

[DESCRIPTION]

[Title of Invention]

NOVEL BORATE COMPOUND-CONTAINING COMPOSITION

[Technical Field]

5 [0001]

The present invention relates to a borate compound-containing composition useful as a cocatalyst for the solution polymerization system of olefins or dienes, and a production method thereof.

10 [Background Art]

[0002]

Many reports have been conventionally made on the use of metallocene compound and non-metallocene type metal complex catalysts such as diimine complex, phenoxy complex, and the like as catalysts for the polymerization of olefins and dienes. In many of these catalyst systems using metal complex catalysts, methylaluminoxane and tetrakis(pentafluorophenyl)borate compounds are used as cocatalysts for stabilizing active species. Tetrakis(pentafluorophenyl)borate compounds are widely used as cocatalysts in solution polymerization systems since they are superior to methylaluminoxane in thermal stability, and the stoichiometric ratio used for metal complexes is lower than that of methylaluminoxane.

[0003]

25 In addition, as a solvent used for polymerization of olefins and dienes by a metal complex catalyst, a non-polar hydrocarbon solvent is generally used. In particular, from the aspects of odor and toxicity, switching to aliphatic hydrocarbon solvents such as hexane and the like from aromatic hydrocarbon solvents such as toluene and the like is progressing.

[0004]

However, it is known that general tetrakis(pentafluorophenyl)borate compounds are hardly soluble in aromatic hydrocarbon solvents such as toluene and the like,

and that even if dissolved, they are separated to form two liquid-liquid phases of a concentrated phase in which the borate compound is dissolved and a dilute phase in which it is not dissolved (Patent document 1).

5 [0005]

In addition, since general tetrakis(pentafluorophenyl)borate compounds are hardly soluble in aliphatic hydrocarbon solvents such as hexane, heptane, and the like, a tetrakis(pentafluorophenyl)borate compound soluble
10 in aliphatic hydrocarbon solvents is desired and has been proposed (Patent document 2). Di(Octadecyl)methylammonium tetrakis(pentafluorophenyl)borate and bis(hydrogenated tallow)methylammonium tetrakis(pentafluorophenyl)borate described in Patent document 2 are useful as compounds easily
15 soluble in hydrocarbon solvents.

[0006]

However, in the production method described in Patent document 2, lithium tetrakis(pentafluorophenyl)borate and hydrochloride of dialkylmethylamine prepared separately are
20 reacted for preparation. With regard to this method, it is feared that lithium tetrakis(pentafluorophenyl)borate, which is a hardly water-soluble starting material, or hydrochloride of long chain aliphatic amine remains in the resultant product to be a catalyst poison, which prevents exhibition of sufficient
25 activity when used as a cocatalyst for polymerization. In fact, in Example 2 of Patent document 2, since diethyl ether remains in the resultant product, it is presumed that a diethyl ether complex of hardly water-soluble lithium tetrakis(pentafluorophenyl)borate remains.

30 [0007]

Patent document 3 discloses a production method of an ammonium tetrakis(pentafluorophenyl)borate derivative by mixing an alkali metal salt of tetrakis(pentafluorophenyl)borate with an amine, and then treating the mixture with a protic acid.
35 However, even in this method, it is feared that an ether

complex of an alkali metal salt of
tetrakis(pentafluorophenyl)borate or a protic acid salt of long
chain aliphatic amine remains in the resultant product and acts
as a catalyst poison.

5 [0008]

Patent document 4 discloses a composition containing a
trialkyl ammonium tetrakis(pentafluorophenyl)borate compound
and an amine compound, and a production method thereof, and
discloses that the composition is soluble in hydrocarbon
10 solvents. However, trialkylamine which is the amine compound
described in Patent document 4 has high basicity and also has
nucleophilic property. Thus, it is feared that it becomes a
catalyst poison in the polymerization reaction of olefins or
dienes.

15 [Citation List]

[Patent document]

[0009]

[Patent document 1]

JP-A- 2018-104335

20 [Patent document 2]

Japanese Translation of PCT Application Publication No. 2000-
507157

[Patent document 3]

Japanese Translation of PCT Application Publication No. 2007-
25 530673

[Patent document 4]

JP-A- 2019-59795

[Summary of Invention]

[Problems to be solved by the Invention]

30 [0010]

In view of those conventional techniques, the present
invention aims to provide a borate compound-containing
composition, which is soluble in hydrocarbon solvents,
particularly aliphatic hydrocarbon solvents, and does not
35 become a catalyst poison for the polymerization reaction of

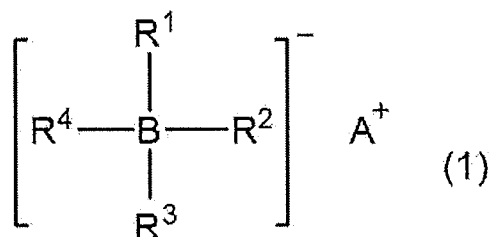
olefin and diene, and an industrial production method thereof.

[Means of Solving the Problems]

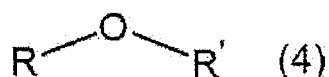
[0011]

The present inventors have conducted intensive studies
5 and found for the first time that a composition containing a
compound represented by the following formula (1) and a
compound represented by the following formula (4):

[0012]



10 [0013]



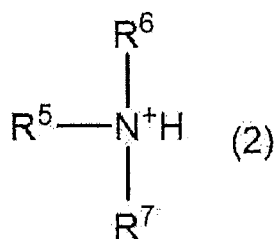
[0014]

wherein

R^1 , R^2 , R^3 and R^4 are each independently a C_{6-14} aryl group
15 substituted by one or more fluorine atoms or one or more fluoro
 C_{1-4} alkyl groups,

A^{+} is a hydrogen ion (H^{+}), a cation having a total carbon
number of not less than 25 and represented by the formula (2):

[0015]

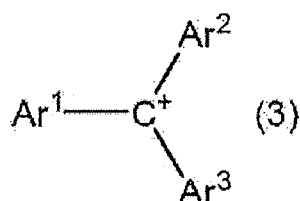


20

[0016]

wherein R^5 , R^6 and R^7 are each independently an optionally
substituted C_{1-30} alkyl group, or an optionally substituted C_{6-14}
aryl group, or a cation having a total carbon number of not
25 less than 25 and represented by the formula (3):

[0017]



[0018]

wherein Ar^1 , Ar^2 and Ar^3 are each independently a C_{6-14} aryl group optionally substituted by one or more C_{1-30} alkyl groups
 5 or C_{1-30} alkoxy groups, and

R and R' are each independently an optionally substituted C_{1-30} alkyl group, an optionally substituted C_{3-15} cycloalkyl group, or an optionally substituted C_{6-14} aryl group,

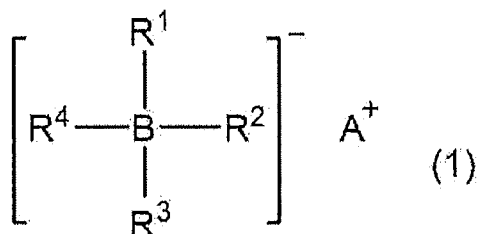
provided that when A^+ is a hydrogen ion (H^+), a total
 10 carbon number of R and R' is not less than 20, and a content of the compound represented by the aforementioned formula (4) with respect to 1 mol of the compound represented by the aforementioned formula (1) is not less than 2 mol, and when A^+ is a cation represented by the formula (2) or a cation
 15 represented by the formula (3), a total carbon number of R and R' is not less than 8 (hereinafter to be also referred to as "the composition of the present invention") is soluble in hydrocarbon solvents, particularly aliphatic hydrocarbon solvents, does not allow generation of a compound to be a
 20 catalyst poison for the polymerization reaction of olefin and diene, and is useful as a cocatalyst, and completed the present invention.

[0019]

Accordingly, the present invention provides the following.

25 [1] A composition containing a compound represented by the following formula (1) and a compound represented by the following formula (4):

[0020]



[0021]



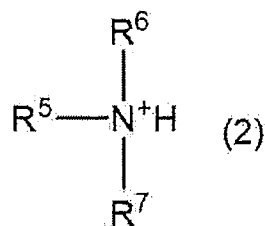
[0022]

5 wherein

R^1 , R^2 , R^3 and R^4 are each independently a C_{6-14} aryl group substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups,

A^+ is a hydrogen ion (H^+), a cation having a total carbon
10 number of not less than 25 and represented by the formula (2):

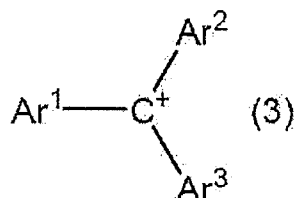
[0023]



[0024]

wherein R^5 , R^6 and R^7 are each independently an optionally
15 substituted C_{1-30} alkyl group, or an optionally substituted C_{6-14} aryl group, or a cation having a total carbon number of not less than 25 and represented by the formula (3):

[0025]



20 [0026]

wherein Ar^1 , Ar^2 and Ar^3 are each independently a C_{6-14} aryl group optionally substituted by one or more C_{1-30} alkyl groups or C_{1-30} alkoxy groups, and

R and R' are each independently an optionally substituted C₁₋₃₀ alkyl group, an optionally substituted C₃₋₁₅ cycloalkyl group, or an optionally substituted C₆₋₁₄ aryl group,

provided that when A⁺ is a hydrogen ion (H⁺), a total
5 carbon number of R and R' is not less than 20, and a content of the compound represented by the aforementioned formula (4) with respect to 1 mol of the compound represented by the aforementioned formula (1) is not less than 2 mol, and when A⁺ is a cation represented by the formula (2) or a cation
10 represented by the formula (3), a total carbon number of R and R' is not less than 8.

[2] The composition of the aforementioned [1], wherein R and R' are each independently a C₁₋₃₀ alkyl group or an optionally substituted C₆₋₁₄ aryl group, and
15 the total carbon number of R and R' is not less than 25 when A⁺ is a hydrogen ion (H⁺), not less than 8 when A⁺ is a cation represented by the formula (2) or a cation represented by the formula (3).

[3] The composition of the aforementioned [1] or [2], wherein
20 R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 9-phenanthryl group, or a 3-phenanthryl group, each of which is substituted by one or
25 more fluorine atoms or trifluoromethyl groups.

[4] The composition of the aforementioned [1] or [2], wherein all of R¹, R², R³ and R⁴ are pentafluorophenyl groups, 2,2',3,3',4',5,5',6,6'-nonafluoro-4-(1,1'-biphenylyl) groups, 2,3,4,5,6,7,8-heptafluoro-1-naphthyl groups, or 1,3,4,5,6,7,8-
30 heptafluoro-2-naphthyl groups.

[5] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a hydrogen ion.

[6] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a cation having a total carbon number of not less
35 than 35 and represented by the aforementioned formula (2), and

R⁵, R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group, or a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

(1) a halogen atom,

5 (2) a C₁₋₃₀ alkyl group,

(3) a C₁₋₃₀ alkoxy group, and

(4) a halo C₁₋₃₀ alkyl group.

[7] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a cation having a total carbon number of not less
10 than 35 and represented by the aforementioned formula (2),

R⁵ is a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

(1) a halogen atom,

(2) a C₁₋₃₀ alkyl group,

15 (3) a C₁₋₃₀ alkoxy group, and

(4) a halo C₁₋₆ alkyl group, and

R⁶ and R⁷ are each independently an optionally substituted C₁₋₃₀ alkyl group.

[8] The composition of any of the aforementioned [1] to [4],
20 wherein A⁺ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (2),

R⁵ is a C₁₋₃₀ alkyl group substituted by a C₆₋₁₄ aryl group substituted by one or more fluorine atoms, or a C₁₋₃₀ alkyl group substituted by one or more fluorine atoms, and

25 R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group optionally substituted by substituent(s) selected from the group consisting of

(1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),

(2) a halogen atom, and

30 (3) a C₁₋₃₀ alkoxy group.

[9] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (2),

R⁵ is a fluoro C₁₋₆ alkyl group, and

35 R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group optionally

substituted by substituent(s) selected from the group consisting of

- (1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),
- (2) a halogen atom, and

5 (3) a C₁₋₃₀ alkoxy group.

[10] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (3), and Ar¹, Ar² and Ar³ are each independently a phenyl group

10 optionally substituted by a C₁₋₃₀ alkyl group or a C₁₋₃₀ alkoxy group.

[11] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a hydrogen ion, and

R and R' are each independently a C₁₋₃₀ alkyl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- (2) a C₁₋₃₀ alkoxy group, and
- (3) a halo C₁₋₃₀ alkoxy group;

20 a C₃₋₁₅ cycloalkyl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- (2) a C₁₋₃₀ alkyl group,
- (3) a C₁₋₃₀ alkoxy group,

25 (4) a halo C₁₋₃₀ alkyl group, and

- (5) a halo C₁₋₃₀ alkoxy group; or

a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,

30 (2) a C₁₋₃₀ alkyl group,

- (3) a C₁₋₃₀ alkoxy group,

(4) a halo C₁₋₃₀ alkyl group, and

- (5) a halo C₁₋₃₀ alkoxy group.

[12] The composition of any of the aforementioned [1] to [4],

35 wherein A⁺ is a hydrogen ion, and R and R' are each

independently a C₁₋₃₀ alkyl group.

[13] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a hydrogen ion,

R and R' are each independently a C₁₄₋₃₀ alkyl group, and

5 the total carbon number of R and R' is not less than 28.

[14] The composition of any of the aforementioned [1] to [4], wherein A⁺ is a hydrogen ion, and

R and R' are the same group.

[15] The composition of any of the aforementioned [1] to [4]

10 and [6] to [10], wherein A⁺ is a cation represented by the aforementioned formula (2) or the formula (3), R and R' are each independently a C₁₋₃₀ alkyl group, and the total carbon number of R and R' is not less than 8.

[16] The composition of any of the aforementioned [1] to [4],

15 [6] to [10], and [15], wherein a content of the compound represented by the aforementioned formula (4) with respect to 1 mol of the compound represented by the aforementioned formula (1) (wherein A⁺ is a cation represented by the aforementioned formula (2) or the formula (3)) is within the range of 0.01 -
20 10 mol.

[17] The composition of any of the aforementioned [1] to [4],

[6] to [10], and [15], wherein a content of the compound

represented by the aforementioned formula (4) with respect to 1 mol of the compound represented by the aforementioned formula

25 (1) (wherein A⁺ is a cation represented by the aforementioned formula (2) or the formula (3)) is within the range of 0.01 - 3 mol.

[18] The composition of any of the aforementioned [1] to [17],

having a solubility of not less than 5 wt% in n-hexane,

30 isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, or a mixed solvent thereof at 25°C.

[19] The composition of any of the aforementioned [1] to [18], substantially free of an ether having a total carbon number of not more than 7.

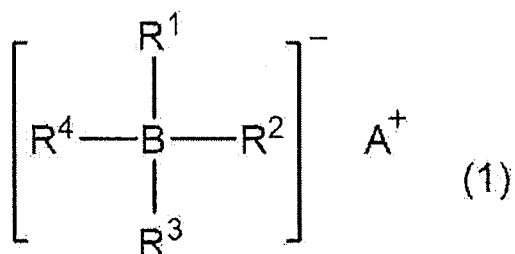
35 [20] A cocatalyst for polymerization of at least one kind of

monomer selected from the group consisting of an olefin and a diene, consisting of the composition of any of the aforementioned [1] to [19].

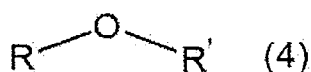
[21] A method for producing a polymer, comprising polymerizing
5 at least one kind of monomer selected from the group consisting of an olefin and a diene by using the composition of any of the aforementioned [1] to [19] as a cocatalyst.

