

DESCRIPTION

METHOD FOR COATING REACTOR

5

Technical Field

The present application claims the Paris Convention priority based on Japanese Patent Application No. 2010-
10 253569 filed on November 12, 2010, the entire content of which is incorporated herein by reference.

The present invention relates to a method for coating a reactor, a reactor having a coated inside wall, an addition polymerization method, a prepolymerization method,
15 a prepolymerized catalyst for addition polymerization, and a method for producing an addition polymer using the same.

Background Art

In a case where a chemical reaction is carried out in
20 a reactor, there may sometimes occur a fouling phenomenon in which a reaction product adheres to a wall surface of the reactor. When fouling occurs, it becomes difficult to remove heat from the wall surface of the reactor.

Therefore, it becomes difficult to control a reaction
25 temperature and, in the worst case, a runaway reaction may

sometimes occur. When fouling occurs, it becomes difficult to remove fouling while continuing a reaction in the reactor. Therefore, it is necessary to open and clean the reactor and thus a decrease in productivity may sometimes
5 occur.

Fouling becomes a particularly significant problem in a polymerization reaction. The method of Patent Document 1 is known as a method of suppressing fouling in the polymerization reaction. It is necessary for the
10 technology described in Patent Document 1 to add a specific compound for suppressing fouling in a reaction system, and the compound is also mixed in the reaction product. Therefore, the technology was not satisfactory from the viewpoint of quality of the reaction product.

15 Prior Art Document

Patent Document

Patent Document 1: JP-A-2005-89583

Summary of the Invention

20 Problems to be Solved by the Invention

An object of the present invention is to provide a reactor which can suppress fouling in a reactor even if a chemical reaction is carried out in the reactor, and an addition polymerization method which can produce an
25 addition polymer while suppressing fouling.

Means for Solving the Problems

A first aspect of the present invention is directed to a method comprising coating an inside wall of a reactor
 5 with a random copolymer represented by Formula [1]:



wherein J is a repeating unit represented by Formula [2]; K is a repeating unit represented by Formula [3]; m represents the number of J in the random copolymer being
 10 from 10 to 3000; n represents the number of K in the random copolymer being from 10 to 3000; and r represents random,



wherein Q in Formula [2] represents $R^1C(=O)O-$, $R^1S(=O)_2O-$,
 15 $(OH)_2P(=O)O-$, $(OH)(OR^1)P(=O)O-$ or $(OR^1)_2P(=O)O-$; R in Formula [3] represents $HO-$ or R^1O- ; and R^1 represents a hydrocarbyl group having 1 to 20 carbon atoms which may have a substituent.

A second aspect of the present invention is directed
 20 to a reactor having a coated inside wall produced by the above method.

A third aspect of the present invention is directed to a method comprising addition polymerizing monomers capable of addition polymerizing in the presence of a catalyst for addition polymerization in the above reactor having a
5 coated inside wall.

A fourth aspect of the present invention is directed to a method for producing a prepolymerized catalyst for addition polymerization, wherein the method comprises addition polymerizing monomers capable of addition
10 polymerizing in a slurry in the presence of a catalyst for addition polymerization in the above reactor having a coated inside wall.

A fifth aspect of the present invention is directed to a prepolymerized catalyst for addition polymerization
15 produced by the above method.

A sixth aspect of the present invention is directed to a method for producing an addition polymer, wherein the method comprises addition polymerizing monomers capable of addition polymerizing in the presence of the above
20 prepolymerized catalyst for addition polymerization.

Effects of the Invention

According to the method of the present invention, it is possible to suppress fouling in a reactor when a
25 chemical reaction is carried out in the reactor.

Particularly, it becomes possible to prevent deterioration of heat transfer efficiency of a polymerization reactor due to fouling even if a polymerization reaction is continuously carried out in the reactor, and thus an operation can be continuously carried out while maintaining stable polymerization.

Furthermore, the prepolymerized catalyst for addition polymerization produced by a slurry prepolymerization method in the reactor having a coated inside wall of the present invention can give an addition polymer with extremely high polymerization activity in a main polymerization which is subsequently carried out after polymerization.

Mode for Carrying Out the Invention

The present invention will be described in detail below.

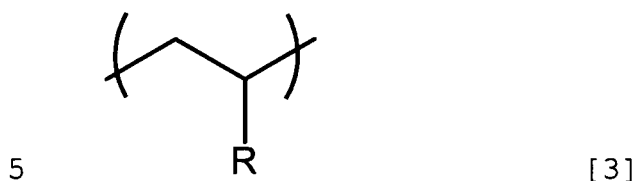
Compound for Coating

A compound to be used for coating an inside wall of a reactor in the present invention is a random copolymer represented by Formula [1]:



wherein J is a repeating unit represented by Formula [2]; K is a repeating unit represented by Formula [3]; m represents the number of J in the random copolymer being

from 10 to 3,000; n represents the number of K in the random copolymer being from 10 to 3,000; and r represents random,



wherein Q in Formula [2] represents $\text{R}^1\text{C}(=\text{O})\text{O}-$, $\text{R}^1\text{S}(=\text{O})_2\text{O}-$, $(\text{OH})_2\text{P}(=\text{O})\text{O}-$, $(\text{OH})(\text{OR}^1)\text{P}(=\text{O})\text{O}-$ or $(\text{OR}^1)_2\text{P}(=\text{O})\text{O}-$; R in Formula [3] represents $\text{HO}-$ or $\text{R}^1\text{O}-$; and R^1 represents a hydrocarbyl group having 1 to 20 carbon atoms which may have a substituent.

R^1 in Formulas [2] and [3] is a hydrocarbyl group having 1 to 20 carbon atoms which may have a substituent. Examples of the hydrocarbyl group having 1 to 20 carbon atoms which may have a substituent include an alkyl group having 1 to 20 carbon atoms which may have a substituent, an aralkyl group having 7 to 20 carbon atoms which may have a substituent, an aryl group having 6 to 20 carbon atoms which may have a substituent and the like.

Examples of the alkyl group having 1 to 20 carbon atoms which may have a substituent include an alkyl group having 1 to 20 carbon atoms, an alkyl group having 1 to 20

carbon atoms which has a halogen atom as a substituent, an alkyl group having 1 to 20 carbon atoms which has a substituted silyl group as a substituent, an alkyl group having 1 to 20 carbon atoms which has a substituted amino group as a substituent, an alkyl group having 1 to 20 carbon atoms which has a hydrocarbyloxy group as a substituent and the like.

Examples of the alkyl group having 1 to 20 carbon atoms include a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, a sec-butyl group, a tert-butyl group, a n-pentyl group, a neopentyl group, an isopentyl group, a n-hexyl group, a n-heptyl group, a n-octyl group, a n-nonyl group, a n-decyl group, a n-undecyl group, a n-dodecyl group, a n-tridecyl group, a n-tetradecyl group, a n-pentadecyl group, a n-hexadecyl group, a n-heptadecyl group, a n-octadecyl group, a n-nonadecyl group, a n-eicosyl group and the like.

Examples of the alkyl group having 1 to 20 carbon atoms which is substituted with a halogen atom include a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a chloromethyl group, a dichloromethyl group, a trichloromethyl group, a bromomethyl group, a dibromomethyl group, a tribromomethyl group, an iodomethyl group, a diiodomethyl group, a triiodomethyl group, a fluoroethyl group, a difluoroethyl

group, a trifluoroethyl group, a tetrafluoroethyl group, a pentafluoroethyl group, a chloroethyl group, a dichloroethyl group, a trichloroethyl group, a tetrachloroethyl group, a pentachloroethyl group, a bromoethyl group, a dibromoethyl group, a tribromoethyl group, a tetrabromoethyl group, a pentabromoethyl group, a perfluoropropyl group, a perfluorobutyl group, a perfluoropentyl group, a perfluorohexyl group, a perfluorooctyl group, a perfluorododecyl group, a perfluoropentadecyl group, a perfluoroeicosyl group, a perchloropropyl group, a perchlorobutyl group, a perchloropentyl group, a perchlorohexyl group, a perchlorooctyl group, a perchlorododecyl group, a perchloropentadecyl group, a perchloroeicosyl group, a perbromopropyl group, a perbromobutyl group, a perbromopentyl group, a perbromohexyl group, a perbromooctyl group, a perbromododecyl group, a perbromopentadecyl group, a perbromoeicosyl group and the like.

Examples of the alkyl group having 1 to 20 carbon atoms which has a substituted silyl group as a substituent include a trimethylsilylmethyl group, a trimethylsilylethyl group, a trimethylsilylpropyl group, a trimethylsilylbutyl group, a bis(trimethylsilyl)methyl group, a bis(trimethylsilyl)ethyl group, a bis(trimethylsilyl)propyl

group, a bis(trimethylsilyl)butyl group, a triphenylsilylmethyl group and the like.

Examples of the alkyl group having 1 to 20 carbon atoms which has a substituted amino group as a substituent
5 include a dimethylaminomethyl group, a dimethylaminoethyl group, a dimethylaminopropyl group, a dimethylaminobutyl group, a bis(dimethylamino)methyl group, a bis(dimethylamino)ethyl group, a bis(dimethylamino)propyl group, a bis(dimethylamino)butyl group, a phenylaminomethyl
10 group, a diphenylaminomethyl group and the like.

Examples of the alkyl group having 1 to 20 carbon atoms which has a hydrocarbyloxy group as a substituent
include a methoxymethyl group, an ethoxymethyl group, a n-propoxymethyl group, an isopropoxymethyl group, a n-
15 butoxymethyl group, a sec-butoxymethyl group, a tert-butoxymethyl group, a phenoxymethyl group, a methoxyethyl group, an ethoxyethyl group, a n-propoxyethyl group, an isopropoxyethyl group, a n-butoxyethyl group, a sec-butoxyethyl group, a tert-butoxyethyl group, a phenoxyethyl
20 group, a methoxy-n-propyl group, an ethoxy-n-propyl group, a n-propoxy-n-propyl group, an isopropoxy-n-propyl group, a n-butoxy-n-propyl group, a sec-butoxy-n-propyl group, a tert-butoxy-n-propyl group, a phenoxy-n-propyl group, a methoxyisopropyl group, an ethoxyisopropyl group, a n-propoxyisopropyl group, an isopropoxyisopropyl group, a n-
25

butoxyisopropyl group, a sec-butoxyisopropyl group, a tert-butoxyisopropyl group, a phenoxyisopropyl group and the like.

Examples of the aralkyl group having 7 to 20 carbon atoms which may have a substituent include an aralkyl group
5 having 7 to 20 carbon atoms, an aralkyl group having 7 to 20 carbon atoms which has a halogen atoms as a substituent and the like.

Examples of the aralkyl group having 7 to 20 carbon
10 atoms include a benzyl group, a (2-methylphenyl)methyl group, a (3-methylphenyl)methyl group, a (4-methylphenyl)methyl group, a (2,3-dimethylphenyl)methyl group, a (2,4-dimethylphenyl)methyl group, a (2,5-dimethylphenyl)methyl group, a (2,6-dimethylphenyl)methyl
15 group, a (3,4-dimethylphenyl)methyl group, a (4,6-dimethylphenyl)methyl group, a (2,3,4-trimethylphenyl)methyl group, a (2,3,5-trimethylphenyl)methyl group, a (2,3,6-trimethylphenyl)methyl group, a (3,4,5-trimethylphenyl)methyl group, a (2,4,6-trimethylphenyl)methyl group, a (2,3,4,5-tetramethylphenyl)methyl group, a (2,3,4,6-tetramethylphenyl)methyl group, a (2,3,5,6-tetramethylphenyl)methyl group, a (pentamethylphenyl)methyl
20 group, an (ethylphenyl)methyl group, a (n-

25

propylphenyl)methyl group, an (isopropylphenyl)methyl group,
a (n-butylphenyl)methyl group, a (sec-butylphenyl)methyl
group, a (tert-butylphenyl)methyl group, a (n-
pentylphenyl)methyl group, a (neopentylphenyl)methyl group,
5 a (n-hexylphenyl)methyl group, a (n-octylphenyl)methyl
group, a (n-decylphenyl)methyl group, a (n-
decylphenyl)methyl group, a (n-tetradecylphenyl)methyl
group, a naphthylmethyl group, an anthracenylmethyl group,
a phenylethyl group, a phenylpropyl group, a phenylbutyl
10 group, a diphenylmethyl group, a diphenylethyl group, a
diphenylpropyl group, a diphenylbutyl group and the like.

Examples of the aralkyl group having 7 to 20 carbon
atoms which has a halogen atoms as a substituent include a
2-fluorobenzyl group, a 3-fluorobenzyl group, a 4-
15 fluorobenzyl group, a 2-chlorobenzyl group, a 3-
chlorobenzyl group, a 4-chlorobenzyl group, a 2-bromobenzyl
group, a 3-bromobenzyl group, a 4-bromobenzyl group, a 2-
iodobenzyl group, a 3-iodobenzyl group, a 4-iodobenzyl
group and the like.

20 Examples of the aryl group having 6 to 20 carbon atoms
which may have a substituent include an aryl group having 6
to 20 carbon atoms, an aryl group having 6 to 20 carbon
atoms which has a halogen atom as a substituent, an aryl
group having 6 to 20 carbon atoms which has a substituted
25 silyl group as a substituent, an aryl group having 6 to 20

carbon atoms which has a substituted amino group as a substituent, an aryl group having 6 to 20 carbon atoms which has a hydrocarbyloxy group as a substituent and the like.

5 Examples of the aryl group having 6 to 20 carbon atoms include a phenyl group, a 2-tolyl group, a 3-tolyl group, a 4-tolyl group, a 2,3-xylyl group, a 2,4-xylyl group, a 2,5-xylyl group, a 2,6-xylyl group, a 3,4-xylyl group, a 3,5-xylyl group, a 2,3,4-trimethylphenyl group, a 2,3,5-trimethylphenyl group, a 2,3,6-trimethylphenyl group, a 2,4,6-trimethylphenyl group, a 3,4,5-trimethylphenyl group, a 2,3,4,5-tetramethylphenyl group, a 2,3,4,6-tetramethylphenyl group, a 2,3,5,6-tetramethylphenyl group, a pentamethylphenyl group, an ethylphenyl group, a 15 diethylphenyl group, a triethylphenyl group, a n-propylphenyl group, an isopropylphenyl group, a n-butylphenyl group, a sec-butylphenyl group, a tert-butylphenyl group, a n-pentylphenyl group, a neopentylphenyl group, a n-hexylphenyl group, a n-20 octylphenyl group, a n-decylphenyl group, a n-dodecylphenyl group, a n-tetradecylphenyl group, a naphthyl group, an anthracenyl group and the like.

 Examples of the aryl group having 6 to 20 carbon atoms which has a halogen atom as a substituent include a 2-25 fluorophenyl group, a 3-fluorophenyl group, a 4-

fluorophenyl group, a 2-chlorophenyl group, a 3-chlorophenyl group, a 4-chlorophenyl group, a 2-bromophenyl group, a 3-bromophenyl group, a 4-bromophenyl group, a 2-iodophenyl group, a 3-iodophenyl group, a 4-iodophenyl group and the like.

Examples of the aryl group having 6 to 20 carbon atoms which has a substituted silyl group as a substituent include a trimethylsilylphenyl group, a bis(trimethylsilyl)phenyl group and the like.

Examples of the aryl group having 6 to 20 carbon atoms which has a substituted amino group as a substituent include a dimethylaminophenyl group, a bis(dimethylamino)phenyl group, a diphenylaminophenyl group and the like.

Examples of the aryl group having 6 to 20 carbon atoms which has a hydrocarbyloxy group as a substituent include a methoxyphenyl group, an ethoxyphenyl group, a n-propoxyphenyl group, an isopropoxyphenyl group, a n-butoxyphenyl group, a sec-butoxyphenyl group, a tert-butoxyphenyl group, a phenoxyphenyl group and the like.

R^1 is preferably an alkyl group having 1 to 20 carbon atoms, more preferably an alkyl group having 1 to 5 carbon atoms, and still more preferably a methyl group, an ethyl group, a n-propyl group or an isopropyl group.

Q in Formula [2] is preferably $R^1C(=O)O-$, more

preferably an acetate group, a propionate group, a butyrate group or a pentylate group, and most preferably an acetate group.

R in Formula [3] is preferably a hydroxy group.

5 m represents the number of 10 to 3,000, preferably the number of 50 to 1,000, and more preferably the number of 100 to 500.

10 n represents the number of 10 to 3,000, preferably the number of 50 to 1,000, and more preferably the number of 100 to 500.

Examples of the random copolymer represented by Formula [1] include a vinyl alcohol-vinyl acetate random copolymer, a methoxyvinyl-vinyl acetate random copolymer and an ethoxyvinyl-vinyl acetate random copolymer.

15 Coating Method

It is possible to employ, as the coating method of the present invention, a method in which a coating liquid which is a liquid containing a coating compound and a solvent is attached to an inside wall of a reactor to form a layer
20 made of the coating liquid, and the solvent is removed from the layer; or a method in which a coating liquid is applied onto a plate prepared separately to form a layer made of the coating liquid and a solvent is removed from the layer to form a film in advance, and then the film is attached to
25 an inside wall of a reactor.

A method of attaching a coating liquid to an inside wall of a reactor is preferably, for example, a method in which a coating liquid atomized by a spray gun is sprayed over an inside wall of a reactor (spray coating); a method in which a coating liquid, with which a brush, a roller, a bleached cotton cloth or the like is impregnated, is applied onto an inside wall of a reactor; a method in which a reactor is filled with a coating liquid and, after the lapse of a prescribed time, the coating liquid is extracted; or a method in which a coating liquid is spread over an inside wall of a reactor using a pipette, a syringe, a dropping pipette or the like.

The coating liquid is a liquid composition containing the coating compound and a solvent. Herein, examples of the solvent include nonpolar solvents such as water, an aliphatic hydrocarbyl solvent and an aromatic hydrocarbyl solvent; and polar solvents such as a halide solvent, an ether-based solvent, an alcohol-based solvent, a phenol-based solvent, a carbonyl-based solvent, a phosphoric acid derivative, a nitrile-based solvent, a nitro compound, an amine-based solvent and a sulfur compound. The solvent is preferably water or an alcohol-based solvent, and particularly preferably an alcohol-based solvent. The concentration of the coating compound in the coating liquid is usually from 0.01% by weight to 10% by weight, and

preferably from 0.05% by weight to 1% by weight.

The solvent can be usually vaporized and removed from a layer made of the coating liquid by maintaining the layer at a temperature within a range from room temperature to
5 200°C for 10 minutes to 20 hours. It is preferred that the solvent is removed by drying under reduced pressure or sweeping the solvent with an inert gas such as nitrogen while optionally heating the layer made of the coating liquid so that the solvent may not remain in the layer.

10 The thickness of the layer made of the coating compound, with which an inside wall of a reactor is coated, is usually 5 mm or less, and preferably 1 mm or less.

The amount of the coating compound based on an area of an inside wall of a reactor is preferably from 0.01 to 50
15 g/m², and more preferably from 0.1 to 5 g/m².

The reactor having a coated inside wall of the present invention can be used in various chemical reactions, and is preferably used for addition polymerization. That is, a method, in which monomers capable of addition polymerizing
20 are addition polymerized in the presence of a catalyst for addition polymerization in a reactor having a coated inside wall, is preferred.

The catalyst for addition polymerization is produced by bringing a compound (A) selected from a transition metal
25 compound or its μ -oxo type transition metal compound dimer,

an activating agent (B) and, optionally, an organoaluminium compound (C) into contact with each other.

Compound (A) selected from Transition Metal Compound or its μ -Oxo Type Transition Metal Compound Dimer

5 There is no particular limitation on the compound (A) selected from a transition metal compound or its μ -oxo type transition metal compound dimer used the present invention as long as it is a transition metal compound which exhibits addition polymerization activity by using in combination
10 with the activating agent (B), and optionally using in combination with the organoaluminium compound (C). Usually, a transition metal compound such as a metallocene complex is used.

Examples of the transition metal compound (A) include
15 a transition metal compound represented by Formula [4] described below or its μ -oxo type transition metal compound dimer:



wherein M^1 is a transition metal atom of Group 4; L^1 is a
20 group having a cyclopentadiene type anionic skeleton or containing a hetero atom; X^1 is a halogen atom, a hydrocarbyloxy group, or a hydrocarbyl group other than groups having a cyclopentadiene type anionic skeleton; a is a number satisfying $0 < a \leq 3$; b is a number satisfying $0 <$
25 $b \leq 3$; when there are more than one L^1 , one L^1 may be

linked to another L^1 either directly or by a group containing a carbon atom, a silicon atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom.

M^1 in Formula [4] is a titanium atom, a zirconium atom
5 or a hafnium atom, and more preferably a zirconium atom.

Examples of the group having a cyclopentadiene type anionic skeleton of L^1 in Formula [4] include an optionally substituted cyclopentadienyl group, an optionally substituted indenyl group and an optionally substituted
10 fluorenyl group. Examples of L^1 include a cyclopentadienyl group, a methylcyclopentadienyl group, an ethylcyclopentadienyl group, a n-butylcyclopentadienyl group, a tert-butylcyclopentadienyl group, a 1,2-dimethylcyclopentadienyl group, a 1,3-
15 dimethylcyclopentadienyl group, a 1-methyl-2-ethylcyclopentadienyl group, a 1-methyl-3-ethylcyclopentadienyl group, a 1-tert-butyl-2-methylcyclopentadienyl group, a 1-tert-butyl-3-methylcyclopentadienyl group, a 1-methyl-2-
20 isopropylcyclopentadienyl group, a 1-methyl-3-isopropylcyclopentadienyl group, a 1-methyl-2-n-butylcyclopentadienyl group, a 1-methyl-3-n-butylcyclopentadienyl group, a η^5 -1,2,3-trimethylcyclopentadienyl group, a η^5 -1,2,4-
25 trimethylcyclopentadienyl group, a

tetramethylcyclopentadienyl group, a
pentamethylcyclopentadienyl group, an indenyl group, a
4,5,6,7-tetrahydroindenyl group, a 2-methylindenyl group, a
3-methylindenyl group, a 4-methylindenyl group, a 5-
5 methylindenyl group, a 6-methylindenyl group, a 7-
methylindenyl group, a 2-tert-butylindenyl group, a 3-tert-
butylindenyl group, a 4-tert-butylindenyl group, a 5-tert-
butylindenyl group, a 6-tert-butylindenyl group, a 7-tert-
butylindenyl group, a 2,3-dimethylindenyl group, a 4,7-
10 dimethylindenyl group, a 2,4,7-trimethylindenyl group, a 2-
methyl-4-isopropylindenyl group, a 4,5-benzindenyl group, a
2-methyl-4,5-benzindenyl group, a 4-phenylindenyl group, a
2-methyl-5-phenylindenyl group, a 2-methyl-4-phenylindenyl
group, a 2-methyl-4-naphthylindenyl group, a fluorenyl
15 group, a 2,7-dimethylfluorenyl group and a 2,7-di-tert-
butylfluorenyl group.

