

DESCRIPTION

TITLE OF THE INVENTION

ACRYLIC RUBBER, ACRYLIC RUBBER COMPOSITION,
5 CROSSLINKED ACRYLIC RUBBER, SEALING MATERIAL, AND
 HOSE MATERIAL

TECHNICAL FIELD

[0001]

10 The present invention relates to acrylic
 rubbers, acrylic rubber compositions, crosslinked
 acrylic rubbers, sealing materials, and hose
 materials.

15 BACKGROUND ART

[0002]

 Acrylic rubbers have been widely used as
 rubber materials for obtaining crosslinked rubbers
 with excellent aging resistance, oil resistance, and
20 heat resistance in various sealing materials, hose
 materials, and other functional parts mainly for
 automotive applications.

[0003]

 For example, Patent Document 1 discloses
25 an acrylic rubber obtained by copolymerizing 10 to
 100 parts by mass of a methacrylate alkyl ester unit
 with 0.5 to 4 parts by mass of a crosslinkable
 monomer, with respect to 100 parts by mass of an
 acrylate alkyl ester.

30

RELATED ART DOCUMENTS

[Patent Document]

[0004]

Patent Document 1: International
Publication No. 2009/099113

SUMMARY OF INVENTION

5 [PROBLEM TO BE SOLVED BY THE INVENTION]
[0005]

However, concerns have been risen for
rubber parts due to adverse effects caused by the
following factors. First, in recent years, thermal
10 environment conditions around internal combustion
engines have become severe due to higher output of
the internal combustion engines and measures against
the exhaust gas. Next, the engine oil is used under
high-temperature conditions without being replaced
15 for a long time, and thereby, progressively
deteriorated due to contact with heat, air,
moisture, exhaust gas, and the like. Therefore,
when used as seal members and hose members for
automobiles that come into contact with the engine
20 oil and the like, a crosslinked rubber of an acrylic
rubber is required to have resistance to engine oil
that has been deteriorated (hereafter, referred to
as the "deteriorated engine oil").

[0006]
25 The problem to be solved by the present
invention is to provide an acrylic rubber, from
which a crosslinked acrylic rubber can be obtained
that is excellent in the heat aging resistance, oil
resistance, and resistance to deteriorated engine
30 oil.

[MEANS FOR SOLVING THE PROBLEM]
[0007]

In one aspect according to the present invention, an acrylic rubber contains 5 to 75 wt% of a methacrylate ester monomeric unit; and 0.5 to 5 wt% of a crosslinkable monomeric unit, wherein the methacrylate ester monomeric unit is at least one species selected from among a methacrylate alkoxyalkyl ester monomeric unit, a methacrylate polyalkylene glycol ester monomeric unit, and a methacrylate alkoxypolyalkylene glycol ester monomeric unit.

[ADVANTAGEOUS EFFECT OF THE PRESENT INVENTION]
[0008]

According to one aspect of the present invention, it is possible to provide an acrylic rubber from which a crosslinked acrylic rubber can be obtained that is excellent in the heat aging resistance, oil resistance, and resistance to deteriorated engine oil.

EMBODIMENTS FOR CARRYING OUT THE INVENTION
[0009]

In the following, embodiments of the present invention will be described in detail.

[0010]

<Acrylic rubber>

An acrylic rubber according to an embodiment of the present invention is an acrylic rubber that contains 5 to 75 wt% of a methacrylate ester monomeric unit; and 0.5 to 5 wt% of a crosslinkable monomeric unit, wherein the methacrylate ester monomeric unit is at least one species selected from among a methacrylate

alkoxyalkyl ester monomeric unit, a methacrylate polyalkylene glycol ester monomeric unit, and a methacrylate alkoxy polyalkylene glycol ester monomeric unit.

5 [0011]

The methacrylate ester monomer constituting the methacrylate ester monomeric unit contained in the acrylic rubber of the present embodiment, is at least one species selected from
10 among a methacrylate alkoxyalkyl alkylene ester monomer, a methacrylate polyalkylene glycol ester monomer, and a methacrylate alkoxy polyalkylene glycol ester monomer.

[0012]

15 As the methacrylate alkoxyalkyl ester monomer, although not limited in particular, an ester of alkoxyalkyl alcohol having 2 to 8 carbon atoms and methacrylic acid is favorable; an ester of alkoxyalkyl alcohol having 3 to 6 carbon atoms and
20 methacrylic acid is more favorable; and an ester of alkoxyalkyl alcohol having 3 to 4 carbon atoms and methacrylic acid is even more favorable. Specifically, for example, methoxymethyl methacrylate, ethoxymethyl methacrylate, 1-
25 methoxyethyl methacrylate, 2-methoxyethyl methacrylate, 1-ethoxyethyl methacrylate, 2-ethoxyethyl methacrylate, 1-propoxyethyl methacrylate, 2-propoxy methyl methacrylate ethyl, 1-butoxyethyl methacrylate, 2-butoxyethyl
30 methacrylate, 1-methoxypropyl methacrylate, 2-methoxypropyl methacrylate, 3-methoxypropyl methacrylate, 1-methoxybutyl methacrylate, 2-methoxybutyl methacrylate, 3-methoxybutyl

methacrylate, 4-methoxybutyl methacrylate, 1-methyl-
2-methoxyethyl methacrylate, 1-ethyl-2-methoxyethyl
methacrylate, and tetrahydrofurfuryl methacrylate,
and the like may be listed. Among these, 2-
5 methoxyethyl methacrylate, 2-ethoxyethyl
methacrylate, 1-methyl-2-methoxyethyl methacrylate,
1-butoxyethyl methacrylate and 4-methoxybutyl
methacrylate are favorable. One of these species
may be used singly, or two or more species may be
10 used together.
[0013]

As the methacrylate alkoxy polyalkylene
glycol ester monomer, although not limited in
particular, an ester of polyalkylene glycol having 2
15 to 30 carbon atoms and methacrylic acid is
favorable; specifically, for example, ethylene
glycol methacrylate, diethylene glycol methacrylate,
triethylene glycol methacrylate, tetraethylene
glycol methacrylate, polyethylene glycol
20 methacrylate, propylene glycol methacrylate,
dipropylene glycol methacrylate, polypropylene
glycol methacrylate, and the like may be listed.
Among these, diethylene glycol methacrylate and
triethylene glycol methacrylate are favorable. One
25 of these species may be used singly, or two or more
species may be used together.
[0014]

As the methacrylate alkoxy polyalkylene
glycol ester monomer, although not limited in
30 particular, an ester of alkoxy polyalkylene glycol
having 5 to 32 carbon atoms and methacrylic acid is
favorable; an ester of alkoxy polyalkylene glycol
having 5 to 11 carbon atoms and methacrylic acid is

more favorable; and an ester of alkoxy polyalkylene glycol having 5 to 7 carbon atoms and methacrylic acid is even more favorable. Specifically, for example, methoxydiethylene glycol methacrylate, 5 methoxytriethylene glycol methacrylate, ethoxydiethylene glycol methacrylate, ethoxytriethylene glycol methacrylate, methoxydipropylene glycol methacrylate, methoxytripropylene glycol methacrylate, 10 methoxypolyethylene glycol methacrylate, ethoxypolyethylene glycol methacrylate, methoxy polypropylene glycol methacrylate, ethoxy polypropylene glycol methacrylate, and the like may be listed. Among these, methoxydiethylene glycol 15 methacrylate and methoxytriethylene glycol methacrylate are favorable. One of these species may be used singly, or two or more species may be used together.

[0015]

20 Among these, a methacrylate alkoxyalkyl ester monomer or a methacrylate alkoxy polyalkylene glycol ester monomer is favorable, and a methacrylate alkoxyalkyl ester monomer is more favorable. Specifically, 2-methoxyethyl 25 methacrylate, 2-ethoxyethyl methacrylate, methoxydiethylene glycol methacrylate, methoxytriethylene glycol methacrylate are more favorable, and 2-methoxyethyl methacrylate and 2-ethoxyethyl methacrylate are even more favorable. 30 One species of these methacrylic acid esters may be used singly, or two or more species may be used together.

[0016]

The content of the above-described methacrylate ester monomeric unit is, with respect to 100 wt% of all the monomer units constituting an acrylic rubber, greater than or equal to 5.0 wt%, favorably greater than or equal to 6.0 wt%, more favorably greater than or equal to 8.0 wt%, and particularly favorably greater than or equal to 10.0 wt%; and less than or equal to 75.0 wt%, favorably less than or equal to 70.0 wt%, more favorably less than or equal to 65.0 wt%, and particularly favorably less than or equal to 50 wt%. If the content of the methacrylate ester monomeric unit is too low, a crosslinked rubber to be obtained does not exhibit satisfactory oil resistance, resistance to deteriorated engine oil, and heat aging resistance; or if the content is too high, a crosslinked rubber to be obtained may exhibit a reduced cold resistance.

[0017]

As the crosslinkable monomer constituting the crosslinkable monomeric unit contained in an acrylic rubber according to the present embodiment, although not limited in particular, for example, a carboxyl group, an epoxy group, a halogen group (or halogen atom), a diene monomer, or the like may be listed. Note that the crosslinkable monomeric unit is a structural unit derived from a crosslinkable monomer having a crosslinkable group in its side chain.

[0018]

As a monomer having a carboxyl group, although not limited in particular, an α,β -

ethylenically unsaturated carboxylic acid monomer or the like may be listed.

[0019]

As an α,β -ethylenically unsaturated
5 carboxylic acid monomer, although not limited in particular, an α,β -ethylenically unsaturated monocarboxylic acid having 3 to 12 carbon atoms; an α,β -ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms; a monoester of an α,β -
10 ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms and an alkanol having 1 to 8 carbon atoms; or the like may be listed. Using an α,β -ethylenically unsaturated carboxylic acid monomer enables to form an acrylic rubber as a
15 carboxyl-group-containing acrylic rubber having a carboxyl group as a crosslinking point, and thereby, further enables to raise the compression set resistance in the case of being formed as a crosslinked rubber.

20 [0020]

As examples of α,β -ethylenically unsaturated monocarboxylic acid having 3 to 12 carbon atoms, acrylic acid, methacrylic acid, α -ethyl acrylic acid, crotonic acid, cinnamic acid,
25 and the like may be listed.

[0021]

As examples of α,β -ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms, butanedioic acid such as fumaric acid and
30 maleic acid; itaconic acid; citraconic acid; chloromaleic acid; and the like may be listed.

[0022]

As examples of monoester of α,β -

ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms and alkanol having 1 to 8 carbon atoms, butanedioic acid mono-chain alkyl ester such as monomethyl fumarate, monoethyl fumarate, mono-n-butyl fumarate, monomethyl maleate, monoethyl maleate, and mono-n-butyl maleate; butanedioic acid monoester having an alicyclic structure such as monocyclopentyl fumarate, monocyclohexyl fumarate, monocyclohexenyl fumarate, monocyclopentyl maleate, monocyclohexyl maleate, and monocyclohexenyl maleate; itaconic acid monoester such as monomethyl itaconate, monoethyl itaconate, mono-n-butyl itaconate, and monocyclohexyl itaconate; and the like may be listed.

