of such a
15 conventional cross linking agent include, for example, ethylene glycol di(meth)acrylate, diethylene glycol di(meth)acrylate, triethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, dipropylene glycol di(meth)acrylate, allyl (meth)acrylate, vinyl
20 (meth)acrylate, trimethylolpropane tri(meth)acrylate, methacryloyloxyethyl acrylate, divinylbenzene, diallyl phthalate, diallyl azipate, triallyl isocyanurate, α-methylene-N-vinylpyrrolidone, 2,2-bis(p-(meth)acryloyloxyphenyl)hexafluoropropane, 2,2-bis(m-
25 (meth)acryloyloxyphenyl)hexafluoropropane, 2,2-bis(o-(meth)acryloyloxyphenyl)hexafluoropropane, 2,2-bis(p-(meth)acryloyloxyphenyl)propane, 2,2-bis(m-

(meth)acryloyloxyphenyl)propane, 2,2-bis(o-
(meth)acryloyloxyphenyl)propane, 1,4-bis(2-
(meth)acryloyloxyhexafluoroisopropyl)benzene, 1,3-bis(2-
(meth)acryloyloxyhexafluoroisopropyl)benzene, 1,2-bis(2-
5 (meth)acryloyloxyhexafluoroisopropyl)benzene, 1,4-bis(2-
(meth)acryloyloxyisopropyl)benzene, 1,3-bis(2-
(meth)acryloyloxyisopropyl)benzene and 1,2-bis(2-
(meth)acryloyloxyisopropyl)benzene. These conventional
cross linking agents may be used alone or in combination
10 as a mixture of two or more different types.

The proportion of the cross linking agent of the
formula I in the ocular lens material of the present
invention is preferably within a range of from about 0.5
to 15 parts by weight, more preferably from 2 to 10 parts
15 by weight, in 100 parts by weight of the total amount of
the copolymer components used. If the cross linking
agent exceeds 15 parts by weight, the physical properties
attributable to other monomer components for
polymerization, such as the oxygen permeability, tend to
20 be low, and the material thereby obtained tends to be
brittle and weak against a stress such as an impact. On
the other hand, if the amount is less than 0.5 part by
weight, a distortion is likely to result and a turbidity
is likely to form in the resulting material, and the
25 ocular lens material tends to be non-uniform and lack in
optical transparency, and thus the effects of using the
cross linking agent tend to be low.

The types, the number and the amounts of monomers as components of the ocular lens material of the present invention other than the cross linking agent of the formula I, may optionally be selected depending upon the physical properties or the nature of the desired ocular lens material.

For example, to obtain a contact lens material having good oxygen permeability, a silicon-containing monomer or a fluorine-containing monomer, preferably a silicon-containing (meth)acrylate, a silicon-containing styrene derivative, a fluorine-containing (meth)acrylate or a fluorine-containing styrene derivative, may be selected.

To improve the strength of a lens and to obtain an ocular lens material having high strength, an alkyl (meth)acrylate, styrene, a styrene derivative or (meth)acrylic acid may preferably be selected.

To impart hydrophilicity to a lens or to obtain a water absorptive soft ocular lens material, a monomer having a hydrophilic group, preferably a hydroxyl group-containing (meth)acrylate, (meth)acrylamide, aminoalkyl (meth)acrylate, (meth)acrylic acid or N-vinyl lactam, may be selected.

To obtain an ocular lens material scarcely stained with lipids, a fluorine-containing monomer, preferably a fluorine-containing (meth)acrylate or a fluorine-containing styrene derivative, may be selected.

To obtain an ocular lens material having a high

refractive index, a monomer containing an aromatic ring, preferably a styrene monomer, may be selected.

To impart an ultraviolet absorptivity to the material or to color the material, a monomer may be suitably
5 selected from polymerizable ultraviolet absorbers, polymerizable dyes and polymerizable ultraviolet absorptive dyes.