There is no particular limitation on hapticity η of
the ligand contained in the group having a cyclopentadiene
type anionic skeleton used in L^1 in Formula [4], and the
20 hapticity η of the ligand may be any value which is
available in the group having a cyclopentadiene type
anionic skeleton. Examples of the hapticity of the ligand
include five, four, three, two and one. The hapticity of
the ligand is preferably five, three or one, and more
25 preferably five or three.

Examples of the hetero atom in the group containing a hetero atom of L¹ in Formula [4] include an oxygen atom, a sulfur atom, a nitrogen atom and a phosphorus atom, and the group is preferably an alkoxy group, an aryloxy group, a thioalkoxy group, a thioaryloxy group, an alkylamino group, an arylamino group, an alkylphosphino group, an arylphosphino group, an chelating ligand, or an aromatic heterocyclic group or aliphatic heterocyclic group containing an oxygen atom, a sulfur atom, an nitrogen atom and/or a phosphorus atom in its ring.

Examples of the group containing a hetero atom of L¹ in Formula [4] include a methoxy group, an ethoxy group, a propoxy group, a butoxy group, a phenoxy group, a 2-methylphenoxy group, 2,6-dimethylphenoxy group, a 2,4,6-trimethylphenoxy group, a 2-ethylphenoxy group, a 4-n-propylphenoxy group, a 2-isopropylphenoxy group, a 2,6-diisopropylphenoxy group, a 4-sec-butylphenoxy group, a 4-tert-butylphenoxy group, a 2,6-di-sec-butylphenoxy group, a 2-tert-butyl-4-methylphenoxy group, a 2,6-di-tert-butylphenoxy group, a 4-methoxyphenoxy group, a 2,6-dimethoxyphenoxy group, a 3,5-dimethoxyphenoxy group, a 2-chlorophenoxy group, a 4-nitrosophenoxy group, a 4-nitrophenoxy group, a 2-aminophenoxy group, a 3-aminophenoxy group, a 4-aminothiophenoxy group, a 2,3,6-trichlorophenoxy group, a 2,4,6-trifluorophenoxy group, a

thiomethoxy group, a dimethylamino group, a diethylamino group, a dipropylamino group, a diphenylamino group, an isopropylamino group, a tert-butylamino group, a pyrrolyl group, a dimethylphosphino group, a 2-(2-oxy-1-propyl)phenoxy group, catechol, resorcinol, 4-isopropylcatechol, 3-methoxycatechol, a 1,8-dihydroxynaphthyl group, a 1,2-dihydroxynaphthyl group, a 2,2'-biphenyldiol group, a 1,1'-bi-2-naphthol group, a 2,2'-dihydroxy-6,6'-dimethylbiphenyl group, a 4,4',6,6'-tetra-tert-butyl-2,2'-methylenediphenoxy group and a 4,4',6,6'-tetramethyl-2,2'-isobutylidenediphenoxy group.

Examples of the group containing a hetero atom also include a group represented by Formula [8]:

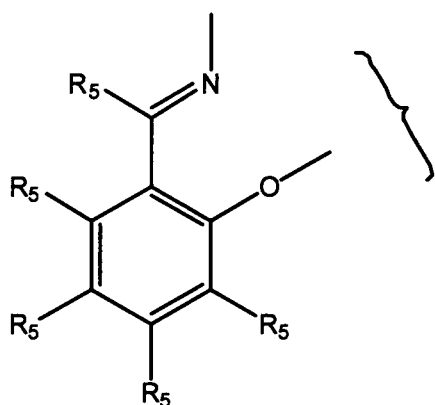


wherein R^4 group each independently represents a hydrogen atom, a halogen atom or a hydrocarbyl group, or any two of R^4 groups are linked to one another to form a hydrocarbylene group.

Examples of R^4 group in Formula [8] include a hydrogen atom, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, a tert-butyl group, a cyclopropyl group, a cyclobutyl group, a cycloheptyl group, a cyclohexyl group, a phenyl group, a 1-naphthyl group, a 2-naphthyl group and a benzyl group.

Examples of the group containing a hetero atom can also include a group represented by Formula [9]:

[Chemical Formula 1]



[9]

wherein R⁵ group each independently represents a hydrogen atom, a halogen atom, a hydrocarbyl group, a halogenated hydrocarbyl group, a hydrocarbyloxy group, a silyl group or an amino group, or any two or more of R⁵ groups are linked to one another to form a ring structure.

Examples of R⁵ group in Formula [9] include a hydrogen atom, a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a tert-butyl group, a 2,6-dimethylphenyl group, a 2-fluorenyl group, a 2-methylphenyl group, a 4-trifluoromethylphenyl group, a 4-methoxyphenyl group, a 4-pyridyl group, a cyclohexyl group, a 2-isopropylphenyl group, a benzyl group, a methyl group, a triethylsilyl group, a diphenylmethylsilyl group, a 1-methyl-1-phenylethyl group, a 1,1-dimethylpropyl group, a 2-chlorophenyl group and a pentafluorophenyl group.

The chelating ligand of L^1 in Formula [4] means a ligand having a plurality of coordination sites, and examples of the ligand include acetylacetonate, diimine, oxazoline, bisoxazoline, terpyridine, acylhydrazone, diethylenetriamine, triethylenetetramine, porphyrin, crown ether and cryptate.

Examples of the heterocyclic group of L^1 in Formula [4] can include a pyridyl group, an N-substituted imidazolyl group and an N-substituted indazolyl group. Among them, a pyridyl group is preferred.

When a plurality of L^1 in Formula [4] are linked to each other by a residue containing a carbon atom, a silicon atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom (that is, when groups having a cyclopentadiene type anionic skeleton are linked to each other by its residue, when groups containing a hetero atom are linked to each other by its residue, or when a group having a cyclopentadiene type anionic skeleton and a group containing a hetero atom are linked to each other by its residue), its residue is preferably a divalent residue in which the atom linked to L^1 is a carbon atom, a silicon atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom, and the number of atoms linking two L^1 is 3 or less. Examples of its residue include alkylene groups such as a methylene group, an ethylene group and a

propylene group; substituted alkylene groups such as a dimethylmethylene group (an isopropylidene group) and a diphenylmethylene group; substituted silylene groups such as a silylene group, a dimethylsilylene group, a
5 diethylsilylene group, a diphenylsilylene group, a tetramethyldisilylene group and a dimethoxysilylene group; and hetero atoms such as a nitrogen atom, an oxygen atom, a sulfur atom and a phosphorus atom. Among them, a methylene group, an ethylene group, a dimethylmethylene group
10 (isopropylidene group), a diphenylmethylene group, a dimethylsilylene group, a diethylsilylene group, a diphenylsilylene group or a dimethoxysilylene group is particularly preferred.

Examples of the halogen atom of X^1 in Formula [4]
15 include a fluorine atom, a chlorine atom, a bromine atom and an iodine atom. Examples of the hydrocarbyl group of X^1 include an alkyl group, an aralkyl group, an aryl group and an alkenyl group. Among them, an alkyl group having 1 to 20 carbon atoms, an aralkyl group having 7 to 20 carbon
20 atoms, an aryl group having 6 to 20 carbon atoms or an alkenyl group having 3 to 20 carbon atoms is particularly preferred.

Examples of the alkyl group having 1 to 20 carbon atoms include a methyl group, an ethyl group, a n-propyl
25 group, an isopropyl group, a n-butyl group, a sec-butyl

group, a tert-butyl group, an isobutyl group, a n-pentyl group, a neopentyl group, an amyl group, a n-hexyl group, a n-octyl group, a n-decyl group, a n-dodecyl group, a n-pentadecyl group and a n-eicosyl group. Among them, a methyl group, an ethyl group, an isopropyl group, a tert-butyl group, an isobutyl group or an amyl group is more preferred. Any of these alkyl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom. Examples of the alkyl group substituted with a halogen atom include a fluoromethyl group, a trifluoromethyl group, a chloromethyl group, a trichloromethyl group, a fluoroethyl group, a pentafluoroethyl group, a perfluoropropyl group, a perfluorobutyl group, a perfluorohexyl group, a perfluorooctyl group, a perchloropropyl group, a perchlorobutyl group and a perbromopropyl group. The hydrogen atom contained in these alkyl groups may be substituted with an alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

Examples of the aralkyl group having 7 to 20 carbon atoms can include a benzyl group, a (2-methylphenyl)methyl group, a (3-methylphenyl)methyl group, a (4-methylphenyl)methyl group, a (2,3-dimethylphenyl)methyl group, a (2,4-dimethylphenyl)methyl group, a (2,5-

dimethylphenyl)methyl group, a (2,6-dimethylphenyl)methyl group, a (3,4-dimethylphenyl)methyl group, a (3,5-dimethylphenyl)methyl group, a (2,3,4-trimethylphenyl)methyl group, a (2,3,5-trimethylphenyl)methyl group, a (2,3,6-trimethylphenyl)methyl group, a (3,4,5-trimethylphenyl)methyl group, a (2,4,6-trimethylphenyl)methyl group, a (2,3,4,5-tetramethylphenyl)methyl group, a (2,3,4,6-tetramethylphenyl)methyl group, a (2,3,5,6-tetramethylphenyl)methyl group, a (pentamethylphenyl)methyl group, an (ethylphenyl)methyl group, a (n-propylphenyl)methyl group, an (isopropylphenyl)methyl group, a (n-butylphenyl)methyl group, a (sec-butylphenyl)methyl group, a (tert-butylphenyl)methyl group, a (n-pentylphenyl)methyl group, a (neopentylphenyl)methyl group, a (n-hexylphenyl)methyl group, a (n-octylphenyl)methyl group, a (n-decylphenyl)methyl group, a (n-dodecylphenyl)methyl group, a naphthylmethyl group and an anthracenylmethyl group, and more preferably a benzyl group. The hydrogen atom contained in these aralkyl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy

group such as a benzyloxy group.

Examples of the aryl group having 6 to 20 carbon atoms include a phenyl group, a 2-tolyl group, a 3-tolyl group, a 4-tolyl group, a 2,3-xylyl group, a 2,4-xylyl group, a 2,5-xylyl group, a 2,6-xylyl group, a 3,4-xylyl group, a 3,5-xylyl group, a 2,3,4-trimethylphenyl group, a 2,3,5-trimethylphenyl group, a 2,3,6-trimethylphenyl group, a 2,4,6-trimethylphenyl group, a 3,4,5-trimethylphenyl group, a 2,3,4,5-tetramethylphenyl group, a 2,3,4,6-tetramethylphenyl group, a 2,3,5,6-tetramethylphenyl group, a pentamethylphenyl group, an ethylphenyl group, a n-propylphenyl group, an isopropylphenyl group, a n-butylphenyl group, a sec-butylphenyl group, a tert-butylphenyl group, a n-pentylphenyl group, a neopentylphenyl group, a n-hexylphenyl group, a n-octylphenyl group, a n-decylphenyl group, a n-dodecylphenyl group, a n-tetradecylphenyl group, a naphthyl group and an anthracenyl group, and more preferably a phenyl group. The hydrogen atom contained in these aryl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

Examples of the alkenyl group having 3 to 20 carbon

atoms include an allyl group, a metalllyl group, a crotyl group and a 1,3-diphenyl-2-propenyl group, and preferably an allyl group or a metalllyl group.

Examples of the hydrocarbyloxy group of X¹ in Formula
5 [1] include an alkoxy group, an aralkyloxy group and an aryloxy group, and preferably an alkoxy group having 1 to 20 carbon atoms, an aralkyloxy group having 7 to 20 carbon atoms or an aryloxy group having 6 to 20 carbon atoms.

Examples of the alkoxy group having 1 to 20 carbon
10 atoms include a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group, a sec-butoxy group, a tert-butoxy group, a n-pentoxy group, a neopentoxy group, a n-hexoxy group, a n-octoxy group, a n-dodesoxy group, a n-pentadesoxy group and a n-icosoxy group, and
15 preferably a methoxy group, an ethoxy group, an isopropoxy group or a tert-butoxy group. The hydrogen atom contained in these alkoxy groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an alkoxy group such as a methoxy
20 group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

Examples of the aralkyloxy group having 7 to 20 carbon atoms include a benzyloxy group, a (2-methylphenyl)methoxy
25 group, a (3-methylphenyl)methoxy group, a (4-

methylphenyl)methoxy group, a (2,3-dimethylphenyl)methoxy group, a (2,4-dimethylphenyl)methoxy group, a (2,5-dimethylphenyl)methoxy group, a (2,6-dimethylphenyl)methoxy group, a (3,4-dimethylphenyl)methoxy group, a (3,5-dimethylphenyl)methoxy group, a (2,3,4-trimethylphenyl)methoxy group, a (2,3,5-trimethylphenyl)methoxy group, a (2,3,6-trimethylphenyl)methoxy group, a (2,4,5-trimethylphenyl)methoxy group, a (2,4,6-trimethylphenyl)methoxy group, a (3,4,5-trimethylphenyl)methoxy group, a (2,3,4,5-tetramethylphenyl)methoxy group, a (2,3,4,6-tetramethylphenyl)methoxy group, a (2,3,5,6-tetramethylphenyl)methoxy group, a (pentamethylphenyl)methoxy group, an (ethylphenyl)methoxy group, a (n-propylphenyl)methoxy group, an (isopropylphenyl)methoxy group, a (n-butylphenyl)methoxy group, a (sec-butylphenyl)methoxy group, a (tert-butylphenyl)methoxy group, a (n-hexylphenyl)methoxy group, a (n-octylphenyl)methoxy group, a (n-decylphenyl)methoxy group, a naphthylmethoxy group and an anthracenylmethoxy group. Among them, a benzyloxy group is more preferred. The hydrogen atom contained in these aralkyloxy groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an

alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

Examples of the aryloxy group having 6 to 20 carbon atoms include a phenoxy group, a 2-methylphenoxy group, a 3-methylphenoxy group, a 4-methylphenoxy group, a 2,3-dimethylphenoxy group, a 2,4-dimethylphenoxy group, a 2,5-dimethylphenoxy group, a 2,6-dimethylphenoxy group, a 3,4-dimethylphenoxy group, a 3,5-dimethylphenoxy group, a 2-tert-butyl-3-methylphenoxy group, a 2-tert-butyl-4-methylphenoxy group, a 2-tert-butyl-5-methylphenoxy group, a 2-tert-butyl-6-methylphenoxy group, a 2,3,4-trimethylphenoxy group, a 2,3,5-trimethylphenoxy group, a 2,3,6-trimethylphenoxy group, a 2,4,5-trimethylphenoxy group, a 2,4,6-trimethylphenoxy group, a 2-tert-butyl-3,4-dimethylphenoxy group, a 2-tert-butyl-3,5-dimethylphenoxy group, a 2-tert-butyl-3,6-dimethylphenoxy group, a 2,6-di-tert-butyl-3-methylphenoxy group, a 2-tert-butyl-4,5-dimethylphenoxy group, a 2,6-di-tert-butyl-4-methylphenoxy group, a 3,4,5-trimethylphenoxy group, a 2,3,4,5-tetramethylphenoxy group, a 2-tert-butyl-3,4,5-trimethylphenoxy group, a 2,3,4,6-tetramethylphenoxy group, a 2-tert-butyl-3,4,6-trimethylphenoxy group, a 2,6-di-tert-butyl-3,4-dimethylphenoxy group, a 2,3,5,6-tetramethylphenoxy group, a 2-tert-butyl-3,5,6-

trimethylphenoxy group, a 2,6-di-tert-butyl-3,5-dimethylphenoxy group, a pentamethylphenoxy group, an ethylphenoxy group, a n-propylphenoxy group, an isopropylphenoxy group, a n-butylphenoxy group, a sec-butylphenoxy group, a tert-butylphenoxy group, a n-hexylphenoxy group, a n-octylphenoxy group, a n-decylphenoxy group, a n-tetradecylphenoxy group, a naphthoxy group and an anthrathenoxy group. The hydrogen atom contained in these aryloxy groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

X^1 in Formula [4] is more preferably a chlorine atom, a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group, a trifluoromethoxy group, a phenyl group, a phenoxy group, a 2,6-di-tert-butylphenoxy group, a 3,4,5-trifluorophenoxy group, a pentafluorophenoxy group, a 2,3,5,6-tetrafluoro-4-pentafluorophenylphenoxy group or a benzyl group.

a in Formula [4] is a number satisfying $0 < a \leq 3$, and b is a number satisfying $0 < b \leq 3$. a and b are

appropriately selected according to the valence of M^1 .

When M^1 is a titanium atom, a zirconium atom or a hafnium atom, a is preferably 2 and also b is preferably 2.

Examples of the compound represented by Formula [4] in which a transition metal atom is a titanium atom, a zirconium atom or a hafnium atom include

bis(cyclopentadienyl)titanium dichloride,
bis(methylcyclopentadienyl)titanium dichloride,
bis(ethylcyclopentadienyl)titanium dichloride, bis(n-butylcyclopentadienyl)titanium dichloride, bis(tert-butylcyclopentadienyl)titanium dichloride, bis(1,2-dimethylcyclopentadienyl)titanium dichloride, bis(1,3-dimethylcyclopentadienyl)titanium dichloride, bis(1-methyl-2-ethylcyclopentadienyl)titanium dichloride, bis(1-methyl-3-ethylcyclopentadienyl)titanium dichloride, bis(1-methyl-2-n-butylcyclopentadienyl)titanium dichloride, bis(1-methyl-3-n-butylcyclopentadienyl)titanium dichloride, bis(1-methyl-2-isopropylcyclopentadienyl)titanium dichloride, bis(1-methyl-3-isopropylcyclopentadienyl)titanium dichloride, bis(1-tert-butyl-2-methylcyclopentadienyl)titanium dichloride, bis(1-tert-butyl-3-methylcyclopentadienyl)titanium dichloride, bis(1,2,3-trimethylcyclopentadienyl)titanium dichloride, bis(1,2,4-trimethylcyclopentadienyl)titanium dichloride, bis(tetramethylcyclopentadienyl)titanium dichloride,

bis(pentamethylcyclopentadienyl)titanium dichloride,
bis(indenyl)titanium dichloride, bis(4,5,6,7-
tetrahydroindenyl)titanium dichloride,
bis(fluorenyl)titanium dichloride, bis(2-
5 phenylindenyl)titanium dichloride,
bis[2-(bis-3,5-trifluoromethylphenyl)indenyl]titanium
dichloride, bis[2-(4-tert-butylphenyl)indenyl]titanium
dichloride, bis[2-(4-trifluoromethylphenyl)indenyl]titanium
dichloride, bis[2-(4-methylphenyl)indenyl]titanium
10 dichloride, bis[2-(3,5-dimethylphenyl)indenyl]titanium
dichloride, bis[2-(pentafluorophenyl)indenyl]titanium
dichloride,
cyclopentadienyl(pentamethylcyclopentadienyl)titanium
dichloride, cyclopentadienyl(indenyl)titanium dichloride,
15 cyclopentadienyl(fluorenyl)titanium dichloride,
indenyl(fluorenyl)titanium dichloride,
pentamethylcyclopentadienyl(indenyl)titanium dichloride,
pentamethylcyclopentadienyl(fluorenyl)titanium dichloride,
cyclopentadienyl(2-phenylindenyl)titanium dichloride,
20 pentamethylcyclopentadienyl(2-phenylindenyl)titanium
dichloride,
dimethylsilylenebis(cyclopentadienyl)titanium dichloride,
dimethylsilylenebis(2-methylcyclopentadienyl)titanium
dichloride, dimethylsilylenebis(3-
25 methylcyclopentadienyl)titanium dichloride,

dimethylsilylenebis(2-n-butylcyclopentadienyl)titanium
dichloride, dimethylsilylenebis(3-n-
butylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(2,3-dimethylcyclopentadienyl)titanium
5 dichloride, dimethylsilylenebis(2,4-
dimethylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(2,5-dimethylcyclopentadienyl)titanium
dichloride, dimethylsilylenebis(3,4-
dimethylcyclopentadienyl)titanium dichloride,
10 dimethylsilylenebis(2,3-
ethylmethylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(2,4-
ethylmethylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(2,5-
15 ethylmethylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(3,5-
ethylmethylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(2,3,4-
trimethylcyclopentadienyl)titanium dichloride,
20 dimethylsilylenebis(2,3,5-
trimethylcyclopentadienyl)titanium dichloride,
dimethylsilylenebis(tetramethylcyclopentadienyl)titanium
dichloride,
dimethylsilylenebis(indenyl)titanium dichloride,
25 dimethylsilylenebis(2-methylindenyl)titanium dichloride,

dimethylsilylenebis(2-tert-butylindenyl)titanium dichloride,
dimethylsilylenebis(2,3-dimethylindenyl)titanium dichloride,
dimethylsilylenebis(2,4,7-trimethylindenyl)titanium
dichloride, dimethylsilylenebis(2-methyl-4-
5 isopropylindenyl)titanium dichloride,
dimethylsilylenebis(4,5-benzindenyl)titanium dichloride,
dimethylsilylenebis(2-methyl-4,5-benzindenyl)titanium
dichloride, dimethylsilylenebis(2-phenylindenyl)titanium
dichloride, dimethylsilylenebis(4-phenylindenyl)titanium
10 dichloride, dimethylsilylenebis(2-methyl-4-
phenylindenyl)titanium dichloride, dimethylsilylenebis(2-
methyl-5-phenylindenyl)titanium dichloride,
dimethylsilylenebis(2-methyl-4-naphthylindenyl)titanium
dichloride, dimethylsilylenebis(4,5,6,7-
15 tetrahydroindenyl)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (indenyl)titanium
dichloride, dimethylsilylene(methylcyclopentadienyl)
(indenyl)titanium dichloride, dimethylsilylene(n-
butylcyclopentadienyl) (indenyl)titanium dichloride,
20 dimethylsilylene(tetramethylcyclopentadienyl)
(indenyl)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (fluorenyl)titanium
dichloride, dimethylsilylene(methylcyclopentadienyl)
(fluorenyl)titanium dichloride, dimethylsilylene(n-
25 butylcyclopentadienyl) (fluorenyl)titanium dichloride,

dimethylsilylene(tetramethylcyclopentadienyl)
(indenyl)titanium dichloride, dimethylsilylene(indenyl)
(fluorenyl)titanium dichloride,
dimethylsilylenebis(fluorenyl)titanium dichloride,
5 dimethylsilylene(cyclopentadienyl)
(tetramethylcyclopentadienyl)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl)
(fluorenyl)titanium dichloride,
cyclopentadienyltitanium trichloride,
10 pentamethylcyclopentadienyltitanium trichloride,
cyclopentadienyl(dimethylamide)titanium dichloride,
cyclopentadienyl(phenoxy)titanium dichloride,
cyclopentadienyl(2,6-dimethylphenyl)titanium dichloride,
cyclopentadienyl(2,6-diisopropylphenyl)titanium dichloride,
15 cyclopentadienyl(2,6-di-tert-butylphenyl)titanium
dichloride, pentamethylcyclopentadienyl(2,6-
dimethylphenyl)titanium dichloride,
pentamethylcyclopentadienyl(2,6-diisopropylphenyl)titanium
dichloride, pentamethylcyclopentadienyl(2,6-tert-
20 butylphenyl)titanium dichloride, indenyl(2,6-
diisopropylphenyl)titanium dichloride, fluorenyl(2,6-
diisopropylphenyl)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (2-phenoxy)titanium
dichloride, dimethylsilylene(cyclopentadienyl) (3-methyl-2-
25 phenoxy)titanium dichloride,