[22] A composition comprising a compound represented by the following formula (1) and a compound represented by the
10 following formula (4):

[0027]



[0028]



15 [0029]

wherein

R^1 , R^2 , R^3 and R^4 are each independently a C_{6-14} aryl group substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups,

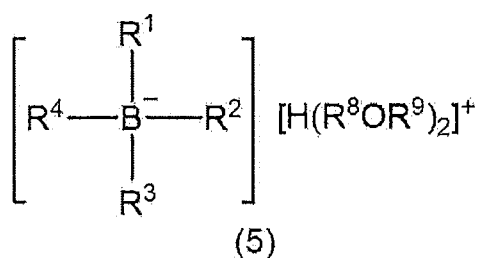
20 A^{+} is a hydrogen ion (H^{+}),

R and R' are each independently an optionally substituted C_{1-30} alkyl group, an optionally substituted C_{3-15} cycloalkyl group, or an optionally substituted C_{6-14} aryl group,

a total carbon number of R and R' is not less than 20, and

25 a content of the compound represented by the aforementioned formula (4) with respect to 1 mol of the compound represented by the aforementioned formula (1) is not less than 2 mol, comprising a step of reacting a compound represented by the following formula (5):

30 [0030]



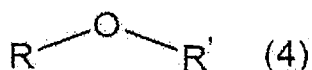
[0031]

wherein

R^1 , R^2 , R^3 and R^4 are as defined above,

- 5 R^8 and R^9 are each independently a C_{1-6} alkyl group, and a total carbon number of R^8OR^9 is not more than 7, with a compound represented by the following formula (4):

[0032]



10 [0033]

wherein R and R' are as defined above.

[23] The production method of the aforementioned [22], wherein both R^8 and R^9 are ethyl groups.

[Effect of the Invention]

15 [0034]

According to the present invention, a composition containing a borate compound which is soluble in hydrocarbon solvents, particularly aliphatic hydrocarbon solvents, and useful as a cocatalyst, and a production method thereof can be
20 provided.

[Description of Embodiments]

[0035]

The definitions of the terms and respective symbols used in the present specification are explained below.

25 [0036]

In the present specification, the "halogen atom" means a fluorine atom, a chlorine atom, a bromine atom, or an iodine atom.

[0037]

30 In the present specification, the "alkyl (group)" means a

linear or branched chain alkyl group having a carbon number of not less than 1.

[0038]

In the present specification, the "C₁₋₃₀ alkyl (group)" means a linear or branched chain alkyl group having a carbon number of 1 to 30. Examples thereof include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, isopentyl, neopentyl, 1-ethylpropyl, hexyl, isohexyl, 1,1-dimethylbutyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 2-ethylbutyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, hexadecyl, octadecyl, nonadecyl, eicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, and the like.

[0039]

In the present specification, the "C₄₋₃₀ alkyl (group)" means a linear or branched chain alkyl group having a carbon number of 4 to 30. Examples thereof include butyl, isobutyl, sec-butyl, tert-butyl, pentyl, isopentyl, neopentyl, 1-ethylpropyl, hexyl, isohexyl, 1,1-dimethylbutyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 2-ethylbutyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, hexadecyl, octadecyl, nonadecyl, eicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, and the like.

[0040]

In the present specification, the "C₁₄₋₃₀ alkyl (group)" means a linear or branched chain alkyl group having a carbon number of 14 to 30. Examples thereof include tetradecyl, hexadecyl, octadecyl, nonadecyl, eicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, and the like.

[0041]

In the present specification, the "C₁₋₆ alkyl (group)" means a linear or branched chain alkyl group having a carbon number of 1 to 6. Examples thereof include methyl, ethyl,

propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, isopentyl, neopentyl, 1-ethylpropyl, hexyl, isoheptyl, 1,1-dimethylbutyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 2-ethylbutyl, and the like. Among them, C₁₋₄ alkyl group is
5 preferred.

[0042]

In the present specification, the "halo C₁₋₃₀ alkyl (group)" means the aforementioned "C₁₋₃₀ alkyl" group in which one or more hydrogen atoms are substituted by halogen atom(s).
10 Specific examples thereof include difluoromethyl, trifluoromethyl, 2-chloroethyl, 2-bromoethyl, 2-iodoethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, pentafluoroethyl, 2,2-difluoropropyl, 2,2,3,3-tetrafluoropropyl, 3,3,3-trifluoropropyl, 2,2,3,3,3-pentafluoropropyl, 2,2-
15 difluorobutyl, 4,4,4-trifluorobutyl, 2,2-difluoropentyl, 5,5,5-trifluoropentyl, 2,2-difluorohexyl, 6,6,6-trifluorohexyl, and the like. Among them, "halo C₁₋₆ alkyl" in which one or more hydrogen atoms in the aforementioned "C₁₋₆ alkyl" group are substituted by halogen atom(s) is preferred.

20 [0043]

In the present specification, the "fluoro C₁₋₆ alkyl (group)" means the aforementioned "halo C₁₋₆ alkyl" group in which the halogen atom is a fluorine atom. Specific examples thereof include difluoromethyl, trifluoromethyl, 2-fluoroethyl, 2,2-difluoroethyl, 2,2,2-trifluoroethyl, pentafluoroethyl, 2,2-
25 difluoropropyl, 2,2,3,3-tetrafluoropropyl, 3,3,3-trifluoropropyl, 2,2,3,3,3-pentafluoropropyl, 2,2-difluorobutyl, 4,4,4-trifluorobutyl, 2,2-difluoropentyl, 5,5,5-trifluoropentyl, 2,2-difluorohexyl, 6,6,6-trifluorohexyl, and the like. Among
30 them, "fluoro C₁₋₄ alkyl (groups)" such as difluoromethyl, trifluoromethyl, 2,2,2-trifluoroethyl, pentafluoroethyl, 2,2-difluoropropyl, 2,2,3,3-tetrafluoropropyl, 3,3,3-trifluoropropyl, 2,2,3,3,3-pentafluoropropyl, 2,2-difluorobutyl, 4,4,4-trifluorobutyl, and the like are preferred, and
35 difluoromethyl, trifluoromethyl, 2,2,2-trifluoroethyl,

pentafluoroethyl, and 2,2-difluoropropyl are more preferred, and trifluoromethyl and 2,2,2-trifluoroethyl are particularly preferred.

[0044]

5 In the present specification, the "cycloalkyl (group)" means a cyclic alkyl group. Unless the carbon number range is particularly limited, it is preferably a C₃₋₁₅ cycloalkyl group, more preferably a C₃₋₈ cycloalkyl group.

[0045]

10 In the present specification, the "C₃₋₁₅ cycloalkyl (group)" means a cyclic alkyl group having a carbon number of 3 to 15. Examples thereof include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cycloundecyl, cyclododecyl, cyclotridecyl, cyclotetradecyl, cyclopentadecyl, and the like. The "C₃₋₈ cycloalkyl (group)" means a cyclic alkyl group having a carbon number of 3 to 8. Examples thereof include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, and the like. Among them, a C₃₋₆ cycloalkyl group is preferred.

20 [0046]

In the present specification, the "alkoxy (group)" means a group in which a linear or branched chain alkyl group is bonded to an oxygen atom.

[0047]

25 In the present specification, the "C₁₋₃₀ alkoxy (group)" means a linear or branched chain alkoxy group having a carbon number of 1 to 30. Examples thereof include methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, sec-butoxy, tert-butoxy, pentyloxy, isopentyloxy, neopentyloxy, hexyloxy, isohexyloxy, 30 1,1-dimethylbutoxy, 2,2-dimethylbutoxy, 3,3-dimethylbutoxy, 2-ethylbutoxy, heptyloxy, octyloxy, nonyloxy, decyloxy, undecyloxy, dodecyloxy, tridecyloxy, tetradecyloxy, hexadecyloxy, octadecyloxy, eicosyloxy, docosyloxy, tricosyloxy, tetracosyloxy, pentacosyloxy, hexacosyloxy, heptacosyloxy, 35 octacosyloxy, nonacosyloxy, triacontyloxy, and the like.

[0048]

In the present specification, the "C₄₋₃₀ alkoxy (group)" means a linear or branched chain alkoxy group having a carbon number of 4 to 30. Examples thereof include butoxy, isobutoxy, 5 sec-butoxy, tert-butoxy, pentyloxy, isopentyloxy, neopentyloxy, hexyloxy, isohexyloxy, 1,1-dimethylbutoxy, 2,2-dimethylbutoxy, 3,3-dimethylbutoxy, 2-ethylbutoxy, heptyloxy, octyloxy, nonyloxy, decyloxy, undecyloxy, dodecyloxy, tridecyloxy, tetradecyloxy, hexadecyloxy, octadecyloxy, eicosyloxy, 10 docosyloxy, tricosyloxy, tetracosyloxy, pentacosyloxy, hexacosyloxy, heptacosyloxy, octacosyloxy, nonacosyloxy, triacontyloxy, and the like.

[0049]

In the present specification, the "C₁₄₋₃₀ alkoxy (group)" 15 means a linear or branched chain alkoxy group having a carbon number of 14 to 30. Examples thereof include tetradecyloxy, hexadecyloxy, octadecyloxy, eicosyloxy, docosyloxy, tricosyloxy, tetracosyloxy, pentacosyloxy, hexacosyloxy, heptacosyloxy, octacosyloxy, nonacosyloxy, triacontyloxy, and the like.

20 [0050]

In the present specification, the "C₁₋₆ alkoxy (group)" means a linear or branched chain alkoxy group having a carbon number of 1 to 6. Examples thereof include methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, sec-butoxy, tert-butoxy, 25 pentyloxy, isopentyloxy, neopentyloxy, hexyloxy, and the like. Among them, a C₁₋₄ alkoxy group is preferred.

[0051]

In the present specification, the "halo C₁₋₃₀ alkoxy (group)" means the aforementioned "C₁₋₃₀ alkoxy" group in which 30 one or more hydrogen atoms are substituted by halogen atom(s). Specific examples thereof include difluoromethoxy, trifluoromethoxy, 2-chloroethoxy, 2-bromoethoxy, 2-iodoethoxy, 2-fluoroethoxy, 2,2-difluoroethoxy, 2,2,2-trifluoroethoxy, pentafluoroethoxy, 2,2-difluoropropoxy, 2,2,3,3- 35 tetrafluoropropoxy, 3,3,3-trifluoropropoxy, 2,2,3,3,3-

pentafluoropropoxy, 2,2-difluorobutoxy, 4,4,4-trifluorobutoxy, 2,2-difluoropentyloxy, 5,5,5-trifluoropentyloxy, 2,2-difluorohexyloxy, 6,6,6-trifluorohexyloxy, and the like. Among them, "halo C₁₋₆ alkoxy" in which one or more hydrogen atoms in
5 the aforementioned "C₁₋₆ alkoxy" group are substituted by halogen atom(s) is preferred.

[0052]

In the present specification, the "fluoro C₁₋₆ alkoxy (group)" means the aforementioned "halo C₁₋₆ alkoxy" group in
10 which the halogen atom is a fluorine atom. Specific examples thereof include difluoromethoxy, trifluoromethoxy, 2-fluoroethoxy, 2,2-difluoroethoxy, 2,2,2-trifluoroethoxy, pentafluoroethoxy, 2,2-difluoropropoxy, 2,2,3,3-tetrafluoropropoxy, 3,3,3-trifluoropropoxy, 2,2,3,3,3-
15 pentafluoropropoxy, 2,2-difluorobutoxy, 4,4,4-trifluorobutoxy, 2,2-difluoropentyloxy, 5,5,5-trifluoropentyloxy, 2,2-difluorohexyloxy, 6,6,6-trifluorohexyloxy, and the like. Among them, "fluoro C₁₋₄ alkoxy (groups)" such as difluoromethoxy, trifluoromethoxy, 2,2,2-trifluoroethoxy, pentafluoroethoxy,
20 pentafluoroethoxy, 2,2-difluoropropoxy, 2,2,3,3-tetrafluoropropoxy, 3,3,3-trifluoropropoxy, 2,2,3,3,3-pentafluoropropoxy, 2,2-difluorobutoxy, 4,4,4-trifluorobutoxy, and the like are preferred; difluoromethoxy, trifluoromethoxy, 2,2,2-trifluoroethoxy, pentafluoroethoxy, and 2,2-
25 difluoropropoxy are more preferred; and trifluoromethoxy and 2,2,2-trifluoroethoxy are particularly preferred.

[0053]

In the present specification, the "aryl (group)" mean a monocyclic or polycyclic (fused) hydrocarbon group showing
30 aromaticity. Specific examples thereof include C₆₋₁₄ aryl groups such as phenyl, 1-naphthyl, 2-naphthyl, 2-biphenyl, 3-biphenyl, 4-biphenyl, 1-anthryl, 2-anthryl, 9-anthryl, 3-phenanthryl, 9-phenanthryl, and the like. Among them, phenyl, 4-biphenyl, 1-naphthyl, and 2-naphthyl are preferred.

35 [0054]

In the present specification, the "nitrogen-containing aromatic heterocyclic compound" means a monocyclic or fused polycyclic aromatic heterocyclic compound containing, besides a carbon atom, 1 to 4 hetero atoms selected from a nitrogen atom, a sulfur atom, and an oxygen atom as ring-constituting atom(s), and containing at least one nitrogen atom as the ring-constituting atom.

Preferable examples of the "nitrogen-containing aromatic heterocyclic compound" include 5- or 6-membered monocyclic nitrogen-containing aromatic heterocyclic compounds such as pyrrole, imidazole, pyrazole, thiazole, isothiazole, oxazole, isoxazole, pyridine, pyrazine, pyrimidine, pyridazine, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,4-thiadiazole, 1,3,4-thiadiazole, triazole, tetrazole, triazine, and the like; 8- to 14-membered fused polycyclic (preferably bi- or tri-cyclic) nitrogen-containing aromatic heterocyclic compounds such as benzimidazole, benzoxazole, benzisoxazole, benzothiazole, benzisothiazole, benzotriazole, imidazopyridine, thienopyridine, furopyridine, pyrrolopyridine, pyrazolopyridine, oxazolopyridine, thiazolopyridine, imidazopyrazine, imidazopyrimidine, thienopyrimidine, furopyrimidine, pyrrolopyrimidine, pyrazolopyrimidine, oxazolopyrimidine, thiazolopyrimidine, pyrazolotriazine, indole, isoindole, 1H-indazole, purine, isoquinoline, quinoline, phthalazine, naphthyridine, quinoxaline, quinazoline, cinnoline, carbazole, β -carboline, phenanthridine, acridine, phenazine, phenothiazine, phenoxathiine, and the like. Among them, 5- or 6-membered monocyclic nitrogen-containing aromatic heterocyclic compound is preferred, and pyridine and imidazole are more preferred.

[0055]

In the present specification, the "optionally substituted" means unsubstituted or having one or more substituents. Unless otherwise particularly indicated, (1) a halogen atom, (2) a nitro group, (3) a cyano group, (4) a C₁₋₃₀ alkyl group, (5) a halo C₁₋₃₀ alkyl group, (6) a C₃₋₈ cycloalkyl

group, (7) a C₁₋₃₀ alkoxy group, (8) a halo C₁₋₃₀ alkoxy group, (9) a C₆₋₁₄ aryl group, and the like can be mentioned as the "substituent". Among them, a halogen atom, a cyano group, a C₁₋₆ alkyl group, a halo C₁₋₆ alkyl group, a C₁₋₆ alkoxy group, a halo C₁₋₆ alkoxy group, and a phenyl group are preferred, and a halogen atom (e.g., fluorine atom), a C₁₋₆ alkyl group (e.g., methyl, ethyl), a C₁₋₆ alkoxy group (e.g., methoxy, ethoxy), and a halo C₁₋₆ alkyl group (e.g., trifluoromethyl) are more preferred. When plural substituents are present, respective substituents may be the same or different. The above-mentioned substituents may also be further substituted by one or more of a C₁₋₆ alkyl group, a C₁₋₆ alkoxy group, a halogen atom, a phenyl group, and the like.