Among them, an ocular lens material comprising a silicon-containing styrene derivative, a fluorine-
10 containing (meth)acrylate and the cross linking agent of the formula I as essential components, is particularly preferably used as a contact lens material, since it is optically transparent without optical distortion and has a high refractive index and excellent mechanical strength
15 and hardness and thus is excellent in the durability against an impact, and yet it is a material having excellent oxygen permeability. The proportion of such a silicon-containing styrene derivative and a fluorine-containing (meth)acrylate in the ocular lens material is
20 preferably within a range of from 40 to 99.5 parts by weight, more preferably within a range of from 50 to 98 parts by weight, in 100 parts by weight of the total amount of the copolymer components, with a view to obtaining a contact lens material which is optically
25 transparent without optical distortion and has a high refractive index and excellent mechanical strength and hardness and thus is excellent in the durability against

an impact and which has excellent oxygen permeability. Further, when the total amount of the silicon-containing styrene derivative and the fluorine-containing (meth)acrylate is 100 parts by weight, the silicon-
5 containing styrene derivative is preferably within a range of from 5 to 95 parts by weight, and the fluorine-containing (meth)acrylate is preferably within a range of from 5 to 95 parts by weight. Further, the silicon-
10 containing styrene derivative is more preferably within a range of from 30 to 90 parts by weight, and the fluorine-containing (meth)acrylate is more preferably within a range of from 10 to 70 parts by weight. Particularly preferably, the silicon-containing styrene derivative is at least 30 parts by weight in 100 parts by weight of the
15 styrene monomer as a copolymer component, and the fluorine-containing (meth)acrylate is at least 40 parts by weight in 100 parts by weight of the (meth)acrylate monomer as a copolymer component.

The ocular lens material of the present invention is
20 prepared by a method which is commonly employed in this technical field by uniformly mixing the cross linking agent of the formula I with various monomer components (such as the (meth)acrylate monomer and the styrene monomer) and adding a polymerization initiator as the
25 case requires.

The polymerization is conducted, if necessary, using a radical polymerization initiator, by gradually heating

within a temperature range of from room temperature to about 130°C or by irradiating electromagnetic waves such as microwaves, ultraviolet rays or radiation rays (γ -rays). In the case of the heat polymerization, the
5 temperature may stepwisely be raised. The polymerization may be conducted by a bulk polymerization method or a solvent polymerization method by means of a solvent, or it may be conducted by any other method.

Specific examples of the radical polymerization
10 initiator include, for example, azobisisobutyronitrile, azobisdimethylvaleronitrile, benzoylperoxide, tert-butylhydroperoxide and cumenehydroperoxide. These initiators may be used alone or in combination as a mixture of two or more different types. In a case where
15 photopolymerization is employed, a photopolymerization initiator or sensitizer may preferably be added.

The amount of the polymerization initiator is preferably within a range of from 0.01 to 1 part by weight per 100 parts by weight of the total monomer
20 mixture subjected to the polymerization.

When the ocular lens material thus obtained is shaped into ocular lenses such as contact lenses or intraocular lenses, shaping methods commonly used by those skilled in the art such as a lathe cutting and polishing method and
25 a molding method, may be employed. For example, the lathe cutting and polishing method is a method in which the polymerization is conducted in a suitable mold or

vessel to obtain a rod-, block- or plate-shaped base material (copolymer), and then the base material is processed into a desired shape by mechanical processing such as lathe cutting and polishing. The molding method is a method in which a mold corresponding to the shape of a desired ocular lens is prepared, and the polymerization of the monomer mixture is conducted in this mold to obtain a molded product, which may further be subjected to mechanical finishing treatment, if necessary.

Further, when the ocular lens material of the present invention is used as an intraocular lens, a supporting portion of the lens may be prepared separately from the lens and then attached to the lens, or it may be molded simultaneously (integrally) with the lens.

Plasma treatment may be applied to the ocular lens material of the present invention, if necessary. The apparatus and method for the treatment may be those commonly employed in this technical field. As the treating conditions, it is common to employ such conditions that the treatment is conducted for from a few seconds to a few tens minutes in an inert gas atmosphere such as helium, neon or argon or in a gas atmosphere such as air, oxygen, nitrogen, carbon monoxide or carbon dioxide under a pressure of from about 0.0001 to a few Torr at a power of from a few W to about 100 W. More preferably, conditions such that the treatment is conducted in an atmosphere of air, oxygen or argon under

a pressure of about from 0.05 to 3 Torr at a power of from about 10 to 60 W for a period of a few minutes, are employed.