- dimethylsilylene(cyclopentadienyl) (3,5-dimethyl-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (3-tert-butyl-2-phenoxy)titanium dichloride,
5 dimethylsilylene(cyclopentadienyl) (3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (3,5-di-tert-butyl-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (5-methyl-3-phenyl-2-phenoxy)titanium dichloride,
10 dimethylsilylene(cyclopentadienyl) (3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (5-methyl-3-trimethylsilyl-2-phenoxy)titanium dichloride,
15 dimethylsilylene(cyclopentadienyl) (3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (3,5-diamyl-2-phenoxy)titanium dichloride,
20 dimethylsilylene(cyclopentadienyl) (3-phenyl-2-phenoxy)titanium dichloride,
dimethylsilylene(cyclopentadienyl) (1-naphthoxy-2-yl)titanium dichloride,
25 dimethylsilylene(methylcyclopentadienyl) (2-

phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3-methyl-2-
phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3,5-dimethyl-2-
5 phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3-tert-butyl-2-
phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3-tert-butyl-5-
methyl-2-phenoxy)titanium dichloride,
10 dimethylsilylene(methylcyclopentadienyl) (3,5-di-tert-
butyl-2-phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (5-methyl-3-
phenyl-2-phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3-tert-
15 butyldimethylsilyl-5-methyl-2-phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (5-methyl-3-
trimethylsilyl-2-phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3-tert-butyl-5-
methoxy-2-phenoxy)titanium dichloride,
20 dimethylsilylene(methylcyclopentadienyl) (3-tert-butyl-5-
chloro-2-phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3,5-diamyl-2-
phenoxy)titanium dichloride,
dimethylsilylene(methylcyclopentadienyl) (3-phenyl-2-
25 phenoxy)titanium dichloride,

dimethylsilylene(methylcyclopentadienyl) (1-naphthoxy-2-yl)titanium dichloride,
dimethylsilylene(n-butylcyclopentadienyl) (2-phenoxy)titanium dichloride, dimethylsilylene(n-
5 butylcyclopentadienyl) (3-methyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3,5-dimethyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3-tert-butyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3-
10 tert-butyl-5-methyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3,5-di-tert-butyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (5-methyl-3-phenyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-
15 butylcyclopentadienyl) (3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (5-methyl-3-trimethylsilyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3-tert-butyl-5-methoxy-2-
20 phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3,5-diamyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl) (3-
25 phenyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-

butylcyclopentadienyl) (1-naphthoxy-2-yl)titanium
dichloride,
dimethylsilylene(tert-butylcyclopentadienyl) (2-
phenoxy)titanium dichloride, dimethylsilylene(tert-
5 butylcyclopentadienyl) (3-methyl-2-phenoxy)titanium
dichloride, dimethylsilylene(tert-butylcyclopentadienyl)
(3,5-dimethyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tert-butylcyclopentadienyl) (3-tert-butyl-
2-phenoxy)titanium dichloride, dimethylsilylene(tert-
10 butylcyclopentadienyl) (3-tert-butyl-5-methyl-2-
phenoxy)titanium dichloride, dimethylsilylene(tert-
butylcyclopentadienyl) (3,5-di-tert-butyl-2-
phenoxy)titanium dichloride, dimethylsilylene(tert-
butylcyclopentadienyl) (5-methyl-3-phenyl-2-
15 phenoxy)titanium dichloride, dimethylsilylene(tert-
butylcyclopentadienyl) (3-tert-butyl-5-methyl-
2-phenoxy)titanium dichloride, dimethylsilylene(tert-
butylcyclopentadienyl) (5-methyl-3-trimethylsilyl-2-
phenoxy)titanium dichloride, dimethylsilylene(tert-
20 butylcyclopentadienyl) (3-tert-butyl-5-methoxy-2-
phenoxy)titanium dichloride, dimethylsilylene(tert-
butylcyclopentadienyl) (3-tert-butyl-5-chloro-2-
phenoxy)titanium dichloride, dimethylsilylene(tert-
butylcyclopentadienyl) (3,5-diamyl-2-phenoxy)titanium
25 dichloride, dimethylsilylene(tert-butylcyclopentadienyl)

(3-phenyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tert-butylcyclopentadienyl) (1-naphthoxy-
2-yl)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (2-
5 phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3-methyl-2-
phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3,5-
dimethyl-2-phenoxy)titanium dichloride,
10 dimethylsilylene(tetramethylcyclopentadienyl) (3-tert-
butyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3-tert-
butyl-5-methyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3,5-di-tert-
15 butyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (5-methyl-3-
phenyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3-tert-
butyldimethylsilyl-5-methyl-2-phenoxy)titanium dichloride,
20 dimethylsilylene(tetramethylcyclopentadienyl) (5-methyl-3-
trimethylsilyl-2-phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3-tert-
butyl-5-methoxy-2-phenoxy)titanium dichloride,
dimethylsilylene(tetramethylcyclopentadienyl) (3-tert-
25 butyl-5-chloro-2-phenoxy)titanium dichloride,

dimethylsilylene(tetramethylcyclopentadienyl) (3,5-diamyl-
2-phenoxy)titanium dichloride,

dimethylsilylene(tetramethylcyclopentadienyl) (3-phenyl-2-
phenoxy)titanium dichloride,

5 dimethylsilylene(tetramethylcyclopentadienyl) (1-naphthoxy-
2-yl)titanium dichloride,

dimethylsilylene(trimethylsilylcyclopentadienyl) (2-
phenoxy)titanium dichloride,

10 dimethylsilylene(trimethylsilylcyclopentadienyl) (3-methyl-
2-phenoxy)titanium dichloride,

dimethylsilylene(trimethylsilylcyclopentadienyl) (3,5-
dimethyl-2-phenoxy)titanium dichloride,

dimethylsilylene(trimethylsilylcyclopentadienyl) (3-tert-
butyl-2-phenoxy)titanium dichloride,

15 dimethylsilylene(trimethylsilylcyclopentadienyl) (3-tert-
butyl-5-methyl-2-phenoxy)titanium dichloride,

dimethylsilylene(trimethylsilylcyclopentadienyl) (3,5-di-
tert-butyl-2-phenoxy)titanium dichloride,

20 dimethylsilylene(trimethylsilylcyclopentadienyl) (5-methyl-
3-phenyl-2-phenoxy)titanium dichloride,

dimethylsilylene(trimethylsilylcyclopentadienyl) (3-tert-
butyldimethylsilyl-5-methyl-2-phenoxy)titanium dichloride,

dimethylsilylene(trimethylsilylcyclopentadienyl) (5-methyl-
3-trimethylsilyl-2-phenoxy)titanium dichloride,

25 dimethylsilylene(trimethylsilylcyclopentadienyl) (3-tert-

butyl-5-methoxy-2-phenoxy)titanium dichloride,
dimethylsilylene(trimethylsilylcyclopentadienyl) (3-tert-
butyl-5-chloro-2-phenoxy)titanium dichloride,
dimethylsilylene(trimethylsilylcyclopentadienyl) (3,5-
5 diamyl-2-phenoxy)titanium dichloride,
dimethylsilylene(trimethylsilylcyclopentadienyl) (3-phenyl-
2-phenoxy)titanium dichloride,
dimethylsilylene(trimethylsilylcyclopentadienyl) (1-
naphthoxy-2-yl)titanium dichloride,
10 dimethylsilylene(indenyl) (2-phenoxy)titanium dichloride,
dimethylsilylene(indenyl) (3-methyl-2-phenoxy)titanium
dichloride, dimethylsilylene(indenyl) (3,5-dimethyl-2-
phenoxy)titanium dichloride, dimethylsilylene(indenyl) (3-
tert-butyl-2-phenoxy)titanium dichloride,
15 dimethylsilylene(indenyl) (3-tert-butyl-5-methyl-2-
phenoxy)titanium dichloride, dimethylsilylene(indenyl)
(3,5-di-tert-butyl-2-phenoxy)titanium dichloride,
dimethylsilylene(indenyl) (5-methyl-3-phenyl-2-
phenoxy)titanium dichloride, dimethylsilylene(indenyl) (3-
20 tert-butyl-5-methyl-2-phenoxy)titanium
dichloride, dimethylsilylene(indenyl) (5-methyl-3-
trimethylsilyl-2-phenoxy)titanium dichloride,
dimethylsilylene(indenyl) (3-tert-butyl-5-methoxy-2-
phenoxy)titanium dichloride, dimethylsilylene(indenyl) (3-
25 tert-butyl-5-chloro-2-phenoxy)titanium dichloride,

dimethylsilylene(indenyl) (3,5-diamyl-2-phenoxy)titanium
dichloride, dimethylsilylene(indenyl) (3-phenyl-2-
phenoxy)titanium dichloride, dimethylsilylene(indenyl) (1-
naphthoxy-2-yl)titanium dichloride,
5 dimethylsilylene(fluorenyl) (2-phenoxy)titanium dichloride,
dimethylsilylene(fluorenyl) (3-methyl-2-phenoxy)titanium
dichloride, dimethylsilylene(fluorenyl) (3,5-dimethyl-2-
phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)
(3-tert-butyl-2-phenoxy)titanium dichloride,
10 dimethylsilylene(fluorenyl) (3-tert-butyl-5-methyl-2-
phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)
(3,5-di-tert-butyl-2-phenoxy)titanium dichloride,
dimethylsilylene(fluorenyl) (5-methyl-3-phenyl-2-
phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)
15 (3-tert-butyl-5-methyl-2-phenoxy)titanium
dichloride, dimethylsilylene(fluorenyl) (5-methyl-3-
trimethylsilyl-2-phenoxy)titanium dichloride,
dimethylsilylene(fluorenyl) (3-tert-butyl-5-methoxy-2-
phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)
20 (3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,
dimethylsilylene(fluorenyl) (3,5-diamyl-2-phenoxy)titanium
dichloride, dimethylsilylene(fluorenyl) (3-phenyl-2-
phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)
(1-naphthoxy-2-yl)titanium dichloride,
25 (tert-butylamide)tetramethylcyclopentadienyl-1,2-

ethanediyltitanium dichloride,
(methanediyl)tetramethylcyclopentadienyl-1,2-
ethanediyltitanium dichloride,
(ethanediyl)tetramethylcyclopentadienyl-1,2-
5 ethanediyltitanium dichloride, (tert-
butylamide)tetramethylcyclopentadienyldimethylsilanetitanium
dichloride,
(benzylamide)tetramethylcyclopentadienyldimethylsilanetitanium
dichloride, (phenyl
10 phosphide)tetramethylcyclopentadienyldimethylsilanetitanium
dichloride, (tert-butylamide)indenyl-1,2-ethanediyltitanium
dichloride, (tert-butylamide)tetrahydroindenyl-1,2-
ethanediyltitanium dichloride, (tert-butylamide)fluorenyl-
1,2-ethanediyltitanium dichloride, (tert-
15 butylamide)indenenyldimethylsilanetitanium dichloride, (tert-
butylamide)tetrahydroindenenyldimethylsilanetitanium
dichloride, (tert-
butylamide)fluorenyldimethylsilanetitanium dichloride,
(dimethylaminomethyl)tetramethylcyclopentadienylyltitanium(II
20 I)dichloride,
(dimethylaminoethyl)tetramethylcyclopentadienylyltitanium(III
) dichloride,
(dimethylaminopropyl)tetramethylcyclopentadienylyltitanium(II
I) dichloride, (N-
25 pyrrolidinyethyl)tetramethylcyclopentadienylyltitanium

dichloride, (B-
dimethylaminoborabenzene)cyclopentadienyltitanium
dichloride, cyclopentadienyl(9-
mesitylboraanthracenyl)titanium dichloride,
5 2,2'-thiobis[4-methyl-6-tert-butylphenoxy]titanium
dichloride, 2,2'-thiobis[4-methyl-6-(1-
methylethyl)phenoxy]titanium dichloride, 2,2'-thiobis(4,6-
dimethylphenoxy)titanium dichloride, 2,2'-thiobis(4-methyl-
6-tert-butylphenoxy)titanium dichloride, 2,2'-
10 methylenebis(4-methyl-6-tert-butylphenoxy)titanium
dichloride, 2,2'-ethylenebis(4-methyl-6-tert-
butylphenoxy)titanium dichloride, 2,2'-sulfinylbis(4-
methyl-6-tert-butylphenoxy)titanium dichloride, 2,2'-
(4,4',6,6'-tetra-tert-butyl-1,1'-biphenoxy)titanium
15 dichloride, (di-tert-butyl-1,3-propanediamide)titanium
dichloride, (dicyclohexyl-1,3-propanediamide)titanium
dichloride,
[bis(trimethylsilyl)-1,3-propanediamide]titanium dichloride,
[bis(tert-butyl dimethylsilyl)-1,3-propanediamide]titanium
20 dichloride, [bis(2,6-dimethylphenyl)-1,3-
propanediamide]titanium dichloride, [bis(2,6-
diisopropylphenyl)-1,3-propanediamide]titanium dichloride,
[bis(2,6-di-tert-butylphenyl)-1,3-propanediamide]titanium
dichloride,
25 [bis(triisopropylsilyl)naphthalenediamide]titanium

dichloride, [bis(trimethylsilyl)naphthalenediamide]titanium
dichloride, [bis(tert-
butyldimethylsilyl)naphthalenediamide]titanium dichloride,
[hydrotris(3,5-dimethylpyrazolyl)borate]titanium
5 trichloride, [hydrotris(3,5-
diethylpyrazolyl)borate]titanium trichloride,
[hydrotris(3,5-di-tert-butyldimethylpyrazolyl)borate]titanium
trichloride, [tris(3,5-dimethylpyrazolyl)methyl]titanium
trichloride, [tris(3,5-diethylpyrazolyl)methyl]titanium
10 trichloride and [tris(3,5-di-tert-
butyldimethylpyrazolyl)methyl]titanium trichloride, compounds in
which "titanium" in these compounds is replaced by
"zirconium" or "hafnium", compounds in which "(2-phenoxy)"
is replaced by "(3-phenyl-2-phenoxy)", "(3-trimethylsilyl-
15 2-phenoxy)" or "(3-tert-butyldimethylsilyl-2-phenoxy)",
compounds in which "dimethylsilylene" is replaced by
"methylene", "ethylene",
"dimethylmethylene(isopropylidene)", "diphenylmethylene",
"diethylsilylene", "diphenylsilylene" or
20 "dimethoxysilylene", compounds in which "dichloride" is
replaced by "difluoride", "dibromide", "diiodide",
"dimethyl", "diethyl", "diisopropyl", "diphenyl", "dibenzyl",
"dimethoxide", "diethoxide", "di(n-propoxide)",
"di(isopropoxide)", "diphenoxide" or
25 "di(pentafluorophenoxide)", and compounds in which

"trichloride" is replaced by "trifluoride", "tribromide",
"triiodide", "trimethyl", "triethyl", "triisopropyl",
"triphenyl", "tribenzyl", "trimethoxide", "triethoxide",
"tri(n-propoxide)", "tri(isopropoxide)", "triphenoxide" or
5 "tri(pentafluorophenoxide)".

These transition metal compounds may be used alone, or
two or more kinds of them may be used in combination.

Among the above-mentioned transition metal compounds,
the compound (A) to be used in the present invention is
10 preferably a transition metal compound represented by
Formula [4] described above. Among them, a compound in
which M^1 in Formula [4] is zirconium, and a transition
metal compound containing at least one group having a
cyclopentadiene type anionic skeleton as L^1 in Formula [4]
15 are preferred. A zirconium compound containing two groups
having a cyclopentadiene type anionic skeleton as L^1 in
Formula [4], L^1 groups being linked to each other by a
group containing a carbon atom, a silicon atom, an oxygen
atom, a sulfur atom or a phosphorus atom, is particularly
20 preferred.

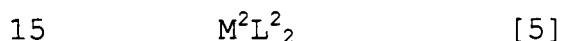
The transition metal compound represented by Formula
[4] can be produced by the production methods described in
JP-A-6-340684, JP-A-7-258321, and International Publication
No. WO 95/00562 and the like.

25 Activating Agent (B)

The activating agent (B) to be used in the present invention may be an agent which can activate the compound (A). When a catalyst for addition polymerization is applied to polymerization which forms addition polymer particles (e.g., slurry polymerization, gas phase polymerization, bulk polymerization, etc.), it is preferred to allow the produced addition polymer to have a fixed shape using the specific particles as one of components of a catalyst for addition polymerization. It is possible to preferably use, as the specific particles, modified particles of the following (I), (II) or (III):

(I): modified particles produced by bringing (a), (b), (c) and (d) described below into contact with each other,

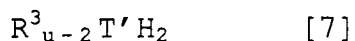
(a): a compound represented by Formula [5],



(b): a compound represented by Formula [6],



(c): a compound represented by Formula [7], and



(d): inorganic oxide particles or organic polymer particles, wherein M^2 in Formula [5] is a Group 12 element; L^2 is a hydrogen atom, a halogen atom or a hydrocarbyl group, and two L^2 may be the same as or different from each other; R^2 is an electron withdrawing group or a group containing an electron withdrawing group, and when there are more than

one R^2 , they may be the same as or different from each other; R^3 is a hydrocarbyl group or a halogenated hydrocarbyl group; T in Formula [6] is a Group 15 element or a Group 16 element; t is the valence of T; T' in Formula
5 [7] is a Group 15 element or a Group 16 element; and u is the valence of T'.

(II): modified particles produced by bringing inorganic oxide particles or organic polymer particles (d) into contact with an aluminoxane (e).

10 (III): modified particles produced by bringing inorganic oxide particles or organic polymer particles (d), the aluminoxane (e) and the compound (A) into contact with each other.

These are further described below sequentially.

15 M^2 in Formula [5] represents a Group 12 element of the Periodic Table of the elements (the 1989 IUPAC revised edition of inorganic chemical nomenclature). Examples of M^2 include a zinc atom, a cadmium atom and a mercury atom. M^2 is particularly preferably a zinc atom.

20 In Formula [5], L^2 is a hydrogen atom, a halogen atom or a hydrocarbyl group. Examples of the halogen atom of L^2 include a fluorine atom, a chlorine atom, a bromine atom and an iodine atom. The hydrocarbyl group of L^2 is preferably an alkyl group, an aryl group or an aralkyl
25 group.

The alkyl group of the hydrocarbyl group of L² is preferably an alkyl group having 1 to 20 carbon atoms, and examples thereof include a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, a sec-butyl group, a tert-butyl group, an isobutyl group, a n-pentyl group, a neopentyl group, a n-hexyl group, a n-heptyl group, a n-octyl group, a n-decyl group, a n-dodecyl group, a n-pentadecyl group and a n-eicosyl group, and more preferably a methyl group, an ethyl group, an isopropyl group, a tert-butyl group or an isobutyl group.

Any of these alkyl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom. Examples of the alkyl group having 1 to 20 carbon atoms which is substituted with a halogen atom can include a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a fluoroethyl group, a difluoroethyl group, a trifluoroethyl group, a tetrafluoroethyl group, a pentafluoroethyl group, a perfluoropropyl group, a perfluorobutyl group, a perfluoropentyl group, a perfluorohexyl group, a perfluorooctyl group, a perfluorododecyl group, a perfluoropentadecyl group, a perfluoroeicosyl group, a 1H,1H-perfluoropropyl group, a 1H,1H-perfluorobutyl group, a 1H,1H-perfluoropentyl group, a 1H,1H-perfluorohexyl group, a 1H,1H-perfluorooctyl group, a 1H,1H-perfluorododecyl

group, a 1H,1H-perfluoropentadecyl group, a 1H,1H-perfluoroeicosyl group, and alkyl groups in which "fluoro" of these alkyl groups is replaced by "chloro", "bromo" or "iodo". Any of these alkyl groups may be substituted with
5 an alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

The aryl group of the hydrocarbyl group of L² is preferably an aryl group having 6 to 20 carbon atoms, and
10 examples thereof include a phenyl group, a 2-tolyl group, a 3-tolyl group, a 4-tolyl group, a 2,3-xylyl group, a 2,4-xylyl group, a 2,5-xylyl group, a 2,6-xylyl group, a 3,4-xylyl group, a 3,5-xylyl group, a 2,3,4-trimethylphenyl group, a 2,3,5-trimethylphenyl group, a 2,3,6-
15 trimethylphenyl group, a 2,4,6-trimethylphenyl group, a 3,4,5-trimethylphenyl group, a 2,3,4,5-tetramethylphenyl group, a 2,3,4,6-tetramethylphenyl group, a 2,3,5,6-tetramethylphenyl group, a pentamethylphenyl group, an ethylphenyl group, a n-propylphenyl group, an
20 isopropylphenyl group, a n-butylphenyl group, a sec-butylphenyl group, a tert-butylphenyl group, an isobutylphenyl group, a n-pentylphenyl group, a neopentylphenyl group, a n-hexylphenyl group, a n-octylphenyl group, a n-decylphenyl group, a n-dodecylphenyl
25 group, a n-tetradecylphenyl group, a naphthyl group and an

anthracenyl group, and more preferably a phenyl group. Any of these aryl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an alkoxy group such as a methoxy group or
5 an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

The aralkyl group of the hydrocarbyl group of L² is preferably an aralkyl group having 7 to 20 carbon atoms, and examples thereof can include a benzyl group, a (2-
10 methylphenyl)methyl group, a (3-methylphenyl)methyl group, a (4-methylphenyl)methyl group, a (2,3-dimethylphenyl)methyl group, a (2,4-dimethylphenyl)methyl group, a (2,5-dimethylphenyl)methyl group, a (2,6-dimethylphenyl)methyl group, a (3,4-dimethylphenyl)methyl
15 group, a (3,5-dimethylphenyl)methyl group, a (2,3,4-trimethylphenyl)methyl group, a (2,3,5-trimethylphenyl)methyl group, a (2,3,6-trimethylphenyl)methyl group, a (3,4,5-trimethylphenyl)methyl group, a (2,4,6-trimethylphenyl)methyl group, a (2,3,4,5-
20 tetramethylphenyl)methyl group, a (2,3,4,6-tetramethylphenyl)methyl group, a (2,3,5,6-tetramethylphenyl)methyl group, a (pentamethylphenyl)methyl group, an (ethylphenyl)methyl group, a (n-
25 propylphenyl)methyl group, an (isopropylphenyl)methyl group,

a (n-butylphenyl)methyl group, a (sec-butylphenyl)methyl group, a (tert-butylphenyl)methyl group, an (isobutylphenyl)methyl group, a (n-pentylphenyl)methyl group, a (neopentylphenyl)methyl group, a (n-hexylphenyl)methyl group, a (n-octylphenyl)methyl group, a (n-decylphenyl)methyl group, a naphthylmethyl group and an anthracenylmethyl group. Among them, a benzyl group is more preferred. Any of these aralkyl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom; an alkoxy group such as a methoxy group or an ethoxy group; an aryloxy group such as a phenoxy group; or an aralkyloxy group such as a benzyloxy group.