[0056]

In the present specification, the "hydrocarbon solvent" means solvents including aromatic hydrocarbon solvents and/or aliphatic hydrocarbon solvents. Among them, aliphatic hydrocarbon solvents are preferable from the aspects of odor and toxicity.

[0057]

In the present specification, examples of the "aromatic hydrocarbon solvent" include benzene, toluene, xylene, and the like.

[0058]

In the present specification, examples of the "aliphatic hydrocarbon solvent" include n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, a mixed solvent thereof, and the like.

[0059]

In the present specification, the "soluble in hydrocarbon solvent (or aliphatic hydrocarbon solvent)" means that the composition of the present invention is dissolved in a solution of a hydrocarbon solvent (or aliphatic hydrocarbon solvent) and the composition of the present invention at 25°C at a concentration of not less than 5 wt% to form a transparent

homogeneous solution. In addition, the "easily soluble in hydrocarbon solvent (or aliphatic hydrocarbon solvent)" means that the composition of the present invention is dissolved in a solution of a hydrocarbon solvent (or aliphatic hydrocarbon solvent) and the composition of the present invention at 25°C at a concentration of not less than 20 wt% (preferably not less than 30 wt%) to form a transparent homogeneous solution.

[0060]

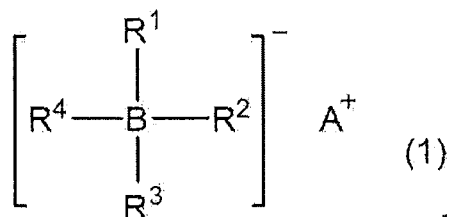
(Composition of the present invention)

The composition of the present invention is explained below.

[0061]

The composition of the present invention is a composition containing a compound represented by the following formula (1) and a compound represented by the following formula (4):

[0062]



[0063]



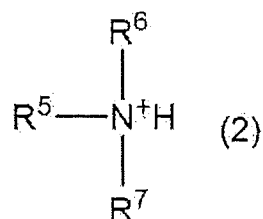
[0064]

wherein

R^1 , R^2 , R^3 and R^4 are each independently a C_{6-14} aryl group substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups,

A^{+} is a hydrogen ion (H^{+}), a cation having a total carbon number of not less than 25 and represented by the formula (2):

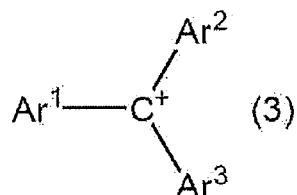
[0065]



[0066]

wherein R^5 , R^6 and R^7 are each independently an optionally substituted C_{1-30} alkyl group, or an optionally substituted C_{6-14} aryl group, or a cation having a total carbon number of not less than 25 and represented by the formula (3):

[0067]



[0068]

wherein Ar^1 , Ar^2 and Ar^3 are each independently a C_{6-14} aryl group optionally substituted by one or more C_{1-30} alkyl groups or C_{1-30} alkoxy groups, and R and R' are each independently an optionally substituted C_{1-30} alkyl group, an optionally substituted C_{3-15} cycloalkyl group, or an optionally substituted C_{6-14} aryl group,

provided that when A^+ is a hydrogen ion (H^+), a total carbon number of R and R' is not less than 20, and a content of the compound represented by the aforementioned formula (4) with respect to 1 mol of the compound represented by the aforementioned formula (1) is not less than 2 mol, and when A^+ is a cation represented by the formula (2) or a cation represented by the formula (3), a total carbon number of R and R' is not less than 8.

[0069]

The composition containing a compound represented by the aforementioned formula (1) and a compound represented by the aforementioned formula (4) is not particularly limited as long as it contains the both compounds, and may include a compound in which the compound represented by the aforementioned formula (4) is coordinated with the compound represented by the aforementioned formula (1) to form a complex. The composition of the present invention is preferably a composition containing a complex formed by a compound represented by the

aforementioned formula (1) and a compound represented by the
aforementioned formula (4).

[0070]

Preferred embodiments of the compound represented by the
5 formula (1) (hereinafter to be also referred to as "compound
(1)") are explained below.

[0071]

Each group of compound (1) is explained below.

[0072]

10 R^1 , R^2 , R^3 and R^4 are preferably each independently a
phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-
biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a
1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-
phenanthryl group, or a 9-phenanthryl group, each substituted
15 by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl
groups (e.g., trifluoromethyl group), more preferably each
independently a phenyl group, a 1-naphthyl group, a 2-naphthyl
group, or a 4-biphenylyl group, each substituted by one or more
fluorine atoms or one or more trifluoromethyl groups,
20 particularly preferably a pentafluorophenyl group, a
2,2',3,3',4',5,5',6,6'-nonafluoro-4-(1,1'-biphenylyl) group, a
2,3,4,5,6,7,8-heptafluoro-1-naphthyl group, or a 1,3,4,5,6,7,8-
heptafluoro-2-naphthyl group, wherein all of R^1 , R^2 , R^3 and R^4
are the same.

25 [0073]

A^+ is preferably a hydrogen ion (H^+).

[0074]

Another preferred embodiment of A^+ is a cation having a
total carbon number of not less than 25, preferably a cation
30 having a total carbon number of not less than 35, and
represented by the aforementioned formula (2).

R^5 , R^6 and R^7 in the formula (2) are preferably each
independently a C_{1-30} alkyl group, or a C_{6-14} aryl group
optionally substituted by substituent(s) selected from the
35 group consisting of

- (1) a halogen atom,
- (2) a C₁₋₃₀ alkyl group,
- (3) a C₁₋₃₀ alkoxy group, and
- (4) a halo C₁₋₃₀ alkyl group,

5 more preferably, R⁵ is a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- (2) a C₁₋₃₀ alkyl group,
- (3) a C₁₋₃₀ alkoxy group and

10 (4) a halo C₁₋₃₀ alkyl group, and

R⁶ and R⁷ are each independently an optionally substituted C₁₋₃₀ alkyl group.

[0075]

Another preferred embodiment of A⁺ is a cation having a
15 total carbon number of not less than 35 and represented by the
aforementioned formula (2), wherein R⁵ in the aforementioned
formula (2) is a C₁₋₃₀ alkyl group substituted by a C₆₋₁₄ aryl
group substituted by one or more fluorine atoms, or a C₁₋₃₀
alkyl group substituted by one or more fluorine atoms, and R⁶
20 and R⁷ are each independently a C₁₋₃₀ alkyl group optionally
substituted by substituent(s) selected from the group
consisting of

- (1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),
- (2) a halogen atom, and
- 25 (3) a C₁₋₃₀ alkoxy group,

more preferably, R⁵ is a fluoro C₁₋₆ alkyl group, and R⁶ and R⁷
are each independently a C₁₋₃₀ alkyl group optionally
substituted by substituent(s) selected from the group
consisting of

- 30 (1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),
- (2) a halogen atom, and
- (3) a C₁₋₃₀ alkoxy group.

[0076]

A yet another preferred embodiment of A⁺ is a cation
35 having a total carbon number of not less than 35 and

represented by the aforementioned formula (3), preferably, Ar¹, Ar² and Ar³ in the formula (3) are each independently a phenyl group optionally substituted by a C₁₋₃₀ alkyl group or a C₁₋₃₀ alkoxy group, more preferably, Ar¹, Ar² and Ar³ are each
5 independently a phenyl group optionally substituted by a C₄₋₃₀ alkyl group.

[0077]

As preferred compound (1), the following compounds can be mentioned.

10 [0078]

[Compound (1-1)]

Compound (1) of the aforementioned formula (1), wherein R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenylyl group, a 3-
15 biphenylyl group, a 4-biphenylyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group, substituted by one or more fluorine atoms or fluoro C₁₋₄ alkyl groups (e.g., trifluoromethyl group), and A⁺ is a hydrogen ion (H⁺).

20 [0079]

[Compound (1-2-A)]

Compound (1) of the aforementioned formula (1), wherein R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenylyl group, a 3-
25 biphenylyl group, a 4-biphenylyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group, each substituted by one or more fluorine atoms or one or more fluoro C₁₋₄ alkyl groups (e.g., trifluoromethyl group), and

30 A⁺ is a cation having a total carbon number of not less than 25 and represented by the aforementioned formula (2), and R⁵, R⁶ and R⁷ in the formula (2) are each independently a C₁₋₃₀ alkyl group or a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

35 (1) a halogen atom,

- (2) a C₁₋₃₀ alkyl group,
- (3) a C₁₋₃₀ alkoxy group and
- (4) a halo C₁₋₃₀ alkyl group.

[0080]

5 [Compound (1-2)]

Compound (1) of the aforementioned formula (1), wherein R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group, each substituted by one or more fluorine atoms or one or more fluoro C₁₋₄ alkyl groups (e.g., trifluoromethyl group), and

A⁺ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (2), and R⁵, R⁶ and R⁷ in the formula (2) are each independently a C₁₋₃₀ alkyl group, or a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- 20 (2) a C₁₋₃₀ alkyl group,
- (3) a C₁₋₃₀ alkoxy group, and
- (4) a halo C₁₋₃₀ alkyl group.

[0081]

[Compound (1-2-B)]

25 Compound (1) of the aforementioned formula (1), wherein R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group (preferably, a phenyl group, a 1-naphthyl group, a 2-naphthyl group, or a 4-biphenyl group), each substituted by one or more fluorine atoms or one or more fluoro C₁₋₄ alkyl groups (e.g., trifluoromethyl group),

A⁺ is a cation having a total carbon number of not less than 25
35 (preferably not less than 35) and represented by the

aforementioned formula (2),

R⁵ in the formula (2) is a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

- 5 (1) a halogen atom,
- (2) a C₁₋₃₀ alkyl group,
- (3) a C₁₋₃₀ alkoxy group, and
- (4) a halo C₁₋₃₀ alkyl group, and

R⁶ and R⁷ are each independently an optionally substituted C₁₋₃₀
10 alkyl group.

[0082]

[Compound (1-2-C)]

Compound (1) of the aforementioned formula (1), wherein R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-
15 naphthyl group, a 2-naphthyl group, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group (preferably, a phenyl group, a 1-naphthyl group, a 2-naphthyl group, or a 4-biphenyl group), each
20 substituted by one or more fluorine atoms or one or more fluoro C₁₋₄ alkyl groups (e.g., trifluoromethyl group),

A⁺ is a cation having a total carbon number of not less than 25 (preferably not less than 35) and represented by the aforementioned formula (2),

25 R⁵ in the formula (2) is a C₁₋₃₀ alkyl group substituted by a C₆₋₁₄ aryl group substituted by one or more fluorine atoms, or a C₁₋₃₀ alkyl group substituted by one or more fluorine atoms, and R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group optionally substituted by substituent(s) selected from the group
30 consisting of

- (1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),
- (2) a halogen atom, and
- (3) a C₁₋₃₀ alkoxy group.

[0083]

35 [compound (1-2-D)]

Compound (1) of the aforementioned formula (1), wherein R^1 , R^2 , R^3 and R^4 are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group (preferably a phenyl group, a 1-naphthyl group, a 2-naphthyl group, or a 4-biphenylyl group), each substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups (e.g., trifluoromethyl group),
10 A^+ is a cation having a total carbon number of not less than 25 (preferably not less than 35) and represented by the aforementioned formula (2),
 R^5 in the formula (2) is a fluoro C_{1-6} alkyl group, and R^6 and R^7 are each independently a C_{1-30} alkyl group optionally
15 substituted by substituent(s) selected from the group consisting of
(1) a C_{6-14} aryl group optionally substituted by halogen atom(s),
(2) a halogen atom, and
(3) a C_{1-30} alkoxy group.

20 [0084]

[Compound (1-3)]

Compound (1) of the aforementioned formula (1), wherein R^1 , R^2 , R^3 and R^4 are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 2-biphenylyl group, a 3-biphenylyl group, a 4-biphenylyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 3-phenanthryl group, or a 9-phenanthryl group, each substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups (e.g., trifluoromethyl group),
25 A^+ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (3), and Ar^1 , Ar^2 and Ar^3 in the formula (3) are each independently a cation which is a phenyl group optionally substituted by a C_{1-30} alkyl group or a C_{1-30} alkoxy group.

35 [0085]

[Compound (1-4)]

Compound (1) of the aforementioned formula (1), wherein R^1 , R^2 , R^3 and R^4 are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, or a 4-biphenylyl group, each substituted by one or more fluorine atoms or one or more trifluoromethyl groups, and A^+ is a hydrogen ion (H^+).

[0086]

[Compound (1-5)]

Compound (1) of the aforementioned formula (1), wherein R^1 , R^2 , R^3 and R^4 are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, or a 4-biphenylyl group, each substituted by one or more fluorine atoms or one or more trifluoromethyl groups, A^+ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (2), and any one of R^5 , R^6 and R^7 in the formula (2) is a phenyl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
 - (2) a C_{1-30} alkyl group,
 - (3) a C_{1-30} alkoxy group, and
 - (4) a halo C_{1-30} alkyl group, and
- the other two are C_{1-30} alkyl groups (preferably C_{14-30} alkyl groups).

[0087]

[Compound (1-6)]

Compound (1) of the aforementioned formula (1), wherein R^1 , R^2 , R^3 and R^4 are each independently a phenyl group, a 1-naphthyl group, a 2-naphthyl group, or a 4-biphenylyl group, each substituted by one or more fluorine atoms or one or more trifluoromethyl groups, A^+ is a cation having a total carbon number of not less than 35 and represented by the aforementioned formula (3), and Ar^1 , Ar^2 and Ar^3 in the formula (3) are each independently a phenyl

group optionally substituted by a C₄₋₃₀ alkyl group.

[0088]

[Compound (1-7)]

Compound (1) of the aforementioned formula (1), wherein
5 R¹, R², R³ and R⁴ are all the same and are pentafluorophenyl
groups, 2,2',3,3',4',5,5',6,6'-nonafluoro-4-(1,1'-biphenylyl)
groups, 2,3,4,5,6,7,8-heptafluoro-1-naphthyl groups, or
1,3,4,5,6,7,8-heptafluoro-2-naphthyl groups, and
A⁺ is a hydrogen ion (H⁺).

10 [0089]

[Compound (1-8)]

Compound (1) of the aforementioned formula (1), wherein
R¹, R², R³ and R⁴ are all the same and are pentafluorophenyl
groups, 2,2',3,3',4',5,5',6,6'-nonafluoro-4-(1,1'-biphenylyl)
15 groups, 2,3,4,5,6,7,8-heptafluoro-1-naphthyl groups, or
1,3,4,5,6,7,8-heptafluoro-2-naphthyl groups, and
A⁺ is a cation having a total carbon number of not less than 35
and represented by the aforementioned formula (2), and any one
of R⁵, R⁶ and R⁷ in the formula (2) is a phenyl group optionally
20 substituted by substituent(s) selected from the group
consisting of

- (1) a halogen atom,
 - (2) a C₁₋₃₀ alkyl group,
 - (3) a C₁₋₃₀ alkoxy group, and
 - 25 (4) a halo C₁₋₃₀ alkyl group, and
- the other two are C₁₋₃₀ alkyl groups (preferably C₁₄₋₃₀ alkyl
groups).