Now, the present invention will be described in further detail with reference to Examples. However, it should be understood that the present invention is by no means restricted to such specific Examples.

EXAMPLE 1

Preparation of 4-vinylbenzyl methacrylate

10 Into a 1 l three necked round bottom flask equipped with a thermometer and a Dimroth condenser having a calcium chloride tube attached thereto, 300 ml of benzene and 103 g (about 1.2 mols) of methacrylic acid were charged. While cooling the mixture in an ice bath to a
15 temperature of not higher than 10°C, 167 g (about 1.1 mols) of 1,8-diazabicyclo[5.4.0]-7-undecene was gradually dropwise added over a period of about 30 minutes by means of a dropping funnel. Then, 153 g (about 1.0 mol) of p-chloromethylstyrene was gradually dropwise added over a
20 period of about 5 minutes by means of a dropping funnel, while maintaining the temperature at a level of not higher than 10°C. Then, the ice bath was removed, and the mixture was reacted at room temperature for 24 hours.

The reaction mixture thus obtained was subjected to
25 aspiration filtration to remove solid by-products. The filtrate was washed twice with a 5% sodium carbonate aqueous solution and then washed three times with water.

The organic layer was dried overnight with anhydrous sodium sulfate. The drying agent was removed by filtration, and the organic layer was concentrated and distilled for purification. The yield of the purified product was 60%. The purified product was a colorless liquid having an aroma. The boiling point during the distillation was 105°C (under 0.12 mmHg).

The infrared absorption spectrum and the ¹H-nuclear magnetic resonance spectrum of the purified product were measured and analyzed, whereby this purified product was ascertained to be 4-vinylbenzyl methacrylate.

EXAMPLE 2

Preparation of a copolymer

60 parts by weight of tris(trimethylsiloxy)silylpropyl methacrylate, 40 parts by weight of trimethylsilylstyrene, 6 parts by weight of 4-vinylbenzyl methacrylate prepared in Example 1, 6.2 parts by weight of N-vinylpyrrolidone and 4.8 parts by weight of methacrylic acid were uniformly mixed, and 0.3 part by weight of azobisdimethylvaleronitrile was added to obtain a blend solution. About 50 ml of the blend solution was introduced into a glass test tube, and the test tube was closed.

Preliminary polymerization was conducted in a water bath of 35°C for 40 hours, and then the test tube was transferred to an air circulating oven. Then, the mixture was reacted at 50°C for 6 hours, and then the

temperature was raised to 130°C at a rate of 10°C per from 1 to 1.5 hours, whereby the components were heat-polymerized to obtain a rod-shaped copolymer.

Then, this rod-shaped copolymer was mechanically
5 processed by lathe cutting and polishing to obtain a test specimen. The physical properties (the appearance, the distortion, the Rockwell hardness, the oxygen permeability coefficient, the refractive index, the impact strength) of the test specimen thus obtained were
10 measured as follows. The results are shown in Table 1.

The test specimen obtained had a transparent appearance without distortion and was suitable to obtain an ocular lens material.

Appearance

15 The appearance of the rod-shaped copolymer was visually observed.

Presence or absence of distortion

The presence or absence of distortion of the rod-shaped copolymer was ascertained by an optical elastic
20 distortion meter (precision distortion meter SVP-30, manufactured by Toshiba Corporation). When no distortion was detected, the distortion was identified as "Nil", and when a white or rainbow distortion was observed, the distortion was identified as "Yes".

25 Rockwell hardness

The Rockwell hardness was measured using a test specimen having a diameter of 12.7 mm and a thickness of

4 mm by a Rockwell superficial hardness meter (ASD, manufactured by Kabushiki Kaisha Akashi Seisakusho) under a load of 30 kg, an indenter of 1/4 inch at 25°C.

Oxygen permeability coefficient

5 With respect to several test specimens having a diameter of 12.7 mm and different thicknesses, the oxygen permeability coefficients were measured in a saline at 35°C by means of a Seikaken type film oxygen permeation measuring instrument manufactured by Rika Seiki Kogyo
10 Kabushiki Kaisha. The unit of the numerical values in Table 1 is

$\frac{\text{ml (STP)} \cdot \text{cm}^2}{\text{cm}^3 \cdot \text{sec} \cdot \text{mmHg}}$. The numerical values in the Table are

15 values obtained by multiplying the values of the original oxygen permeability coefficients by 10^{11} .