L^2 in Formula [5] is preferably a hydrogen atom, an alkyl group or an aryl group, more preferably a hydrogen atom or an alkyl group, and particularly preferably an alkyl group. Two L^2 may be the same as or different from each other.

T in Formula [6] represents a Group 15 element or a Group 16 element of the Periodic Table of the elements (the 1989 IUPAC revised edition of inorganic chemical nomenclature). Examples of the Group 15 element include a nitrogen atom, a phosphorus atom and the like; and specific examples of the Group 16 element include an oxygen atom, a sulfur atom and the like. T is preferably a nitrogen atom

or an oxygen atom, and particularly preferably an oxygen atom.

t in Formula [6] represents the valence of T, and t is 3 when T is the Group 15 element and t is 2 when T is the Group 16 element.

T' in Formula [7] represents a Group 15 element or a Group 16 element of the Periodic Table of the elements (the 1989 IUPAC revised edition of inorganic chemical nomenclature). Examples of the Group 15 element include a nitrogen atom, a phosphorus atom and the like; and specific examples of the Group 16 element include an oxygen atom, a sulfur atom and the like. T' is preferably a nitrogen atom or an oxygen atom, and particularly preferably an oxygen atom.

u in Formula [7] represents the valence of T', and u is 3 when T' is the Group 15 element and u is 2 when T' is the Group 16 element.

R² in Formula [6] represents an electron withdrawing group or a group containing an electron withdrawing group and, when there are more than one R², they may be the same as or different from each other. A substituent constant σ of Hammett's rule is known as an indicator of electron withdrawing properties, and examples of the electron-withdrawing group include functional groups having a positive substituent constant σ of Hammett's rule.

Examples of the electron withdrawing group include a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, a nitro group, a carbonyl group, a sulfone group, a phenyl group and the like. Examples of the group containing an electron withdrawing group include a halogenated alkyl group, a halogenated aryl group, a (halogenated alkyl)aryl group, a cyanated aryl group, a nitrated aryl group, an ester group (an alkoxy carbonyl group, an aralkyloxy carbonyl group or an aryloxy carbonyl group) and the like.

Examples of the halogenated alkyl group include a fluoromethyl group, a chloromethyl group, a bromomethyl group, an iodomethyl group, a difluoromethyl group, a dichloromethyl group, a dibromomethyl group, a diiodomethyl group, a trifluoromethyl group, a trichloromethyl group, a tribromomethyl group, a triiodomethyl group, a 2,2,2-trifluoroethyl group, a 2,2,2-trichloroethyl group, a 2,2,2-tribromoethyl group, a 2,2,2-triiodoethyl group, a 2,2,3,3,3-pentafluoropropyl group, a 2,2,3,3,3-pentachloropropyl group, a 2,2,3,3,3-pentabromopropyl group, a 2,2,3,3,3-pentaiodopropyl group, a 2,2,2-trifluoro-1-trifluoromethylethyl group, a 2,2,2-trichloro-1-trichloromethylethyl group, a 2,2,2-tribromo-1-tribromomethylethyl group, a 2,2,2-triiodo-1-triiodomethylethyl group, a 1,1-bis(trifluoromethyl)-2,2,2-

trifluoroethyl group, a 1,1-bis(trichloromethyl)-2,2,2-trichloroethyl group, a 1,1-bis(tribromomethyl)-2,2,2-tribromoethyl group, a 1,1-bis(triiodomethyl)-2,2,2-triiodoethyl group and the like.

5 Examples of the halogenated aryl group include a 2-fluorophenyl group, a 3-fluorophenyl group, a 4-fluorophenyl group, a 2,4-difluorophenyl group, a 2,6-difluorophenyl group, a 3,4-difluorophenyl group, a 3,5-difluorophenyl group, a 2,4,6-trifluorophenyl group, a
10 3,4,5-trifluorophenyl group, a 2,3,5,6-tetrafluorophenyl group, a pentafluorophenyl group, a 2,3,5,6-tetrafluoro-4-trifluoromethylphenyl group, a 2,3,5,6-tetrafluoro-4-pentafluorophenylphenyl group, a perfluoro-1-naphthyl group, a perfluoro-2-naphthyl group, a 2-chlorophenyl group, a 3-
15 chlorophenyl group, a 4-chlorophenyl group, a 2,4-dichlorophenyl group, a 2,6-dichlorophenyl group, a 3,4-dichlorophenyl group, a 3,5-dichlorophenyl group, a 2,4,6-trichlorophenyl group, a 3,4,5-trichlorophenyl group, a
2,3,5,6-tetrachlorophenyl group, a pentachlorophenyl group,
20 a 2,3,5,6-tetrachloro-4-trichloromethylphenyl group, a 2,3,5,6-tetrachloro-4-pentachlorophenylphenyl group, a perchloro-1-naphthyl group, a perchloro-2-naphthyl group, a 2-bromophenyl group, a 3-bromophenyl group, a 4-bromophenyl group, a 2,4-dibromophenyl group, a 2,6-dibromophenyl group,
25 a 3,4-dibromophenyl group, a 3,5-dibromophenyl group, a

2,4,6-tribromophenyl group, a 3,4,5-tribromophenyl group, a
2,3,5,6-tetrabromophenyl group, a pentabromophenyl group, a
2,3,5,6-tetrabromo-4-tribromomethylphenyl group, a 2,3,5,6-
tetrabromo-4-pentabromophenylphenyl group, a perbromo-1-
5 naphthyl group, a perbromo-2-naphthyl group, a 2-iodophenyl
group, a 3-iodophenyl group, a 4-iodophenyl group, a 2,4-
diiodophenyl group, a 2,6-diiodophenyl group, a 3,4-
diiodophenyl group, a 3,5-diiodophenyl group, a 2,4,6-
triiodophenyl group, a 3,4,5-triiodophenyl group, a
10 2,3,5,6-tetraiodophenyl group, a pentaiodophenyl group, a
2,3,5,6-tetraiodo-4-triiodomethylphenyl group, a 2,3,5,6-
tetraiodo-4-pentaiodophenylphenyl group, a periodo-1-
naphthyl group, a periodo-2-naphthyl group and the like.

Examples of the (halogenated alkyl)aryl group include
15 a 2-(trifluoromethyl)phenyl group, a 3-
(trifluoromethyl)phenyl group, a 4-(trifluoromethyl)phenyl
group, a 2,6-bis(trifluoromethyl)phenyl group, a 3,5-
bis(trifluoromethyl)phenyl group, a 2,4,6-
tris(trifluoromethyl)phenyl group, a 3,4,5-
20 tris(trifluoromethyl)phenyl group and the like.

Examples of the cyanated aryl group include a 2-
cyanophenyl group, a 3-cyanophenyl group, a 4-cyanophenyl
group and the like.

Examples of the nitrated aryl group include a 2-
25 nitrophenyl group, a 3-nitrophenyl group, a 4-nitrophenyl

group and the like.

Examples of the ester group include a methoxycarbonyl group, an ethoxycarbonyl group, a normal propoxycarbonyl group, an isopropoxycarbonyl group, a phenoxycarbonyl group, a trifluoromethoxycarbonyl group, a pentafluorophenoxycarbonyl group and the like.

R^2 is preferably a halogenated hydrocarbonyl group, and more preferably a halogenated alkyl group or a halogenated aryl group. R^2 is still more preferably a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a 2,2,2-trifluoroethyl group, a 2,2,3,3,3-pentafluoropropyl group, a 2,2,2-trifluoro-1-trifluoromethylethyl group, a 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl group, a 2-fluorophenyl group, a 3-fluorophenyl group, a 4-fluorophenyl group, a 2,4-difluorophenyl group, a 2,6-difluorophenyl group, a 3,4-difluorophenyl group, a 3,5-difluorophenyl group, a 2,4,6-trifluorophenyl group, a 3,4,5-trifluorophenyl group, a 2,3,5,6-tetrafluorophenyl group, a pentafluorophenyl group, a 2,3,5,6-tetrafluoro-4-trifluoromethylphenyl group, a 2,3,5,6-tetrafluoro-4-pentafluorophenylphenyl group, a perfluoro-1-naphthyl group, a perfluoro-2-naphthyl group, a chloromethyl group, a dichloromethyl group, a trichloromethyl group, a 2,2,2-trichloroethyl group, a 2,2,3,3,3-pentachloropropyl group, a 2,2,2-trichloro-1-trichloromethylethyl group, a 1,1-

bis(trichloromethyl)-2,2,2-trichloroethyl group, a 4-chlorophenyl group, a 2,6-dichlorophenyl group, a 3,5-dichlorophenyl group, a 2,4,6-trichlorophenyl group, a 3,4,5-trichlorophenyl group or a pentachlorophenyl group, particularly preferably a fluoroalkyl group or a fluoroaryl group, and most preferably a trifluoromethyl group, a 2,2,2-trifluoro-1-trifluoromethylethyl group, a 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl group, a 3,5-difluorophenyl group, a 3,4,5-trifluorophenyl group or a pentafluorophenyl group.

R^3 in Formula [7] represents a hydrocarbyl group or a halogenated hydrocarbyl group. The hydrocarbyl group in R^3 is preferably an alkyl group, an aryl group or an aralkyl group, and the same hydrocarbyl group as that described as L^2 in Formula [7] is used. Examples of the halogenated hydrocarbyl group in R^3 include a halogenated alkyl group, a halogenated aryl group, a (halogenated alkyl)aryl group and the like, and the same halogenated alkyl group, halogenated aryl group and (halogenated alkyl)aryl group as those listed as specific examples of the electron withdrawing group in R^2 of Formula [6] are used.

R^3 in Formula [7] is preferably a halogenated hydrocarbyl group, and more preferably a fluorinated hydrocarbyl group.

Examples of the compound (a) to be used to obtain

modified particles (I) include, when M^2 is a zinc atom, dialkyl zinc such as dimethyl zinc, diethyl zinc, dipropyl zinc, di-n-butyl zinc, diisobutyl zinc or di-n-hexyl zinc; diaryl zinc such as diphenyl zinc, dinaphthyl zinc or
5 bis(pentafluorophenyl) zinc; dialkenyl zinc such as diallyl zinc; halogenated alkyl zinc such as bis(cyclopentadienyl) zinc, methyl zinc chloride, ethyl zinc chloride, propyl zinc chloride, n-butyl zinc chloride, isobutyl zinc chloride, n-hexyl zinc chloride, methyl zinc bromide, ethyl
10 zinc bromide, propyl zinc bromide, n-butyl zinc bromide, isobutyl zinc bromide, n-hexyl zinc bromide, methyl zinc iodide, ethyl zinc iodide, propyl zinc iodide, n-butyl zinc iodide, isobutyl zinc iodide or n-hexyl zinc iodide; and halogenated zinc such as zinc fluoride, zinc chloride, zinc
15 bromide or zinc iodide.

The compound (a) is preferably dialkyl zinc, more preferably dimethyl zinc, diethyl zinc, dipropyl zinc, di-n-butyl zinc, diisobutyl zinc or di-n-hexyl zinc, and particularly preferably dimethyl zinc or diethyl zinc.

20 Examples of the amines of the compound (b) include di(fluoromethyl)amine, di(chloromethyl)amine, di(bromomethyl)amine, di(iodomethyl)amine, bis(difluoromethyl)amine, bis(dichloromethyl)amine, bis(dibromomethyl)amine, bis(diiodomethyl)amine,
25 bis(trifluoromethyl)amine, bis(trichloromethyl)amine,

bis(tribromomethyl)amine, bis(triiodomethyl)amine,
bis(2,2,2-trifluoroethyl)amine, bis(2,2,2-
trichloroethyl)amine, bis(2,2,2-tribromoethyl)amine,
bis(2,2,2-triiodoethyl)amine, bis(2,2,3,3,3-
5 pentafluoropropyl)amine, bis(2,2,3,3,3-
pentachloropropyl)amine, bis(2,2,3,3,3-
pentabromopropyl)amine, bis(2,2,3,3,3-pentaiodopropyl)amine,
bis(2,2,2-trifluoro-1-trifluoromethylethyl)amine,
bis(2,2,2-trichloro-1-trichloromethylethyl)amine,
10 bis(2,2,2-tribromo-1-tribromomethylethyl)amine, bis(2,2,2-
triiodo-1-triiodomethylethyl)amine, bis(1,1-
bis(trifluoromethyl)-2,2,2-trifluoroethyl)amine, bis(1,1-
bis(trichloromethyl)-2,2,2-trichloroethyl)amine, bis(1,1-
bis(tribromomethyl)-2,2,2-tribromoethyl)amine, bis(1,1-
15 bis(triiodomethyl)-2,2,2-triiodoethyl)amine, bis(2-
fluorophenyl)amine, bis(3-fluorophenyl)amine, bis(4-
fluorophenyl)amine, bis(2-chlorophenyl)amine, bis(3-
chlorophenyl)amine, bis(4-chlorophenyl)amine, bis(2-
bromophenyl)amine, bis(3-bromophenyl)amine, bis(4-
20 bromophenyl)amine, bis(2-iodophenyl)amine, bis(3-
iodophenyl)amine, bis(4-iodophenyl)amine, bis(2,6-
difluorophenyl)amine, bis(3,5-difluorophenyl)amine,
bis(2,6-dichlorophenyl)amine, bis(3,5-dichlorophenyl)amine,
bis(2,6-dibromophenyl)amine, bis(3,5-dibromophenyl)amine,
25 bis(2,6-diiodophenyl)amine, bis(3,5-diiodophenyl)amine,

bis(2,4,6-trifluorophenyl)amine, bis(2,4,6-trichlorophenyl)amine, bis(2,4,6-tribromophenyl)amine, bis(2,4,6-triiodophenyl)amine, bis(3,4,5-trifluorophenyl)amine, bis(3,4,5-trichlorophenyl)amine, bis(3,4,5-tribromophenyl)amine, bis(3,4,5-triiodophenyl)amine, bis(pentafluorophenyl)amine, bis(pentachlorophenyl)amine, bis(pentabromophenyl)amine, bis(pentaiodophenyl)amine, bis(2-(trifluoromethyl)phenyl)amine, bis(3-(trifluoromethyl)phenyl)amine, bis(4-(trifluoromethyl)phenyl)amine, bis(2,6-di(trifluoromethyl)phenyl)amine, bis(3,5-di(trifluoromethyl)phenyl)amine, bis(2,4,6-tri(trifluoromethyl)phenyl)amine, bis(3,4,5-tri(trifluoromethyl)phenyl)amine, bis(2-cyanophenyl)amine, (3-cyanophenyl)amine, bis(4-cyanophenyl)amine, bis(2-nitrophenyl)amine, bis(3-nitrophenyl)amine, bis(4-nitrophenyl)amine and the like. Further examples of the compound (b) include phosphine compounds in which a nitrogen atom is substituted with a phosphorus atom. Those phosphine compounds are compounds in which amine of the above-mentioned specific examples are replaced by phosphine.

Examples of the alcohols of the compound (b) include fluoromethanol, chloromethanol, bromomethanol, iodomethanol, difluoromethanol, dichloromethanol, dibromomethanol,

diiodomethanol, trifluoromethanol, trichloromethanol,
tribromomethanol, triiodomethanol, 2,2,2-trifluoroethanol,
2,2,2-trichloroethanol, 2,2,2-tribromoethanol, 2,2,2-
triiodoethanol, 2,2,3,3,3-pentafluoropropanol, 2,2,3,3,3-
5 pentachloropropanol, 2,2,3,3,3-pentabromopropanol,
2,2,3,3,3-pentaiodopropanol, 2,2,2-trifluoro-1-
trifluoromethylethanol, 2,2,2-trichloro-1-
trichloromethylethanol, 2,2,2-tribromo-1-
tribromomethylethanol, 2,2,2-triiodo-1-triiodomethylethanol,
10 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanol, 1,1-
bis(trichloromethyl)-2,2,2-trichloroethanol, 1,1-
bis(tribromomethyl)-2,2,2-tribromoethanol, 1,1-
bis(triiodomethyl)-2,2,2-triiodoethanol and the like.

Further examples of the compound (b) include thiol
15 compounds in which an oxygen atom is substituted with a
sulfur atom. Those thiol compounds are compounds in which
methanol of the above-mentioned specific examples is
replaced by methanethiol, ethanol is replaced by
ethanethiol, and propanol is replaced by propanethiol.

20 Examples of the phenols of the compound (b) include 2-
fluorophenol, 3-fluorophenol, 4-fluorophenol, 2,4-
difluorophenol, 2,6-difluorophenol, 3,4-difluorophenol,
3,5-difluorophenol, 2,4,6-trifluorophenol, 3,4,5-
trifluorophenol, 2,3,5,6-tetrafluorophenol,
25 pentafluorophenol, 2,3,5,6-tetrafluoro-4-

trifluoromethylphenol, 2,3,5,6-tetrafluoro-4-
pentafluorophenylphenol, perfluoro-1-naphthol, perfluoro-2-
naphthol, 2-chlorophenol, 3-chlorophenol, 4-chlorophenol,
2,4-dichlorophenol, 2,6-dichlorophenol, 3,4-dichlorophenol,
5 3,5-dichlorophenol, 2,4,6-trichlorophenol, 3,4,5-
trichlorophenol, 2,3,5,6-tetrachlorophenol,
pentachlorophenol, 2,3,5,6-tetrachloro-4-
trichloromethylphenol, 2,3,5,6-tetrachloro-4-
pentachlorophenylphenol, perchloro-1-naphthol, perchloro-2-
10 naphthol, 2-bromophenol, 3-bromophenol, 4-bromophenol, 2,4-
dibromophenol, 2,6-dibromophenol, 3,4-dibromophenol, 3,5-
dibromophenol, 2,4,6-tribromophenol, 3,4,5-tribromophenol,
2,3,5,6-tetrabromophenol, pentabromophenol, 2,3,5,6-
tetrabromo-4-tribromomethylphenol, 2,3,5,6-tetrabromo-4-
15 pentabromophenylphenol, perbromo-1-naphthol, perbromo-2-
naphthol, 2-iodophenol, 3-iodophenol, 4-iodophenol, 2,4-
diiodophenol, 2,6-diiodophenol, 3,4-diiodophenol, 3,5-
diiodophenol, 2,4,6-triiodophenol, 3,4,5-triiodophenol,
2,3,5,6-tetraiodophenol, pentaiodophenol, 2,3,5,6-
20 tetraiodo-4-triiodomethylphenol, 2,3,5,6-tetraiodo-4-
pentaiodophenylphenol, periodo-1-naphthol, periodo-2-
naphthol, 2-(trifluoromethyl)phenol, 3-
(trifluoromethyl)phenol, 4-(trifluoromethyl)phenol, 2,6-
bis(trifluoromethyl)phenol, 3,5-bis(trifluoromethyl)phenol,
25 2,4,6-tris(trifluoromethyl)phenol, 3,4,5-

tris(trifluoromethyl)phenol, 2-cyanophenol, 3-cyanophenol, 4-cyanophenol, 2-nitrophenol, 3-nitrophenol, 4-nitrophenol and the like. Further examples of the compound (b) include thiophenol compounds in which an oxygen atom is substituted
5 with a sulfur atom. Those thiophenol compounds are compounds in which phenol of the above-mentioned specific examples is replaced by thiophenol.

Preferably, the amine of the compound (b) is bis(trifluoromethyl)amine, bis(2,2,2-trifluoroethyl)amine,
10 bis(2,2,3,3,3-pentafluoropropyl)amine, bis(2,2,2-trifluoro-1-trifluoromethylethyl)amine, bis(1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl)amine or bis(pentafluorophenyl)amine, the alcohol of the compound (b) is trifluoromethanol, 2,2,2-trifluoroethanol, 2,2,3,3,3-pentafluoropropanol,
15 2,2,2-trifluoro-1-trifluoromethylethanol or 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanol, and the phenol of the compound (b) is 2-fluorophenol, 3-fluorophenol, 4-fluorophenol, 2,6-difluorophenol, 3,5-difluorophenol, 2,4,6-trifluorophenol, 3,4,5-trifluorophenol,
20 pentafluorophenol, 2-(trifluoromethyl)phenol, 3-(trifluoromethyl)phenol, 4-(trifluoromethyl)phenol, 2,6-bis(trifluoromethyl)phenol, 3,5-bis(trifluoromethyl)phenol, 2,4,6-tris(trifluoromethyl)phenol or 3,4,5-tris(trifluoromethyl)phenol.

25 The compound (b) is more preferably

bis(trifluoromethyl)amine, bis(pentafluorophenyl)amine, trifluoromethanol, 2,2,2-trifluoro-1-trifluoromethylethanol, 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanol, 2-fluorophenol, 3-fluorophenol, 4-fluorophenol, 2,6-difluorophenol, 3,5-difluorophenol, 2,4,6-trifluorophenol, 3,4,5-trifluorophenol, pentafluorophenol, 4-(trifluoromethyl)phenol, 2,6-bis(trifluoromethyl)phenol or 2,4,6-tris(trifluoromethyl)phenol, and still more preferably 3,5-difluorophenol, 3,4,5-trifluorophenol, pentafluorophenol or 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanol.

Examples of the compound (c) include water, hydrogen sulfide, amine and an aniline compound. Examples of the amine include alkylamines such as methylamine, ethylamine, n-propylamine, isopropylamine, n-butylamine, sec-butylamine, tert-butylamine, isobutylamine, n-pentylamine, neopentylamine, isopentylamine, n-hexylamine, n-octylamine, n-decylamine, n-dodecylamine, n-pentadecylamine and n-eicosylamine; aralkylamines such as allylamine, cyclopentadienylamine and benzylamine; fluoromethylamine, difluoromethylamine, trifluoromethylamine, 2,2,2-trifluoroethylamine, 2,2,3,3,3-pentafluoropropylamine, 2,2,2-trifluoro-1-trifluoromethylethylamine, 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethylamine, perfluoropropylamine, perfluorobutylamine,

perfluoropentylamine, perfluorohexylamine,
perfluorooctylamine, perfluorododecylamine,
perfluoropentadecylamine, perfluoroeicosylamine; and
halogenated alkylamines in which "fluoro" of these amines
5 are replaced by "chloro", "bromo" or "iodo".