[0090]

[Compound (1-9)]

30 Compound (1) of the aforementioned formula (1), wherein
R¹, R², R³ and R⁴ are all the same and are pentafluorophenyl
groups, 2,2',3,3',4',5,5',6,6'-nonafluoro-4-(1,1'-biphenylyl)
groups, 2,3,4,5,6,7,8-heptafluoro-1-naphthyl groups, or
1,3,4,5,6,7,8-heptafluoro-2-naphthyl groups, and
35 A⁺ is a cation having a total carbon number of not less than 35

and represented by the aforementioned formula (3), and Ar¹, Ar² and Ar³ in the formula (3) are each independently a phenyl group optionally substituted by a C₄₋₃₀ alkyl group.

[0091]

5 Specific preferable examples of compound (1) include hydrogenated tetrakis(pentafluorophenyl)borate, hydrogenated tetrakis(heptafluoronaphthyl)borate, hydrogenated tetrakis(nonafluorobiphenyl)borate, N,N-di-octadecylmethylammonium tetrakis(pentafluorophenyl)borate, 10 N,N-di-octadecylanilinium tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-(2,3,4,5,6-pentafluorophenyl)methylammonium tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-2,2,3,3,3- 15 pentafluoropropylammonium tetrakis(pentafluorophenyl)borate, N,N-di-dodecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-2,2-difluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-3,3,3-trifluoropropylammonium 20 tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-2-fluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-di-docosyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-bis(3,7,11,15-tetramethylhexadecyl)-2,2,2-trifluoroethylammonium 25 tetrakis(pentafluorophenyl)borate, N,N-bis(3,7,11-trimethyldodecyl)-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-ditetradecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate, N,N-di-hexadecyl-2,2,2-trifluoroethylammonium 30 tetrakis(pentafluorophenyl)borate, N,N-di-octadecyl-2,2,2-trifluoroethylammonium tetrakis(heptafluoronaphthyl)borate, N,N-di-octadecyl-2,2,2-trifluoroethylammonium tetrakis(nonafluorobiphenyl)borate, and the like.

[0092]

35 A preferred embodiment of a compound represented by the

formula (4) (hereinafter to be also referred to as "compound (4)") is explained in the following.

[0093]

Each group of compound (4) is explained in the following.

5 [0094]

Preferred embodiments of compound (4) vary depending on the kind of A^+ in compound (1).

[0095]

When A^+ in compound (1) is a hydrogen ion (H^+),
10 the total carbon number of R and R' is not less than 20, preferably not less than 25, more preferably not less than 28, further preferably not less than 30.

R and R' are each independently an optionally substituted C_{1-30} alkyl group, an optionally substituted C_{3-15} cycloalkyl
15 group, or an optionally substituted C_{6-14} aryl group, preferably each independently a C_{1-30} alkyl group optionally substituted by substituent(s) selected from the group consisting of

(1) a halogen atom,
(2) a C_{1-30} alkoxy group, and
20 (3) a halo C_{1-30} alkoxy group;
a C_{3-15} cycloalkyl group optionally substituted by substituent(s) selected from the group consisting of
(1) a halogen atom,
(2) a C_{1-30} alkyl group,
25 (3) a C_{1-30} alkoxy group,
(4) a halo C_{1-30} alkyl group, and
(5) a halo C_{1-30} alkoxy group; or
a C_{6-14} aryl group optionally substituted by substituent(s) selected from the group consisting of

30 (1) a halogen atom,
(2) a C_{1-30} alkyl group,
(3) a C_{1-30} alkoxy group,
(4) a halo C_{1-30} alkyl group, and
(5) a halo C_{1-30} alkoxy group,
35 further preferably each independently a C_{14-30} alkyl group.

[0096]

When A^+ in compound (1) is a cation represented by the formula (2) or a cation represented by the formula (3), the total carbon number of R and R' is preferably not less than 8,
5 more preferably not less than 10.

R and R' are preferably each independently a C_{1-30} alkyl group.

[0097]

When A^+ in compound (1) is a hydrogen ion (H^+), preferred
10 compounds (4) are, for example, the following compounds.

[0098]

[Compound (4-1-A)]

Compound (4) of the aforementioned formula (4), wherein R and R' are each independently a C_{1-30} alkyl group optionally
15 substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- (2) a C_{1-30} alkoxy group, and
- (3) a halo C_{1-30} alkoxy group;

20 a C_{3-15} cycloalkyl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- (2) a C_{1-30} alkyl group,
- (3) a C_{1-30} alkoxy group,
- 25 (4) a halo C_{1-30} alkyl group, and
- (5) a halo C_{1-30} alkoxy group; or

a C_{6-14} aryl group optionally substituted by substituent(s) selected from the group consisting of

- (1) a halogen atom,
- 30 (2) a C_{1-30} alkyl group,
- (3) a C_{1-30} alkoxy group,
- (4) a halo C_{1-30} alkyl group, and
- (5) a halo C_{1-30} alkoxy group, and

the total carbon number of R and R' is not less than 20

35 (preferably not less than 25).

[0099]

[Compound (4-1-B)]

Compound (4) of the aforementioned formula (4), wherein R and R' are each independently a C₁₋₃₀ alkyl group, or

5 a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

(1) a halogen atom,

(2) a C₁₋₃₀ alkyl group,

(3) a C₁₋₃₀ alkoxy group,

10 (4) a halo C₁₋₃₀ alkyl group, and

(5) a halo C₁₋₃₀ alkoxy group, and

the total carbon number of R and R' is not less than 20 (preferably not less than 25).

[0100]

15 [Compound (4-1-C)]

Compound (4) of the aforementioned formula (4), wherein R and R' are each independently a C₁₋₃₀ alkyl group, and the total carbon number of R and R' is not less than 20 (preferably not less than 25).

20 [0101]

[Compound (4-1)]

Compound (4) of the aforementioned formula (4), wherein R and R' are each independently a C₁₄₋₃₀ alkyl group, and the total carbon number of R and R' is not less than 28.

25 [0102]

Specific preferable examples of compound (4) when A⁺ in compound (1) is a hydrogen ion (H⁺) include didecyl ether, didodecyl ether, ditetradecyl ether, dihexadecyl ether, dioctadecyl ether, docosyl ethyl ether, tetradecyloxyethyl
30 tetradecyl ether, and the like.

[0103]

As preferable compound (4) when A⁺ in compound (1) is a cation represented by the formula (2) or a cation represented by the formula (3), the following compounds can be mentioned.

35 [0104]

[Compound (4-2)]

Compound (4) of the aforementioned formula (4), wherein R and R' are each independently a C₁₋₃₀ alkyl group, and the total carbon number of R and R' is not less than 8.

5 [0105]

[Compound (4-3)]

Compound (4) of the aforementioned formula (4), wherein R and R' are each independently a C₁₋₃₀ alkyl group, and the total carbon number of R and R' is not less than 10.

10 [0106]

Specific preferable examples of compound (4) when A⁺ in compound (1) is a cation represented by the formula (2) or a cation represented by the formula (3) include dibutyl ether, dihexyl ether, dioctyl ether, didecyl ether, didodecyl ether, 15 ditetradecyl ether, dihexadecyl ether, dioctadecyl ether, cyclopentyl methyl ether, diphenyl ether, octadecyl phenyl ether, and the like. Among them, didodecyl ether, ditetradecyl ether, dihexadecyl ether, and dioctadecyl ether are preferred.
[0107]

20 When the total carbon number of R and R' groups in compound (4) is not more than 7, it is feared that industrial control of the content thereof is difficult due to the low boiling point.

[0108]

25 Specific examples of the preferable combination of compound (1) and compound (4) contained in the composition of the present invention include combination of compound (1-1) and compound (4-1), combination of compound (1-2) and compound (4-2), combination of compound (1-3) and compound (4-2), 30 combination of compound (1-4) and compound (4-1), combination of compound (1-5) and compound (4-3), combination of compound (1-6) and compound (4-3), combination of compound (1-7) and compound (4-1), combination of compound (1-8) and compound (4-3), combination of compound (1-9) and compound (4-3), 35 combination of compound (1-2-A) and compound (4-2), combination

of compound (1-2-B) and compound (4-2), combination of compound (1-2-C) and compound (4-2), combination of compound (1-2-D) and compound (4-1), combination of compound (1-2-D) and compound (4-2), combination of compound (1-2-D) and compound (4-1-C),
5 and the like.

[0109]

In the composition of the present invention, the preferable content range of compound (4) per 1 mol of compound (1) varies depending on the kind of A^+ .

10 [0110]

When A^+ in compound (1) is hydrogen ion (H^+), the content of compound (4) is not less than 2 mol, preferably 2 to 3 mol, per 1 mol of compound (1).

[0111]

15 When A^+ in compound (1) is a cation represented by the formula (2) or a cation represented by the formula (3), the content of compound (4) is generally 0.01 to 10 mol, preferably 0.01 to 3 mol, per 1 mol of compound (1).

Here, the content of compound (4) per 1 mol of compound
20 (1) corresponds to the amount of each compound charged at the time of production, regardless of whether A^+ in compound (1) is a hydrogen ion (H^+), a cation represented by the formula (2), or a cation represented by the formula (3).

[0112]

25 The composition of the present invention is soluble in a hydrocarbon solvent at room temperature (15 to 30°C). In addition, conventionally-known borate compounds (e.g., hydrogenated tetrakis(pentafluorophenyl)borate, hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex,
30 lithium tetrakis(pentafluorophenyl)borate, etc.) are insoluble in aliphatic hydrocarbon solvents such as hexane and the like, and they could be a catalyst poison for metal catalysts used in homogenous polymerization reactions of olefins and dienes. In contrast, the composition of the present invention shows good
35 solubility also in aliphatic hydrocarbon solvents and does not

become a catalyst poison. Therefore, it is useful as a cocatalyst in homogenous polymerization reactions of olefins and dienes

[0113]

5 (Production method of the composition of the present invention)

The production method of the composition of the present invention is explained below.

[0114]

The composition of the present invention does not
10 substantially contain an ether compound (e.g., diethyl ether, etc.) having a total carbon number of not more than 7 that could be a catalyst poison. Not substantially containing an ether compound having a total carbon number of not more than 7 means that, as a result of ^1H -NMR analysis, an ether compound
15 having a total carbon number of not more than 7 is not detected.

[0115]

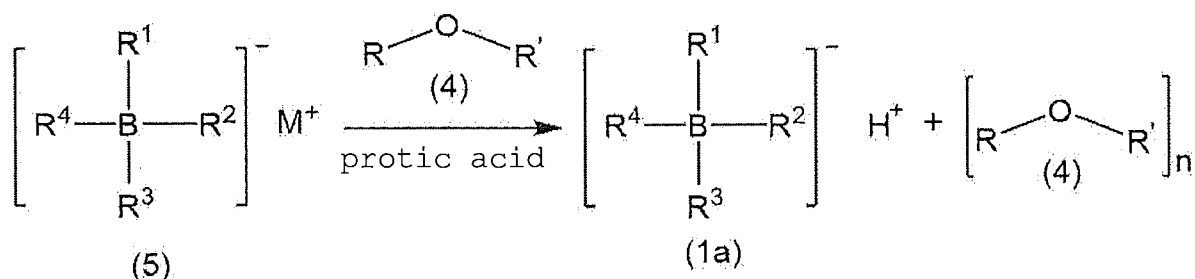
The production method of the composition of the present invention is not particularly limited, and the composition of the present invention can be produced, for example, according
20 to the following Production Method 1 to Production Method 4, and the like.

[0116]

(Production Method 1) (Production method of the composition of the present invention containing compound (1a) in which A^+ is a
25 hydrogen ion (H^+))

Production Method 1 is a method for obtaining the composition of the present invention containing compound (1a) and compound (4) (or a complex of compound (1a) and compound (4)) by reacting compound (5) and a protic acid in the presence
30 of compound (4) in a solvent that does not affect the reaction.

[0117]



[0118]

wherein M^+ is a metal ion (e.g., lithium ion, potassium ion, sodium ion, etc.), n is a number of not less than 2, and other
 5 respective symbols are as defined above.

[0119]

The reaction solvent for this reaction is not particularly limited. Examples thereof include aromatic hydrocarbons such as toluene, xylene, and the like; halogenated
 10 hydrocarbons such as chloroform, dichloromethane, 1,2-dichloroethane, and the like, aliphatic hydrocarbons such as hexane, isohexane, heptane, octane, methylcyclohexane, and the like, and a mixture thereof. Among them, dichloromethane, 1,2-dichloroethane, hexane, isohexane, heptane, octane, and
 15 methylcyclohexane are preferred.

[0120]

As compound (5) to be used as a starting material in this production method, a metal salt in which A^+ in the aforementioned formula (1) is replaced with M^+ can be mentioned.
 20 As compound (5), a commercially available product or a purified product may also be used, or one prepared by a method known per se may be used. Specific examples of compound (5) include lithium tetrakis(pentafluorophenyl)borate, potassium tetrakis(pentafluorophenyl)borate, lithium
 25 tetrakis(heptafluoronaphthyl)borate, potassium tetrakis(heptafluoronaphthyl)borate, chloromagnesium tetrakis(pentafluorophenyl)borate, chloromagnesium tetrakis(heptafluoronaphthyl)borate, bromomagnesium tetrakis(pentafluorophenyl)borate, bromomagnesium
 30 tetrakis(heptafluoronaphthyl)borate, lithium

tetrakis(nonafluorobiphenyl)borate, potassium
tetrakis(nonafluorobiphenyl)borate, chloromagnesium
tetrakis(nonafluorobiphenyl)borate, bromomagnesium
tetrakis(nonafluorobiphenyl)borate, and the like.

5 [0121]

As compound (4) to be used in this production method, the
aforementioned compound (4-1), compound (4-2), and the like can
be mentioned.

The amount of compound (4) to be used is not less than 2
10 mol, preferably 2 to 3 mol, per 1 mol of compound (5).

[0122]

As the protic acid to be used in this production method,
hydrogen chloride, hydrochloric acid, sulfuric acid, nitric
acid, hydrobromic acid, hydroiodic acid, and the like can be
15 mentioned. Among them, hydrochloric acid and hydrogen
chloride-diethyl ether solution are preferred.

The amount of the protic acid to be used poses no
particular problem as long as it is equivalent or more with
respect to 1 mol of compound (5). It is preferable to wash the
20 organic phase with water until the pH of the aqueous phase
after washing is not less than 3 so that the protic acid used
in the organic phase after treatment will not remain. When the
pH of the aqueous phase is less than 3, it is feared that a
salt of the protic acid used in the organic phase remains in
25 the composition of the present invention and becomes a catalyst
poison at the time of polymerization.

[0123]

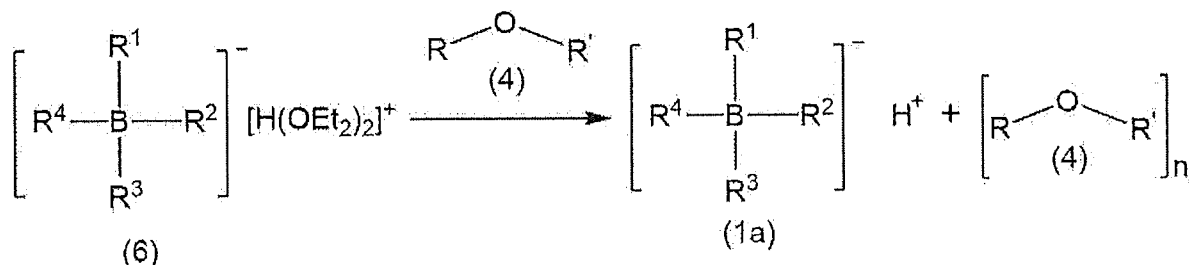
The reaction temperature is generally 0°C to 40°C,
preferably 10°C to 35°C, more preferably room temperature (15°C
30 to 30°C), and the reaction time is generally about 10 min to 10
hr, preferably about 1 to 3 hr.