[0023]

Among these, butanedioic acid mono-chain alkyl ester or butenedioic acid monoester having an alicyclic structure is favorable; mono-n-butyl fumarate, mono-n-butyl maleate, monocyclohexyl fumarate, and monocyclohexyl maleate are more favorable; and mono-n-butyl maleate and mono-n-butyl fumarate is furthermore favorable. One species of these α,β -ethylenically unsaturated carboxylic acid monomers may be used singly, or two or more species may be used together. Among the monomers described above, dicarboxylic acid includes a monomer existing as an anhydride.

[0024]

As monomers having an epoxy group, although not limited in particular, an epoxy-group-containing (meth)acrylate ester such as glycidyl (meth)acrylate; epoxy-group-containing styrene such as p-vinylbenzyl glycidyl ether; epoxy-group-

containing ether such as allyl glycidyl ether, vinyl glycidyl ether, 3,4-epoxy-1-pentene, 3,4-epoxy-1-butene, 4,5-epoxy-2-pentene, 4-vinylcyclohexyl glycidyl ether, cyclohexenyl methyl glycidyl ether,
5 3,4-epoxy-1-Vinylcyclohexene, and allylphenyl glycidyl ether; and the like may be listed.
[0025]

As monomers having a halogen group, although not limited in particular, unsaturated
10 alcohol ester of halogen-containing saturated carboxylic acid, haloalkyl (meth)acrylate ester, haloacyloxyalkyl (meth)acrylate ester, (haloacetylcarbamoxyloxy)alkyl (meth)acrylate ester, halogen-containing unsaturated ether, halogen-
15 containing unsaturated ketone, halomethyl-group-containing aromatic vinyl compound, halogen-containing unsaturated amide, haloacetyl-group-containing unsaturated monomer, and the like may be listed.

20 [0026]

As specific examples of unsaturated alcohol ester of halogen-containing saturated carboxylic acid, vinyl chloroacetate, vinyl 2-chloropropionate, allyl chloroacetate, and the like
25 may be listed.

[0027]

As specific examples of haloalkyl (meth)acrylate ester, chloromethyl (meth)acrylate, 1-chloroethyl (meth)acrylate, 2-chloroethyl
30 (meth)acrylate, 1,2-dichloroethyl (meth)acrylate, 2-chloropropyl (meth)acrylate, 3-chloropropyl (meth)acrylate, 2,3-dichloropropyl (meth)acrylate, and the like may be listed.

[0028]

As specific examples of haloacyloxyalkyl
(meth)acrylate ester, 2-(chloroacetoxy)ethyl
(meth)acrylate, 2-(chloroacetoxy)propyl
5 (meth)acrylate, 3-(chloroacetoxy)propyl
(meth)acrylate, 3-(hydroxychloroacetoxy)propyl
(meth)acrylate, and the like may be listed.

[0029]

As specific examples of
10 (haloacetylcarbamoxyloxy)alkyl (meth)acrylate ester,
2-(chloroacetylcarbamoxyloxy)ethyl (meth)acrylate, 3-
(chloroacetylcarbamoxyloxy)propyl (meth)acrylate, and
the like may be listed.

[0030]

15 As specific examples of halogen-containing
unsaturated ether, chloromethyl vinyl ether, 2-
chloroethyl vinyl ether, 3-chloropropyl vinyl ether,
2-chloroethyl allyl ether, 3-chloropropyl allyl
ether, and the like may be listed.

20 [0031]

As specific examples of halogen-containing
unsaturated ketone, 2-chloroethylvinyl ketone, 3-
chloropropyl vinyl ketone, 2-chloroethyl allyl
ketone, and the like may be listed.

25 [0032]

As specific examples of halomethyl-
containing aromatic vinyl compounds, p-
chloromethylstyrene, m-chloromethylstyrene, o-
chloromethylstyrene, p-chloromethyl- α -methylstyrene,
30 and the like may be listed.

[0033]

As specific examples of halogen-containing
unsaturated amide, N-chloromethyl (meth)acrylamide,

and the like may be listed.

[0034]

As specific examples of haloacetyl-group-containing unsaturated monomers, 3-

5 (hydroxychloroacetoxy)propylallyl ether, p-vinylbenzyl chloroacetate, and the like may be listed.

[0035]

As diene monomers, although not limited in particular, for example, conjugated diene monomers and non-conjugated diene monomers may be listed.

Note that if diene monomers contain polyfunctional monomers described above, diene monomers considered here are diene monomers other than monomers of components contained in the polyfunctional monomers.

15 [0036]

As specific examples of conjugated diene monomers, 1,3-butadiene, isoprene, piperylene, and the like may be listed.

20 [0037]

As specific examples of non-conjugated diene monomers, ethylidene norbornene, dicyclopentadiene, dicyclopentadienyl (meth)acrylate, 2-dicyclopentadienylethyl (meth)acrylate, and the like may be listed.

25 [0038]

Among the above crosslinkable monomers, a monomeric unit having a carboxyl group, an epoxy group, or a halogen group is favorable, and a monomeric unit having a carboxyl group is more favorable. Further, among the monomer units having a carboxyl group, an α,β -ethylenically unsaturated carboxylic acid monomer is particularly favorable.

In the case of using an α,β -ethylenically unsaturated carboxylic acid monomer, the acrylic rubber can be made as a carboxyl-group-containing acrylic rubber as described above. Forming the acrylic rubber as a carboxyl-group-containing acrylic rubber imparts satisfactory resistance to deteriorated engine oil, and improves the heat aging resistance and compression set resistance.

[0039]

The content of a crosslinkable monomeric unit is, with respect to 100 wt% as the total of all monomeric units constituting an acrylic rubber, greater than or equal to 0.5 wt%, favorably greater than or equal to 0.6 wt%, and more favorably greater than or equal to 0.7 wt%; and less than or equal to 5 wt%, favorably less than or equal to 4.0 wt%, and more favorably less than or equal to 3.0 wt%. Note that if the crosslinkable monomeric unit accounts for less than 0.5 wt%, crosslinking of the acrylic rubber may not be completed sufficiently and a sufficient mechanical strength may not be obtained. Also, if exceeding 5 wt%, the acrylic rubber may be excessively crosslinked and the elasticity of a crosslinked rubber may be reduced.

[0040]

An acrylic rubber of the present embodiment may further contain 20 to 94.5 wt% of a (meth)acrylate ester monomeric unit, excluding the methacrylate ester monomeric unit and the crosslinkable monomeric unit described above. Here, "(meth)acrylic acid" refers to both "acrylic acid" and "methacrylic acid". Therefore, for example, methyl (meth)acrylate, which will be described

later, refers to methyl acrylate and/or methyl methacrylate.

[0041]

As a (meth)acrylate ester monomer
5 constituting a (meth)acrylate ester monomeric unit
contained in an acrylic rubber of the present
embodiment, although not limited in particular, for
example, excluding the above-described methacrylate
ester monomers and crosslinkable monomers, a
10 (meth)acrylate alkyl ester monomer, an acrylate
alkoxyalkyl ester monomer, and the like may be
listed.

[0042]

As the (meth)acrylate alkyl ester monomer,
15 although not limited in particular, an ester of
alkanol having 1 to 8 carbon atoms and (meth)acrylic
acid is favorable; specifically, methyl
(meth)acrylate, ethyl (meth)acrylate, n-propyl
(meth)acrylate, isopropyl (meth)acrylate, n-butyl
20 (meth)acrylate, isobutyl (meth)acrylate, n-hexyl
(meth)acrylate, 2-ethylhexyl (meth)acrylate,
cyclohexyl (meth)acrylate, n-octyl (meth)acrylate,
and the like may be listed. Among these, methyl
(meth)acrylate, ethyl (meth)acrylate, n-propyl
25 (meth)acrylate, and n-butyl (meth)acrylate are
favorable; and ethyl acrylate, n-butyl acrylate,
methyl methacrylate, ethyl methacrylate, n-propyl
methacrylate, and n-butyl methacrylate are
particularly favorable. One of these species may be
30 used singly, or two or more species may be used
together.

[0043]

As the acrylate alkoxyalkyl ester monomer,

although not limited in particular, an ester of alkoxyalkyl alcohol having 2 to 8 carbon atoms and acrylic acid is favorable; specifically, methoxymethyl acrylate, ethoxymethyl acrylate, 1-methoxyethyl acrylate, 2-methoxyethyl acrylate, 1-ethoxyethyl acrylate, 2-ethoxyethyl acrylate, 1-propoxyethyl acrylate, 2-propoxyethyl acrylate, 1-butoxyethyl acrylate, 2-butoxyethyl acrylate, 1-methoxypropyl acrylate, 2-methoxypropyl acrylate, 3-methoxypropyl acrylate, 3-ethoxypropyl acrylate, 1-methoxybutyl acrylate, 2-methoxybutyl acrylate, 3-methoxybutyl acrylate, 4-methoxybutyl acrylate, 4-ethoxybutyl acrylate, and the like may be listed. Among these, 2-ethoxyethyl acrylate and 2-methoxyethyl acrylate are favorable. One of these species may be used singly, or two or more species may be used together.

[0044]

In the case where the (meth)acrylate alkyl ester monomer is an acrylate ester monomeric unit excluding the above-described methacrylate ester monomer units and crosslinkable monomer units, the content of the acrylate ester monomeric unit is, with respect to the total as 100 wt% of all monomer units constituting an acrylic rubber, favorably greater than or equal to 20.0 wt%, more favorably greater than or equal to 25.0 wt%, even more favorably greater than or equal to 30.0 wt%, and particularly favorably greater than or equal to 40.0 wt%; also, favorably less than or equal to 94.5 wt%, more favorably less than or equal to 85.0 wt%, even more favorably less than or equal to 80.0 wt%, particularly favorably less than or equal to 75.0

wt%. If the content of the acrylate ester monomeric unit is too low, an obtained crosslinked rubber may have reduced cold-resistance and oil-resistance; on the other hand, if too high, an obtained crosslinked rubber may have reduced resistance to deteriorated engine oil.

[0045]

Also, in the case where the (meth)acrylate alkyl ester monomer is a methacrylate ester monomeric unit excluding the above-described methacrylate ester monomer units and crosslinkable monomer units, the content of the methacrylate alkyl ester monomeric unit is, with respect to the total as 100 wt% of all monomer units constituting an acrylic rubber, favorably greater than or equal to 0 wt% and less than or equal to 55.0 wt%, more favorably greater than or equal to 0 wt% and less than or equal to 40.0 wt%, even more favorably greater than or equal to 0 wt% and less than or equal to 30.0 wt%, and particularly favorably greater than or equal to 0 wt% and less than or equal to 25 wt%. If the content of the methacrylate alkyl ester monomeric unit is excessive, a crosslinked rubber to be obtained may have reduced oil resistance and cold resistance.