Examples of the aniline compound of the compound (c)
include aniline, naphthylamine, anthracenylamine, 2-
tolylamine, 3-tolylamine, 4-tolylamine, 2,3-xylylamine,
2,4-xylylamine, 2,5-xylylamine, 2,6-xylylamine, 3,4-
10 xylylamine, 3,5-xylylamine, 2,3,4-trimethylaniline, 2,3,5-
trimethylaniline, 2,3,6-trimethylaniline, 2,4,6-
trimethylaniline, 3,4,5-trimethylaniline, 2,3,4,5-
tetramethylaniline, 2,3,4,6-tetramethylaniline, 2,3,5,6-
tetramethylaniline, pentamethylaniline, 2-ethylaniline, 3-
15 ethylaniline, 4-ethylaniline, 2,3-diethylaniline, 2,4-
diethylaniline, 2,5-diethylaniline, 2,6-diethylaniline,
3,4-diethylaniline, 3,5-diethylaniline, 2,3,4-
triethylaniline, 2,3,5-triethylaniline, 2,3,6-
triethylaniline, 2,4,6-triethylaniline, 3,4,5-
20 triethylaniline, 2,3,4,5-tetraethylaniline, 2,3,4,6-
tetraethylaniline, 2,3,5,6-tetraethylaniline,
pentaethylaniline, and alkylaniline in which "ethyl" of
these compounds is replaced by "n-propyl", "isopropyl", "n-
butyl", "sec-butyl", "tert-butyl", "n-pentyl", "neopentyl",
25 "n-hexyl", "n-octyl", "n-decyl", "n-dodecyl" or "n-

tetradecyl"; halogenated anilines such as 2-fluoroaniline, 3-fluoroaniline, 4-fluoroaniline, 2,6-difluoroaniline, 3,5-difluoroaniline, 2,4,6-trifluoroaniline, 3,4,5-trifluoroaniline and pentafluoroaniline; 2-

5 (trifluoromethyl)aniline, 3-(trifluoromethyl)aniline, 4-(trifluoromethyl)aniline, 2,6-di(trifluoromethyl)aniline, 3,5-di(trifluoromethyl)aniline, 2,4,6-tri(trifluoromethyl)aniline, and (halogenated alkyl)aniline in which "fluoro" of these compounds is replaced by
10 "chloro", "bromo" or "iodo".

The compound (c) is preferably water, hydrogen sulfide, methylamine, ethylamine, n-propylamine, isopropylamine, n-butylamine, sec-butylamine, tert-butylamine, isobutylamine, n-octylamine, aniline, 2,6-xylylamine, 2,4,6-

15 trimethylaniline, naphthylamine, anthracenylamine, benzylamine, trifluoromethylamine, pentafluoroethylamine, perfluoropropylamine, perfluorobutylamine, perfluoropentylamine, perfluorohexylamine, perfluorooctylamine, perfluorododecylamine,

20 perfluoropentadecylamine, perfluoroeicosylamine, 2-fluoroaniline, 3-fluoroaniline, 4-fluoroaniline, 2,6-difluoroaniline, 3,5-difluoroaniline, 2,4,6-trifluoroaniline, 3,4,5-trifluoroaniline, pentafluoroaniline, 2-(trifluoromethyl)aniline, 3-

25 (trifluoromethyl)aniline, 4-(trifluoromethyl)aniline, 2,6-

bis(trifluoromethyl)aniline, 3,5-
bis(trifluoromethyl)aniline or 2,4,6-
tris(trifluoromethyl)aniline, particularly preferably water,
trifluoromethylamine, perfluorobutylamine,
5 perfluorooctylamine, perfluoropentadecylamine, 2-
fluoroaniline, 3-fluoroaniline, 4-fluoroaniline, 2,6-
difluoroaniline, 3,5-difluoroaniline, 2,4,6-
trifluoroaniline, 3,4,5-trifluoroaniline,
pentafluoroaniline, 2-(trifluoromethyl)aniline, 3-
10 (trifluoromethyl)aniline, 4-(trifluoromethyl)aniline, 2,6-
bis(trifluoromethyl)aniline, 3,5-
bis(trifluoromethyl)aniline or 2,4,6-
tris(trifluoromethyl)aniline, and most preferably water or
pentafluoroaniline.

15 Examples of (d) include inorganic oxide particles and
organic polymer particles. Among them, porous particles
having a uniform particle diameter and used commonly as a
carrier are preferred. Regarding the particle diameter
distribution of (d), from the viewpoint of the particle
20 diameter distribution of the produced addition polymer, the
volume-based geometric standard deviation of the particle
diameter of (d) is preferably 2.5 or less, more preferably
2.0 or less, and still more preferably 1.7 or less.

Any inorganic oxide may be used as the inorganic oxide
25 particles (d) and a plurality of inorganic substances may

be used in combination. Examples of the inorganic oxide include SiO_2 , Al_2O_3 , MgO , ZrO_2 , TiO_2 , B_2O_3 , CaO , ZnO , BaO and ThO_2 , as well as a mixture thereof, $\text{SiO}_2\text{-MgO}$, $\text{SiO}_2\text{-Al}_2\text{O}_3$, $\text{SiO}_2\text{-TiO}_2$, $\text{SiO}_2\text{-V}_2\text{O}_5$, $\text{SiO}_2\text{-Cr}_2\text{O}_3$ and $\text{SiO}_2\text{-TiO}_2\text{-MgO}$.

5 These inorganic oxides are preferably SiO_2 and/or Al_2O_3 , and particularly preferably SiO_2 (i.e., silica). The inorganic oxide may contain a small amount of carbonates, sulfates, nitrates and oxides components, such as Na_2CO_3 , K_2CO_3 , CaCO_3 , MgCO_3 , Na_2SO_4 , $\text{Al}_2(\text{SO}_4)_3$, BaSO_4 , KNO_3 ,
10 $\text{Mg}(\text{NO}_3)_2$, $\text{Al}(\text{NO}_3)_3$, Na_2O , K_2O and Li_2O .

The inorganic oxide is preferably dried to substantially remove moisture, and the drying method is preferably a method of drying by heating. The drying temperature of the inorganic oxide whose moisture cannot be
15 visually confirmed is usually from 100 to 1,500°C, preferably from 100 to 1,000°C, and still more preferably from 200 to 800°C. There is no particular limitation on the drying time, and the drying time is preferably from 10 minutes to 50 hours, and more preferably from 1 hour to 30
20 hours. Examples of the method of drying the inorganic oxide by heating include a method in which an inorganic oxide is dried by circulating a dried inert gas (e.g., nitrogen, argon, etc.) at a given flow rate during heating, or a method in which an inorganic oxide is dried by heating
25 under reduced pressure.

Usually, hydroxyl groups are formed and exist on a surface of an inorganic oxide. A modified inorganic oxide produced by substituting active hydrogen of surface hydroxyl groups with various substituents may be used as the inorganic oxide. Examples of the modified inorganic oxide include inorganic oxides subjected to a contact treatment with trialkylchlorosilane such as trimethylchlorosilane or tert-butyldimethylchlorosilane; triarylchlorosilane such as triphenylchlorosilane; dialkyldichlorosilane such as dimethyldichlorosilane; diaryldichlorosilane such as diphenyldichlorosilane; alkyltrichlorosilane such as methyltrichlorosilane; aryltrichlorosilane such as phenyltrichlorosilane; trialkylalkoxysilane such as trimethylmethoxysilane; triarylalkoxysilane such as triphenylmethoxysilane; dialkyldialkoxysilane such as dimethyldimethoxysilane; diaryldialkoxysilane such as diphenyldimethoxysilane; alkyltrialkoxysilane such as methyltrimethoxysilane; aryltrialkoxysilane such as phenyltrimethoxysilane; tetraalkoxysilane such as tetramethoxysilane; alkylidisilazane such as 1,1,1,3,3,3-hexamethyldisilazane; tetrachlorosilane; alcohol such as methanol or ethanol; phenol; dialkyl magnesium such as dibutyl magnesium, butylethyl magnesium or butyloctyl magnesium; and alkyl lithium such as butyl lithium.

Further examples include inorganic oxides produced by
subjecting inorganic oxides which brought into contact with
trialkyl aluminum to a contact treatment with dialkylamine
such as diethylamine or diphenylamine; alcohol such as
5 methanol or ethanol; and phenol.

The strength of the inorganic oxide per se may be
sometimes increased by hydrogen bonding of hydroxyl groups
to each other. In that case, if all active hydrogen of
surface hydroxyl groups are substituted with various
10 substituents, a decrease in particle strength may sometimes
occur. Therefore, it is not necessarily required to
substitute all active hydrogen of surface hydroxyl groups
of the inorganic oxide, and the substitution ratio of the
surface hydroxyl groups may be appropriately determined.
15 There is no particular limitation on a method of changing
the substitution ratio of the surface hydroxyl groups.
Examples of the method include a method of changing the
amount of the compound to be used in the contact treatment.

There is no particular limitation on the average
20 particle diameter of the inorganic oxide particles, and the
average particle diameter is usually from 1 to 5,000 μm ,
preferably from 5 to 1,000 μm , more preferably from 10 to
500 μm , and still more preferably from 10 to 100 μm . The
pore volume is preferably 0.1 ml/g or more, and more
25 preferably from 0.3 to 10 ml/g. The specific surface area

is preferably from 10 to 1,000 m²/g, and more preferably from 100 to 500 m²/g.

Any organic polymer may be used as the organic polymer particles (d), and also a mixture of a plurality of kinds of organic polymers may be used. The organic polymer is preferably a polymer which has a functional group containing active hydrogen, or a non-proton-donating Lewis basic functional group.

There is no particular limitation on the functional group containing active hydrogen as long as the functional group has active hydrogen. Examples of the functional group include a primary amino group, a secondary amino group, an imino group, an amide group, a hydrazide group, an amidino group, a hydroxy group, a hydroperoxy group, a carboxyl group, a formyl group, a carbamoyl group, a sulfonic acid group, a sulfinic acid group, a sulfenic acid group, a thiol group, a thioformyl group, a pyrrolyl group, an imidazolyl group, a piperidyl group, an indazolyl group and a carbazolyl group. The functional group is preferably a primary amino group, a secondary amino group, an imino group, an amide group, an imide group, a hydroxy group, a formyl group, a carboxyl group, a sulfonic acid group or a thiol group, and particularly preferably a primary amino group, a secondary amino group, an amide group or a hydroxy group. These groups may be substituted with a halogen atom

or a hydrocarbyl group having 1 to 20 carbon atoms.

There is no particular limitation on the non-proton-donating Lewis basic functional group as long as it is a functional group which has a Lewis base moiety containing
5 no active hydrogen atom. Examples of the functional group include a pyridyl group, an N-substituted imidazolyl group, an N-substituted indazolyl group, a nitrile group, an azide group, an N-substituted imino group, an N,N-substituted amino group, an N,N-substituted aminooxy group, an N,N,N-
10 substituted hydrazino group, a nitroso group, a nitro group, a nitrooxy group, a furyl group, a carbonyl group, a thiocarbonyl group, an alkoxy group, an alkyloxycarbonyl group, an N,N-substituted carbamoyl group, a thioalkoxy group, a substituted sulfinyl group, a substituted sulfonyl
15 group and a substituted sulfonic acid group. The functional group is preferably a heterocyclic group, and more preferably an aromatic heterocyclic group containing an oxygen atom and/or a nitrogen atom in its ring. The functional group is particularly preferably a pyridyl group,
20 an N-substituted imidazolyl group or an N-substituted indazolyl group, and most preferably a pyridyl group. These groups may be substituted with a halogen atom or a hydrocarbyl group having 1 to 20 carbon atoms.

There is no particular limitation on the content of
25 the functional group having active hydrogen or the non-

proton-donating Lewis basic functional group in the organic polymer. The content is preferably from 0.01 to 50 mmol/g, and more preferably from 0.1 to 20 mmol/g, expressed by the molar number of the functional groups per gram of the organic polymer.

Examples of a method for producing the organic polymer, which has a functional group having active hydrogen or a non-proton-donating Lewis basic functional group, include a method of homopolymerizing a monomer which has a functional group having active hydrogen or a non-proton-donating Lewis basic functional group, and one or more polymerizable unsaturated groups, or a method of copolymerizing the said monomer with the other monomer having a polymerizable unsaturated group. It is preferred to copolymerize together with a crosslinking polymerizable monomer having two or more polymerizable unsaturated groups at this time.

Examples of the polymerizable unsaturated group include alkenyl groups such as a vinyl group and an allyl group; and alkynyl groups such as an ethyne group.

Examples of the monomer, which has a functional group having active hydrogen and one or more polymerizable unsaturated groups, include a vinyl group-containing primary amine, a vinyl group-containing secondary amine, a vinyl group-containing amide compound and a vinyl group-containing hydroxy compound. Examples of the monomer

include N-(1-ethenyl)amine, N-(2-propenyl)amine, N-(1-ethenyl)-N-methylamine, N-(2-propenyl)-N-methylamine, 1-ethenylamide, 2-propenylamide, N-methyl-(1-ethenyl)amide, N-methyl-(2-propenyl)amide, vinyl alcohol, 2-propen-1-ol
5 and 3-buten-1-ol. Examples of the monomer, which has a functional group having a Lewis base moiety containing no active hydrogen atom and one or more polymerizable unsaturated groups, include vinylpyridine, vinyl(N-substituted)imidazole and vinyl(N-substituted)indazole.

10 Examples of the other monomer having a polymerizable unsaturated group include ethylene, α -olefin, an aromatic vinyl compound and a cyclic olefin compound. Examples of the monomer include ethylene, propylene, 1-butene, 1-hexene, 4-methyl-1-pentene, styrene, norbornene and
15 dicyclopentadiene. Ethylene or styrene is preferred. Two or more kinds of these monomers may be used. Examples of the crosslinking polymerizable monomer having two or more polymerizable unsaturated groups include divinylbenzene and the like.

20 There is no particular limitation on the average particle diameter of the organic polymer particles, and the average particle diameter is usually from 1 to 5,000 μm , preferably from 5 to 1,000 μm , and more preferably from 10 to 500 μm . There is no particular limitation on the pore
25 volume, and the pore volume is preferably 0.1 ml/g or more,

and more preferably 0.3 to 10 ml/g. There is no particular limitation on the specific surface area, and the specific surface area is preferably from 10 to 1,000 m²/g, and more preferably from 50 to 500 m²/g.

5 These organic polymer particles are preferably dried to substantially remove moisture, and more preferably dried by heating. The drying temperature of the organic polymer whose moisture cannot be visually confirmed is usually from 30 to 400°C, preferably from 50 to 200°C, and more
10 preferably from 70 to 150°C. There is no particular limitation on the heating time, and the heating time is preferably from 10 minutes to 50 hours, and more preferably from 1 hour to 30 hours. Examples of the method of drying the organic polymer particles by heating include a method
15 in which organic polymer particles are dried by circulating a dried inert gas (e.g., nitrogen, argon, etc.) at a given flow rate while heating, or a method in which organic polymer particles are dried by heating under reduced pressure.

20 There is no particular limitation on the order of bringing (a), (b), (c) and (d) described above into contact with each other so as to obtain modified particle (I) of the present invention, and examples of the order include the following orders:

25 <1> an order in which a contact product of (a) and (b) is

brought into contact with (c) to obtain a contact product
and the obtained contact product is brought into contact
with (d);

<2> an order in which a contact product of (a) and (b) is
5 brought into contact with (d) to obtain a contact product
and the obtained contact product is brought into contact
with (c);

<3> an order in which a contact product of (a) and (c) is
brought into contact with (b) to obtain a contact product
10 and the obtained contact product is brought into contact
with (d);

<4> an order in which a contact product of (a) and (c) is
brought into contact with (d) to obtain a contact product
and the obtained contact product is brought into contact
15 with (b);

<5> an order in which a contact product of (a) and (d) is
brought into contact with (b) to obtain a contact product
and the obtained contact product is brought into contact
with (c);

20 <6> an order in which a contact product of (a) and (d) is
brought into contact with (c) to obtain a contact product
and the obtained contact product is brought into contact
with (b);

<7> an order in which a contact product of (b) and (c) is
25 brought into contact with (a) to obtain a contact product

and the obtained contact product is brought into contact with (d);

<8> an order in which a contact product of (b) and (c) is brought into contact with (d) to obtain a contact product

5 and the obtained contact product is brought into contact with (a);

<9> an order in which a contact product of (b) and (d) is brought into contact with (a) to obtain a contact product and the obtained contact product is brought into contact

10 with (c);

<10> an order in which a contact product of (b) and (d) is brought into contact with (c) to obtain a contact product and the obtained contact product is brought into contact with (a);

15 <11> an order in which a contact product of (c) and (d) is brought into contact with (a) to obtain a contact product and the obtained contact product is brought into contact with (b); and

<12> an order in which a contact product of (c) and (d) is brought into contact with (b) to obtain a contact product and the obtained contact product is brought into contact with (a).

The contact order is preferably <1>, <2>, <3>, <5>, <11> or <12> described above. The contact order is particularly preferably <2> or <5>.

Such a contact treatment is preferably carried out under an inert gas atmosphere. The treatment temperature is usually from -100 to 300°C, and preferably from -80 to 200°C. The treatment time is usually from 1 minute to 200 hours, and preferably from 10 minutes to 100 hours. Such a treatment may be carried out using a solvent, or these compounds may be directly brought into contact with each other without using a solvent.

A solvent which is inert to (a), (b), (c), (d) described above and contact products thereof is used as the solvent. However, as described above, when the respective compounds are brought into contact with each other in a stepwise manner, a solvent capable of reacting with a certain compound in a certain stage can be used in another stage if the solvent does not react with each compound in another stage. That is, the solvent to be used in each step is the same or different. Examples of the solvent include nonpolar solvents such as an aliphatic hydrocarbyl solvent and an aromatic hydrocarbyl solvent; and polar solvents such as a halide solvent, an ether-based solvent, an alcohol-based solvent, a phenol-based solvent, a carbonyl-based solvent, a phosphoric acid derivative, a nitrile-based solvent, a nitro compound, an amine-based solvent and a sulfur compound. Examples thereof include aliphatic hydrocarbyl solvents such as butane, pentane,

hexane, heptane, octane, 2,2,4-trimethylpentane and cyclohexane; aromatic hydrocarbyl solvents such as benzene, toluene and xylene; halide solvents such as dichloromethane, difluoromethane, chloroform, 1,2-dichloroethane, 1,2-
5 dibromoethane, 1,1,2-trichloro-1,2,2-trifluoroethane, tetrachloroethylene, chlorobenzene, bromobenzene and o-dichlorobenzene; ether-based solvents such as dimethyl ether, diethyl ether, diisopropyl ether, di-n-butyl ether, methyl-tert-butyl-ether, anisole, 1,4-dioxane, 1,2-
10 dimethoxyethane, bis(2-methoxyethyl)ether, tetrahydrofuran and tetrahydropyran; alcohol-based solvents such as methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 2-butanol, 2-methyl-1-propanol, 3-methyl-1-butanol, cyclohexanol, benzyl alcohol, ethylene glycol, propylene
15 glycol, 2-methoxyethanol, 2-ethoxyethanol, diethylene glycol, triethylene glycol and glycerin; phenol-based solvents such as phenol and p-cresol; carbonyl-based solvents such as acetone, ethyl methyl ketone, cyclohexanone, acetic anhydride, ethyl acetate, butyl
20 acetate, ethylene carbonate, propylene carbonate, N,N-dimethylformamide, N,N-dimethylacetamide and N-methyl-2-pyrrolidone; phosphoric acid derivatives such as hexamethylphosphoric acid triamide and triethyl phosphate; nitrile-based solvents such as acetonitrile, propionitrile,
25 succinonitrile and benzonitrile; nitro compounds such as

nitromethane and nitrobenzene; amine-based solvents such as pyridine, piperidine and morpholine; and sulfur compounds such as dimethyl sulfoxide and sulfolane.

When a contact product (f) produced by bringing the
5 compounds (a), (b) and (c) into contact with each other is brought into contact with the particles (d), namely, when the contact product (f) is produced in the respective methods of <1>, <3> and <7> described above, a solvent (s1)
10 is preferably the above aliphatic hydrocarbyl solvent, aromatic hydrocarbyl solvent or ether-based solvent.

When the contact product (f) is brought into contact with the particles (d), a solvent (s2) is preferably a polar solvent. The E_T^N value (C. Reichardt, "Solvents and Solvents Effects in Organic Chemistry", 2nd ed., VCH Verlag
15 (1988)) or the like is known as an indicator which represents the polarity of the solvent, and a solvent satisfying the range of the following inequality expression: $0.8 \geq E_T^N \geq 0.1$ is particularly preferred. Examples of the polar solvent include dichloromethane,
20 dichlorodifluoromethane, chloroform, 1,2-dichloroethane, 1,2-dibromoethane, 1,1,2-trichloro-1,2,2-trifluoroethane, tetrachloroethylene, chlorobenzene, bromobenzene, o-dichlorobenzene, dimethyl ether, diethyl ether, diisopropyl ether, di-n-butyl ether, methyl-tert-butyl ether, anisole,
25 1,4-dioxane, 1,2-dimethoxyethane, bis(2-methoxyethyl)ether,

tetrahydrofuran, tetrahydropyran, methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 2-butanol, 2-methyl-1-propanol, 3-methyl-1-butanol, cyclohexanol, benzyl alcohol, ethylene glycol, propylene glycol, 2-methoxyethanol, 2-ethoxyethanol, diethylene glycol, triethylene glycol, acetone, ethyl methyl ketone, cyclohexanone, acetic anhydride, ethyl acetate, butyl acetate, ethylene carbonate, propylene carbonate, N,N-dimethylformamide, N,N-dimethylacetamide, N-methyl-2-pyrrolidone, hexamethylphosphoric acid triamide, triethyl phosphate, acetonitrile, propionitrile, succinonitrile, benzonitrile, nitromethane, nitrobenzene, ethylenediamine, pyridine, piperidine, morpholine, dimethyl sulfoxide and sulfolane. The solvent (s2) is more preferably dimethyl ether, diethyl ether, diisopropyl ether, di-n-butyl ether, methyl-tert-butyl ether, anisole, 1,4-dioxane, 1,2-dimethoxyethane, bis(2-methoxyethyl)ether, tetrahydrofuran, tetrahydropyran, methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 2-butanol, 2-methyl-1-propanol, 3-methyl-1-butanol, cyclohexanol, benzylalcohol, ethylene glycol, propylene glycol, 2-methoxyethanol, 2-ethoxyethanol, diethylene glycol or triethylene glycol, particularly preferably di-n-butyl ether, methyl-tert-butyl ether, 1,4-dioxane, tetrahydrofuran, methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 2-butanol, 2-methyl-1-propanol, 3-methyl-1-

butanol or cyclohexanol, and most preferably tetrahydrofuran, methanol, ethanol, 1-propanol or 2-propanol.