[0124]

(Production Method 2) (Production method of the composition of
the present invention containing compound (1a) in which A⁺ is a
35 hydrogen ion (H⁺))

Production Method 2 is a method for obtaining the composition of the present invention containing compound (1a) and compound (4) (or a complex of compound (1a) and compound (4)) by reacting compound (6) and compound (4).

5 [0125]



[0126]

wherein each symbol is as defined above.

[0127]

10 The reaction solvent for this reaction is not particularly limited. Examples thereof include aromatic hydrocarbon solvents such as toluene, xylene, and the like; halogenated hydrocarbon solvents such as chloroform, dichloromethane, 1,2-dichloroethane, and the like, aliphatic
15 hydrocarbon solvents such as hexane, isohexane, heptane, octane, methylcyclohexane, and the like, and a mixture thereof. Among them, dichloromethane, 1,2-dichloroethane, hexane, isohexane, heptane, octane, and methylcyclohexane are preferred.

[0128]

20 As compound (6) to be used as a starting material in this production method, a commercially available product or one produced according to a method known per se (see, for example, Organometallics, 2000, 19, 1442-1444) or a method similar thereto can be used.

25 [0129]

As compound (4) to be used in this production method, the aforementioned compound (4-1), compound (4-2), and the like can be mentioned.

The amount of compound (4) to be used is generally not
30 less than 2 mol, preferably 2 to 3 mol, per 1 mol of compound (6).

[0130]

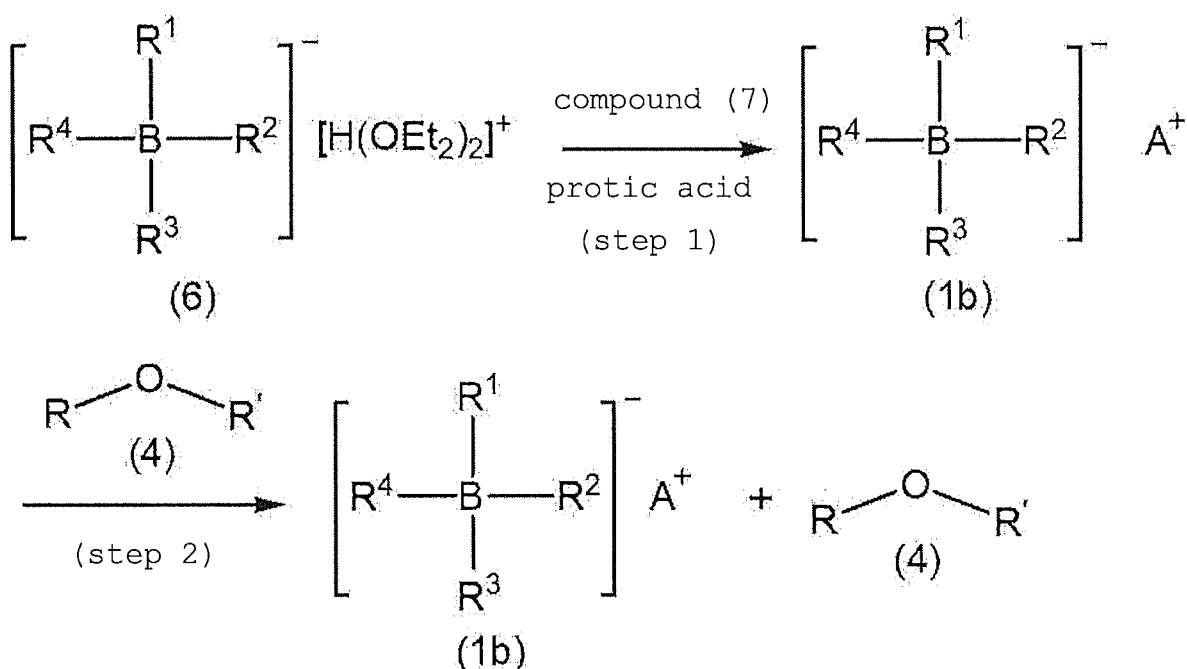
The reaction temperature is generally 0°C to 40°C, preferably 10°C to 35°C, more preferably room temperature (15°C to 30°C), and the reaction time is generally about 10 min to 10 hr, preferably about 1 to 3 hr.

[0131]

(Production Method 3) (Production method of the composition of the present invention containing compound (1b) in which A⁺ is a cation other than a hydrogen ion (H⁺))

Production Method 3 is a method for obtaining the composition of the present invention containing compound (1b) and compound (4) by a step of adding and suspending compound (6) and compound (7) (e.g., amine deprotonated from a cation represented by the aforementioned formula (2)) in a solvent that does not affect the reaction, adding dropwise protic acid to the suspension, stirring the mixture, filtering the mixture, and concentrating the filtrate under reduced pressure to obtain compound (1b) (step 1), and a step of mixing and stirring compound (1b) and compound (4) in a solvent that does not affect the reaction to give the composition of the present invention containing compound (1b) and compound (4) (step 2).

[0132]



[0133]

wherein each symbol is as defined above.

[0134]

(Step 1)

5 As the solvent to be used in this step, hydrocarbon solvents such as toluene, n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, and the like, and a mixture thereof can be mentioned. Among them, aliphatic hydrocarbon solvents such as n-hexane, isohexane, n-heptane, n-
10 octane, cyclohexane, methylcyclohexane, and the like are preferred.

[0135]

 As compound (7) to be used in this step, a tertiary amine deprotonated from a cation represented by the aforementioned
15 formula (2), and the like can be mentioned. Among them, tertiary amines such as di(hydrogenated tallow)alkylmethylaniline, N,N-dioctadecylmethylaniline, N,N-dioctadecylaniline, N,N-dioctadecyl-2,2,2-trifluoroethylamine, N,N-dioctadecyl-(2,3,4,5,6-pentafluorophenyl)methylaniline, N,N-dioctadecyl-
20 2,2,3,3,3-pentafluoropropylamine, N,N-didodecyl-2,2,2-trifluoroethylamine, N,N-dioctadecyl-2,2-difluoroethylamine, N,N-dioctadecyl-3,3,3-trifluoropropylamine, N,N-dioctadecyl-2-fluoroethylamine, N,N-didocosyl-2,2,2-trifluoroethylamine, N,N-bis(3,7,11,15-tetramethylhexadecyl)-2,2,2-trifluoroethylamine,
25 N,N-bis(3,7,11-trimethyldodecyl)-2,2,2-trifluoroethylamine, N,N-ditetradecyl-2,2,2-trifluoroethylamine, N,N-dihexadecyl-2,2,2-trifluoroethylamine, and the like are preferred.

 The amount of compound (7) to be used is generally 1 to 10 mol, preferably 1 to 2 mol, per 1 mol of compound (6).

30 [0136]

 As the protic acid to be used in this step, hydrogen chloride, sulfuric acid, nitric acid, hydrogen bromide, hydrogen iodide, and the like can be mentioned. Among them, hydrogen chloride is preferred (hydrogen chloride-diethyl ether
35 solution is more preferred).

The amount of the protic acid to be used poses no particular problem as long as it is equivalent or more with respect to 1 mol of compound (7). It is preferable to wash the organic phase with water until the pH of the aqueous phase
5 after washing is not less than 3 so that the protic acid used in the organic phase after treatment will not remain. When the pH of the aqueous phase is less than 3, it is feared that a salt of the protic acid used in the organic phase remains in the composition of the present invention and becomes a catalyst
10 poison at the time of polymerization.

[0137]

In Production Method 3, compound (1b) prepared as described above can be used as it is in step 2.

[0138]

15 (Step 2)

The solvent to be used in this step is not particularly limited. Examples thereof include aliphatic hydrocarbon solvents such as n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, and the like. Among them, n-
20 hexane is preferred.

[0139]

As compound (4) to be used in this step, the aforementioned compound (4-3), compound (4-4), and the like can be mentioned.

25 The amount of compound (4) to be used is generally 0.01 to 10 mol, preferably 0.01 to 3 mol, per 1 mol of compound (1b).

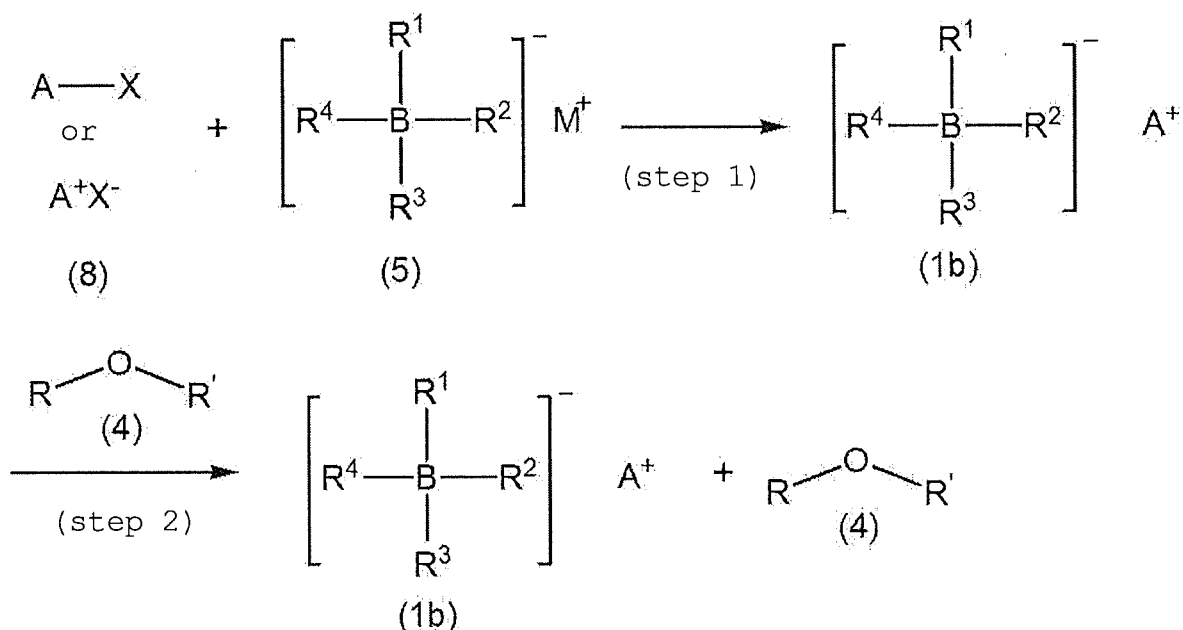
[0140]

The reaction temperature is generally 0°C to 40°C, preferably 10°C to 35°C, more preferably room temperature (15°C
30 to 30°C), and the reaction time is generally about 10 min to 10 hr, preferably about 1 to 3 hr.

[0141]

(Production Method 4) (Production method of the composition of the present invention containing compound (1b) in which A⁺ is a
35 cation other than a hydrogen ion (H⁺))

Production Method 4 is a method for obtaining the composition of the present invention containing compound (1b) and compound (4) by a step of adding compound (8) and compound (5) to a solvent that does not affect the reaction, stirring
 5 the mixture, filtering the mixture, and concentrating the filtrate under reduced pressure to give compound (1b) (step 1), and a step of mixing and stirring compound (1b) and compound (4) in a solvent that does not affect the reaction (step 2).
 [0142]



[0143]

wherein X is a halogen atom, and other respective symbols are as defined above.

[0144]

15 (Step 1)

As the solvent to be used in this step, hydrocarbon solvents such as toluene, n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, n-heptane, and the like, halogenated solvents such as dichloromethane, chloroform, and
 20 the like, and a mixture thereof can be mentioned. Among them, aliphatic hydrocarbon solvents such as n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, and the like are preferred.

[0145]

As compound (8) to be used in this step, N,N-dioctadecylmethylamine hydrochloride, di(hydrogenated tallow)alkylmethylamine hydrochloride, N,N-dioctadecylaniline hydrochloride, N,N-dioctadecyl-2,2,2-trifluoroethylamine hydrochloride, N,N-dioctadecyl-(2,3,4,5,6-pentafluorophenyl)methylamine hydrochloride, N,N-dioctadecyl-2,2,3,3,3-pentafluoropropylamine hydrochloride, N,N-didodecyl-2,2,2-trifluoroethylamine hydrochloride, N,N-dioctadecyl-2,2-difluoroethylamine hydrochloride, N,N-dioctadecyl-3,3,3-trifluoropropylamine hydrochloride, N,N-dioctadecyl-2-fluoroethylamine hydrochloride, N,N-didocosyl-2,2,2-trifluoroethylamine hydrochloride, N,N-bis(3,7,11,15-tetramethylhexadecyl)-2,2,2-trifluoroethylamine hydrochloride, N,N-bis(3,7,11-trimethyldodecyl)-2,2,2-trifluoroethylamine hydrochloride, N,N-ditetradecyl-2,2,2-trifluoroethylamine hydrochloride, N,N-dihexadecyl-2,2,2-trifluoroethylamine hydrochloride, or tri(p-octylphenyl)chloromethane is preferred.

The amount of compound (8) to be used is generally 1 to 2 mol, preferably 1 to 1.1 mol, per 1 mol of compound (5).

[0146]

In Production Method 4, compound (1b) prepared as described above can be used as it is in step 2.

[0147]

(Step 2)

The solvent to be used in this step is not particularly limited. Examples thereof include aliphatic hydrocarbon solvents such as n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane, and the like. Among them, n-hexane is preferred.

[0148]

As compound (4) to be used in this step, the aforementioned compound (4-3), compound (4-4), and the like can be mentioned.

The amount of compound (4) to be used is generally 0.01 to 10 mol, preferably 0.01 to 3 mol, per 1 mol of compound (1b).

[0149]

The reaction temperature is generally 0°C to 40°C, preferably 10°C to 35°C, more preferably room temperature (15°C to 30°C), and the reaction time is generally about 10 min to 10 hr, preferably about 1 to 3 hr.

[0150]

The composition of the present invention contains compound (1) and compound (4), soluble (or easily soluble) in hydrocarbon solvents, particularly aliphatic hydrocarbon solvents, and does not substantially contain a compound that could be a catalyst poison such as basic and highly nucleophilic amine compound, ether compound with a total carbon number of not more than 7, and the like. Therefore, it is useful as a cocatalyst for polymerization of olefins and dienes.

[0151]

The present invention includes a production method of a polymer by polymerizing at least one kind of monomer selected from the group consisting of an olefin and a diene, by using the composition of the present invention as a cocatalyst.

[0152]

Production of a polymer by using the compound of the present invention (compound (1)) (or composition) as a cocatalyst can be specifically performed according to, for example, the method described in the below-mentioned

Experimental Example.

[Example]

[0153]

The present invention is specifically explained in detail in the following by referring to Examples, Production Examples, and Experimental Example; however, the present invention is not limited to those Examples and the like. % means mol/mol% for yield and wt% for others unless particularly indicated. The room temperature refers to a temperature of from 15°C to 30°C unless particularly indicated.

[0154]

For the analysis, the following instrument was used.

^1H -NMR and ^{19}F -NMR: (JEOL) 400YH manufactured by JEOL Ltd.

[0155]

[Example 1]

5 Dihexadecyl ether (manufactured by Tokyo Chemical Industry Co., Ltd.) (0.92 g, 1.93 mmol) and a lithium tetrakis(pentafluorophenyl)borate tri-diethyl ether complex (manufactured by AGC INC.) (1.00 g, 0.97 mmol) were added to dichloromethane (10 ml), 6 M hydrochloric acid (15 ml) was
10 added, and the mixture was stirred at room temperature for 1 hr. The reaction mixture was partitioned, and the organic phase was concentrated. To the concentrated solution was added n-hexane (15 ml), and the mixture was stirred and concentrated. This operation was repeated to give an oily hydrogenated
15 tetrakis(pentafluorophenyl)borate bis(dihexadecyl ether) complex (1.67 g).