[0046]

In the present embodiment, a methacrylate alkyl ester monomeric unit may be used in combination with a methacrylate ester monomeric unit described above. In this case, the contents of the methacrylate alkyl ester monomeric unit and the methacrylate ester monomeric unit described above are, with respect to 100 wt% as the total of these,

such that the content of the methacrylate alkyl ester monomeric unit is favorably greater than or equal to 0 wt% and less than or equal to 90 wt%, more favorably greater than or equal to 0 wt% and less than or equal to 85 wt%; and the content of the methacrylate ester monomeric unit is favorably greater than or equal to 10 wt% and less than or equal to 100 wt%, and more favorably greater than or equal to 15 wt% and less than or equal to 100 wt%.

10 [0047]

Note that in the present embodiment, it is favorable that the contents of the (meth)acrylate ester monomeric units are such that the (meth)acrylate alkyl ester monomeric unit accounts for greater than or equal to 30 wt% and less than or equal to 100 wt%, and the acrylate alkoxyalkyl ester monomeric unit accounts for greater than or equal to 0 wt% and less than or equal to 70 wt%.

[0048]

20 An acrylic rubber according to the present embodiment may contain other copolymerizable monomeric units in addition to the (meth)acrylate monomeric unit and crosslinkable monomeric unit described above as long as properties of the acrylic rubber are maintained.

25 [0049]

As the other copolymerizable monomers, although not limited in particular, for example, olefinic monomers, aromatic vinyl monomers, α,β -ethylenically unsaturated dicarboxylate diester monomers, α,β -ethylenically unsaturated nitrile monomers, halogenated vinyl compounds, vinyl ether compounds, vinyl ester compounds, and the like may

be listed.

[0050]

As the olefinic monomer, although not limited in particular, ethylene, propylene, 1-butene, 2-butene, 1-hexene, 1-octene, and the like may be listed. Among these, ethylene is favorable.

[0051]

As the aromatic vinyl monomer, although not limited in particular, for example, styrene, α -methylstyrene, p-dimethylaminostyrene, divinylbenzene, 2-vinylpyridine, 4-vinylpyridine, and the like may be listed.

[0052]

As the α,β -ethylenically unsaturated dicarboxylate diester monomer, although not limited in particular, for example, diesters of α,β -ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms and alcohol having 1 to 8 carbon atoms may be listed. Two organic groups of a diester may be the same or different. As specific examples of α,β -ethylenically unsaturated dicarboxylic acid diesters, maleic diesters such as dimethyl maleate, diethyl maleate, dipropyl maleate, di-n-butyl maleate, diisobutyl maleate, dicyclopentyl maleate, dicyclohexyl maleate, dibenzyl maleate, and diphenyl maleate; fumarate diesters such as dimethyl fumarate, diethyl fumarate, dipropyl fumarate, di-n-butyl fumarate, diisobutyl fumarate, dicyclopentyl fumarate, dicyclohexyl fumarate, dibenzyl fumarate, and diphenyl fumarate; citraconate diesters such as Dimethyl citraconate, diethyl citraconate, dipropyl citraconate, di-n-butyl citraconate, dibenzyl

citraconate, and diphenyl citraconate; itaconic acid diesters such as dimethyl itaconate, diethyl itaconate, di-n-butyl itaconate, diisobutyl itaconate, dicyclohexyl itaconate, dibenzyl itaconate, and diphenyl itaconate; mesaconic acid diesters such as dimethyl mesaconate, diethyl mesaconate, dipropyl mesaconate, di-n-butyl mesaconate, dibenzyl mesaconate, diphenyl mesaconate; 2-pentenedioic acid diesters such as dimethyl 2-pentenedioic acid, diethyl 2-pentenedioic acid, dipropyl 2-pentenedioic acid, di-n-butyl 2-pentenedioic acid, dibenzyl 2-pentenedioic acid, and diphenyl 2-pentenedioic acid; acetylenedicarboxylic acid dicyclohexyl; and the like may be listed.

[0053]

As the α,β -ethylenically unsaturated nitrile monomer, although not limited in particular, for example, acrylonitrile, methacrylonitrile, and vinylidene cyanide, and the like may be listed.

[0054]

As the vinyl halide compound, although not limited in particular, for example, vinyl chloride, vinylidene chloride, and allyl chloride, and the like may be listed.

[0055]

As the vinyl ether compound, although not limited in particular, for example, ethyl vinyl ether, dimethylaminoethyl vinyl ether, and n-butyl vinyl ether, and the like may be listed.

[0056]

As the vinyl ester compound, although not limited in particular, for example, vinyl acetate, vinyl propionate, vinyl pivalate, vinyl benzoate,

and vinyl cinnamate, and the like may be listed.

[0057]

Also, in addition to the above vinyl ester compounds, a monomer having two or more
5 (meth)acryloyloxy groups (polyfunctional acrylic monomer) such as (meth)acrylic acid diester of ethylene glycol, (meth)acrylic acid diester of propylene glycol, 1,4-butanediol di(meth)acrylate, trimethylolpropane tri(meth)acrylate,
10 pentaerythritol tetra(meth)acrylate, and the like; a diallyl compound such as diallyl phthalate and diallyl fumarate; a polyfunctional (meth)acrylic monomer such as (meth)acrylate allyl and (meth)acrylate dicyclopentenyl; an acrylamide
15 monomer such as (meth)acrylamide, N,N-dimethylacrylamide, N,N-diethylacrylamide, and N-isopropyl (meth)acrylamide; a hydroxyl-group-containing (meth)acrylate ester monomer; a nitrogen-group-containing (meth)acrylate ester monomer such
20 as 2-aminoethyl (meth)acrylate, N-methylaminoethyl (meth)acrylate, N,N-dimethylaminoethyl (meth)acrylate, N-ethylaminoethyl (meth)acrylate, and N,N-diethylaminoethyl (meth)acrylate; any compound such as maleimide, methylmaleimide,
25 ethylmaleimide, phenylmaleimide, vinylimidazole, and N-vinylpyrrolidone; and the like may be listed.

[0058]

Among these, ethylene, styrene, dimethyl maleate, diethyl maleate, dipropyl maleate, di-n-
30 butyl maleate, diisobutyl maleate, dimethyl fumarate, diethyl fumarate, dipropyl fumarate, di-n-butyl fumarate, diisobutyl fumarate, dimethyl itaconate, diethyl itaconate, dipropyl itaconate,

di-n-butyl itaconate, diisobutyl itaconate,
acrylonitrile, vinyl acetate, and vinyl propionate
are favorable; ethylene, diethyl maleate, di-n-butyl
maleate, diethyl fumarate, di-n-butyl fumarate,
5 diethyl itaconate, di-n-butyl itaconate,
acrylonitrile, and vinyl acetate are more favorable.
One of these species may be used singly, or two or
more may be used together.

[0059]

10 In the present embodiment, the content of
the other monomeric units in an acrylic rubber is
less than or equal to 40 wt%, favorably less than or
equal to 30 wt%, and more favorably less than or
equal to 20 wt%. Also, in the case where the other
15 copolymerizable monomer is an olefinic monomeric
unit, the content of the olefinic monomeric unit is
favorably greater than or equal to 1.0 wt%, more
favorably greater than or equal to 5.0 wt%, more
favorably greater than or equal to 10.0 wt%; also,
20 favorably less than or equal to 30.0 wt%, more
favorably less than or equal to 25.0 wt%, and even
more favorably less than or equal to 20.0 wt%.

[0060]

The method of producing an acrylic rubber
25 according to the present embodiment is not limited
in particular, and an acrylic rubber may be produced
by copolymerizing predetermined monomers according
to a publicly-known polymerization method.
Specifically, it can be produced by adopting
30 publicly-known methods such as emulsion
polymerization, suspension polymerization, solution
polymerization, and bulk polymerization. Among
these, an emulsion polymerization method under

normal pressure can be favorably adopted from the view point of ease of controlling the polymerization reaction and the like.

[0061]

5 All species and all of the amounts of the above monomers are not necessarily supplied to the reaction field from the beginning of the reaction, and may be added continuously or intermittently over the entire reaction time in consideration of the
10 copolymerization reactivity ratio, the reaction conversion rate, and the like, or may be introduced all at once or by partitioned amounts during the course of or in the latter half of the reaction. Also, although the preparation ratio of each monomer
15 in the polymerization reaction needs to be adjusted depending on the reactivity of the monomer, as the polymerization reaction proceeds almost quantitatively, the ratio may be adjusted according to the monomeric unit composition of a desired
20 acrylic rubber to be obtained.

[0062]

 The Mooney viscosity (polymer Mooney viscosity (ML1+4, 100 °C)) of an acrylic rubber produced in this way is, although not limited in
25 particular, from the viewpoint of processability, favorably greater than or equal to 10 and less than or equal to 100, more favorably greater than or equal to 15 and less than or equal to 90, and particularly favorably greater than or equal to 20
30 and less than or equal to 80. If the Mooney viscosity is too low, the shape retention of the acrylic rubber composition is reduced, and thereby, the molding processability may be reduced and the

mechanical strength of a crosslinked product may be reduced. On the other hand, if the Mooney viscosity is too high, the fluidity may be reduced, and thereby, the molding processability may be reduced.

5 [0063]

By crosslinking an acrylic rubber according to the present embodiment obtained in this way, a crosslinked acrylic rubber having excellent heat aging resistance, oil resistance, and
10 resistance to deteriorated engine oil can be obtained.

[0064]

<Acrylic rubber composition>

An acrylic rubber composition according to
15 the present embodiment contains an acrylic rubber and a crosslinking agent.

[0065]

As an acrylic rubber contained in an acrylic rubber composition of the present
20 embodiment, the acrylic rubber described above can be used.

[0066]

The crosslinking agent used in the present embodiment is not limited as long as being capable
25 of reacting with a structural unit derived from a crosslinkable monomer, which acts as a crosslinking point in an acrylic rubber, to form a crosslinked structure.

[0067]

30 As the crosslinking agent, it is possible to use conventional, publicly-known crosslinking agents, which includes, for example, polyamine compound such as diamine compound and its carbonate;

polyhydrazide compound; sulfur; sulfur donor;
triazinethiol compound; polyvalent epoxy compound;
organocarboxylic ammonium salt; dithiocarbamate
metal salt; polyvalent carboxylic acid; quaternary
5 onium salt; imidazole compound; isocyanuric acid
compound; organic peroxide; and the like. One
species of these crosslinking agents may be used
singly, or two or more species may be used together.
It is favorable to select crosslinking agents
10 appropriately in accordance with the type of
crosslinkable monomeric unit.

[0068]

Note that in the case where the
crosslinkable monomer constituting the crosslinkable
15 monomeric unit of an acrylic rubber is a
crosslinkable monomer containing a carboxyl group, a
polyamine compound and carbonates thereof, a
guanidine compound, a polyhydrazide compound are
favorable as the crosslinking agent, and a polyamine
20 compound and carbonates thereof are more favorable.