It is also possible to use, as the solvent (s2), a
5 mixed solvent of the polar solvent and a hydrocarbyl solvent. The aliphatic hydrocarbyl solvent and the aromatic hydrocarbyl solvent listed above are used as the hydrocarbyl solvent. Examples of the mixed solvent of the polar solvent and the hydrocarbyl solvent can include a
10 hexane/methanol mixed solvent, a hexane/ethanol mixed solvent, a hexane/1-propanol mixed solvent, a hexane/2-propanol mixed solvent, a heptane/methanol mixed solvent, a heptane/ethanol mixed solvent, a heptane/1-propanol mixed solvent, a heptane/2-propanol mixed solvent, a
15 toluene/methanol mixed solvent, a toluene/ethanol mixed solvent, a toluene/1-propanol mixed solvent, a toluene/2-propanol mixed solvent, a xylene/methanol mixed solvent, a xylene/ethanol mixed solvent, a xylene/1-propanol mixed solvent and a xylene/2-propanol mixed solvent. The mixed
20 solvent is preferably a hexane/methanol mixed solvent, a hexane/ethanol mixed solvent, a heptane/methanol mixed solvent, a heptane/ethanol mixed solvent, a toluene/methanol mixed solvent, a toluene/ethanol mixed solvent, a xylene/methanol mixed solvent or a
25 xylene/ethanol mixed solvent. The mixed solvent is more

preferably a hexane/methanol mixed solvent, a hexane/ethanol mixed solvent, a toluene/methanol mixed solvent or a toluene/ethanol mixed solvent. The mixed solvent is most preferably a toluene/ethanol mixed solvent.

5 The content of an ethanol fraction in the toluene/ethanol mixed solvent is preferably within a range from 10 to 50% by volume, and more preferably from 15 to 30% by volume.

It is also possible to use a hydrocarbyl solvent as the solvent (s1) and the solvent (s2) in a method in which
10 the contact product (f) produced by bringing (a), (b) and (c) into contact with each other is brought into contact with (d), namely, in the respective methods of <1>, <3> and <7> described above. In this case, the shorter the time until the produced contact product (f) is brought into
15 contact with the particles (d) after bringing (a), (b) and (c) into contact with each other, the better. The time is preferably from 0 to 5 hours, more preferably from 0 to 3 hours, and most preferably from 0 to 1 hour. When the contact product (f) is brought into contact with the
20 particles (d), the temperature at that time is usually from -100°C to 40°C, preferably from -20°C to 20°C, and most preferably from -10°C to 10°C.

In the case of <2>, <5>, <6>, <8>, <9>, <10>, <11> and <12> described above, any of the above nonpolar solvent and
25 the above polar solvent can be used. The nonpolar solvent

is preferred. The reason is considered that, since a contact product of (a) and (c), or a contact product produced by bringing a contact product of (a) and (b) into contact with (c) commonly exhibits low solubility in a nonpolar solvent, in a case where (d) exists in a reaction system when these contact products are formed, the thus formed contact products are precipitated on a surface of (d) and are more likely to be immobilized.

There is no particular limitation on the amount of the respective compounds of (a), (b) and (c) described above to be brought into contact with each other. When a molar ratio of the amount of the respective compounds to be brought into contact with each other is assumed to be a molar ratio (a) : (b) : (c) = 1 : y : z, it is preferred that y and z substantially satisfy Formula (1) described below:

$$|m - y - 2z| < 1 \quad (1)$$

wherein m in Formula (1) represents the valence of M^2 .

y in Formula (1) is preferably a number of 0.01 to 1.99, more preferably a number of 0.10 to 1.80, still more preferably a number of 0.20 to 1.50, and most preferably a number of 0.30 to 1.00. Preferable range of z in Formula (1) is determined by m, y and Formula (1).

Compounds (a) and (d) are each used in such an amount that the number of typical metal atoms derived from the

compound (a) contained in the modified particles (I) is preferably 0.05 mmol or more, and more preferably from 0.1 to 20 mmol, expressed by the molar number of the typical metal atoms per gram of the produced modified particles (I).

5 In order to allow the reaction to proceed more quickly, a heating step at a higher temperature is preferably added after the contact treatment described above. In the heating step, a solvent having a high boiling point is preferably used so as to achieve a higher temperature. In
10 the case of carrying out the heating step, the solvent used in the contacting step may be replaced by another solvent having a higher boiling point.

In the modified particles (I), as a result of the contact treatment, the compounds (a), (b), (c) and/or (d)
15 as raw materials may remain as an unreacted product. However, the produced modified particles (I) are preferably washed so as to remove the unreacted product from the produced modified particles (I). A solvent to be used to wash the modified particles (I) may be the same or
20 different used to produce the modified particles (I). The modified particles (I) are preferably washed under an inert gas atmosphere. The washing temperature is usually from -100 to 300°C, and preferably from -80 to 200°C. The washing time is usually from 1 minute to 200 hours, and
25 preferably from 10 minutes to 100 hours.

It is preferred to remove the solvent in a state where the modified particles (I) in the solvent are sedimented and amorphous or fine particles float at the upper portion of slurry, in the case of the above washing treatment, so as to obtain modified particles (I) having a uniform particle diameter and shape.

After the contact treatment or the washing treatment, the solvent is preferably distilled off from the product, followed by drying the product at a temperature of 0°C or higher under reduced pressure for 1 hour to 24 hours. The drying treatment is more preferably carried out at a temperature of 0°C to 200°C for 1 hour to 24 hours, still more preferably at a temperature of 10°C to 200°C for 1 hour to 24 hours, particularly preferably at a temperature of 10°C to 160°C for 2 hours to 18 hours, and most preferably at a temperature of 15°C to 160°C for 4 hours to 18 hours.

Examples of a method for producing the modified particles (I) is described in more detail below by way of a case where M^2 is a zinc atom, the compound (b) is 3,4,5-trifluorophenol, the compound (c) is water, and (d) is silica. Using tetrahydrofuran as a solvent, a solution of diethyl zinc in hexane is added thereto to form a mixture (1). After cooling the mixture (1) to 3°C, 3,4,5-trifluorophenol is added dropwise to the mixture (1) in an

equimolar amount based on the amount of diethyl zinc to form a mixture (2), followed by stirring the mixture (2) at room temperature for 10 minutes to 24 hours. Furthermore, water is added dropwise to the mixture (2) in a 0.5-fold molar amount based on the amount of diethyl zinc to form a mixture (3), followed by stirring the mixture (3) at room temperature for 10 minutes to 24 hours. Then, the solvent is distilled off from the mixture (3) and a product is obtained. The product is dried at 120°C under reduced pressure for 8 hours and a solid component (1) is obtained. Tetrahydrofuran and silica are added to the solid component (1) to form a mixture (4), followed by stirring the mixture (4) at 40°C for 2 hours, thereby a solid component (2) is obtained. The solid component (2) is washed with tetrahydrofuran and then dried at 120°C under reduced pressure for 8 hours. Thus, the modified particles (I) of the present invention can be produced.

A cyclic aluminoxane having a structure represented by Formula $\{-\text{Al}(\text{E}^1)-\text{O}-\}_c$ and/or a linear aluminoxane having a structure represented by Formula $\text{E}^2\{-\text{Al}(\text{E}^2)-\text{O}-\}_d\text{AlE}^2_2$ is/are preferably used as the aluminoxane (e) used in the preparation of modified particles (II).

In the formulas, E^1 and E^2 each represent a hydrocarbyl group, each E^1 may be the same or different, each E^2 may be the same or different, c represents a number of 2 or more,

and d represents a number of 1 or more.

The hydrocarbyl group in E¹ or E² is preferably a hydrocarbyl group having 1 to 8 carbon atoms, and more preferably an alkyl group.

5 Examples of E¹ and E² include alkyl groups such as a methyl group, an ethyl group, a normal propyl group, an isopropyl group, a normal butyl group, an isobutyl group, a normal pentyl group and a neopentyl group. c is a number of 2 or more, and d is a number of 1 or more. E¹ and E²
10 are preferably methyl groups or isobutyl groups, c is from 2 to 40, and d is from 1 to 40.

The above aluminoxane can be produced by various methods. There is no particular limitation on the methods, and the aluminoxane may be produced in accordance with a
15 known method. For example, the aluminoxane can be produced by bringing a solution, prepared by dissolving trialkyl aluminum (e.g., trimethyl aluminum, etc.) in a proper organic solvent (benzene, aliphatic hydrocarbyl, etc.), into contact with water. Further examples of the method
20 include a method in which the aluminoxane is produced by bringing a metal salt containing crystal water (e.g., copper sulfate hydrate, etc.) into contact with trialkyl aluminum (e.g., trimethyl aluminum, etc.). It is
25 considered that the aluminoxane produced by such a method is usually a mixture of a cyclic aluminoxane and a linear

aluminoxane.

The particles (d) used to obtain the modified particles (II) are particles similar to (d) used in the modified particles (I).

5 The modified particles (II) can be produced by bringing the aluminoxane (e) into contact with the particles (d) using any method. Specifically, the modified particles (II) can be produced by dispersing the particles (d) in a solvent and adding the aluminoxane (e) thereto.

10 In this case, any solvent described in the description of the method for producing the modified particles (I) can be used, and the solvent is preferably a solvent which does not react with the aluminoxane (e), and more preferably a solvent which dissolves the aluminoxane (e). Specifically,
15 aromatic hydrocarbyl solvents such as toluene and xylene, or aliphatic hydrocarbyl solvents such as hexane, heptane and octane are preferred, and toluene or xylene is more preferred.

20 The contacting temperature and contacting time used in the case of bringing the aluminoxane (e) into contact with the particles (d) can be optionally selected. The temperature is usually from -100°C to 200°C, preferably from -50°C to 150°C, and still more preferably from -20°C to 120°C. Particularly in an initial stage of the reaction,
25 these are preferably reacted at a low temperature so as to

suppress heat generation. The amounts of the aluminoxane (e) and the particles (d), which are brought into contact with each other, are optional amounts. The amount of the aluminoxane (e) is usually from 0.01 to 100 mmol, preferably from 0.1 to 20 mmol, and still more preferably from 1 to 10 mmol, expressed by aluminum atoms per gram of the particles (d).

Modified particles (III) are produced by further using the compound (A) in the preparation of the modified particles (II).

The transition metal compound represented by Formula [4] or its μ -oxo type transition metal compound dimer is used as the compound (A).

The modified particles (III) can be produced by bringing the aluminoxane (e), the particles (d) and the compound (A) into contact with each other using any method. It is preferable that the aluminoxane (e), the particles (d) and the compound (A) be brought into contact with each other in a solvent. It is also possible to use, as the solvent, any solvent described above. The solvent is preferably a solvent which does not react with the aluminoxane (e) and the compound (A), and more preferably a solvent which dissolves the aluminoxane (e) and the compound (A). Specifically, aromatic hydrocarbyl solvents such as toluene and xylene, or aliphatic hydrocarbyl

solvents such as hexane, heptane and octane are preferred, and toluene or xylene is more preferred.

The contacting temperature and contacting time used in the case of bringing the aluminoxane (e), the particles (d) and the compound (A) into contact with each other are optionally selected. The temperature is usually from -100°C to 200°C, preferably from -50°C to 150°C, and still more preferably from -20°C to 120°C. Particularly in an initial stage of the reaction, these are preferably reacted at a low temperature so as to suppress heat generation.

The amounts of the aluminoxane (e), the particles (d) and the compound (A), which are brought into contact with each other, are optional amounts. The amount of the aluminoxane (e) is usually from 0.01 to 100 mmol, preferably from 0.1 to 20 mmol, and still more preferably from 1 to 10 mmol, expressed by aluminum atoms per gram of the particles (d). The amount of the compound (A) is usually from 0.1 to 1,000 μ mol, preferably from 1 to 500 μ mol, and still more preferably from 10 to 200 μ mol, expressed by the transition metal atoms per gram of the particles (d).

Organoaluminium Compound (C)

The organoaluminium compound (C) to be used in the present invention is a known organoaluminium compound. It is preferably an organoaluminium compound represented by

Formula [8]:



wherein each R^6 independently represents a hydrocarbyl group; each Y independently represents a hydrogen atom, a halogen atom, an alkoxy group, an aralkyloxy group or an aryloxy group; and d is a number satisfying $0 < d \leq 3$.

R^6 in Formula [8] is preferably a hydrocarbyl group having 1 to 24 carbon atoms, and more preferably an alkyl group having 1 to 24 carbon atoms. Examples of R^6 include a methyl group, an ethyl group, a n-propyl group, a n-butyl group, an isobutyl group, a n-hexyl group, a 2-methylhexyl group, a n-octyl group and the like, and preferably an ethyl group, a n-butyl group, an isobutyl group, a n-hexyl group or a n-octyl group.

Examples of a case where Y is a halogen atom include a fluorine atom, a chlorine atom, a bromine atom and an iodine atom, and preferably a chlorine atom.

The alkoxy group in Y is preferably an alkoxy group having 1 to 24 carbon atoms, and examples of the alkoxy group include a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group, a sec-butoxy group, a tert-butoxy group, a n-pentoxy group, a neopentoxy group, a n-hexoxy group, a n-octoxy group, a n-dodesoxy group, a n-pentadesoxy group, a n-icosoxy group and the like, and preferably a methoxy group, an ethoxy group or a tert-butoxy group.

The aryloxy group in Y is preferably an aryloxy group having 6 to 24 carbon atoms, and examples of the aryloxy group include a phenoxy group, a 2-methylphenoxy group, a 3-methylphenoxy group, a 4-methylphenoxy group, a 2,3-dimethylphenoxy group, a 2,4-dimethylphenoxy group, a 2,5-dimethylphenoxy group, a 2,6-dimethylphenoxy group, a 3,4-dimethylphenoxy group, a 3,5-dimethylphenoxy group, a 2,3,4-trimethylphenoxy group, a 2,3,5-trimethylphenoxy group, a 2,3,6-trimethylphenoxy group, a 2,4,5-trimethylphenoxy group, a 2,4,6-trimethylphenoxy group, a 3,4,5-trimethylphenoxy group, a 2,3,4,5-tetramethylphenoxy group, a 2,3,4,6-tetramethylphenoxy group, a 2,3,5,6-tetramethylphenoxy group, a pentamethylphenoxy group, an ethylphenoxy group, a n-propylphenoxy group, an isopropylphenoxy group, a n-butylphenoxy group, a sec-butylphenoxy group, a tert-butylphenoxy group, a n-hexylphenoxy group, a n-octylphenoxy group, a n-decylphenoxy group, a n-tetradecylphenoxy group, a naphthoxy group, an anthrathenoxy group and the like.

The aralkyloxy group in Y is preferably an aralkyloxy group having 7 to 24 carbon atoms, and examples of the aralkyloxy group include a benzyloxy group, a (2-methylphenyl)methoxy group, a (3-methylphenyl)methoxy group, a (4-methylphenyl)methoxy group, a (2,3-dimethylphenyl)methoxy group, a (2,4-dimethylphenyl)methoxy

group, a (2,5-dimethylphenyl)methoxy group, a (2,6-dimethylphenyl)methoxy group, a (3,4-dimethylphenyl)methoxy group, a (3,5-dimethylphenyl)methoxy group, a (2,3,4-trimethylphenyl)methoxy group, a (2,3,5-trimethylphenyl)methoxy group, a (2,3,6-trimethylphenyl)methoxy group, a (2,4,5-trimethylphenyl)methoxy group, a (2,4,6-trimethylphenyl)methoxy group, a (3,4,5-trimethylphenyl)methoxy group, a (2,3,4,5-tetramethylphenyl)methoxy group, a (2,3,5,6-tetramethylphenyl)methoxy group, a (pentamethylphenyl)methoxy group, an (ethylphenyl)methoxy group, a (n-propylphenyl)methoxy group, an (isopropylphenyl)methoxy group, a (n-butylphenyl)methoxy group, a (sec-butylphenyl)methoxy group, a (tert-butylphenyl)methoxy group, a (n-hexylphenyl)methoxy group, a (n-octylphenyl)methoxy group, a (n-decylphenyl)methoxy group, a (n-tetradecylphenyl)methoxy group, a naphthylmethoxy group, an anthracenylmethoxy group and the like, and preferably a benzyloxy group.

Examples of the organoaluminium compound represented by Formula [8] include trialkyl aluminums such as trimethyl aluminum, triethyl aluminum, tri-n-propyl aluminum, tri-n-butyl aluminum, triisobutyl aluminum, tri-n-hexyl aluminum and tri-n-octyl aluminum; dialkyl aluminum chlorides such

as dimethyl aluminum chloride, diethyl aluminum chloride, di-n-propyl aluminum chloride, di-n-butyl aluminum chloride, diisobutyl aluminum chloride and di-n-hexyl aluminum chloride; alkyl aluminum dichlorides such as methyl
5 aluminum dichloride, ethyl aluminum dichloride, n-propyl aluminum dichloride, n-butyl aluminum dichloride, isobutyl aluminum dichloride and n-hexyl aluminum dichloride; dialkyl aluminum hydrides such as dimethyl aluminum hydride, diethyl aluminum hydride, di-n-propyl aluminum hydride, di-
10 n-butyl aluminum hydride, diisobutyl aluminum hydride and di-n-hexyl aluminum hydride; alkyl(dialkoxy) aluminums such as methyl(dimethoxy) aluminum, methyl(diethoxy) aluminum and methyl(di-tert-butoxy) aluminum; dialkyl(alkoxy) aluminums such as dimethyl(methoxy) aluminum,
15 dimethyl(ethoxy) aluminum and dimethyl(tert-butoxy) aluminum; alkyl(diaryloxy) aluminums such as methyl(diphenoxy) aluminum, methylbis(2,6-diisopropylphenoxy) aluminum and methylbis(2,6-diphenylphenoxy) aluminum; and dialkyl(aryloxy) aluminums
20 such as dimethyl(phenoxy) aluminum, dimethyl(2,6-diisopropylphenoxy) aluminum and dimethyl(2,6-diphenylphenoxy) aluminum.

Among them, the organoaluminium compound is preferably trialkyl aluminum, more preferably trimethyl aluminum,
25 triethyl aluminum, tri-n-butyl aluminum, triisobutyl

aluminum, tri-n-hexyl aluminum or tri-n-octyl aluminum, and particularly preferably triisobutyl aluminum or tri-n-octyl aluminum.

These organoaluminium compounds may be used alone, or
5 two or more kinds of them may be used in combination.

The catalyst for addition polymerization in the present invention is a catalyst produced by bringing the compound (A) selected from a transition metal compound or its μ -oxo type transition metal compound dimer, the
10 activating agent (B) and, optionally, the organoaluminium compound (C) into contact with each other. An addition polymer can be produced by addition polymerizing monomers capable of addition polymerizing in a reactor having a coated inside wall in the presence of the catalyst for
15 addition polymerization.

Electron-Donating Compound (D)

When the addition polymer is produced, an electron-donating compound (D) may exist in a reactor having a coated inside wall. The electron-donating compound (D) is
20 preferably a compound containing a nitrogen atom, a phosphorus atom, an oxygen atom or a sulfur atom, and examples thereof include an oxygen-containing compound, a nitrogen-containing compound, a phosphorus-containing compound and a sulfur-containing compound. Among these
25 compounds, an oxygen-containing compound or a nitrogen-

containing compound is preferred. Examples of the oxygen-containing compound include alkoxysilicons, ethers, ketones, aldehydes, carboxylic acids, esters of an organic acid or inorganic acid, acid amides and acid anhydrides of an organic acid or inorganic acid and the like. Among them, alkoxysilicons or ethers are preferred. Examples of the nitrogen-containing compound include amines, nitriles, isocyanates and the like, and preferably amines.

The alkoxysilicon is preferably an alkoxysilicon compound represented by Formula $R^7_rSi(OR^8)_{4-r}$, wherein each R^7 independently represents a hydrocarbyl group having 1 to 20 carbon atoms, a hydrogen atom, or a hetero atom-containing substituent; each R^8 independently represents a hydrocarbyl group having 1 to 20 carbon atoms; r represents a number satisfying $0 \leq r < 4$.

When R^7 and R^8 are hydrocarbyl groups, examples thereof include linear alkyl groups such as a methyl group, an ethyl group, a propyl group, a butyl group and a pentyl group; branched alkyl groups such as an isopropyl group, a sec-butyl group, a tert-butyl group and a tert-amyl group; cycloalkyl groups such as a cyclopentyl group and a cyclohexyl group; cycloalkenyl groups such as a cyclopentenyl group; and aryl groups such as a phenyl group and a tolyl group. When R^7 is a hetero atom-containing substituent, examples of the hetero atom include an oxygen

atom, a nitrogen atom, a sulfur atom and a phosphorus atom.

Examples thereof include a dimethylamino group, a

methylethylamino group, a diethylamino group, an ethyl n-

propylamino group, a di-n-propylamino group, a pyrrolyl

5 group, a pyridyl group, a pyrrolidinyl group, a piperidyl

group, a perhydroindolyl group, a perhydroisoindolyl group,

a perhydroquinolyl group, a perhydroisoquinolyl group, a

perhydrocarbazolyl group, a perhydroacridinyl group, a

furyl group, a pyranyl group, a perhydrofuryl group, a

10 thienyl group and the like.

R^7 and R^8 are preferably alkyl groups, and also r is preferably a number satisfying $4 > r \geq 2$.