^1H NMR(CDCl_3) δ : 0.88 (t, 12H), 1.25 (m, 104H), 1.59 (m, 8H), 3.60 (t, 8H);

^{19}F NMR(CDCl_3) δ : -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).

20 [0156]

It was confirmed that the complex (composition) obtained in Example 1 dissolves in n-hexane at a concentration of 20 wt%.

[0157]

[Example 2]

25 Dihexadecyl ether (0.56 g, 1.21 mmol) and a hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex (0.50 g, 0.60 mmol) obtained by a method known per se (see, for example, Organometallics, 2000, 19, 1442-1444) was dissolved in 1,2-dichloroethane (10 ml), and the mixture was concentrated. To
30 the concentrated solution was added 1,2-dichloroethane (10 ml), and the mixture was stirred and then concentrated. This operation was repeated twice. To the concentrated solution was added n-hexane (10 ml), and the mixture was stirred and then concentrated. This operation was repeated three times to
35 obtain an oily hydrogenated tetrakis(pentafluorophenyl)borate

bis(dihexadecyl ether) complex (0.97 g).

[0158]

[Example 3]

Ditetradecyl ether (manufactured by Tokyo Chemical
5 Industry Co., Ltd.) (0.50 g, 1.21 mmol) and a hydrogenated
tetrakis(pentafluorophenyl)borate diethyl ether complex (0.50 g,
0.60 mmol) were dissolved in 1,2-dichloroethane (10 ml), and
the mixture was concentrated. To the concentrated solution was
added 1,2-dichloroethane (10 ml), and the mixture was stirred
10 and then concentrated. This operation was repeated twice. To
the concentrated solution was added hexane (10 ml), and the
mixture was stirred and then concentrated. This operation was
repeated three times to give an oily hydrogenated
tetrakis(pentafluorophenyl)borate bis(ditetradecyl ether)
15 complex (0.94 g).

^1H NMR(CDCl_3) δ : 0.88 (t, 12H), 1.25 (m, 88H), 1.65 (m, 8H),
3.79 (t, 8H);

^{19}F NMR(CDCl_3) δ : -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).

[0159]

20 It was confirmed that the complex (composition) obtained
in Example 3 dissolves in n-hexane at a concentration of 20 wt%.

[0160]

[Example 4]

(1) N,N-Dioctadecylaniline (3.3 g, 5.5 mmol) produced by a
25 method known per se (see, for example, Huaxue Xuebao, 2008,
66(14), 1687-1692) and a lithium
tetrakis(perfluorophenyl)borate tri-diethyl ether complex (5.0
g, 5.5 mmol) were suspended in n-hexane (50 mL). Then, 1.0 M
hydrogen chloride-diethyl ether solution (5.5 mL) was added
30 dropwise, and the mixture was stirred at room temperature for 3
hr. The obtained suspension was filtered, and the filtrate was
concentrated under reduced pressure at 50°C to give N,N-
dioctadecylanilinium tetrakis(pentafluorophenyl)borate (7.0 g,
90%).

35 ^1H NMR (CDCl_3) δ : 0.86-0.89 (6H, m), 1.15-1.50 (27H, m), 3.40-

3.50 (4H, m), 7.26-7.28 (2H, m), 7.58-7.63 (3H, m);

¹⁹F NMR (CDCl₃) δ: -133.8 (8F, t), -163.3 (4F, t), -167.4 (8F, t).

(2) To N,N-dioctadecylanilinium

tetrakis(pentafluorophenyl)borate (127.8 mg, 0.1 mmol) obtained
5 the above-mentioned (1) was added n-hexane (474 mg) to prepare
a two-layer separation solution (concentration: 20 wt%).
Ditetradecyl ether (21 mg, 0.05 mmol) was added thereto, and
the mixture was stirred to give a homogeneous n-hexane solution.
[0161]

10 [Example 5]

To N,N-dioctadecylanilinium

tetrakis(pentafluorophenyl)borate (127.8 mg, 0.1 mmol) obtained
in Example 4 (1) was added n-hexane (474 mg) to prepare a two-
layer separation solution (concentration: 20 wt%). Didodecyl
15 ether (manufactured by Tokyo Chemical Industry Co., Ltd.) (17.7
mg, 0.05 mmol) was added thereto, and the mixture was stirred
to give a homogeneous n-hexane solution.

[0162]

[Example 6]

20 To N,N-dioctadecylanilinium

tetrakis(pentafluorophenyl)borate (127.8 mg, 0.1 mmol) obtained
in Example 4 (1) was added n-hexane (474 mg) to prepare a two-
layer separation solution (concentration: 20 wt%). Dibutyl
ether (manufactured by Junsei Chemical Co., Ltd.) (6.5 mg, 0.2
25 mmol) was added thereto, and the mixture was stirred to give a
homogeneous n-hexane solution.

[0163]

[Example 7]

Dioctadecyl ether (manufactured by Tokyo Chemical
30 Industry Co., Ltd.) (0.66 g, 1.21 mmol) and hydrogenated
tetrakis(pentafluorophenyl)borate diethyl ether complex (0.50 g,
0.60 mmol) were dissolved in dichloromethane (15 ml), and the
mixture was concentrated. To the concentrated solution was
added dichloromethane (15 ml), and the mixture was stirred and
35 then concentrated. This operation was repeated 4 times. To

the concentrated solution was added n-hexane (10 ml), and the mixture was stirred and then concentrated. This operation was repeated three times to give a solid hydrogenated tetrakis(pentafluorophenyl)borate bis(dioctadecyl ether)

5 complex (1.05 g).

^1H NMR(CDCl_3) δ : 0.88 (t, 12H), 1.25 (m, 120H), 1.65 (m, 8H), 3.79 (t, 8H);

^{19}F NMR(CDCl_3) δ : -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).
[0164]

10 It was confirmed that the complex (composition) obtained in Example 7 dissolves in n-hexane at a concentration of 20 wt%.
[0165]

[Example 8]

Didodecyl ether (manufactured by Tokyo Chemical Industry
15 Co., Ltd.) (0.45 g, 1.21 mmol) and a hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex (0.50 g, 0.60 mmol) were dissolved in 1,2-dichloroethane (10 ml), and the mixture was concentrated. To the concentrated solution was added 1,2-dichloroethane (10 ml), and the mixture was stirred
20 and then concentrated. This operation was repeated twice. To the concentrated solution was added methylcyclohexane (10 ml), and the mixture was stirred and then concentrated. This operation was repeated three times to give an oily hydrogenated tetrakis(pentafluorophenyl)borate bis(didodecyl ether) complex
25 (0.90 g).

^1H NMR(CDCl_3) δ : 0.88 (t, 12H), 1.25 (m, 72H), 1.65 (m, 8H), 3.60 (t, 8H);

^{19}F NMR(CDCl_3) δ : -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).
[0166]

30 It was confirmed that the complex (composition) obtained in Example 8 dissolves in methylcyclohexane at a concentration of 20 wt%.

[0167]

[Example 9]

35 Didecyl ether (manufactured by Tokyo Chemical Industry

Co., Ltd.) (0.38 g, 1.21 mmol) and a hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex (0.50 g, 0.60 mmol) were dissolved in 1,2-dichloroethane (10 ml), and the mixture was concentrated. To the concentrated solution was added 1,2-dichloroethane (10 ml), and the mixture was stirred and then concentrated. This operation was repeated twice. To the concentrated solution was added methylcyclohexane (10 ml), and the mixture was stirred and then concentrated. This operation was repeated three times to give an oily hydrogenated tetrakis(pentafluorophenyl)borate bis(didecyl ether) complex (0.81 g).

^1H NMR(CDCl_3) δ : 0.88 (t, 12H), 1.25 (m, 56H), 1.65 (m, 8H), 3.60 (t, 8H);

^{19}F NMR(CDCl_3) δ : -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).

[0168]

It was confirmed that the complex (composition) obtained in Example 9 dissolves in methylcyclohexane at a concentration of 20 wt%.

[0169]

[Example 10]

A diethyl ether solution of lithium tetrakis(heptafluoronaphthyl)borate (47wt%, 5.00 g, 2.28 mmol) produced by a method known per se (see, for example, WO 2007/070770) was added to 1,2-dichloroethane (10 ml). Then, 6 M hydrochloric acid (7.6 ml) was added and the mixture was stirred at room temperature for 1 hr. The reaction mixture was partitioned, and the organic phase was concentrated. The concentrated solution was dissolved by adding ditetradecyl ether (manufactured by Tokyo Chemical Industry Co., Ltd.) (1.88 g, 4.55 mmol) and 1,2-dichloroethane (30 ml), and the mixture was concentrated. To the concentrated solution was added 1,2-dichloroethane (30 ml), and the mixture was stirred and then concentrated. This operation was repeated twice. To the concentrated solution was added n-hexane (30 ml), and the mixture was stirred and then concentrated. This operation was

repeated three times to give an oily hydrogenated tetrakis(heptafluoronaphthyl)borate bis(ditetradecyl ether) complex (4.21 g).

¹H NMR(CDCl₃) δ: 0.87 (t, 12H), 1.22 (m, 88H), 1.58 (m, 8H),
5 3.66 (t, 8H);
¹⁹F NMR(CDCl₃) δ: -108.3 (m, 4F), -125.1 (m, 4F), -145.1 (m, 4F),
-149.0 (m, 4F), -154.5 (m, 4F), -158.3 (m, 4F), -159.8 (m, 4F).
[0170]

It was confirmed that the complex (composition) obtained
10 in Example 10 dissolves in n-hexane at a concentration of 20 wt%.

[0171]

[Production Example 1]

Docosylbromide (manufactured by Tokyo Chemical Industry
15 Co., Ltd.) (1.00 g, 2.57 mmol) and cesium carbonate (1.26 g, 3.85 mmol) were added to ethanol (20 ml), and the mixture was reacted in a microwave synthesizer (manufactured by Biotage) at 150°C for 30 min. After completion of the reaction, water and methylcyclohexane were added for partitioning, and the organic
20 phase was concentrated. The concentrated solution was purified by column chromatography to give docosyl ethyl ether (0.60 g) as a white solid.

¹H NMR(CDCl₃) δ: 0.89 (t, 3H), 1.21 (t, 3H), 1.26 (m, 38H),
1.57 (m, 2H), 3.41 (t, 2H), 3.47 (q, 2H).
25 [0172]

[Example 11]

Docosyl ethyl ether (0.21 g, 0.60 mmol) obtained in Production Example 1 and a hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex (0.25 g,
30 0.30 mmol) were dissolved in 1,2-dichloroethane (5 ml), and the mixture was concentrated. To the concentrated solution was added 1,2-dichloroethane (5 ml), and the mixture was stirred and then concentrated. This operation was repeated twice. To the concentrated solution was added methylcyclohexane (5 ml),
35 and the mixture was stirred and then concentrated. This

operation was repeated three times to give a solid hydrogenated tetrakis(pentafluorophenyl)borate bis(docosyl ethyl ether) complex (0.46 g).

¹H NMR(CDCl₃) δ: 0.87 (m, 12H), 1.27 (m, 82H), 1.65 (m, 4H),
5 3.76 (t, 4H), 3.85(q, 4H);
¹⁹F NMR(CDCl₃) δ: -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).
[0173]

It was confirmed that the complex (composition) obtained in Example 11 dissolves in methylcyclohexane at a concentration
10 of 20 wt%.

[0174]

[Production Example 2]

Tetradecylbromide (manufactured by Tokyo Chemical Industry Co., Ltd.) (1.79 g, 6.44 mmol), ethylene glycol (0.20
15 g, 3.22 mmol), tetrabutylammonium bromide (manufactured by Tokyo Chemical Industry Co., Ltd.) (0.10 g, 0.32 mmol), and potassium hydroxide (0.64 g, 9.67 mmol) were added to dioxane (10 ml), and the mixture was heated at 100°C for 3 hr. After cooling, water and diethyl ether were added thereto for
20 partitioning. The organic phase was dried over sodium sulfate, and then concentrated. The concentrate was purified by column chromatography to give ethylene glycol ditetradecyl ether (0.32 g) as a white solid.

¹H NMR(CDCl₃) δ: 0.88 (t, 6H), 1.25 (m, 44H), 1.58 (m, 4H),
25 3.46 (t, 4H), 3.57 (s, 4H).

[0175]

[Example 12]

Ethylene glycol ditetradecyl ether (0.22 g, 0.48 mmol) obtained in Production Example 2 and a hydrogenated
30 tetrakis(pentafluorophenyl)borate diethyl ether complex (0.20 g, 0.24 mmol) were dissolved in 1,2-dichloroethane (5 ml), and the mixture was concentrated. To the concentrated solution was added 1,2-dichloroethane (5 ml), and the mixture was stirred and then concentrated. This operation was repeated twice. To
35 the concentrated solution was added n-hexane (5 ml), and the

mixture was stirred and then concentrated. This operation was repeated three times to give an oily hydrogenated tetrakis(pentafluorophenyl)borate bis (ethylene glycol ditetradecyl ether) complex (0.41 g).

5 ^1H NMR(CDCl_3) δ : 0.87 (t, 12H), 1.27 (m, 88H), 1.58 (m, 8H), 3.58 (t, 8H), 3.70 (s, 8H);
 ^{19}F NMR(CDCl_3) δ : -132.9 (d, 8F), -162.2 (t, 4F), -166.3 (t, 8F).
[0176]

It was confirmed that the complex (composition) obtained
10 in Example 12 dissolves in n-hexane at a concentration of 20 wt%.

[0177]

[Production Example 3]

N,N-Dioctadecylamine (2.0 g, 3.8 mmol) and triethylamine
15 (0.5 g, 5.0 mmol) were dissolved in tetrahydrofuran (10 mL), and trifluoroacetic anhydride (1.0 g, 4.8 mmol) was added at room temperature. The mixture was stirred at room temperature for 1 hr, water was added, and the mixture was extracted with ethyl acetate. The organic layer was washed with 1 M
20 hydrochloric acid and saturated brine, dried over anhydrous magnesium sulfate, and concentrated under reduced pressure. The residue was purified by column chromatography (n-hexane/ethyl acetate =100/0-95/5) to give N,N-dioctadecyl-2,2,2-trifluoroacetamide (1.87 g, 79%).

25 ^1H NMR (CDCl_3) δ : 0.89 (6H, t), 1.26-1.43 (62H, m), 1.56-1.59 (4H, m), 3.30-3.37 (4H, m);
 ^{19}F NMR (CDCl_3) δ : -68.1 (3F, s).
[0178]

[Production Example 4]

30 N,N-Dioctadecyl-2,2,2-trifluoroacetamide (1.0 g, 1.6 mmol) obtained in Production Example 3 was dissolved in tetrahydrofuran (10 mL), 1 M borane-tetrahydrofuran complex tetrahydrofuran solution (5 mL) was added, and the mixture was refluxed for 3 hr. The mixture was ice-cooled, water was
35 carefully added dropwise thereto, and the mixture was extracted

with ethyl acetate. The organic layer was washed with saturated brine, dried over anhydrous magnesium sulfate, and concentrated under reduced pressure to give N,N-dioctadecyl-2,2,2-trifluoroethylamine (0.87 g, 88%).

5 ^1H NMR (CDCl_3) δ : 0.88 (6H, t), 1.25-1.40 (60H, m), 1.42-1.44 (4H, m), 2.56 (4H, t), 3.00 (2H, q);

^{19}F NMR (CDCl_3) δ : -69.2 (3F, t).