[0069]

As the polyvalent amine compound and
carbonates thereof, although not limited in
particular, polyvalent amine compounds having 4 to
25 30 carbon atoms and carbonates thereof are
favorable. As examples of such polyvalent amine
compounds and carbonates thereof, aliphatic
polyvalent amine compounds and carbonates thereof;
aromatic polyvalent amine compounds and carbonates
30 thereof; and the like may be listed.

[0070]

Among these, as the aliphatic polyvalent
amine compound and carbonates thereof, although not

limited in particular, for example,
examethylenediamine, hexamethylenediamine carbamate,
N,N'-dicinnamylidene-1,6-hexanediamine, carbonates
thereof, and the like may be listed. Among these,
5 hexamethylenediamine carbamate is favorable.
[0071]

Also, as the aromatic polyvalent amine
compound, although not limited in particular, for
example, 4,4'-methylenedianiline, p-
10 phenylenediamine, m-phenylenediamine, 4,4'-
diaminodiphenyl ether, 3,4'-diaminodiphenyl ether,
4,4'-(m-phenylenediisopropylidene) dianiline, 4,4'-
(p-phenylenediisopropylidene) dianiline, 2,2'-bis
[4-(4-aminophenoxy) phenyl] propane, 4,4'-
15 diaminobenzanilide, 4,4'-bis (4-aminophenoxy)
biphenyl, m-xylylenediamine, p-xylylenediamine,
1,3,5-benzenetriamine, and the like may be listed.
Among these, 2,2'-bis[4-(4-aminophenoxy) phenyl]
propane is favorable.
20 [0072]

Also, in the case where the crosslinkable
monomer constituting the crosslinkable monomeric
unit is a crosslinkable monomer containing an epoxy
group, as the crosslinking agent,
25 hexamethylenediamine, hexamethylenediamine
carbamate, aliphatic polyvalent amine compounds, and
carbonates thereof; aromatic polyvalent amine
compounds such as 4,4'-methylenedianiline;
carboxylic acid ammonium salts such as ammonium
30 benzoate and ammonium adipate; dithiocarbamic acid
compounds such as dimethyldithiocarbamic acid and
zinc dimethyldithiocarbamate; polyhydric carboxylic
acids such as tetradecanoic acid; quaternary onium

salts such as cetyltrimethylammonium bromide;
imidazole compounds such as 2-methylimidazole;
isocyanuric acid compounds such as isocyanuric acid
and ammonium isocyanuric acid; and the like can be
5 used. Among these, ammonium benzoate,
dimethyldithiocarbamic acid, and isocyanuric acid
are favorable.

[0073]

Also, in the case where the crosslinkable
10 monomer constituting the crosslinkable monomeric
unit is a crosslinkable monomer containing a halogen
group, as the crosslinking agent, it is possible to
use triazinethiol derivatives such as
trithiocyanuric acid, 1,3,5-triazine trithiol,
15 2,4,6-trimelcapto-s-triazine; organic carboxylic
acid ammonium salts such as ammonium adipate; a
mixture of metal soap and sulfur; dipentamethylene
thiuram hexasulfide; triethyl thiuram disulfide; and
the like. Among these, 1,3,5-triazine trithiol and
20 a mixture of metallic soap and sulfur are favorable.

[0074]

The content of the crosslinking agent in
an acrylic rubber composition of the present
embodiment is, with respect to 100 parts by weight
25 of an acrylic rubber in the acrylic rubber
composition, favorably greater than or equal to 0.05
parts by weight, more favorably greater than or
equal to 0.1 parts by weight, and even more
favorably greater than or equal to 0.2 parts by
30 weight; and favorably less than or equal to 10 parts
by weight, more favorably less than or equal to 5
parts by weight. If the content of the crosslinking
agent is too low, it may not be sufficiently

crosslinked, and it may become difficult to maintain the shape of a crosslinked acrylic rubber. On the other hand, if the content is too high, a crosslinked acrylic rubber may become too hard,
5 which impairs the elasticity.
[0075]

An acrylic rubber composition of the present embodiment may contain a crosslinking accelerator in addition to a crosslinking agent.
10 The crosslinking accelerator is not limited in particular as long as being capable of accelerating crosslinking in combination with the crosslinking agent.
[0076]

15 As such a crosslinking accelerator, for example, an aliphatic monovalent secondary amine compound, aliphatic monovalent tertiary amine compound, guanidine compound such as 1,3-di-o-tolylguanidine, dithiocarbamic acid such as zinc
20 dibutyldithiocarbamate and zinc salt thereof, thiourea compounds such as diethylthiourea, imidazole compound, quaternary onium salt, tertiary phosphine compound, alkali metal salt of weak acids, and diazabicycloalkene compound, and the like may be
25 used. One species of these crosslinking accelerators may be used singly, or two or more species may be used together.
[0077]

The amount of the crosslinking accelerator
30 to be used is, with respect to 100 parts by weight of an acrylic rubber in the acrylic rubber composition, favorably greater than or equal to 0.1 parts by weight, more favorably greater than or

equal to 0.2 parts by weight, and even more favorably greater than or equal to 0.5 parts by weight; and favorably less than or equal to 10 parts by weight, more favorably less than or equal to 7.5 parts by weight, and even more favorably less than or equal to 5 parts by weight. An excessive amount of the crosslinking accelerator may result in a too high rate of crosslinking, blooming of the crosslinking accelerator on the surface of a crosslinked material, and/or making a crosslinked material too hard when performing crosslinking. An insufficient amount of the crosslinking accelerator may result in a too low rate of crosslinking and/or a significantly reduced tensile strength of a crosslinked material.

[0078]

Also, in addition to the components described above, an acrylic rubber composition according to the present embodiment may contain compounding agents commonly used in the field of acrylic rubber, where the compounding agents include a crosslinking activator, a filler, a lubricant, an antiaging agent, an antiscorching agent, a process oil, and a plasticizer, each of which may be compounded by a necessary amount.

[0079]

The filler is not limited in particular, and a carbon-based material such as carbon black, graphite, or the like can be used. In particular, it is favorable to use carbon black. As specific examples of carbon black, furnace black, acetylene black, thermal black, channel black, and the like may be listed. Among these, it is favorable to use

furnace black; as specific examples, SAF, ISAF, ISAF-HS, ISAF-LS, IISAF-HS, HAF, HAF-HS, HAF-LS, MAF, FEF, and the like may be listed, among which FEF, MAF, and HAF-HS are particularly favorable. As
5 specific examples of graphite, natural graphite such as scaly graphite and flake graphite; and artificial graphite may be listed. Note that One species of these carbon-based materials described above may be used singly, or two or more species may be combined
10 to be used. The amount of filler to be added is favorably 40 to 90 parts by weight with respect to 100 parts by weight of an acrylic rubber in the acrylic rubber composition.

[0080]

15 As fillers other than carbon-based materials, for example, metal powders such as aluminum powders; inorganic powders such as hard clay, talc, calcium carbonate, titanium oxide, calcium sulfate, calcium carbonate, aluminum
20 hydroxide; powders of organic powders such as starch and polystyrene powders; short fibers such as glass fibers (milled fibers), carbon fibers, aramid fibers, potassium titanate whiskers; silica; mica; and the like may be listed. One species of these
25 fillers may be used singly, or two or more species may be combined to be used.

[0081]

As specific examples of lubricants,
hydrocarbon waxes; fatty acid amide waxes, aromatic
30 fatty acid ester; fatty alcohol waxes, partial ester waxes of polyhydric alcohol and fatty acid, silicone oil, polyorganosiloxane, disstearyl epoxy hexahydrophthalate, sodium alkyl sulfate, long-chain

aliphatic compound, non-ionic ester-based activator,
block copolymer of ethylene oxide and propylene
oxide, tetrafluoroethylene resin powder, and the
like may be listed. One of these lubricants may be
5 used singly, or two or more species may be combined
to be used.

[0082]

As an antiaging agent, a phenolic, amine,
phosphatic, or sulfuric antiaging agent may be used.
10 As representative examples of the phenolic type,
2,2-methylenebis(4-methyl-6-t-butylphenol) and the
like may be listed; and as representative examples
of the amine type, 4,4'-bis(α , α -
dimethylbenzyl)diphenylamine and the like may be
15 listed. One species of these antiaging agents may
be used singly, or two or more species may be
combined to be used.

[0083]

As an antiscorching agent, although not
20 limited in particular, an organic acid antiscorching
agent such as phthalic anhydride, benzoic acid,
salicylic acid, or apple acid; a nitroso-compound-
based antiscorching agent such as N-
nitrosodiphenylamine; a thiophthalimide-based
25 antiscorching agent such as N-
(cyclohexylthio)phthalimide; sulfonamide derivative;
2-mercaptobenzimidazole; trichloromeramine;
stearylamine; or the like may be listed. One
species of these antiscorching agents may be used
30 singly, or two or more species may be used together.

[0084]

Also, an acrylic rubber composition
according to the present embodiment may be

compounded with polymers such as a rubber other than an acrylic rubber according to the present embodiment, elastomer, resin, or the like as necessary. Note that the content of polymers including rubber, elastomer, and resin other than the acrylic rubber is, with respect to 100 parts by weight of the acrylic rubber in an acrylic rubber composition, favorably less than or equal to 100 parts by weight, more favorably less than or equal to 50 parts by weight, and even more favorably less than or equal to 20 parts by weight.

[0085]

As a rubber other than an acrylic rubber, for example, natural rubber (NR), isoprene rubber (IR), solution-polymerized SBR (solution-polymerized styrene butadiene rubber), emulsion-polymerized SBR (emulsion-polymerized styrene butadiene rubber), low-cis BR (butadiene rubber), high-cis BR (trans-bond content of butadiene being 70 to 95%), styrene-isoprene copolymer rubber, butadiene-isoprene copolymer rubber, ethylene propylene diene rubber (EPDM), emulsion-polymerized styrene-acrylonitrile-butadiene copolymer rubber, acrylonitrile-butadiene copolymer rubber, polyisoprene-SBR block copolymer rubber, polystyrene-polybutadiene-polystyrene block copolymer, acrylic rubber other than those described above, epichlorohydrin rubber, fluorine rubber, silicone rubber, ethylene-propylene rubber, urethane rubber, or the like may be listed.

[0086]

As an elastomer, for example, olefinic elastomer, styrenic elastomer, polyester-based elastomer, polyamide-based elastomer, polyurethane-

based elastomer, polysiloxane-based elastomer, or the like may be listed.

[0087]

As a resin, for example, olefinic resin, styrenic resin, acrylic resin, polyphenylene ether, polyester, polycarbonate, polyamide, or the like may be listed.

[0088]

As a method for preparing an acrylic rubber composition of the present embodiment, a mixing method such as roll mixing, Banbury mixing, screw mixing, solution mixing, or the like may be suitably adopted. Although the sequence of compounding is not limited in particular, components that are hard to react or decompose by heat may be mixed sufficiently, and then, components that are susceptible to reaction or decomposition (e.g., crosslinking agents, crosslinking accelerators, etc.) may be mixed in a short period of time at a temperature that does not cause reaction or decomposition.