Examples of the alkoxysilicons include

tetramethoxysilane, methyltrimethoxysilane,

15 ethyltrimethoxysilane, normal propyltrimethoxysilane,

isopropyltrimethoxysilane, normal butyltrimethoxysilane,

isobutyltrimethoxysilane, sec-butyltrimethoxysilane, tert-

butyltrimethoxysilane, normal pentyltrimethoxysilane, tert-

amyltrimethoxysilane, dimethyldimethoxysilane,

20 diethyldimethoxysilane, di-normal butyldimethoxysilane,

diisobutyldimethoxysilane, di-tert-butyldimethoxysilane,

methylethyldimethoxysilane, methyl-normal-

propyldimethoxysilane, methyl-normal-butyldimethoxysilane,

methydisobutyldimethoxysilane, tert-

25 butylmethyldimethoxysilane, tert-butylethyldimethoxysilane,

tert-butyl-normal-propyldimethoxysilane, tert-butylisopropyldimethoxysilane, tert-butyl-normal-butyldimethoxysilane, tert-butylisobutyldimethoxysilane, tert-amylmethyldimethoxysilane, tert-amylethyldimethoxysilane, tert-amyl-normal-propyldimethoxysilane, tert-amyl-normal-butyldimethoxysilane, isobutylisopropyldimethoxysilane, dicyclobutyldimethoxysilane, cyclobutylmethyldimethoxysilane, cyclobutylethyldimethoxysilane, cyclobutylisopropyldimethoxysilane, cyclobutyl-normal-butyldimethoxysilane, cyclobutylisobutyldimethoxysilane, cyclobutyl-tert-butyldimethoxysilane, dicyclopentyldimethoxysilane, cyclopentylmethyldimethoxysilane, cyclopentyl-normal-propyldimethoxysilane, cyclopentylisopropyldimethoxysilane, cyclopentyl-normal-butyldimethoxysilane, cyclopentylisobutyldimethoxysilane, cyclopentyl-tert-butyldimethoxysilane, dicyclohexyldimethoxysilane, cyclohexylmethyldimethoxysilane, cyclohexylethyldimethoxysilane, cyclohexyl-normal-propyldimethoxysilane, cyclohexylisopropyldimethoxysilane, cyclohexyl-normal-butyldimethoxysilane, cyclohexylisobutyldimethoxysilane, cyclohexyl-tert-butyldimethoxysilane, cyclohexylcyclopentyldimethoxysilane,

cyclohexylphenyldimethoxysilane, diphenyldimethoxysilane,
phenylmethyldimethoxysilane, phenylethyldimethoxysilane,
phenyl-normal-propyldimethoxysilane,
phenylisopropyldimethoxysilane, phenyl-normal-
5 butyldimethoxysilane, phenylisobutyldimethoxysilane,
phenyl-tert-butyldimethoxysilane,
phenylcyclopentyldimethoxysilane, 2-
norbornanemethyldimethoxysilane,
bis(perhydroquinolino)dimethoxysilane,
10 bis(perhydroisoquinolino)dimethoxysilane,
(perhydroquinolino) (perhydroisoquinolino)dimethoxysilane,
(perhydroquinolino)methyldimethoxysilane,
(perhydroisoquinolino)methyldimethoxysilane,
(perhydroquinolino)ethyldimethoxysilane,
15 (perhydroisoquinolino)ethyldimethoxysilane,
(perhydroquinolino) (n-propyl)dimethoxysilane,
(perhydroisoquinolino) (n-propyl)dimethoxysilane,
((perhydroquinolino) (tert-butyl)dimethoxysilane,
(perhydroisoquinolino) (tert-butyl)dimethoxysilane,
20 trimethylmethoxysilane, triethylmethoxysilane, tri-normal-
propylmethoxysilane, triisopropylmethoxysilane, tri-normal-
butylmethoxysilane, triisobutylmethoxysilane, tri-tert-
butylmethoxysilane and the like. Examples thereof include
compounds in which methoxy of these compounds is replaced
25 by ethoxy, propoxy, normal butoxy, isobutoxy, tert-butoxy

or phenoxy. Dialkyldialkoxysilane or trialkylmonoalkoxysilane is preferred, and trialkylmonoalkoxysilane is more preferred.

Examples of the ethers include a dialkyl ether, an alkylaryl ether, a diaryl ether, a diether compound, cyclic ethers and cyclic diethers.

Examples of the ether include dimethyl ether, diethyl ether, di-normal-propyl ether, diisopropyl ether, di-normal-butyl ether, diisobutyl ether, di-tert-butyl ether, dicyclohexyl ether, diphenyl ether, methyl ethyl ether, methyl-normal-propyl ether, methyl isopropyl ether, methyl-normal-butyl ether, methyl isobutyl ether, methyl-tert-butyl ether, methyl cyclohexyl ether, methylphenyl ether, ethylene oxide, propylene oxide, oxetane, tetrahydrofuran, 2,5-dimethyltetrahydrofuran, tetrahydropyran, 1,2-dimethoxyethane, 1,2-diethoxyethane, 1,2-diisobutoxyethane, 2,2-dimethoxypropane, 1,3-dimethoxypropane, 2,2-diisobutyl-1,3-dimethoxypropane, 2-isopropyl-2-isopentyl-1,3-dimethoxypropane, 2,2-bis(cyclohexylmethyl)-1,3-dimethoxypropane, 2-isopropyl-2-3,7-dimethyloctyl-1,3-dimethoxypropane, 2,2-diisopropyl-1,3-dimethoxypropane, 2-isopropyl-2-cyclohexylmethyl-1,3-dimethoxypropane, 2,2-dicyclohexyl-1,3-dimethoxypropane, 2-isopropyl-2-isobutyl-1,3-dimethoxypropane, 2,2-diisopropyl-1,3-dimethoxypropane, 2,2-dipropyl-1,3-dimethoxypropane, 2-isopropyl-2-

cyclohexyl-1,3-dimethoxypropane, 2-isopropyl-2-cyclopentyl-
1,3-dimethoxypropane, 2,2-dicyclopentyl-1,3-
dimethoxypropane, 2-heptyl-2-pentyl-1,3-dimethoxypropane,
1,2-dimethoxybenzene, 1,3-dimethoxybenzene, 1,4-
5 dimethoxybenzene, 1,3-dioxolane, 1,4-dioxane, 1,3-dioxane
and the like. The ether is preferably diethyl ether, di-
normal-butyl ether, methyl-normal-butyl ether, methylphenyl
ether, tetrahydrofuran, 1,3-dioxane, 1,4-dioxane or 1,3-
dioxolane, and more preferably diethyl ether, di-normal-
10 butyl ether or tetrahydrofuran.

Examples of the carboxylic acid ester include mono or
polyvalent carboxylic acid esters, and examples of the
carboxylic acid ester include a saturated aliphatic
carboxylic acid ester, an unsaturated aliphatic carboxylic
15 acid ester, an alicyclic carboxylic acid ester and an
aromatic carboxylic acid ester. Examples of the carboxylic
acid ester include methyl acetate, ethyl acetate, normal
butyl acetate, isobutyl acetate, tert-butyl acetate, phenyl
acetate, methyl propionate, ethyl propionate, ethyl
20 butyrate, ethyl valerate, ethyl acrylate, methyl
methacrylate, methyl benzoate, ethyl benzoate, normal butyl
benzoate, isobutyl benzoate, tert-butyl benzoate, methyl
toluate, ethyl toluate, methyl anisate, ethyl anisate,
dimethyl succinate, diethyl succinate, di-normal-butyl
25 succinate, dimethyl malonate, diethyl malonate, di-normal-

butyl malonate, dimethyl maleate, dibutyl maleate, diethyl itaconate, di-normal-butyl itaconate, monoethyl phthalate, dimethyl phthalate, methylethyl phthalate, diethyl phthalate, di-normal-propyl phthalate, diisopropyl phthalate, di-normal-butyl phthalate, diisobutyl phthalate, di-tert-butyl phthalate, dipentyl phthalate, di-n-hexyl phthalate, diheptyl phthalate, di-normal-octyl phthalate, di(2-ethylhexyl)phthalate, diisodecyl phthalate, dicyclohexyl phthalate, diphenyl phthalate, dimethyl isophthalate, diethyl isophthalate, di-normal-butyl isophthalate, diisobutyl isophthalate, di-tert-butyl isophthalate, dimethyl terephthalate, diethyl terephthalate, di-normal-butyl terephthalate, diisobutyl terephthalate, di-tert-butyl terephthalate and the like. The carboxylic acid ester is preferably methyl acetate, ethyl acetate, methyl benzoate, ethyl benzoate, dimethyl phthalate, diethyl phthalate, di-normal-butyl phthalate, diisobutyl phthalate, dimethyl terephthalate or diethyl terephthalate, and still more preferably methyl benzoate, dimethyl phthalate, diethyl phthalate, diisobutyl phthalate or dimethyl terephthalate.

Examples of the amines include trihydrocarbylamine, trimethylamine, triethylamine, tripropylamine, tri-normal-butylamine, triisobutylamine, trihexylamine, trioctylamine, tridodecylamine and triphenylamine. Triethylamine or

trioctylamine is preferred.

The alkoxysilicons, the ethers or the amines are preferably used as the electron-donating compound (D). The amines are more preferably used. These electron-donating
5 compounds (D) may be used alone, or two or more kinds of them may be used in combination.

Catalyst for Addition Polymerization

The catalyst for addition polymerization in the present invention is produced by bringing the compound (A),
10 the activating agent (B) and, optionally, the organoaluminium compound (C) into contact with each other. Regarding the ratio of amounts of the respective components to be brought into contact with each other, the amount of the compound (A) based on the amount of the activating
15 agent (B) is usually from 0.1 to 1,000 $\mu\text{mol/g}$, preferably from 1 to 500 $\mu\text{mol/g}$, and more preferably from 10 to 300 $\mu\text{mol/g}$. The amount of the organoaluminium compound (C) based on the amount of the compound (A) is usually from 0.01 to 10,000 mmol/g , preferably from 0.1 to 1,000 mmol/g ,
20 and more preferably from 0.5 to 200 mmol/g .

There is no particular limitation on a method of bringing the compound (A), the activating agent (B) and the organoaluminium compound (C) into contact with each other, and examples of the method include methods of <13> to <15>
25 described below:

<13> a method in which a contact product produced by bringing the above respective components into contact with each other is supplied in a polymerization vessel;

<14> a method in which the above respective components are separately supplied in a polymerization vessel and these components are brought into contact with each other in the polymerization vessel; and

<15> a method in which the above respective components are partially brought into contact with each other to obtain a precontact product before supplying the components in a polymerization vessel, and the precontact product is brought into contact with the remaining components in the polymerization vessel.

The contacting method is preferably <14> described above. The compound (A) may be supplied in the polymerization vessel in a powder or in a slurry state of being suspended in a solvent.

There is no particular limitation on the order of bringing the compound (A), the activating agent (B) and the organoaluminium compound (C) into contact with each other, and examples of the order include orders of <16> to <21> described below:

<16> an order in which a contact product produced by bringing the compound (A) into contact with the activating agent (B) is brought into contact with the organoaluminium

compound (C);

<17> an order in which a contact product produced by bringing the compound (A) into contact with the organoaluminium compound (C) is brought into contact with the activating agent (B);

<18> an order in which a contact product produced by bringing the activating agent (B) into contact with the organoaluminium compound (C) is brought into contact with the compound (A);

<19> an order in which a contact product produced by bringing the compound (A) into contact with the organoaluminium compound (C) is brought into contact with a contact product produced by bringing the activating agent (B) into contact with the organoaluminium compound (C);

<20> an order in which a contact product produced by bringing the compound (A) into contact with the activating agent (B) is brought into contact with a contact product produced by bringing the activating agent (B) into contact with the organoaluminium compound (C); and

<21> an order in which a contact product produced by bringing the compound (A) into contact with the organoaluminium compound (C) is brought into contact with a contact product produced by bringing the compound (A) into contact with the activating agent (B).

The contact order is preferably <16> described above.

The respective components may be brought into contact with each other in a solvent. It is preferred to use a solvent since an active spot can be efficiently formed. The solvent may be any solvent which does not deactivate the thus formed active spot. The solvent is more preferably a solvent which dissolves the compound (A). Specifically, it is also possible to use aliphatic hydrocarbyl solvents such as butane, pentane, hexane and octane; aromatic hydrocarbyl solvents such as benzene, toluene and xylene; halogenated hydrocarbyl solvents such as dichloromethane; and polar solvents such as ethers, esters, and ketones. When the solvent is used in polymerization (e.g., slurry polymerization, gas-phase polymerization, bulk polymerization, etc.) for forming particles, it is preferred to use a solvent which does not dissolve the formed addition polymer. Specifically, an aliphatic hydrocarbyl solvent is preferred. At the time of contacting, a monomer may exist.

In the case of bringing the respective components into contact with each other, the temperature is an optional temperature. The temperature is usually from -50°C to 100°C, preferably from -30°C to 80°C, and more preferably from -10°C to 60°C. The time required to bring the respective components into contact with each other is an optional time. The contacting time is usually from

continuous charging (substantially 0 minute) to 24 hours, preferably from 1 minute to 12 hours, and more preferably from 3 minutes to 10 hours.

It is preferred to bring the respective components
5 into contact with each other while stirring them.

Addition Polymerization Method

The addition polymerization method of the present invention is a method comprising addition polymerizing monomers capable of addition polymerizing in a reactor
10 having a coated inside wall in the presence of the catalyst for addition polymerization.

Examples of the addition polymerization method of the present invention include (1) a gas-phase polymerization method in which gaseous monomers are polymerized, (2) a
15 solution polymerization method or slurry polymerization method (suspension polymerization method) in which monomers are polymerized in a solvent, and (3) a bulk polymerization method in which monomers as a liquid are polymerized. The method of the present invention is particularly preferably
20 applied to a slurry polymerization method and a gas-phase polymerization method.

Examples of the solvent to be used in solution polymerization or slurry polymerization include aliphatic hydrocarbyl solvents such as butane, pentane, hexane,
25 heptane and octane; aromatic hydrocarbyl solvents such as

benzene and toluene; and halogenated hydrocarbyl solvents such as dichloromethane. It is also possible to use monomers per se as the solvent. The addition

polymerization can be carried out by any of batchwise

5 polymerization and continuous polymerization methods.

Furthermore, the main polymerization may be carried out in two or more stages under a different reaction condition.

The polymerization time of the addition polymerization is generally determined according to the kind of the objective

10 addition polymer and the polymerization reactor to be used, and is usually from 1 minute to 20 hours.

The solution polymerization or slurry polymerization can be carried out in accordance with known methods and conditions. The method is preferably a method in which

15 monomers, a solvent and other materials to be supplied are optionally continuously or intermittently supplied to a polymerization reactor, and the formed addition polymer is continuously or intermittently extracted from the

polymerization reactor. It is possible to use, as the

20 polymerization reactor, a loop reactor or a reactor

equipped with a stirrer, or a reactor in which a plurality of reactors equipped with a stirrer, each having a

different kind and a different polymerization reaction

condition, are connected in series, in parallel or in a

25 combination thereof, as long as it is a reactor having a

coated inside wall.

The solvent, the polymerization temperature and the polymerization pressure are respectively selected so that it be possible to maintain the catalyst for addition
5 polymerization in a suspended state and to maintain the solvent and at least part of the monomers in a liquid phase, and thus the monomers can be brought into contact with the catalyst for addition polymerization. The polymerization temperature is usually from about -50 °C to about 150°C.
10 The polymerization pressure is usually from about 0.001 MPa to about 10 MPa.

In the solution polymerization and the slurry polymerization, the catalyst for addition polymerization or components to be used to obtain the catalyst, and monomers
15 can be supplied to a polymerization reactor in an optional order by a known method. Examples of the method of supplying them to the polymerization reactor include (1) a method in which the catalyst for addition polymerization or components to be used to obtain the catalyst, and monomers
20 are simultaneously supplied, and (2) a method in which the catalyst for addition polymerization or components to be used to obtain the catalyst, and monomers are successively supplied.

The gas-phase polymerization can be carried out in
25 accordance with known methods and conditions. A reactor

for gas-phase polymerization is a fluidized bed type reaction vessel having a coated inside wall. Preferably, the fluidized bed type reaction vessel is a fluidized bed type reaction vessel having an enlarged portion. The
5 reactor may have a stirring blade in the reaction vessel.

Examples of a method in which the catalyst for addition polymerization or components to be used to obtain the catalyst in the gas-phase polymerization is supplied to a polymerization vessel include a method in which the
10 catalyst or the components is supplied in a state free from moisture usually together with an inert gas such as nitrogen or argon, hydrogen or ethylene; or a method in which a solution prepared by dissolving the catalyst or the components in a solvent or a slurry prepared by diluting
15 the catalyst or the components with the solvent is supplied. The components to be used to obtain the catalyst for addition polymerization may be individually supplied, or may be supplied after bringing any two or more of the components into contact with each other in an optional
20 order in advance.

There is no particular limitation on the polymerization temperature in the gas-phase polymerization as long as polymerization temperature is lower than the melting temperature of an addition polymer to be produced,
25 and the polymerization temperature is preferably from 0°C

to 150°C, and particularly preferably from 30°C to 100°C.
For the purpose of controlling the melt fluidity of the
addition polymer to be produced, hydrogen may be added as a
molecular weight modifier. An inert gas may be allowed to
5 coexist in a gas when gaseous monomers are polymerized.

It is possible to control the molecular weight of the
produced addition polymer by the polymerization temperature
or a molecular weight modifier such as hydrogen.

Prepolymerization Method and Prepolymerized Catalyst for 10 Addition Polymerization

A prepolymerized catalyst for addition polymerization
can be produced by addition polymerizing monomers capable
of addition polymerizing in a reactor having a coated
inside wall in the presence of a catalyst for addition
15 polymerization. Addition polymerization of monomers
capable of addition polymerizing in the presence of a
catalyst for addition polymerization, which is carried out
so as to obtain a prepolymerized catalyst for addition
polymerization, may be sometimes referred to as
20 prepolymerization.

In the present invention, there is no particular
limitation on the prepolymerization method which is carried
out in the reactor having a coated inside wall, and the
prepolymerization method is preferably solution
25 polymerization or slurry polymerization using a solvent.

Examples thereof include a method in which prepolymerization is carried out in the presence of a solvent, and the like.

When the catalyst for prepolymerization is produced,
5 an electron-donating compound (D) may exist in the reactor having a coated inside wall. It is possible to use, as the electron-donating compound (D), compounds exemplified as the electron-donating compound (D) which can be used to produce an addition polymer.

10 The prepolymerization method can be carried out by any of batchwise polymerization and continuous polymerization methods. Furthermore, the polymerization may be carried out in two or more stages under a different reaction condition. Generally, the polymerization time is
15 appropriately determined according to the kind of the objective addition polymer and the polymerization reactor to be used, and is within a range from 1 minute to 20 hours. The prepolymerization temperature is usually from -50°C to 100°C, preferably from -30°C to 80°C, and more preferably
20 from -10°C to 60°C. The temperature may be changed on the way. The prepolymerization pressure is usually from 0.001 MPa to 5 MPa, and preferably from 0.01 MPa to 2 MPa.

The produced prepolymerized catalyst for addition polymerization may be used directly in the main
25 polymerization. When the prepolymerized catalyst for

addition polymerization is formed by the method of prepolymerization in the presence of a solvent, the prepolymerized catalyst for addition polymerization may be used in the main polymerization in a state of a solution or a slurry solution. Alternatively, the prepolymerized catalyst for addition polymerization may be used in the main polymerization in a state of a solid after subjecting to treatments such as removal of a monomer, distillation of a solvent, filtration, washing, drying and the like.

The prepolymerization is carried out so that the amount of a polymer produced by prepolymerization (also referred to as prepolymerization degree) usually becomes 0.1 to 1,000 g, preferably 0.5 to 500 g, and particularly preferably 1 to 100 g, per 1 g of the activating agent (B).

Main Polymerization and Addition Polymer

In the present invention, when an addition polymer is produced using the prepolymerized catalyst for addition polymerization (main polymerization), the produced prepolymerized catalyst for addition polymerization may be used as the catalyst for addition polymerization as it is or after bringing the prepolymerized catalyst for addition polymerization into contact with an organoaluminium compound. From the viewpoint of superior polymerization activity, the latter is preferred. The organoaluminium compounds exemplified as the compound (C) are used as the

organoaluminium compound in the latter case. When the
organoaluminium compound is used, the amount thereof used is
usually from 1 to 10,000 mol/mol, preferably from 10 to
5,000 mol/mol, and more preferably from 30 to 1,000 mmol/g,
5 based on the compound (A).

When the prepolymerized catalyst for addition
polymerization and the organoaluminium compound (C) are used
to bring into contact with each other, the prepolymerized
catalyst for addition polymerization and the organoaluminium
10 compound (C) can be supplied in a polymerization reactor in
an optional order. Alternatively, they may be supplied in
the polymerization reactor after they are brought into
contact with each other in advance. When the main
polymerization is carried out after the prepolymerization,
15 the prepolymerization needs to be carried out in a reactor
having a coated inside wall, however, the main
polymerization may or may not be carried out in the reactor
having a coated inside wall.

There is no particular limitation on a method of
20 supplying the prepolymerized catalyst for addition
polymerization of the present invention and the
organoaluminium compound (C) to a reactor for preparation of
a catalyst or a polymerization reactor for main
polymerization. Examples of the method include a method in
25 which a prepolymerized catalyst for addition polymerization

and an organoaluminium compound (C) are supplied in a solid state; a method in which a prepolymerized catalyst for addition polymerization and an organoaluminium compound (C) are supplied in a state of a solution, a suspension or a slurry, in a hydrocarbyl solvent from which a component for deactivating a catalyst component, such as moisture or oxygen, has been sufficiently removed; and the like.

Examples of the hydrocarbyl solvent in this method can include aliphatic hydrocarbyl solvents such as butane, pentane, hexane, heptane and octane; aromatic hydrocarbyl solvents such as benzene and toluene; and halogenated hydrocarbyl solvents such as dichloromethane. Among them, an aliphatic hydrocarbyl solvent or an aromatic hydrocarbyl solvent is preferred, and an aliphatic hydrocarbyl solvent is more preferred.

There is no particular limitation on a polymerization method in the main polymerization. Examples of the method can include (1) a gas-phase polymerization method in which gaseous monomers are polymerized, (2) a solution polymerization method or slurry polymerization method (suspension polymerization method) in which monomers are polymerized in a solvent, and (3) a bulk polymerization method in which monomers as a liquid are polymerized. The main polymerization can be carried out by any of batchwise polymerization and continuous polymerization manners. The

main polymerization may be carried out in two or more stages under a different reaction condition. The polymerization time of the main polymerization is generally determined according to the kind of the objective addition
5 polymer and the polymerization reactor to be used, and is usually from 1 minute to 20 hours.

The prepolymerized catalyst for addition polymerization of the present invention is particularly preferably applied to the polymerization in which an
10 addition polymer is produced in the form of particles in the main polymerization, like slurry polymerization, gas-phase polymerization and bulk polymerization.

The solution polymerization or slurry polymerization can be carried out in accordance with the above methods and
15 conditions.

The gas-phase polymerization can be carried out in accordance with known methods and conditions. The reactor for gas-phase polymerization is a fluidized bed type reaction vessel, and preferably a fluidized bed type
20 reaction vessel having an enlarged portion. The reactor may have a stirring blade in a reaction vessel.

Examples of a method in which the prepolymerized catalyst for addition polymerization is supplied to a polymerization vessel include a method in which the
25 catalyst is supplied in a state free from moisture usually

together with an inert gas such as nitrogen or argon,
hydrogen or ethylene; or a method in which the catalyst is
supplied in a state of a solution prepared by dissolving
the catalyst in a solvent or in a state of a slurry
5 prepared by diluting the catalyst with the solvent.