[0179]

[Production Example 5]

10 N,N-Dioctadecyl-2,2,2-trifluoroethylamine (1.0 g, 1.7 mmol) obtained in Production Example 4 was dissolved in n-hexane (10 mL), 1.0 M hydrogen chloride-diethyl ether solution (10 mL) was added, and the mixture was stirred at room temperature for 3 hr. The precipitate was collected by
15 filtration, washed with n-hexane, and dried under reduced pressure to give N,N-dioctadecyl-2,2,2-trifluoroethylamine hydrochloride (0.987 g, 93%).

^1H NMR (CDCl_3) δ : 0.88 (6H, t), 1.19-1.40 (60H, m), 1.93 (4H, br s), 3.15 (4H, br s), 3.77 (2H, q);

20 ^{19}F NMR (CDCl_3) δ : -61.4 (3F, t).

[0180]

[Production Example 6]

N,N-Dioctadecyl-2,2,2-trifluoroethylamine hydrochloride (0.32 g, 0.50 mmol) obtained in Production Example 5 was
25 dissolved in chloroform (30 mL), lithium tetrakis(pentafluorophenyl)borate tri-diethyl ether complex (0.45 g, 0.5 mmol) was added, and the mixture was stirred at room temperature for 1 hr. Insoluble material was removed by filtration, and the filtrate was concentrated under reduced
30 pressure. The residue was dried under reduced pressure at 45°C to give N,N-dioctadecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate (0.62 g, 97%).

^1H NMR (CDCl_3) δ : 0.88 (6H, t), 1.19-1.40 (60H, m), 1.94 (4H, br s), 3.15 (4H, br s), 3.77 (2H, q);

35 ^{19}F NMR (CDCl_3) δ : -64.7 (3F, t), -132.1 (8H, m), -161.1 (4H, m),

-165.5 (8H, m).

[0181]

[Example 13]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
5 tetrakis(pentafluorophenyl)borate (0.30 g, 0.22 mmol) obtained
in Production Example 6 was mixed with ditetradecyl ether (0.09
g, 0.22 mmol) to give a composition containing N,N-dioctadecyl-
2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate
and ditetradecyl ether.

10 ^1H NMR (CDCl_3) δ : 0.85-0.90 (12H, m), 1.20-1.33 (104H, m),
1.52-1.68 (8H, m), 3.14-3.18 (4H, m), 3.40 (4H, t), 3.62 (2H,
q);

^{19}F NMR (CDCl_3) δ : -66.8 (3F, br s), -134.0 (8F, m), -163.2 (4F,
t), -167.5 (8F, m).

15 [0182]

n-Hexane was added to the composition obtained in Example
13 to prepare a 20 wt% n-hexane solution thereof, and the
solution was confirmed to be a homogeneous solution.

[0183]

20 Isohexane was added to the composition obtained in
Example 13 to prepare a 20 wt% isohexane solution thereof, and
the solution was confirmed to be a homogeneous solution.

[0184]

n-Heptane was added to the composition obtained in
25 Example 13 to prepare a 20 wt% n-heptane solution thereof, and
the solution was confirmed to be a homogeneous solution.

[0185]

ISOPAR E^(R) was added to the composition obtained in
Example 13 to prepare a 20 wt% ISOPAR E^(R) solution thereof, and
30 the solution was confirmed to be a homogeneous solution.

[0186]

Cyclohexane was added to the composition obtained in
Example 13 to prepare a 20 wt% cyclohexane solution thereof,
and the solution was confirmed to be a homogeneous solution.

35 [0187]

Methylcyclohexane was added to the composition obtained in Example 13 to prepare a 20 wt% methylcyclohexane solution thereof, and the solution was confirmed to be a homogeneous solution.

5 [0188]

[Example 14]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate (300 mg, 0.23 mmol) obtained in Production Example 6 was mixed with dibutyl ether (62 mg,
10 0.46 mmol) to give a composition containing N,N-dioctadecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate and dibutyl ether.

^1H NMR (CDCl_3) δ : 0.87 (6H, t), 0.92 (12H, t), 1.20-1.68 (78H, m), 3.14-3.18 (4H, m), 3.41 (8H, t), 3.62 (2H, q);

15 ^{19}F NMR (CDCl_3) δ : -66.7 (3F, s), -134.0 (8F, s), -163.3 (4F, t), -167.5 (8H, m).

[0189]

It was confirmed that the composition obtained in Example 14 dissolves in n-hexane at a concentration of 30 wt%.

20 [0190]

[Example 15]

N,N-Ditetradecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate (58 mg, 0.05 mmol) and didodecyl ether (40 mg, 0.10 mmol) were added and mixed to give
25 a composition containing N,N-ditetradecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate and didodecyl ether.

^1H NMR (CDCl_3) δ : 0.85-0.88 (18H, m), 1.24-1.35 (116H, m), 1.51-1.58 (8H, m), 1.64-1.70 (4H, m), 3.11-3.15 (4H, m), 3.38
30 (8H, t), 3.60 (2H, q);

^{19}F NMR (CDCl_3) δ : -66.6 (3F, s), -134.0 (8F, s), -163.5 (4F, t), -167.6 (8F, t).

[0191]

n-Hexane was added to the composition obtained in Example
35 15 to prepare a 20 wt% n-hexane solution thereof, and the

solution was confirmed to be a homogeneous solution.

[0192]

[Example 16]

N,N-Dihexadecyl-2,2,2-trifluoroethylammonium
5 tetrakis(pentafluorophenyl)borate (60 mg, 0.05 mmol) and
dihexadecyl ether (23 mg, 0.05 mmol) were added and mixed to
give a composition containing N,N-dihexadecyl-2,2,2-
trifluoroethylammonium tetrakis(pentafluorophenyl)borate and
dihexadecyl ether.

10 ^1H NMR (CDCl_3) δ : 0.86-0.90 (12H, m), 1.20-1.36 (104H, m),
1.52-1.58 (4H, m), 1.63-1.70 (4H, m), 3.15-3.19 (4H, m), 3.39
(4H, t), 3.64 (2H, q);
 ^{19}F NMR (CDCl_3) δ : -66.7 (3F, s), -134.1 (8F, s), -163.5 (4F, t),
-167.6 (8F, t).

15 [0193]

n-Hexane was added to the composition obtained in Example
16 to prepare a 20 wt% n-hexane solution thereof, and the
solution was confirmed to be a homogeneous solution.

[0194]

20 [Example 17]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate (64 mg, 0.05 mmol) obtained
in Production Example 6 and dioctyl ether (12 mg, 0.05 mmol)
were added and mixed to give a composition containing N,N-
25 dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate and dioctyl ether.

^1H NMR (CDCl_3) δ : 0.88 (12H, t), 1.20-1.37 (80H, m), 1.52-1.58
(4H, m), 1.65-1.70 (4H, m), 3.14-3.19 (4H, m), 3.39 (4H, t),
3.63 (2H, q);
30 ^{19}F NMR (CDCl_3) δ : -66.6 (3F, br s), -134.0 (8F, br s), -163.4
(4F, t), -167.6 (8F, t).

[0195]

n-Hexane was added to the composition obtained in Example
17 to prepare a 20 wt% n-hexane solution thereof, and the
35 solution was confirmed to be a homogeneous solution.

[0196]

[Example 18]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate (64 mg, 0.05 mmol) obtained
5 in Production Example 6 and didodecyl ether (15 mg, 0.05 mmol)
were added and mixed to give a composition containing N,N-
dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate and didodecyl ether.

¹H NMR (CDCl₃) δ: 0.86-0.90 (12H, m), 1.20-1.38 (96H, m), 1.53-
10 1.60 (4H, m), 1.65-1.72 (4H, m), 3.15-3.20 (4H, m), 3.39 (4H,
t), 3.65 (2H, q);

¹⁹F NMR (CDCl₃) δ: -66.4 (3F, br s), -134.0 (8F, br s), -163.4
(4F, t), -167.5 (8F, m).

[0197]

15 n-Hexane was added to the composition obtained in Example
18 to prepare a 20 wt% n-hexane solution thereof, and the
solution was confirmed to be a homogeneous solution.

[0198]

[Example 19]

20 N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate (64 mg, 0.05 mmol) obtained
in Production Example 6 and dihexadecyl ether (23 mg, 0.05
mmol) were added and mixed to give a composition containing
N,N-dioctadecyl-2,2,2-trifluoroethylammonium
25 tetrakis(pentafluorophenyl)borate and dihexadecyl ether.

¹H NMR (CDCl₃) δ: 0.86-0.98, (12H, m), 1.20-1.35 (112H, m),
1.52-1.75 (8H, m), 3.15-3.20 (4H, m), 3.39 (4H, t), 3.65 (2H,
q);

¹⁹F NMR (CDCl₃) δ: -66.5 (3F, br s), -134.2 (8F, br s), -163.6
30 (4F, t), -167.7 (8F, m).

[0199]

n-Hexane was added to the composition obtained in Example
19 to prepare a 20 wt% n-hexane solution thereof, and the
solution was confirmed to be a homogeneous solution.

35 [0200]

[Example 20]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate (64 mg, 0.05 mmol) obtained
in Production Example 6 and diphenyl ether (8.5 mg, 0.05 mmol)
5 were added and mixed to give a composition containing N,N-
dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate and diphenyl ether.
¹H NMR (CDCl₃) δ: 0.86-0.90, (6H, m), 1.20-1.40 (58H, m), 1.62-
1.68 (4H, m), 3.12-3.16 (4H, m), 3.61 (4H, q), 6.99-7.03 (4H,
10 m), 7.08-7.12 (2H, m), 7.31-7.36 (4H, m);
¹⁹F NMR (CDCl₃) δ: -66.9 (3F, br s), -134.1 (8F, br s), -163.4
(4F, t), -167.6 (8F, m).

[0201]

n-Hexane was added to the composition obtained in Example
15 20 to prepare a 20 wt% n-hexane solution thereof, and the
solution was confirmed to be a homogeneous solution.

[0202]

[Example 21]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
20 tetrakis(pentafluorophenyl)borate (64 mg, 0.05 mmol) obtained
in Production Example 6 and octadecyl phenyl ether (18 mg, 0.05
mmol) were added and mixed to give a composition containing
N,N-dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate and octadecyl phenyl ether.
25 ¹H NMR (CDCl₃) δ: 0.84-0.98 (12H, m), 1.20-1.44 (85H, m), 1.62-
1.81 (6H, m), 3.13-3.18 (4H, m), 3.61 (4H, q), 3.95 (2H, t),
6.88-6.94 (2H, m), 7.25-7.30 (3H, m);
¹⁹F NMR (CDCl₃) δ: -66.8 (3F, br s), -134.1 (8F, br s), -163.4
(4F, t), -167.6 (8F, m).

30 [0203]

n-Hexane was added to the composition obtained in Example
21 to prepare a 20 wt% n-hexane solution thereof, and the
solution was confirmed to be a homogeneous solution.

[0204]

35 [Example 22]

N,N-Dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate (64 mg, 0.05 mmol) obtained
in Production Example 6 and cyclopentyl methyl ether (10 mg,
0.10 mmol) were added and mixed to give a composition
5 containing N,N-dioctadecyl-2,2,2-trifluoroethylammonium
tetrakis(pentafluorophenyl)borate and cyclopentyl methyl ether.
¹H NMR (CDCl₃) δ: 0.88 (6H, t), 1.20-1.35 (60H, m), 1.53-1.56
(4H, m), 1.61-1.76 (16H, m), 3.12-3.17 (4H, m), 3.28 (6H, s),
3.61 (2H, q), 3.79-3.83 (2H, m);
10 ¹⁹F NMR (CDCl₃) δ: -66.6 (3F, br s), -133.9 (8F, br s), -163.5
(4F, t), -167.6 (8F, m).
[0205]

n-Hexane was added to the composition obtained in Example
22 to prepare a 20 wt% n-hexane solution thereof, and the
15 solution was confirmed to be a homogeneous solution.
[0206]

[Production Example 7]

Synthesis of N,N-ditetradecyl-2,2,2-trifluoroethylamine

1-Tetradecanal (4.0 g, 18.8 mmol), 2,2,2-
20 trifluoroethylamine (0.90 g, 9.1 mmol), and acetic acid (0.3
mL) were dissolved in tetrahydrofuran (30 mL), sodium
triacetoxymethylborohydride (4.0 g, 18.9 mmol) was added, and the
mixture was stirred at room temperature for 15 hr. The
reaction mixture was basified by adding saturated aqueous
25 sodium hydrogen carbonate solution, and extracted with n-hexane.
The organic layer was washed with saturated brine, dried over
anhydrous sodium sulfate, and concentrated under reduced
pressure. The residue was purified by silica gel column
chromatography (n-hexane/ethyl acetate =100/0-95/5) to give the
30 title compound (4.0 g, 89%).
¹H NMR (CDCl₃) δ: 0.88 (6H, t), 1.26-1.43 (48H, m), 2.55 (4H,
t), 3.00 (2H, q);
¹⁹F NMR (CDCl₃) δ: -71.3 (3F, t).
[0207]

35 [Production Example 8]

Synthesis of N,N-ditetradecyl-2,2,2-trifluoroethylamine
hydrochloride

N,N-Ditetradecyl-2,2,2-trifluoroethylamine (1.50 g, 3.05 mmol) obtained in Production Example 7 was dissolved in n-
5 hexane (30 mL), 1.0 M hydrogen chloride-diethyl ether solution (20 mL) was added, and the mixture was stirred for 1 hr. The reaction mixture was concentrated under reduced pressure to give the title compound (1.45 g, 90%).

¹H NMR (CDCl₃) δ: 0.88 (6H, t), 1.20-1.40 (44H, m), 1.96 (4H,
10 br s), 3.15 (4H, br s), 3.78 (2H, q);

¹⁹F NMR (CDCl₃) δ: -63.4 (3F, t).

[0208]

[Production Example 9]

Synthesis of N,N-ditetradecyl-2,2,2-trifluoroethylammonium
15 tetrakis(pentafluorophenyl)borate

N,N-Ditetradecyl-2,2,2-trifluoroethylamine hydrochloride (0.60 g, 1.14 mmol) obtained in Production Example 8 was dissolved in chloroform (30 mL), lithium
tetrakis(pentafluorophenyl)borate tri-diethyl ether complex
20 (1.04 g, 1.14 mmol) was added, and the mixture was stirred at room temperature for 1 hr. Insoluble material was removed by filtration, and the filtrate was concentrated under reduced pressure. The residue was dried under reduced pressure at 70°C to give the title compound (1.34 g, 100%).

25 ¹H NMR (CDCl₃) δ: 0.88 (6H, t), 1.19-1.36 (44H, m), 1.65-1.70 (4H, m), 3.14-3.18 (4H, m), 3.62 (2H, q);

¹⁹F NMR (CDCl₃) δ: -66.4 (3F, t), -134.0 (8F, m), -163.4 (4F, t), -167.6 (8F, t).

[0209]

30 [Production Example 10]

Synthesis of N,N-dihexadecyl-2,2,2-trifluoroethylamine

1-Hexadecanal (4.0 g, 16.6 mmol), 2,2,2-
trifluoroethylamine (0.84 g, 8.5 mmol), and acetic acid (0.5 mL) were dissolved in tetrahydrofuran (50 mL), sodium
35 triacetoxymethylborohydride (4.0 g, 18.9 mmol) was added, and the

mixture was stirred at room temperature for 15 hr. The reaction mixture was basified by adding saturated aqueous sodium hydrogen carbonate solution, and extracted with n-hexane. The organic layer was washed with saturated brine, dried over
5 anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (n-hexane/ethyl acetate =100/0-95/5) to give the title compound (4.56 g, 98%).