[0089]

By crosslinking an acrylic rubber composition according to the present embodiment obtained in this way, a crosslinked acrylic rubber having excellent heat aging resistance, oil resistance, and resistance to deteriorated engine oil can be obtained.

[0090]

<Crosslinked acrylic rubber>

A crosslinked acrylic rubber according to the present embodiment is obtained by crosslinking an acrylic rubber composition described above.

[0091]

Crosslinking is performed by heating an acrylic rubber composition. Crosslinking conditions include crosslinking temperature being favorably
5 higher than or equal to 130 °C, and more favorably higher than or equal to 140; and favorably lower than or equal to 220 °C, and more favorably lower than or equal to 200 °C;
10 Crosslinking time is favorably longer than or equal to 30 seconds, more favorably longer than or equal to 1 minute; and favorably shorter than or equal to 2 hours, and more favorably shorter than or equal to 1 hour. This first stage of crosslinking may also
15 be referred to as "primary crosslinking".

[0092]

As a molding method for obtaining a desired shape of a crosslinked acrylic rubber, a conventional, publicly-known molding method may be
20 adopted, which may be extrusion, injection molding, transfer molding, compression molding, or the like. Also, heating and molding may be performed simultaneously for crosslinking.

[0093]

25 Typical rubber processing steps may be adopted for extrusion molding. For example, a rubber composition prepared by roll mixing or the like is fed to the feed opening of an extruder, softened by heat coming from the barrel in the
30 course of being transferred to the head by the screw, and then, passed through a die having a predetermined shape provided in the head; in this way, it is possible to obtain a long extrusion

molding article (plate, bar, pipe, hose, deformed article, etc.) having a desired cross-sectional shape.

[0094]

5 Note that the method of producing an extrusion molding article itself is not limited in particular and may follow a publicly-known producing method. Also, the structure of an extrusion molding article is not limited in particular; for example, a
10 structure with fiber coating or thread core, a laminated product with other rubber or resin, and the like may be listed. An extrusion molding article formed into a desired shape is crosslinked. An extrusion molding article is crosslinked by
15 primary crosslinking in a steam can after having been molded into a predetermined shape. Also, secondary crosslinking may also be performed in hot air in an oven as necessary.

[0095]

20 In injection molding, transfer molding, and compression molding, shaping can be performed by filling the mold cavity having the shape of one or several products with an acrylic rubber composition of the present embodiment. In this case,
25 crosslinking may be performed after the molding, or crosslinking may be performed simultaneously with the molding.

[0096]

30 The molding temperature is normally higher than or equal to 10 °C and favorably higher than or equal to 25 °C; and normally lower than or equal to 200 °C and favorably lower than or equal to 120 °C. The crosslinking temperature is normally higher than

or equal to 130 °C and favorably higher than or
equal to 150 °C; and normally lower than or equal to
220 °C and favorably lower than or equal to 190 °C.
The crosslinking time is normally 2 minutes or
5 longer, and favorably 3 minutes or longer; and
normally 10 hours or shorter, and favorably 5 hours
or shorter. The method of heating may be suitably
selected from among methods used for crosslinking a
rubber such as press heating, steam heating, oven
10 heating, and hot air heating.
[0097]

Also, depending on the shape and size of a
crosslinked rubber, a crosslinked rubber of the
present embodiment may be further heated to be
15 applied with secondary crosslinking. Secondary
crosslinking is favorably performed for 1 to 48
hours, although it depends on the method of heating,
crosslinking temperature, shape, and the like. The
heating method and the heating temperature can be
20 selected appropriately.
[0098]

A crosslinked rubber of the present
embodiment exhibits excellent heat aging resistance,
oil resistance, cold resistance, and resistance to
25 deteriorated engine oil while maintaining the basic
properties as rubber including the tensile strength,
elongation, and hardness. Therefore, taking
advantage of these characteristics, a crosslinked
rubber of the present embodiment is suitably used
30 in, for example, a wide range of fields including
transportation machinery such as automobiles,
general devices, and electrical devices, for
products including an O-ring, packing, oil seal,

bearing seal, head cover gasket, plug tube gasket,
cam journal orifice gasket, cylinder head plug
gasket, engine head cover gasket, spool valve
gasket, oil pressure sensor gasket, camshaft thrust
5 gasket, oil filter gasket, oil cooler gasket, oil
pan gasket, oil filter cartridge gasket, oil path
orifice gasket, oil filter base gasket, oil level
pipe gasket, oil pump gasket, chain case gasket,
transmission seal gasket, crankshaft seal gasket,
10 camshaft seal gasket, bar stem seal gasket, baffle
plate gasket, valve timing control valve gasket,
gallery cap bolt gasket, lower block orifice gasket,
power steering seal belt cover seal, positive
crankcase ventilation valve gasket, and sealing
15 material such as CVJ and R & P boot material; a
cushioning material, anti-vibration material; a wire
coating material; an industrial belt; a tube or hose
such as an oil hose, fuel hose, and drain hose
including a transmission oil cooler hose, engine oil
20 cooler hose, turbo intercooler hose, turbo air duct
hose, power steering hose, hot air hose, radiator
hose, power steering hose, diesel turbocharger hose,
and those used under high-pressure in industrial
machinery and construction machinery; a seat; and
25 the like. Among these, it can be applied to sealing
materials and hose materials.

[Examples]

[0099]

30 In the following, examples will be
presented to describe the present embodiment in more
detail. In the following, "parts" and "%" are by
weight unless otherwise specified. Note that the

present embodiment is not limited only to these examples. Characteristics were measured and evaluated as follows.

[0100]

5 <Mooney viscosity>

 The Mooney viscosity ML1+4 (polymer Mooney viscosity (ML1+4, 100 °C)) of an acrylic rubber was measured at 100 °C according to a Mooney viscosity test of a non-crosslinked rubber physical test
10 method compliant with JIS K6300.

[0101]

 <Normal physical properties (tensile strength, elongation, and hardness)>

 Each of the acrylic rubber compositions
15 obtained in Examples and Comparative examples was placed in a mold of 15 cm in length, 15 cm in width, and 0.2 cm in depth, and pressed at 170 °C for 20 minutes while being pressed with a pressing pressure of 10 MPa, so as to obtain a sheet-shaped
20 crosslinked acrylic rubber. The obtained sheet-shaped crosslinked acrylic rubber was placed in a gear-type oven and heat-treated at 170 °C for 4 hours. Next, a test piece was prepared by punching out the sheet-shaped crosslinked acrylic rubber with
25 a dumbbell shape No. 3. Using this test piece, the tensile strength (MPa) and elongation (%) were measured according to JIS K6251. Also, the hardness of this test piece was measured according to JIS K6253 using a durometer hardness tester (type A).

30 [0102]

 <Heat aging resistance test>

 A test piece prepared in substantially the same way as the test piece used for evaluating the

normal physical properties described above was placed in a gear-type oven at a temperature of 175 °C for 168 hours, and then, the elongation was measured, and by comparing the obtained results with the normal physical properties measured according to the above method, the heat aging resistance was evaluated. The elongation was measured according to JIS K6251, and from the obtained measurement results, the elongation change rate ΔE (%) was calculated. The elongation change rate ΔE (%) is the change rate (%) of a measured value of the elongation of the test piece after having been placed in a heating environment (after the heat aging resistance test) with respect to the elongation of the test piece before being placed in the heating environment (a measured value of the normal physical property). A smaller absolute value of the elongation change rate ΔE (%) indicates a better heat aging resistance.

[0103]

<Cold resistance test>

As the cold resistance test, a low temperature torsion test (Gehman torsion test) was performed according to JIS K6261. As for the test piece, a test piece prepared in substantially the same way as the test piece used for evaluating the normal physical properties described above, was punched out of the obtained sheet-shaped crosslinked acrylic rubber, to prepare a test piece having a length of 40.0 ± 2.5 mm, a width of 3.0 ± 0.2 mm, and a thickness of 2.0 ± 0.2 mm. The test was performed using a Gehman stiffness tester (manufactured by Toyo Seiki Seisaku-sho, Ltd.), to determine a

temperature at which the specific modulus reached 10 (hereinafter, referred to as Gehman T10). A lower value of Gehman T10 indicates a better cold resistance.

5 [0104]

<Oil resistance test>

The oil resistance test was performed according to JIS K6258. A test piece was prepared in substantially the same way as the test piece used
10 for evaluating the normal physical properties described above, which was then punched out of the obtained sheet-shaped crosslinked acrylic rubber, to prepare a test piece having a length of 30 mm, a width of 20 mm, and a thickness of 2.0 ± 0.2 mm. This
15 test piece was placed in a glass tube having an internal volume of 250 cc, into which 200 cc of a liquid for testing was poured, so as to immerse the entire test piece in the liquid. The glass tube was placed in a heating tank and heated at 150 °C for 72
20 hours. As the liquid for testing, a lubricating oil for testing No. 3 oil described in JIS K6258 (product name "IRM903", manufactured by Japan Sun Oil Co., Ltd.) was used. After the heating, the test piece was taken out, the liquid for testing was
25 wiped off, and then, the volume of the test piece was measured, and the volume change rate ΔV (%) was calculated from the obtained measurement result. The volume change rate ΔV (%) is the change rate (%) of a measured value of the volume of the test piece
30 after the immersion in the lubricating oil for testing (a measured value of the normal physical property after the oil resistance test) with respect to a measured value of the volume of the test piece

before the immersion (a measured value of the normal physical property). A smaller absolute value of the volume change rate ΔV (%) indicates a better oil resistance.

5 [0105]

<Resistance to deteriorated engine oil test by immersion>

A test piece prepared in substantially the same way as the test piece used for evaluating the
10 normal physical properties described above was placed in a glass tube having an internal volume of 250 cc, into which 200 cc of a liquid for testing was poured, so as to immerse the entire test piece in the liquid. The glass tube was placed in the
15 autoclave, and placed in a heating tank and heated at 160 °C for 168 hours. A liquid for testing (deteriorated engine oil) was prepared by mixing 197.7 g of an engine oil (product name "Mobil 10W-40SM/CF", manufactured by ExxonMobil, "Mobil" is a
20 registered trademark) with 0.1 g of sulfuric acid of 95% purity, 1.2 g of nitric acid of 50% purity, 1.0 g of acetic acid of 99.7% purity, and 0.04 g of formic acid of 98% purity. Note that the acid concentrations in the liquid for testing are 500 ppm
25 for the sulfuric acid, 3,000 ppm for the nitric acid, 5,000 ppm for the acetic acid, and 200 ppm for the formic acid. After the heating, the test piece was taken out of the container, any adhered liquid for testing was wiped off thoroughly, the test piece
30 was then cooled under a room temperature condition, and then, the hardness was measured; by comparing the obtained results with the normal physical properties measured according to the above method,

the deteriorated engine oil test was evaluated. The hardness was measured according to JIS K6253, and from the obtained measurement results, the hardness change was determined. The hardness change is the difference between a measured hardness value of a test piece after immersion in the engine oil, and a measured hardness value of the test piece that has not been immersed in the engine oil (measured value of a normal physical property). A smaller hardness change (difference in the measured values of hardness) indicates a slower progression of deterioration and better resistance to deteriorated engine oil.