There is no particular limitation on the
polymerization temperature of gas-phase polymerization as
long as the polymerization temperature is lower than the
melting temperature of an addition polymer to be produced,
10 and the polymerization temperature is preferably from 0°C
to 150°C, and particularly preferably from 30°C to 100°C.
For the purpose of controlling the melt fluidity of the
addition polymer to be produced, hydrogen may be added as a
molecular weight modifier. An inert gas may be allowed to
15 coexist in a gas when gaseous monomers are polymerized.

Monomers capable of Addition Polymerizing

The method for producing an addition polymer of the
present invention is a method comprising addition
polymerizing monomers capable of addition polymerizing in
20 the presence of the above catalyst for addition
polymerization or prepolymerized catalyst for addition
polymerization of the present invention.

Examples of the monomer in the method for producing an
addition polymer of the present invention can include an
25 olefin, a diolefin, a cyclic olefin, an alkenylaromatic

hydrocarbyl and a polar monomer, each having 2 to 20 carbon atoms, and two or more kinds of monomers can also be simultaneously used.

Examples of the monomer include olefins such as
5 ethylene, propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 5-methyl-1-hexene, 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene and vinylcyclohexane; diolefins such as 1,5-hexadiene, 1,4-hexadiene, 1,4-pentadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 4-methyl-1,4-hexadiene, 5-
10 methyl-1,4-hexadiene, 7-methyl-1,6-octadiene, 5-ethylidene-2-norbornene, dicyclopentadiene, 5-vinyl-2-norbornene, norbornadiene, 5-methylene-2-norbornene, 1,5-cyclooctadiene, 5,8-endomethylenehexahydronaphthalene, 1,3-butadiene, isoprene, 1,3-hexadiene, 1,3-octadiene, 1,3-cyclooctadiene
15 and 1,3-cyclohexadiene; cyclic olefins such as norbornene, 5-methyl-2-norbornene, 5-ethyl-2-norbornene, 5-butyl-2-norbornene, 5-phenyl-2-norbornene, 5-benzyl-2-norbornene, tetracyclododecene, tricyclodecene, tricycloundecene, pentacyclopentadecene, pentacyclohexadecene, 8-
20 methyltetracyclododecene, 8-ethyltetracyclododecene, 5-acetyl-2-norbornene, 5-acetyloxy-2-norbornene, 5-methoxycarbonyl-2-norbornene, 5-ethoxycarbonyl-2-norbornene, 5-methyl-5-methoxycarbonyl-2-norbornene, 5-cyano-2-norbornene, 8-methoxycarbonyltetracyclododecene, 8-methyl-
25 8-tetracyclododecene and 8-cyanotetracyclododecene;

alkenylaromatic hydrocarbyls such as styrene,
alkenylbenzenes (e.g., 2-phenylpropylene, 2-phenylbutene,
and 3-phenylpropylene), alkylstyrenes (e.g., p-
methylstyrene, m-methylstyrene, o-methylstyrene, p-
5 ethylstyrene, m-ethylstyrene, o-ethylstyrene, α -
methylstyrene, 2,4-dimethylstyrene, 2,5-dimethylstyrene,
3,4-dimethylstyrene, 3,5-dimethylstyrene, 3-methyl-5-
ethylstyrene, 1,1-diphenylethylene, p-tertiary butylstyrene,
and p-secondary butylstyrene), bisalkenylbenzenes (e.g.,
10 divinylbenzene) and alkenylnaphthalene (e.g., 1-
vinylnaphthalene); α,β -unsaturated carboxylic acids (e.g.,
acrylic acid, methacrylic acid, fumaric acid, maleic
anhydride, itaconic acid, itaconic anhydride, and
bicyclo(2,2,1)-5-heptene-2,3-dicarboxylic acid), metal
15 salts of metals such as sodium, potassium, lithium, zinc,
magnesium and calcium of the α,β -unsaturated carboxylic
acid; and α,β -unsaturated carboxylic acid esters (e.g.,
methyl acrylate, ethyl acrylate, n-propyl acrylate,
isopropyl acrylate, tert-butyl acrylate, 2-ethylhexyl
20 acrylate, methyl methacrylate, ethyl methacrylate, n-propyl
methacrylate, isopropyl methacrylate, n-butyl methacrylate,
and isobutyl methacrylate), unsaturated dicarboxylic acids
(e.g., maleic acid and itaconic acid), vinyl esters (e.g.,
vinyl acetate, vinyl propionate, vinyl caproate, vinyl
25 caprate, vinyl laurate, vinyl stearate, and vinyl

trifluoroacetate) and polar monomers such as unsaturated carboxylic acid glycidyl esters (e.g., glycidyl acrylate, glycidyl methacrylate, and itaconic acid monoglycidyl ester).

5 The present invention is applied to homopolymerization or copolymerization of these monomers. Examples of the combination of monomers to be used for copolymerization include ethylene and propylene, ethylene and 1-butene, ethylene and 1-hexene, ethylene and 1-octene, and propylene
10 and 1-butene. Ethylene and α -olefin are preferred as the monomer to be used.

 The monomer to be used in prepolymerization of the present invention is preferably ethylene, propylene, 1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-nonene,
15 1-decene, 4-methyl-1-pentene or vinylcyclohexane. In the prepolymerization of the present invention, two or more kinds of olefins can also be simultaneously used.

 The addition polymer produced in the present invention is particularly preferably a copolymer of ethylene and α -olefin. Among them, a copolymer of ethylene and α -olefin
20 having a polyethylene crystal structure is preferred. The α -olefin is preferably α -olefin having 3 to 8 carbon atoms and examples of the α -olefin include 1-butene, 1-hexene and 1-octene.

Examples

The present invention will be described in more detail below by way of examples and comparative examples, but the present invention is not limited thereto. Properties of
5 addition polymers in the examples were measured by the following procedures.

(1) Elemental Analysis

Zn: After placing a sample in an aqueous sulfuric acid solution (1M), ultrasonic waves were applied to the aqueous
10 sulfuric acid solution containing the sample thereby extracting a metal component into the aqueous sulfuric acid solution from the sample. A liquid portion of the aqueous sulfuric acid solution containing the metal component was subjected to quantitative determination using ICP
15 spectrometry.

F: A sample was combusted in a flask filled with oxygen and the generated combustion gas was absorbed in an aqueous sodium hydroxide solution (10%), and then the obtained aqueous solution was subjected to quantitative
20 determination using an ionic electrode method.

(2) MFR: MFR is a melt flow rate (unit: g/10 minutes) measured at 190°C under a load of 21.18 N (2.16 kg) in accordance with the method defined in JIS K7210-1995.

(3) Swell ratio = SR: A value which is obtained by dividing
25 a strand diameter obtained at the time of the measurement

of MFR by an inner diameter (2.095 mm) of a die.

(4) Melt flow rate ratio = MFRR: A value which is obtained by dividing a melt flow rate (MFR) measured at 190°C under a load of 211.82 N (21.60 kg) by a melt flow rate measured under a load of 21.18 N (2.16 kg) in accordance with the method defined in JIS K7210-1995.

In the entire measurement of the above melt flow rate, a polymer blended in advance with 1,000 ppm of an antioxidant was used.

[Example 1]

(1) Production of Reactor having Coated Inside Wall

A solution (50 ml) of POVAL (KURARAY CO., LTD., brand name: LM-25) ($m = 160$ and $n = 90$ in Formula [1], $Q = -OC(=O)CH_3$ in Formula [2], $R = OH$ in Formula [3]), the concentration of which was adjusted to 1 mg/ml, in ethanol was applied using a pipette to an inside wall of an autoclave (having an inner volume of 3 liters) equipped with a stirrer and heated to 90°C, thereby forming a layer made of the solution. The autoclave having an inside wall on which the layer had formed was dried under reduced pressure at 90°C for about 1 hour thereby vaporizing ethanol as a solvent from the layer, and thus obtaining an autoclave having an inside wall coated with POVAL. The amount of POVAL based on the inside wall area of the reactor was 0.5 g/m².

(2) Production of Modified Particles (B)

In the same manner as in the preparation of the component (A) of Examples 1(1) and (2) of JP-A-2009-79180, modified particles (B) in the present specification were produced. As a result of an elemental analysis, the content of Zn was 11% by weight and the content of F was 6.4% by weight in the modified particles (B).

(3) Prepolymerization

The autoclave having a coated inside wall was dried under reduced pressure and then air in the autoclave was replaced by nitrogen. After evacuation of nitrogen from the autoclave, 480 g of butane and 203 mg (379 μmol) of ethylenebis(indenyl)zirconium diphenoxide (A) were added into the autoclave. After stirring a mixture in the autoclave at 50°C for 2 hours, the mixture was cooled to 30°C. Then, 1 g of ethylene was added and 7.0 g of the modified particles (B) produced in (1) described above was added. Then, 3.5 ml (3.5 mmol) of a solution of triisobutyl aluminum (C), the concentration of which was adjusted to 1.0 mmol/ml, in hexane was added and prepolymerization was initiated. First, prepolymerization was carried out at 30°C for 30 minutes while supplying ethylene at a rate of 0.13 g/minute. Then, the supplying gas was changed to an ethylene/hydrogen mixed gas (concentration of hydrogen: 0.182 mol%), and the

temperature was raised to 50°C over 30 minutes while supplying the mixed gas at a rate of 0.58 g/minute and ethylene was continuously polymerized at 50°C for 3 hours. The monomers and butane were purged from the autoclave and the prepolymerized catalyst for addition polymerization was
5 obtained. The amount obtained was 133.2 g and the polymerization degree per modified particles (B) was 18.9 g/g. The polymer was not attached to the inside wall of the autoclave.

10 (4) Main Polymerization

After evacuating argon in an autoclave (having an inner volume of 5 liters) equipped with a stirrer, which was dried under reduced pressure and of which inside atmosphere was replaced by argon, hydrogen (partial
15 pressure of 0.037 MPa) was added and 235 g of butene-1 and 965 g of butane were supplied to the autoclave, and then the temperature was raised to 70°C. Thereafter, ethylene was added so that its partial pressure might become 1.6 MPa, and the system was stabilized. As a result of gas
20 chromatographic analysis, the gas composition in the system was as follows: the content of hydrogen = 1.91 mol%. A solution (2.0 ml) of triisobutyl aluminum, the concentration of which was adjusted to 1 mmol/ml, in hexane was supplied thereto. Then, 1.0 ml of a solution of
25 triethylamine, the concentration of which was adjusted to

0.1 mmol/ml, in toluene was added to the autoclave.

Furthermore, 384.8 mg of the prepolymerized catalyst for addition polymerization produced in (3) described above was supplied. Ethylene and butene-1 were polymerized at 70°C
5 for 3 hours while feeding an ethylene/hydrogen mixed gas (hydrogen: 0.313 mol%) so as to maintain the total pressure at a given value. As a result, 90 g of an olefin polymer was obtained. Polymerization activity per modified particles (B) was 4,400 g/g. The obtained olefin polymer
10 exhibited an MFR of 2.51 and an SR of 1.44.

[Example 2]

(1) Production of Reactor having Coated Inside Wall

In the same manner as in Example 1(1), except that 200 ml of a solution of POVAL (KURARAY CO., LTD., brand name:
15 LM-25), the concentration of which was adjusted to 1 mg/ml, in ethanol was applied, a reactor having an inside wall coated with POVAL was obtained. The amount of POVAL based on the inside wall area of the reactor was 1.9 g/m².

(2) Prepolymerization

20 In the same manner as in Example 1(3), except that 173 mg (324 μ mol) of ethylenebis(indenyl)zirconium diphenoxide (A) and 7.0 g of the modified particles (B) produced in Example 1(2) described above were added, and that the autoclave having a coated inside wall produced in Example
25 2(1) described above was used, prepolymerization was

carried out. The amount of the prepolymerized catalyst for addition polymerization obtained was 129.7 g, and polymerization degree per modified particles (B) was 18.6 g/g. The polymer was not attached to the inside wall of the autoclave.

(3) Main Polymerization

After evacuating argon in an autoclave (having an inner volume of 5 liters) equipped with a stirrer, which was dried under reduced pressure and of which inside atmosphere was replaced by argon, hydrogen (partial pressure of 0.037 MPa) was added and 235 g of butene-1 and 965 g of butane were supplied to the autoclave, and then the temperature was raised to 70°C. Thereafter, ethylene was added so that its partial pressure might become 1.6 MPa, and the system was stabilized. As a result of gas chromatographic analysis, the gas composition in the system was as follows: the content of hydrogen = 1.95 mol%. A solution (2.0 ml) of triisobutyl aluminum, the concentration of which was adjusted to 1 mmol/ml, in hexane was supplied thereto. Then, 1.0 ml of a solution of triethylamine, the concentration of which was adjusted to 0.1 mmol/ml, in toluene was added to the autoclave. Furthermore, 384.1 mg of the prepolymerized catalyst for addition polymerization produced in Example 2(2) described above was supplied. Ethylene and butene-1 were polymerized

at 70°C for 3 hours while feeding an ethylene/hydrogen mixed gas (hydrogen: 0.301 mol%) so as to maintain the total pressure at a given value. As a result, 105 g of an olefin polymer was obtained. Polymerization activity per modified particles (B) was 5,100 g/g. The obtained olefin polymer exhibited an MFR of 1.86 and an SR of 1.42.

[Comparative Example 1]

(1) Prepolymerization

In the same manner as in Example 1(3), except that the inside wall of the autoclave was not coated, and that 173 mg (324 μ mol) of ethylenebis(indenyl)zirconium diphenoxide (A) and 7.3 g of the modified particles (B) produced in Example 1(2) described above were added, prepolymerization was carried out. The amount of the prepolymerized catalyst for addition polymerization obtained was 123.9 g and polymerization degree per modified particles (B) was 16.9 g/g. The obtained prepolymerized catalyst for addition polymerization (5.8 g) was obtained as a product attached to the inside wall of the autoclave.

(2) Main Polymerization

After evacuating argon in an autoclave (having an inner volume of 5 liters) equipped with a stirrer, which was dried under reduced pressure and of which inside atmosphere was replaced by argon, hydrogen (partial pressure of 0.037 MPa) was added and 235 g of butene-1 and

965 g of butane were supplied to the autoclave, and then the temperature was raised to 70°C. Thereafter, ethylene was added so that its partial pressure might become 1.6 MPa, and the system was stabilized. As a result of gas

5 chromatographic analysis, the gas composition in the system was as follows: the content of hydrogen = 1.84 mol%. A

solution (2.0 ml) of triisobutyl aluminum, the concentration of which was adjusted to 1 mmol/ml, in hexane was supplied thereto. Then, 1.0 ml of a solution of

10 triethylamine, the concentration of which was adjusted to 0.1 mmol/ml, in toluene was added to the autoclave.

Furthermore, 349.0 mg of the prepolymerized catalyst for addition polymerization produced in Comparative example 1(1) described above was supplied. Ethylene and butene-1

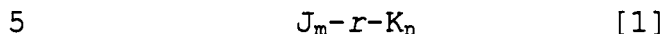
15 were polymerized at 70°C for 3 hours while feeding an ethylene/hydrogen mixed gas (hydrogen: 0.293 mol%) so as to maintain the total pressure at a given value. As a result,

62 g of an olefin polymer was obtained. Polymerization activity per modified particles (B) was 3,000 g/g. The

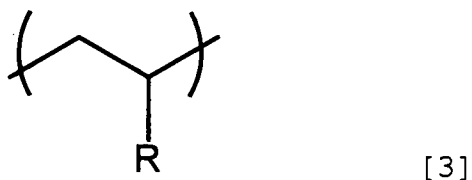
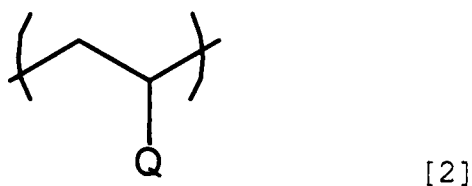
20 obtained olefin polymer exhibited an MFR of 4.54 and an SR of 1.48.

CLAIMS

1. A method comprising coating an inside wall of a reactor with a random copolymer represented by Formula [1],



wherein J is a repeating unit represented by Formula [2]; K is a repeating unit represented by Formula [3]; m represents the number of J in the random copolymer being from 10 to 3000; n represents the number of K in the random copolymer being from 10 to 3000; r represents random,



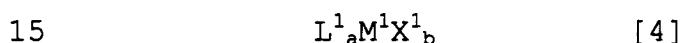
wherein Q in Formula [2] represents $R^1C(=O)O-$, $R^1S(=O)_2O-$, $(OH)_2P(=O)O-$, $(OH)(OR^1)P(=O)O-$ or $(OR^1)_2P(=O)O-$; R in
15 Formula [3] represents $HO-$ or R^1O- ; R^1 represents a hydrocarbyl group having 1 to 20 carbon atoms which may have a substituent.

2. The method according to claim 1, wherein the reactor
20 is a reactor for addition polymerization.

3. A reactor having a coated inside wall produced by the method according to claim 1 or 2.

4. A method comprising addition polymerizing monomers
5 capable of addition polymerizing in the presence of a catalyst for addition polymerization in the reactor having a coated inside wall according to claim 3.

5. The method according to claim 4, wherein the catalyst
10 for addition polymerization is a catalyst produced by bringing a compound (A) selected from a transition metal compound represented by Formula [4] or its μ -oxo type transition metal compound dimer, and an activating agent (B) into contact with each other,



wherein M^1 is a transition metal atom of Group 4; L^1 is a group having a cyclopentadiene type anionic skeleton or containing a hetero atom; X^1 is a halogen atom, a hydrocarbyloxy group, or a hydrocarbyl group other than
20 groups having a cyclopentadiene type anionic skeleton; a is a number satisfying $0 < a \leq 3$; b is a number satisfying $0 < b \leq 3$; when there are more than one L^1 , one L^1 may be linked to another L^1 either directly or by a group containing a carbon atom, a silicon atom, a nitrogen atom,
25 an oxygen atom, a sulfur atom or a phosphorus atom.

6. The method according to claim 4, wherein the catalyst for addition polymerization is a catalyst produced by bringing a compound (A) selected from a transition metal compound represented by Formula [4] or its μ -oxo type transition metal compound dimer, an activating agent (B) and an organoaluminium compound (C) into contact with each other,



wherein M^1 is a transition metal atom of Group 4; L^1 is a group having a cyclopentadiene type anionic skeleton or containing a hetero atom; X^1 is a halogen atom, a hydrocarbyloxy group, or a hydrocarbyl group other than groups having a cyclopentadiene type anionic skeleton; a is a number satisfying $0 < a \leq 3$; b is a number satisfying $0 < b \leq 3$; when there are more than one L^1 , one L^1 may be linked to another L^1 either directly or by a group containing a carbon atom, a silicon atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom.

7. The method according to claim 5 or 6, wherein the activating agent (B) is a modified particle produced by bringing the following (a), (b), (c) and (d) into contact with each other,

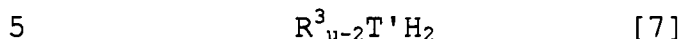
(a): a compound represented by Formula [5],



(b): a compound represented by Formula [6],



(c): a compound represented by Formula [7],



(d): an inorganic oxide particle or an organic polymer particle,

wherein M^2 in Formula [5] is a Group 12 element; L^2 is a hydrogen atom, a halogen atom or a hydrocarbyl group, and
10 two L^2 may be the same as or different from each other; R^2 is an electron withdrawing group or a group containing an electron withdrawing group, and when there are more than one R^2 , they may be the same as or different from each other; R^3 is a hydrocarbyl group or a halogenated
15 hydrocarbyl group; T in Formula [6] is a Group 15 element or a Group 16 element; t is the valence of T; T' in Formula [7] is a Group 15 element or a Group 16 element; u is the valence of T'.

20 8. The method according to any one of claims 4 to 7, wherein the addition polymerization is carried out in a gas phase.

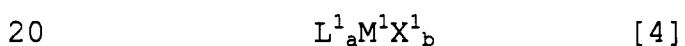
25 9. The method according to any one of claims 4 to 7, wherein the addition polymerization is carried out in

slurry.

10. The method according to any one of claims 4 to 9,
wherein the monomers capable of addition polymerizing are
5 ethylene and an α -olefin.

11. A method for producing a prepolymerized catalyst for
addition polymerization, wherein the method comprises
addition polymerizing monomers capable of addition
10 polymerizing in slurry in the presence of a catalyst for
addition polymerization in the reactor having a coated
inside wall according to claim 3.

12. The method according to claim 11, wherein the catalyst
15 for addition polymerization is a catalyst produced by
bringing a compound (A) selected from a transition metal
compound represented by Formula [4] or its μ -oxo type
transition metal compound dimer, and an activating agent
(B) into contact with each other,



wherein M^1 is a transition metal atom of Group 4; L^1 is a
group having a cyclopentadiene type anionic skeleton or
containing a hetero atom; X^1 is a halogen atom, a
hydrocarbyloxy group, or a hydrocarbyl group other than
25 groups having a cyclopentadiene type anionic skeleton; a is

a number satisfying $0 < a \leq 3$; b is a number satisfying $0 < b \leq 3$; when there are more than one L^1 , one L^1 may be linked to another L^1 either directly or by a group containing a carbon atom, a silicon atom, a nitrogen atom,
5 an oxygen atom, a sulfur atom or a phosphorus atom.

13. The method according to claim 11, wherein the catalyst for addition polymerization is a catalyst produced by bringing a compound (A) selected from a transition metal
10 compound represented by Formula [4] or its μ -oxo type transition metal compound dimer, an activating agent (B) and an organoaluminium compound (C) into contact with each other,



15 wherein M^1 is a transition metal atom of Group 4; L^1 is a group having a cyclopentadiene type anionic skeleton or containing a hetero atom; X^1 is a halogen atom, a hydrocarbyloxy group, or a hydrocarbyl group other than groups having a cyclopentadiene type anionic skeleton; a is
20 a number satisfying $0 < a \leq 3$; b is a number satisfying $0 < b \leq 3$; when there are more than one L^1 , one L^1 may be linked to another L^1 either directly or by a group containing a carbon atom, a silicon atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom.

14. A prepolymerized catalyst for addition polymerization produced by the method according any one of claims 11 to 13.

15. A method for producing an addition polymer, wherein
5 the method comprises addition polymerizing monomers capable of addition polymerizing in the presence of the prepolymerized catalyst for addition polymerization according to claim 14.

10 16. A method for producing an addition polymer, wherein the method comprises addition polymerizing monomers capable of addition polymerizing in the presence of the prepolymerized catalyst for addition polymerization according to claim 14 and an organoaluminium compound (C).

15 17. The method according to claim 15 or 16, wherein the monomers capable of addition polymerizing are ethylene and an α -olefin.