Refractive index

The refractive index (n_D^{20}) of a test specimen having a diameter of 12.7 mm and a thickness of 4 mm was
20 measured by an Abbe refractometer (1T manufactured by Atago K.K.).

Impact strength

A steel ball having a weight of 6.75 g was dropped onto a test piece having a thickness of 0.5 mm, and the
25 height (mm) when the test piece broke was measured as the impact strength.

EXAMPLES 3 TO 9

In the same manner as in Example 2, the components as identified in Table 1 were uniformly mixed and polymerized to obtain a copolymer, and a test specimen
5 was prepared therefrom, and various physical properties were measured in the same manner. The results are shown in Table 1.

COMPARATIVE EXAMPLES 1 TO 5

In the same manner as in Example 2, a test specimen
10 was prepared by a blend composition as shown in Table 1 using a conventional cross linking agent (ethylene glycol dimethacrylate, divinylbenzene, allyl methacrylate, or trimethylolpropane trimethacrylate), and various physical properties were measured in the same manner. The results
15 are shown in Table 1.

Symbols used in Table 1

SiMA: Tris(trimethylsiloxy)silylpropyl methacrylate
SiSt1: Trimethylsilylstyrene
SiSt2: Tris(trimethylsiloxy)silylstyrene
20 6FP: 2,2,2,2',2',2'-hexafluoroisopropyl methacrylate
VBMA: 4-vinylbenzyl methacrylate
EDMA: Ethylene glycol dimethacrylate
DVBz: Divinylbenzene
AMA: Allyl methacrylate
25 TMP: Trimethylolpropane trimethacrylate
N-VP: N-vinylpyrrolidone
MAA: Methacrylic acid

MMA: Methyl methacrylate

V-65: Azobisdimethylvaleronitrile

Table 1

Example No.		2	3	4	5	6	7	8	9
Blend component (parts by weight)	(Meth)acrylic monomer	SiMA 60 MAA 4.8	6FP 54 MAA 4.8	6FP 35 MAA 4.8	6FP 35 MAA 4.8	6FP 35 MAA 4.8	6FP 17 MAA 4.8	6FP 6 MMA 30 SiMA 4 MAA 4	6FP 7 MMA 15 SiMA 5 MAA 4
	Styrene monomer	SiSt1 40	SiSt2 46	SiSt2 65	SiSt2 65	SiSt2 65	SiSt2 83	SiSt2 46	SiSt2 61
	Other monomer	N-VP 6.2	N-VP 6.2	N-VP 6.2	N-VP 6.2	N-VP 6.2	N-VP 6.2		
	Cross linking agent	VBMA 6	VBMA 6	VBMA 3	VBMA 6	VBMA 9	VBMA 6	VBMA 10	VBMA 8
	Polymerization initiator	V-65 0.3	V-65 0.3	V-65 0.3	V-65 0.3	V-65 0.3	V-65 0.3	V-65 0.3	V-65 0.3
Physical properties	Appearance	Trans- parent	Trans- parent	Trans- parent	Trans- parent	Trans- parent	Trans- parent	Trans- parent	Trans- parent
	Distortion	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Rockwell hardness (30X)	40	58	38	45	49	39	76	61
	Oxygen permeability coefficient	125	209	260	247	230	270	60	101
	Refractive index	1.488	1.436	1.447	1.449	1.454	1.450	1.468	1.462
	Impact strength	35	34	29	37	38	31	31	27

Table 1 (continued)