[0106]

[Production example 1: acrylic rubber A]

In a polymerization reactor equipped with a thermometer and a stirring device, 200 parts of water, 3 parts of sodium lauryl sulfate, 88.5 parts of n-butyl acrylate, 10 parts of 2-methoxyethyl methacrylate, and 1.5 parts of mono-n-butyl maleate were prepared, which was twice applied with degassing under reduced pressure and nitrogen substitution, so as to sufficiently remove oxygen. Thereafter, 0.005 parts of cumene hydroperoxide and 0.002 parts of sodium formaldehyde sulfoxylate were added to start emulsion polymerization at a temperature of 30 °C, and reacted until the polymerization conversion rate reached 95% under normal pressure. The obtained emulsion polymerization liquid was coagulated with an aqueous calcium chloride solution, washed with water, and dried to obtain an acrylic rubber A.

[0107]

[Production example 2: acrylic rubber B]

78.5 parts of n-butyl acrylate and 20
parts of 2-methoxyethyl methacrylate were used;
other than these, an acrylic rubber B was obtained
5 in substantially the same way as in Production
example 1.

[0108]

[Production example 3: acrylic rubber C]

68.5 parts of n-butyl acrylate and 30
10 parts of 2-methoxyethyl methacrylate were used;
other than these, an acrylic rubber C was obtained
in substantially the same way as in Production
example 1.

[0109]

15 [Production example 4: acrylic rubber D]

58.5 parts of n-butyl acrylate and 40
parts of 2-methoxyethyl methacrylate were used;
other than these, an acrylic rubber D was obtained
in substantially the same way as in Production
20 example 1.

[0110]

[Production example 5: acrylic rubber E]

68.5 parts of n-butyl acrylate and 20
parts of 2-methoxyethyl methacrylate were used, and
25 10 parts of methyl methacrylate were added; other
than these, an acrylic rubber E was obtained in
substantially the same way as in Production example
1.

[0111]

30 [Production example 6: acrylic rubber F]

58.5 parts of n-butyl acrylate and 20
parts of 2-methoxyethyl methacrylate were used, and
20 parts of n-butyl methacrylate were added; other

than these, an acrylic rubber F was obtained in substantially the same way as in Production example 1.

[0112]

5 [Production example 7: acrylic rubber G]
68.5 parts of n-butyl acrylate and 20 parts of 2-methoxyethyl methacrylate were used, and 10 parts of ethyl methacrylate were added; other than these, an acrylic rubber G was obtained in
10 substantially the same way as in Production example 1.

[0113]

 [Production example 8: acrylic rubber H]
43.5 parts of n-butyl acrylate were used,
15 and 55 parts of 2-ethoxyethyl methacrylate were added instead of 2-methoxyethyl methacrylate; other than these, an acrylic rubber H was obtained in
substantially the same way as in Production example 1.

20 [0114]

 [Production example 9: acrylic rubber I]
28.5 parts of n-butyl acrylate were used, and 70 parts of 2-ethoxyethyl methacrylate were added instead of 2-methoxyethyl methacrylate; other
25 than these, an acrylic rubber I was obtained in substantially the same way as in Production example 1.

[0115]

 [Production example 10: acrylic rubber J]
30 78.5 parts of n-butyl acrylate were added, and 20 parts of methoxydiethylene glycol methacrylate were added instead of 2-methoxyethyl methacrylate; other than these, an acrylic rubber J

was obtained in substantially the same way as in
Production example 1.

[0116]

[Production example 11: acrylic rubber K]

5 78.5 parts of n-butyl acrylate were added,
and 20 parts of methoxytriethylene glycol
methacrylate were added instead of 2-methoxyethyl
methacrylate; other than these, an acrylic rubber K
was obtained in substantially the same way as in
10 Production example 1.

[0117]

[Production example 12: acrylic rubber L]

In a pressure-resistant polymerization
reactor equipped with a thermometer and a stirring
15 device, 200 parts of water, 3 parts of sodium lauryl
sulfate, 68.5 parts of n-butyl acrylate, 20 parts of
2-methoxyethyl methacrylate, and 1.5 parts of mono-
n-butyl maleate were prepared, which was twice
applied with degassing under reduced pressure and
20 nitrogen substitution, so as to sufficiently remove
oxygen. Then, ethylene was pressed into the reactor
to adjust the pressure to 35 kg/cm². Thereafter,
0.005 parts of cumene hydroperoxide and 0.002 parts
of sodium formaldehyde sulfoxylate were added to
25 start emulsion polymerization at a temperature of
60 °C, and reacted until the polymerization
conversion rate reached 95%. The obtained emulsion
polymerization liquid was coagulated with an aqueous
calcium chloride solution, washed with water, and
30 dried to obtain an acrylic rubber L.

[0118]

[Production example 13: acrylic rubber M]

48.5 parts of n-butyl acrylate and 40

parts of 2-methoxyethyl methacrylate were used, and
5 parts of 2-methoxyethyl acrylate and 5 parts of
ethyl acrylate were added; other than these, an
acrylic rubber M was obtained in substantially the
5 same way as in Production example 1.

[0119]

[Production example 14: acrylic rubber N]

1.5 parts of vinyl chloroacetate were
added instead of mono-n-butyl maleate; other than
10 these, an acrylic rubber N was obtained in
substantially the same way as in Production example
4.

[0120]

[Production example 15: acrylic rubber O]

1.5 parts of allyl glycidyl ether were
added instead of mono-n-butyl maleate; other than
these, an acrylic rubber O was obtained in
substantially the same way as in Production example
4.

20 [0121]

[Production example 16: acrylic rubber P]

In a polymerization reactor equipped with
a thermometer and a stirring device, 200 parts of
water, 3 parts of sodium lauryl sulfate, 65 parts of
25 n-butyl acrylate, 10 parts of methyl methacrylate,
19 parts of 2-methoxyethyl acrylate, 4.5 parts of
ethyl acrylate, and 1.5 parts of mono-n-butyl
maleate were prepared, which was twice applied with
degassing under reduced pressure and nitrogen
30 substitution, so as to sufficiently remove oxygen.
Thereafter, 0.005 parts of cumene hydroperoxide and
0.002 parts of sodium formaldehyde sulfoxylate were
added to start emulsion polymerization at a

temperature of 30 °C, and reacted until the polymerization conversion rate reached 95% under normal pressure. The obtained emulsion polymerization liquid was coagulated with an aqueous calcium chloride solution, washed with water, and dried to obtain an acrylic rubber P.

[0122]

[Production example 17: acrylic rubber Q]

18 parts of methyl methacrylate and 11 parts of 2-methoxyethyl acrylate were used; other than these, an acrylic rubber Q was obtained in substantially the same way as in Production example 16.

[0123]

[Production example 18: acrylic rubber R]

77 parts of n-butyl acrylate and 17 parts of 2-methoxyethyl acrylate were added, and methyl methacrylate was not used; other than these, an acrylic rubber R was obtained in substantially the same way as in Production example 16.

[0124]

[Production example 19: acrylic rubber S]

98.5 parts of n-butyl acrylate were added, and methyl methacrylate, 2-methoxyethyl acrylate, and ethyl acrylate were not used; other than these, an acrylic rubber S was obtained in substantially the same way as in Production example 16.

[0125]

[Production example 20: acrylic rubber T]

59 parts of n-butyl acrylate, 20 parts of methyl methacrylate, and 20 parts of ethyl acrylate were used, 1.1 parts allyl glycidyl ether were added instead of mono-n-butyl maleate, and 2-methoxyethyl

acrylate was not used; other than these, an acrylic rubber T was obtained in substantially the same way as in Production example 16.

[0126]

5 [Production example 21: acrylic rubber U]

71 parts of n-butyl acrylate were added, and 28 parts of ethyl methacrylate instead of methyl methacrylate, 1.1 parts of allyl glycidyl ether instead of mono-n-butyl maleate were added, and 2-methoxyethyl acrylate and ethyl acrylate were not
10 used; other than these, an acrylic rubber U was obtained in substantially the same way as in Production example 16.

[0127]

15 [Production example 22: acrylic rubber V]

57.3 parts of n-butyl acrylate were added, and 41.5 parts of n-butyl methacrylate instead of methyl methacrylate, 1.1 parts of allyl glycidyl ether instead of mono-n-butyl maleate were added,
20 and 2-methoxyethyl acrylate and ethyl acrylate were not used; other than these, an acrylic rubber V was obtained in substantially the same way as in Production example 16.

[0128]

25 [Production example 23: acrylic rubber W]

98.5 parts of n-butyl acrylate were used, 1.5 parts of chlorovinyl acetate instead of malein mono n-butyl were added, and methyl methacrylate, 2-methoxyethyl acrylate, and ethyl acrylate were not
30 used; other than these, an acrylic rubber W was obtained in substantially the same way as in Production example 16.

[0129]

[Production example 24: acrylic rubber X]

98.5 parts of n-butyl acrylate were used,
1.5 parts allyl glycidyl ether were added instead of
mono-n-butyl maleate, and methyl methacrylate, 2-
5 methoxyethyl acrylate, and ethyl acrylate were not
used; other than these, an acrylic rubber X was
obtained in substantially the same way as in
Production example 16.

[0130]

10 <Preparation of acrylic rubber
composition>

[Example 1]

By using a Banbury mixer, 100 parts of the
acrylic rubber A obtained in Production example 1
15 were added with 60 parts of HAF carbon black
(product name "Seast 3", manufactured by Tokai
Carbon Co., filler, "Seast" is a registered
trademark), 1 part of stearic acid (product name
"stearic acid Sakura", manufactured by Japanese Oil
20 Co., Ltd., lubricant), 1 part of ester wax (product
name "Greg G-8205", manufactured by Dainippon Ink
and Chemicals, lubricant), and 2 parts of 4,4'-bis
(α,α -dimethylbenzyl) diphenylamine (product name
"Nocrac CD", manufactured by Ouchi Shinko Chemical
25 Industrial Co., Ltd., antiaging agent, "Nocrac" is a
registered trademark), and mixed for 5 minutes at
50 °C. Next, the obtained mixture was transferred
to a roll at 50 °C, into which 0.5 parts of
hexamethylenediamine carbamate (product name "Diak
30 #1", manufactured by DuPont Elastomer Co.,
crosslinking agent) and 2 parts of 1,3-di-o-tolyl
guanidine (product name "Nocceler DT", manufactured
by Ouchi Shinko Chemical Industrial Co., Ltd.,

crosslinking accelerator, "Nocceler" is a registered
trademark) were compounded and kneaded to obtain an
acrylic rubber composition. Using the obtained
acrylic rubber composition, a test piece of the
5 crosslinked acrylic rubber was obtained by the
method described above, which was evaluated for the
Mooney viscosity, normal physical properties
(tensile strength, elongation, hardness), heat aging
resistance test, oil resistance test, cold
10 resistance, and resistance to deteriorated engine
oil test. The results are shown in Table 1.
[0131]

[Example 2]

Instead of the acrylic rubber A obtained
15 in Production example 1, 100 parts of the acrylic
rubber B obtained in Production example 2 were used;
other than these, under the same conditions as in
Example 1, an acrylic rubber composition was
obtained and evaluated. The results are shown in
20 Table 1.
[0132]

[Example 3]

Instead of the acrylic rubber A obtained
in Production example 1, 100 parts of the acrylic
25 rubber C obtained in Production example 3 were used;
other than these, under the same conditions as in
Example 1, an acrylic rubber composition was
obtained and evaluated. The results are shown in
Table 1.
30 [0133]

[Example 4]

Instead of the acrylic rubber A obtained
in Production example 1, 100 parts of the acrylic

rubber D obtained in Production example 4 were used;
other than these, under the same conditions as in
Example 1, an acrylic rubber composition was
obtained and evaluated. The results are shown in

5 Table 1.

[0134]

[Example 5]

Instead of the acrylic rubber A obtained
in Production example 1, 100 parts of the acrylic
10 rubber E obtained in Production example 5 were used;
other than these, under the same conditions as in
Example 1, an acrylic rubber composition was
obtained and evaluated. The results are shown in
Table 1.

15 [0135]

[Example 6]

Instead of the acrylic rubber A obtained
in Production example 1, 100 parts of the acrylic
rubber F obtained in Production example 6 were used;
20 other than these, under the same conditions as in
Example 1, an acrylic rubber composition was
obtained and evaluated. The results are shown in
Table 1.

[0136]

25 [Example 7]

Instead of the acrylic rubber A obtained
in Production example 1, 100 parts of the acrylic
rubber G obtained in Production example 7 were used;
other than these, under the same conditions as in
30 Example 1, an acrylic rubber composition was
obtained and evaluated. The results are shown in
Table 1.

[0137]

[Example 8]

Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber H obtained in Production example 8 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 2.

[0138]

10 [Example 9]

Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber I obtained in Production example 9 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 2.

[0139]

[Example 10]

20 Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber J obtained in Production example 10 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 2.

[0140]

[Example 11]

30 Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber K obtained in Production example 11 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was

obtained and evaluated. The results are shown in Table 2.

[0141]

[Example 12]

5 Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber L obtained in Production example 12 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was
10 obtained and evaluated. The results are shown in Table 2.

[0142]

[Example 13]

15 Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber N obtained in Production example 13 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was
20 obtained and evaluated. The results are shown in Table 2.

[0143]

[Example 14]

25 By using a Banbury mixer, 100 parts of the acrylic rubber N obtained in Production example 14 were added with 60 parts of HAF carbon black (product name "Seast 3", manufactured by Tokai Carbon Co., filler); 1 part of stearic acid (product name "stearic acid Sakura", manufactured by Japanese Oil Co., Ltd., lubricant); 1 part of ester wax
30 (product name "Greg G-8205", manufactured by Dainippon Ink and Chemicals, lubricant); and 2 parts of 4,4'-bis (α,α -dimethylbenzyl) diphenylamine (product name "Nocrac CD", manufactured by Ouchi

Shinko Chemical Industrial Co., Ltd., antiaging agent), and mixed for 5 minutes at 50 °C. Next, the obtained mixture was transferred to a roll at 50 °C, into which 0.5 parts of 1,3,5-triazinetriethiol
5 (product name "ZISNET-F", manufactured by Sanyo Chemical Industries, Ltd., crosslinking agent, "ZISNET" is a registered trademark), 1.5 parts of zinc dibutyldithiocarbamate (product name "Nocceler BZ", manufactured by Ouchi Shinko Chemical
10 Industrial Co., Ltd., crosslinking accelerator), 0.3 parts of diethyl thiourea (product name "Nocceler EUR", manufactured by Ouchi Shinko Chemical Industrial Co., Ltd., crosslinking accelerator), and 0.2 parts of N-(cyclohexylthio) phthalimide (product
15 name "Retarder CTP", manufactured by Ouchi Shinko Chemical Industrial Co., Ltd., scorch inhibitor) were compounded and kneaded to obtain an acrylic rubber composition. Using the obtained acrylic rubber composition, a test piece of the crosslinked
20 acrylic rubber was obtained by the method described above, which was evaluated for the Mooney viscosity, normal physical properties (tensile strength, elongation, hardness), heat aging resistance test, oil resistance test, cold resistance, and resistance
25 to deteriorated engine oil test. The results are shown in Table 4.

[0144]

[Example 15]

By using a Banbury mixer, 100 parts of the
30 acrylic rubber O obtained in Production example 15 were added with 60 parts of HAF carbon black (product name "Seast 3", manufactured by Tokai Carbon Co., filler), 1 part of stearic acid (product

name "stearic acid Sakura", manufactured by Japanese Oil Co., Ltd., lubricant), and 2 parts of 4,4'-bis (α,α -dimethylbenzyl) diphenylamine (product name "Nocrac CD", manufactured by Ouchi Shinko Chemical Industrial Co., Ltd., antiaging agent), and mixed for 5 minutes at 50 °C. Next, the obtained mixture was transferred to a roll at 50 °C, into which 1.1 parts of ammonium benzoate (product name "VULNOC AB-S", manufactured by Ouchi Shinko Chemical Industrial Co., Ltd., crosslinking agent, " VULNOC " is a registered trademark) were compounded and kneaded to obtain an acrylic rubber composition. Using the obtained acrylic rubber composition, a test piece of the crosslinked acrylic rubber was obtained by the method described above, which was evaluated for the Mooney viscosity, normal physical properties (tensile strength, elongation, hardness), heat aging resistance test, oil resistance test, cold resistance, and resistance to deteriorated engine oil test. The results are shown in Table 4.

[0145]

[Comparative example 1]

Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber P obtained in Production example 16 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0146]

[Comparative example 2]

Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic

rubber Q obtained in Production example 17 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0147]

[Comparative example 3]

Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber R obtained in Production example 18 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0148]

[Comparative example 4]

Instead of the acrylic rubber A obtained in Production example 1, 100 parts of the acrylic rubber S obtained in Production example 19 were used; other than these, under the same conditions as in Example 1, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0149]

[Comparative example 5]

Instead of the acrylic rubber O obtained in Production example 15, 100 parts of the acrylic rubber T obtained in Production example 20 were used; other than these, under the same conditions as in Example 15, an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0150]

[Comparative example 6]

Instead of the acrylic rubber O obtained in Production example 15, 100 parts of the acrylic rubber U obtained in Production example 21 were

5 used; other than these, under the same conditions as in Example 15, and an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0151]

10 [Comparative example 7]

Instead of the acrylic rubber O obtained in Production example 15, 100 parts of the acrylic rubber V obtained in Production example 22 were used; other than these, under the same conditions as

15 in Example 15, and an acrylic rubber composition was obtained and evaluated. The results are shown in Table 3.

[0152]

[Comparative example 8]

20 Instead of the acrylic rubber N obtained in Production example 14, 100 parts of the acrylic rubber W obtained in Production example 23 were used; other than these, under the same conditions as in Example 14, an acrylic rubber composition was

25 obtained and evaluated. The results are shown in Table 4.

[0153]

[Comparative example 9]

30 Instead of the acrylic rubber O obtained in Production example 15, 100 parts of the acrylic rubber X obtained in Production example 24 were used; other than these, under the same conditions as in Example 15, an acrylic rubber composition was

obtained and evaluated. The results are shown in Table 4.

[0154]

[Table 1]

	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7
Acrylic rubber (rubber composition)							
2-methoxyethyl methacrylate	10	20	30	40	20	20	20
2-ethoxyethyl methacrylate							
Methoxy diethylene glycol methacrylate							
Methoxy triethylene glycol methacrylate							
n-butyl methacrylate						20	
Methyl methacrylate					10		
Ethyl methacrylate							10
n-butyl acrylate	88.5	78.5	68.5	58.5	68.5	58.5	68.5
2-methoxyethyl acrylate							
Ethyl acrylate							
Ethylene							
Mono n-butyl maleate	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vinyl chloroacetate							
Allyl glycidyl ether							
Acrylic rubber composition							
Acrylic rubber	100	100	100	100	100	100	100
HAF carbon black (filler)	60	60	60	60	60	60	60
stearic acid	1	1	1	1	1	1	1
Ester-based wax (lubricant)	1	1	1	1	1	1	1
4,4'-bis (α, α'-dimethylbenzyl) diphenylamine (antiaging agent)	2	2	2	2	2	2	2
Hexamethylene diamine carbamate (crosslinking agent)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1,3-di-o-tolylguanidine (crosslinking accelerator)	2	2	2	2	2	2	2
Ammonium benzoate							
1,3,5-triazinetriethiol							
Zinc dibutyldithiocarbamate							
Diethylthiourea							
N- (cyclohexylthio) phthalimide							
Mooney viscosity							
Polymer Mooney viscosity (ML1+4,100 °C)	28	30	34	42	37	40	38
Normal physical properties							
Tensile strength (MPa)	9.0	9.8	10.1	10.0	11.4	9.9	10.6
Elongation (%)	180	170	190	220	220	210	210
Hardness (DuroA)	71	72	74	75	77	78	77
Heat aging resistance test (175 °C × 168h)							
Elongation change rate Δ E (%)	15	24	26	30	27	20	25
Oil resistance test (IRM903, 150 °C × 72hr)							
Volume change rate Δ V (%)	61	53	39	30	40	59	49
Cold resistance test (Gehman torsion test)							
Gehman T10 (°C)	-40	-37	-32	-28	-27	-28	-28
Deteriorated-engine-oil-resistance test by immersion (deteriorated oil 160 °C × 168h)							
Hardness change	21	10	5	4	7	8	7

[0155]

[Table 2]

	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Ex. 13
Acrylic rubber (rubber composition)						
	H	I	J	K	L	M
2-methoxyethyl methacrylate					20	40
2-ethoxyethyl methacrylate	55	70				
Methoxy diethylene glycol methacrylate			20			
Methoxy triethylene glycol methacrylate				20		
n-butyl methacrylate						
Methyl methacrylate						
Ethyl methacrylate						
n-butyl acrylate	43.5	28.5	78.5	78.5	68.5	48.5
2-methoxyethyl acrylate						5
Ethyl acrylate						5
Ethylene					10	
Mono n-butyl maleate	1.5	1.5	1.5	1.5	1.5	1.5
Vinyl chloroacetate						
Allyl glycidyl ether						
Acrylic rubber composition						
Acrylic rubber	100	100	100	100	100	100
HAF carbon black (filler)	60	60	60	60	60	60
stearic acid	1	1	1	1	1	1
Ester-based wax (lubricant)	1	1	1	1	1	1
4,4'-bis (α, α'-dimethylbenzyl) diphenylamine (antiaging agent)	2	2	2	2	2	2
Hexamethylene diamine carbamate (crosslinking agent)	0.5	0.5	0.5	0.5	0.5	0.5
1,3-di-o-tolylguanidine (crosslinking accelerator)	2	2	2	2	2	2
Ammonium benzoate						
1,3,5-triazinetriethiol						
Zinc dibutyldithiocarbamate						
Diethylthiourea						
N- (cyclohexylthio) phthalimide						
Mooney viscosity						
Polymer Mooney viscosity (ML1+4,100 °C)	38	52	25	28	28	37
Normal physical properties						
Tensile strength (MPa)	9.3	9.0	9.5	9.6	10.5	10.2
Elongation (%)	180	170	180	160	230	210
Hardness (DuroA)	75	78	72	72	72	73
Heat aging resistance test (175 °C × 168h)						
Elongation change rate Δ E (%)	35	30	5	8	-5	15
Oil resistance test (IRM903, 150 °C × 72hr)						
Volume change rate Δ V (%)	46	40	52	53	55	30
Cold resistance test (Gehman torsion test)						
Gehman T10 (°C)	-28	-23	-36	-36	-35	-24
Deteriorated-engine-oil-resistance test by immersion (deteriorated oil 160 °C × 168h)						
Hardness change	3	2	13	15	12	8