Example No.		Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Blend compo- nent (parts by weight)	(Meth)acrylic monomer	SiMA 60 MAA 4.8	6FP 54 MAA 4.8	6FP 54 MAA 4.8	6FP 54 MAA 4.8	6FP 54 MAA 4.8
	Styrene monomer	SiSt1 40	SiSt2 46	SiSt2 46	SiSt2 46	SiSt2 46
	Other monomer	N-VP 6.2	N-VP 6.2	N-VP 6.2	N-VP 6.2	N-VP 6.2
	Cross linking agent	EDMA 6	EDMA 6	DVBz 6	AMA 6	TMP 6
	Polymerization initiator	V-65 0.22	V-65 0.3	V-65 0.3	V-65 0.3	V-65 0.3
Physical proper- ties	Appearance	Turbid	Turbid	Turbid	Slightly turbid	Turbid
	Distortion	Yes	Yes	Yes	Slightly yes	Yes
	Rockwell hardness (30X)	35	56	51	20	59
	Oxygen permeability coefficient	121	170	180	187	175
	Refractive index	1.483	1.434	1.437	1.434	1.435
	Impact strength	34	30	21	15	28

As is evident from the comparison of Examples and Comparative Examples, with respect to the ocular lens material obtainable by copolymerizing a (meth)acrylic monomer and a styrene monomer, in the Examples of the present invention, the appearance was transparent without distortion, and the material had no problem as an ocular lens material. Whereas, in Comparative Examples 1 to 3 and 5 wherein conventional cross linking agents were used, the appearance was turbid and a distortion was observed, and the products were not suitable as optical lens materials. In Comparative Example 4, the product was substantially transparent, and the distortion was less than those in other Comparative Examples, but inferior to those in the Examples of the present invention, and the hardness and the impact strength were also lower than those in the Examples of the present invention, and thus an ocular lens material having satisfactory physical properties was not obtained.

Further, among them, an ocular lens material containing a silicon-containing styrene derivative and a fluorine-containing (meth)acrylate and the vinylbenzyl (meth)acrylate as the main components (particularly Examples 3 to 7), is a material which is optically transparent without distortion and has a high refractive index and excellent mechanical strength and hardness and thus has excellent durability against an impact and which has an extremely high oxygen permeability with an oxygen

permeability coefficient of at least 200 (the unit is the same as in Table 1). Thus, this optical lens material is suitable for use as a contact lens material.

It is evident from the comparison in the oxygen permeability coefficients between Example 3 and Comparative Examples 2 to 5 that the oxygen permeability coefficients in the Comparative Examples are all lower than 190 (the unit is the same as in Table 1) and inferior to the oxygen permeation coefficient in Example 3, in spite of the fact that in each Example, the copolymer was composed of the same composition except that the cross linking agent used was different.

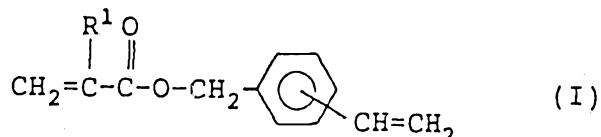
The ocular lens material of the present invention is a strong copolymer with a cross linked network structure formed by the linking agent of the formula I and is optically transparent without distortion. Particularly an ocular lens material of the present invention comprising a styrene monomer and a (meth)acrylate monomer as the copolymer components, is an ocular lens material which is tough and excellent in the mechanical strength and hardness, is transparent without distortion and has excellent optical properties.

Among them, a material containing a silicon-containing styrene derivative and a fluorine-containing (meth)acrylate and the vinylbenzyl (meth)acrylate as the main components, is a material which is optically transparent without a distortion and has a high

refractive index and excellent mechanical strength and hardness and thus is excellent in the durability against an impact and which has an extremely high oxygen permeability. Thus, it is suitable for use as a contact
5 lens material.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. An ocular lens material, comprising a copolymer of a styrene monomer; with an acrylic monomer and/or a methacrylate monomer; and a cross linking agent of the formula:



wherein R¹ is a hydrogen atom or a methyl group and wherein the content of the cross linking agent is from 0.5 to 15 parts by weight in 100 parts by weight of the total copolymer components.

2. The ocular lens material according to claim 1, which is a contact lens material comprising the cross linking agent of the formula I, a silicon-containing styrene derivative, and a fluorine-containing acrylate and/or a fluorine-containing methacrylate.

3. An ocular lens fabricated from the optical lens material of claim 1 or claim 2.

4. Ocular lens materials or methods for their manufacture, substantially as hereinbefore described with reference to the Examples.

DATED this 28th day of August 1990.

MENICON CO., LTD.

By Its Patent Attorneys

DAVIES & COLLISON