[0156]

[Table 3]

	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5	Comp. Ex. 6	Comp. Ex. 7
Acrylic rubber (rubber composition)	P	Q	R	S	T	U	V
2-methoxyethyl methacrylate							
2-ethoxyethyl methacrylate							
Methoxy diethylene glycol methacrylate							
Methoxy triethylene glycol methacrylate							
n-butyl methacrylate							41.5
Methyl methacrylate	10	18			20		
Ethyl methacrylate						28	
n-butyl acrylate	65	65	77	98.5	59	71	57.3
2-methoxyethyl acrylate	19	11	17				
Ethyl acrylate	4.5	4.5	4.5		20		
Ethylene							
Mono n-butyl maleate	1.5	1.5	1.5	1.5			
Vinyl chloroacetate							
Allyl glycidyl ether					1.1	1.1	1.1
Acrylic rubber composition							
Acrylic rubber	100	100	100	100	100	100	100
HAF carbon black (filler)	60	60	60	60	60	60	60
stearic acid	1	1	1	1	1	1	1
Ester-based wax (lubricant)	1	1	1	1			
4,4'-bis (α, α -dimethylbenzyl) diphenylamine (antiaging agent)	2	2	2	2	2	2	2
Hexamethylene diamine carbamate (crosslinking agent)	0.5	0.5	0.5	0.5			
1,3-di-o-tolylguanidine (crosslinking accelerator)	2	2	2	2			
Ammonium benzoate					1.1	1.1	1.1
1,3,5-triazinetriethiol							
Zinc dibutyldithiocarbamate							
Diethylthiourea							
N- (cyclohexylthio) phthalimide							
Mooney viscosity							
Polymer Mooney viscosity (ML1+4,100 °C)	33	36	29	23	38	39	40
Normal physical properties							
Tensile strength (MPa)	11.6	12.2	9.0	8.5	10.5	9.8	9.1
Elongation (%)	190	170	150	160	220	200	170
Hardness (DuroA)	71	72	73	72	74	73	74
Heat aging resistance test (175 °C × 168h)							
Elongation change rate Δ E (%)	21	23	7	21	-45	-48	-40
Oil resistance test (IRM903, 150 °C × 72hr)							
Volume change rate Δ V (%)	33	36	45	70	34	64	94
Cold resistance test (Gehman torsion test)							
Gehman T10 (°C)	-34	-29	-43	-45	-25	-27	-28
Deteriorated-engine-oil-resistance test by immersion (deteriorated oil 160 °C × 168h)							
Hardness change	26	23	34	33	24	13	7

[0157]

[Table 4]

	Ex. 14	Ex. 15	Comp. Ex. 8	Comp. Ex. 9
Acrylic rubber (rubber composition)				
	N	O	W	X
2-methoxyethyl methacrylate	40	40		
2-ethoxyethyl methacrylate				
Methoxy diethylene glycol methacrylate				
Methoxy triethylene glycol methacrylate				
n-butyl methacrylate				
Methyl methacrylate				
Ethyl methacrylate				
n-butyl acrylate	58.5	58.5	98.5	98.5
2-methoxyethyl acrylate				
Ethyl acrylate				
Ethylene				
Mono n-butyl maleate				
Vinyl chloroacetate	1.5		1.5	
Allyl glycidyl ether		1.5		1.5
Acrylic rubber composition				
Acrylic rubber	100	100	100	100
HAF carbon black (filler)	60	60	60	60
stearic acid	1	1	1	1
Ester-based wax (lubricant)	1		1	
4,4'-bis (α , α -dimethylbenzyl) diphenylamine (antiaging agent)	2	2	2	2
Hexamethylene diamine carbamate (crosslinking agent)				
1,3-di-o-tolylguanidine (crosslinking accelerator)				
Ammonium benzoate		1.1		1.1
1,3,5 -triazinetriethiol	0.5		0.5	
Zinc dibutyldithiocarbamate	1.5		1.5	
Diethylthiourea	0.3		0.3	
N- (cyclohexylthio) phthalimide	0.2		0.2	
Mooney viscosity				
Polymer Mooney viscosity (ML1+4,100 °C)	39	38	23	24
Normal physical properties				
Tensile strength (MPa)	10.5	10.8	8.5	8.5
Elongation (%)	240	260	160	160
Hardness (DuroA)	76	77	72	72
Heat aging resistance test (175 °C × 168h)				
Elongation change rate ΔE (%)	0	-40	-10	-48
Oil resistance test (IRM903, 150 °C × 72hr)				
Volume change rate ΔV (%)	35	38	75	77
Cold resistance test (Gehman torsion test)				
Gehman T10 (°C)	-29	-29	-44	-44
Deteriorated-engine-oil-resistance test by immersion (deteriorated oil 160 °C × 168h)				
Hardness change	10	13	37	36

[0158]

As shown in Tables 1 to 3, in any of Examples 1 to 15, the absolute value of the elongation change rate ΔE (%) in the heat aging resistance test was within 40%; the absolute value of the volume change rate ΔV (%) in the oil resistance test was within 63%; and the hardness change in the resistance to deteriorated engine oil test by immersion was less than or equal to 22.

10 [0159]

In contrast, in Comparative examples 1 to 5, the hardness change in the resistance to deteriorated engine oil test by immersion exceeded 22. Also, in Comparative Examples 4, 6, 7, 8 and 9, the absolute value of volume change rate ΔV in the oil resistance test exceeded 63%. Further, in Comparative Examples 5, 6, and 9, the absolute value of the elongation change rate ΔE (%) in the heat aging resistance test exceeded 40%.

20 [0160]

From these results, it was understood that an acrylic rubber of the present embodiment, which contains 5 to 75 wt% of a methacrylate ester monomeric unit; and 0.5 to 5 wt% of a crosslinkable monomeric unit, wherein the methacrylate ester monomeric unit is at least one species selected from among a methacrylate alkoxyalkyl ester monomeric unit, a methacrylate polyalkylene glycol ester monomeric unit, and a methacrylate alkoxy polyalkylene glycol ester monomeric unit, could maintain the basic properties as rubber including the Mooney viscosity (polymer Mooney viscosity (ML1+4, 100 °C)) and normal physical

properties (tensile strength, elongation, hardness),
and cold resistance, and from the acrylic rubber, a
crosslinked acrylic rubber excellent in the aging
resistance, oil resistance, and resistance to
5 deteriorated engine oil could be obtained (Examples
1 to 15).

[0161]

Also, as shown in Table 4, it was
understood that from an acrylic rubber according to
10 the present embodiment, even in the case of using an
epoxy group and a halogen group as a crosslinkable
monomer, a crosslinked acrylic rubber that is
excellent in the heat aging resistance, oil
resistance, cold resistance, and resistance to
15 deteriorated engine oil, could be obtained (Examples
14 and 15).

[0162]

In the following, favorable aspects of the
present invention will be additionally noted.

20 [0163]

In a first aspect according to the present
invention, an acrylic rubber contains 5 to 75 wt% of
a methacrylate ester monomeric unit; and 0.5 to 5
wt% of a crosslinkable monomeric unit, wherein the
25 methacrylate ester monomeric unit is at least one
species selected from among a methacrylate
alkoxyalkyl ester monomeric unit, a methacrylate
polyalkylene glycol ester monomeric unit, and a
methacrylate alkoxypolyalkylene glycol ester
30 monomeric unit.

[0164]

In a second aspect according to the
present invention, the acrylic rubber further

contains 20 to 94.5 wt% of a (meth)acrylate ester monomeric unit, excluding the methacrylate ester monomeric unit and the crosslinkable monomeric unit.

[0165]

5 In a third aspect according to the present invention, the crosslinkable monomeric unit is a monomeric unit having at least one of a carboxyl group, an epoxy group, and a halogen group.

[0166]

10 In a fourth aspect according to the present invention, an acrylic rubber composition contains the acrylic rubber.

[0167]

 In a fifth aspect according to the present
15 invention, a crosslinked acrylic rubber is obtained by crosslinking the acrylic rubber composition.

[0168]

 In a sixth aspect according to the present
20 invention, a sealing material contains the crosslinked acrylic rubber.

[0169]

 In a seventh aspect according to the present invention, a hose material contains the crosslinked acrylic rubber.

25 [0170]

 As above, aspects of the present embodiment have been described with reference to examples. Note that the present embodiment is not limited to specific aspects or examples, and various
30 modifications and changes can be made within the scope of the present invention as described in the claims.

[0171]

This international application claims priority under Japanese Patent Application No. 2018-057873 filed on March 26, 2018, the entire contents of which are hereby incorporated by reference.

CLAIMS

1. An acrylic rubber comprising:
 - 5 5 to 75 wt% of a methacrylate ester monomeric unit; and
 - 0.5 to 5 wt% of a crosslinkable monomeric unit,wherein the methacrylate ester monomeric
10 unit is at least one species selected from among a methacrylate alkoxyalkyl ester monomeric unit, a methacrylate polyalkylene glycol ester monomeric unit, and a methacrylate alkoxy polyalkylene glycol ester monomeric unit, and
15 wherein a crosslinkable monomer constituting the crosslinkable monomeric unit is at least one species selected from among an α,β -ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms; and a monoester of an α,β -
20 ethylenically unsaturated dicarboxylic acid having 4 to 12 carbon atoms and an alkanol having 1 to 8 carbon atoms.
- 25 2. The acrylic rubber as claimed in claim 1, further comprising:
 - 20 to 94.5 wt% of a (meth)acrylate ester monomeric unit, excluding the methacrylate ester monomeric unit and the crosslinkable monomeric unit.
- 30 3. An acrylic rubber composition containing the acrylic rubber as claimed in claim 1

or 2.

4. A crosslinked acrylic rubber obtained
5 by crosslinking the acrylic rubber composition as
claimed in claim 3.

5. A sealing material comprising:
10 the crosslinked acrylic rubber as claimed
in claim 4.

6. A hose material comprising:
15 the crosslinked acrylic rubber as claimed
in claim 4.