^1H NMR (CDCl_3) δ : 0.88 (6H, t), 1.26-1.43 (56H, m), 2.56 (4H,
10 t), 3.00 (2H, q);

^{19}F NMR (CDCl_3) δ : -71.3 (3F, t).

[0210]

[Production Example 11]

Synthesis of N,N-dihexadecyl-2,2,2-trifluoroethylamine
15 hydrochloride

N,N-Dihexadecyl-2,2,2-trifluoroethylamine (1.50 g, 2.74 mmol) obtained in Production Example 10 was dissolved in n-hexane (30 mL), 1.0 M hydrogen chloride-diethyl ether solution (20 mL) was added, and the mixture was stirred for 1 hr. The
20 reaction mixture was concentrated under reduced pressure to give the title compound (1.55 g, 97%).

^1H NMR (CDCl_3) δ : 0.88 (6H, t), 1.19-1.40 (52H, m), 1.93 (4H, br s), 3.15 (4H, br s), 3.77 (2H, q);

^{19}F NMR (CDCl_3) δ : -63.4 (3F, t).

25 [0211]

[Production Example 12]

Synthesis of N,N-dihexadecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate

N,N-Dihexadecyl-2,2,2-trifluoroethylamine hydrochloride
30 (0.60 g, 1.03 mmol) obtained in Production Example 11 was dissolved in chloroform (30 mL), lithium tetrakis(pentafluorophenyl)borate tri-diethyl ether complex (0.95 g, 1.05 mmol) was added, and the mixture was stirred at room temperature for 1 hr. Insoluble material was removed by
35 filtration, and the filtrate was concentrated under reduced

pressure. The residue was dried under reduced pressure at 70°C to give the title compound (1.51 g).

^1H NMR (CDCl_3) δ : 0.88 (6H, t), 1.19-1.36 (54H, m), 1.65-1.70 (4H, m), 3.14-3.18 (4H, m), 3.62 (2H, q);

5 ^{19}F NMR (CDCl_3) δ : -66.4 (3F, t), -134.0 (8F, m), -163.4 (4F, t), -167.6 (8F, t).

[0212]

[Example 23]

N,N-Dihexadecyl-2,2,2-trifluoroethylamine hydrochloride
10 (8.10 g, 13.9 mmol) obtained in Production Example 11 was dissolved in dichloromethane (80 mL), ditetradecyl ether (8.10 g, 13.9 mmol) and lithium tetrakis(pentafluorophenyl)borate tri-diethyl ether complex (14.2 g, 13.7 mmol) was added, and the mixture was stirred at room temperature for 1 hr. Water
15 was added to the reaction mixture, and the mixture was stirred at room temperature for 1 hr. The aqueous layer was separated, and the organic layer was washed with water. The organic layer was dried over anhydrous sodium sulfate, and then filtered, and the filtrate was concentrated under reduced pressure. The
20 residue was dried under reduced pressure at 80°C to give a composition (22.5 g) containing N,N-dihexadecyl-2,2,2-trifluoroethylammonium tetrakis(pentafluorophenyl)borate and ditetradecyl ether.

^1H NMR (CDCl_3) δ : 0.87-0.89 (12H, m), 1.20-1.80 (104H, m), 3.21-
25 3.24 (4H, m), 3.38-3.41 (4H, m), 3.69 (2H, q);

^{19}F NMR (CDCl_3) δ : -66.7 (3F, brs), -134.0 (8F, m), -163.4 (4F, t), -167.5 (8F, t).

[0213]

n-Hexane was added to the composition obtained in Example
30 23 to prepare a 20 wt% n-hexane solution thereof, and the solution was confirmed to be a homogeneous solution.

[0214]

[Example 24]

N,N-Dihexadecyl-2,2,2-trifluoroethylammonium
35 tetrakis(pentafluorophenyl)borate (439.2 mg, 0.36 mmol)

obtained in Production Example 12 was mixed with didodecyl ether (254 mg, 0.72 mmol), and n-hexane (1.756 g) was added to prepare a homogeneous n-hexane solution of a composition containing N,N-dihexadecyl-2,2,2-trifluoroethylammonium
5 tetrakis(pentafluorophenyl)borate and didodecyl ether. The solution was confirmed to be a homogeneous solution. This solution was concentrated under reduced pressure and analyzed by NMR.

¹H NMR (CDCl₃) δ: 0.87-0.91 (12H, m), 1.20-1.42 (100H, m), 1.53-
10 1.69 (12H, m), 3.20-3.24 (4H, m), 3.40 (8H, t), 3.67 (2H, q);
¹⁹F NMR (CDCl₃) δ: -66.9 (3F, t), -134.0 (8F, m), -163.8 (4F, t), -167.4 (8F, t).

[0215]

[Example 25]

15 Ditetradecyl ether (5.96 g, 14.3 mmol) and lithium tetrakis(pentafluorophenyl)borate tri-diethyl ether complex (5.00 g, 4.81 mmol) were suspended in dichloroethane (25 mL), 6 M hydrochloric acid (5.5 mL, 30.0 mmol) was added, and the mixture was stirred at room temperature for 2 hr. The organic
20 layer was obtained and washed with water (10 mL). The organic layer was dried over anhydrous sodium sulfate, concentrated under reduced pressure, and dried under reduced pressure at room temperature for 16 hr to give a composition (10.4 g) containing hydrogenated tetrakis(pentafluorophenyl)borate
25 bis(ditetradecyl ether) complex and ditetradecyl ether.

¹H NMR (CDCl₃) δ: 0.88 (18H, t), 1.20-1.30 (94H, m), 1.56-1.60 (12H, m), 3.57 (12H, t);

¹⁹F NMR (CDCl₃) δ: -134.0 (8F, m), -163.8 (4F, t), -167.8 (8F, t).

30 [0216]

n-Hexane was added to the composition obtained in Example 25 to prepare a 20 wt% n-hexane solution thereof, and the solution was confirmed to be a homogeneous solution.

[0217]

35 [Comparative Example 1]

It was confirmed that a hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex obtained by a method known per se (see, for example, Organometallics, 2000, 19, 1442-1444) is hardly soluble in
5 aliphatic hydrocarbon solvents such as hexane, cyclohexane, and the like. In the below-mentioned Experimental Example, the hydrogenated tetrakis(pentafluorophenyl)borate diethyl ether complex was used as the cocatalyst of Comparative Example 1.
[0218]

10 [Comparative Example 2]

Attempts were made to prepare a 10 wt% n-hexane solution of N,N-dioctadecylmethylammonium tetrakis(pentafluorophenyl)borate obtained by a method known per se (see, for example, US Patent No. 6121185, the
15 specification), but a homogeneous solution was not obtained. In the below-mentioned Experimental Example, N,N-dioctadecylmethylammonium tetrakis(pentafluorophenyl)borate was used as a cocatalyst in Comparative Example 2.
[0219]

20 [Experimental Example] (Evaluation of polymerization performance)

A general polymerization method using the composition (complex) of the present invention as a cocatalyst is shown below.

25 [0220]

Into 100 mL autoclave in a glove box were added 1-octene, triisobutylaluminum (TIBA, 0.55 M n-hexane solution), and a solvent (methylcyclohexane (MCH) or toluene) to give a comonomer solution. Dimethylsilylene(tert-butylamide)-
30 (tetramethylcyclopentadienyl)-titanium (IV)-dichloride (CGC, polymerization catalyst), triisobutylaluminum (0.55 M n-hexane solution), and a solvent were added to prepare a catalyst solution at a predetermined concentration, and the solution was transferred to a Schlenk flask. The composition (cocatalyst)
35 of the present invention was dissolved in a solvent, and a

cocatalyst solution at a predetermined concentration was prepared and transferred to the Schlenk flask. The comonomer solution, the catalyst solution, and the cocatalyst solution were mixed, and adjusted such that the total amount of the
5 solvent and the total amount of triisobutylaluminum would be constant. The inside of the autoclave was purged with ethylene gas, the catalyst solution and the cocatalyst solution were successively added to the autoclave, and the ethylene gas pressure was immediately adjusted to a predetermined pressure,
10 and the mixture was stirred at a predetermined temperature (25°C or 100°C) for a predetermined time. The reaction mixture was ice-cooled, the ethylene gas was removed, the mixture was poured into methanol (100 mL) containing hydrochloric acid (3 mL), and the mixture was stirred at room temperature for 30 min.
15 The precipitate was collected by filtration and dried under reduced pressure at 60°C to give an ethylene-octene copolymer.
[0221]

Measurement of melting point

Measurement by the differential scanning calorimetry
20 method (DSC) was performed using DSC6220 instrument (Seiko Instruments Inc.). A sample (polymer) was heated at a rate of 10°C/min from 40°C to 150°C, and the melting point was measured.
[0222]

The results of the polymerization reaction at 25°C and
25 100°C are shown in Table 1 and Table 2, respectively.

[0223]

[Table 1]

cocatalyst	catalyst amount (μmol)	solvent	time (min)	yield (g)	activity (kg/mol of Ti·h)	melting point ($^{\circ}\text{C}$)
Comparative Example 2	0.3	MCH	6	0.119	3967	83.8
Example 2	0.1	MCH	3	0.192	38400	82.5
Example 3	0.1	MCH	3	0.276	55200	82.8
Example 5	0.1	MCH	3	0.036	7200	71.9
Example 10	0.05	MCH	1.5	0.078	62400	66.5
Example 13	0.05	MCH	1.5	0.134	107200	63.3, 68.0
Comparative Example 1	0.1	toluene	1.5	0.75	300000	70.9
Example 3	0.1	toluene	1.5	1.2	480000	72.4
Example 10	0.05	toluene	1.5	0.845	676000	86.0

Reaction conditions; catalyst: CGC, catalyst:cocatalyst = 1:1, TIBA (total amount 3000 μmol), total amount of solvent (40 mL),
 5 1-octene (1 mL), ethylene pressure (8 atm), 25 $^{\circ}\text{C}$.

[0224]

[Table 2]

cocatalyst	catalyst amount (μmol)	solvent	time (min)	yield (g)	activity (kg/mol of Ti·h)	melting point ($^{\circ}\text{C}$)
Comparative Example 2	0.02	MCH	3	0.026	26000	90.0
Example 3	0.02	MCH	3	0.23	232300	90.3
Example 13	0.02	MCH	3	0.15	145300	93.2

Reaction conditions; catalyst: CGC, catalyst:cocatalyst = 1:1,
 10 TIBA (total amount 100 μmol), total amount of solvent (40 mL), 1-octene (1 mL), ethylene pressure (8 atm), 100 $^{\circ}\text{C}$.

[0225]

According to Table 1 and Table 2, the compositions (or complexes) of the present invention (Examples 2, 3, 5, 10, and
 15 13) all showed higher activity than the compound of Comparative Example 2 in the polymerization reaction in methylcyclohexane (MCH) regardless of the polymerization temperature. The

compositions (or complexes) of the present invention (Examples 3 and 10) also showed higher activity than the compound of Comparative 1 (Table 1) in the polymerization reaction in toluene. Furthermore, as shown in Table 1, the compositions
5 (or complexes) of the present invention (Examples 2, 3, 5, 10, and 13) afforded polymers having a lower melting point than Comparative Example depending on the polymerization conditions, and the uptake amount of comonomer is considered to have increased.

10 [Industrial Applicability]
[0226]

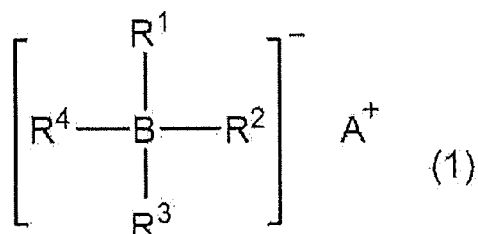
The composition of the present invention is soluble (or easily soluble) in hydrocarbon solvents, particularly aliphatic hydrocarbon solvents, and does not become a catalyst poison.
15 Thus, it is useful as a cocatalyst for polymerization of olefins and dienes.
[0227]

This application is based on patent application Nos. 2020-043244 filed in Japan (filing date: March 12, 2020), 2020-
20 144176 filed in Japan (filing date: August 28, 2020), and 2020-196703 filed in Japan (filing date: November 27, 2020), the contents of which are incorporated in full herein.

[CLAIMS]

[Claim 1]

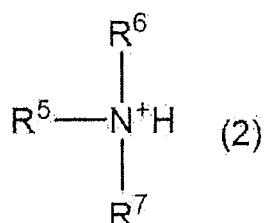
A composition containing a compound represented by the following formula (1) and a compound represented by the following formula (4):



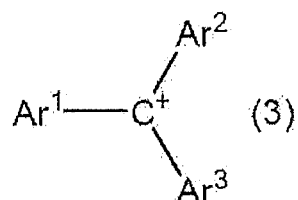
wherein

R^1 , R^2 , R^3 and R^4 are each independently a C_{6-14} aryl group substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups,

A^{+} is a hydrogen ion (H^{+}), a cation having a total carbon number of not less than 25 and represented by the formula (2):



wherein R^5 , R^6 and R^7 are each independently an optionally substituted C_{1-30} alkyl group, or an optionally substituted C_{6-14} aryl group, or a cation having a total carbon number of not less than 25 and represented by the formula (3):



wherein Ar^1 , Ar^2 and Ar^3 are each independently a C_{6-14} aryl group optionally substituted by one or more C_{1-30} alkyl groups or C_{1-30} alkoxy groups, and R and R' are each independently an optionally substituted C_{1-30}

alkyl group, an optionally substituted C₃₋₁₅ cycloalkyl group,
or an optionally substituted C₆₋₁₄ aryl group,

provided that when A⁺ is a hydrogen ion (H⁺), a total
carbon number of R and R' is not less than 20, and a content of
5 the compound represented by the formula (4) with respect to 1
mol of the compound represented by the formula (1) is not less
than 2 mol, and
when A⁺ is a cation represented by the formula (2) or a cation
represented by the formula (3), a total carbon number of R and
10 R' is not less than 8.

[Claim 2]

The composition according to claim 1, wherein
R and R' are each independently a C₁₋₃₀ alkyl group or an
optionally substituted C₆₋₁₄ aryl group, and
15 the total carbon number of R and R' is
not less than 25 when A⁺ is a hydrogen ion (H⁺),
not less than 8 when A⁺ is a cation represented by the formula
(2) or a cation represented by the formula (3).

[Claim 3]

20 The composition according to claim 1 or 2, wherein
R¹, R², R³ and R⁴ are each independently a phenyl group, a 1-
naphthyl group, a 2-naphthyl group, a 2-biphenyl group, a 3-
biphenyl group, a 4-biphenyl group, a 1-anthryl group, a 2-
anthryl group, a 9-anthryl group, a 9-phenanthryl group, or a
25 3-phenanthryl group, each of which is substituted by one or
more fluorine atoms or trifluoromethyl groups.

[Claim 4]

The composition according to claim 1 or 2, wherein
all of R¹, R², R³ and R⁴ are pentafluorophenyl groups,
30 2,2',3,3',4',5,5',6,6'-nonafluoro-4-(1,1'-biphenyl) groups,
2,3,4,5,6,7,8-heptafluoro-1-naphthyl groups, or 1,3,4,5,6,7,8-
heptafluoro-2-naphthyl groups.

[Claim 5]

The composition according to any one of claims 1 to 4,
35 wherein A⁺ is a hydrogen ion.

[Claim 6]

The composition according to any one of claims 1 to 4, wherein A⁺ is a cation having a total carbon number of not less than 35 and represented by the formula (2), and

5 R⁵, R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group, or a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

(1) a halogen atom,

(2) a C₁₋₃₀ alkyl group,

10 (3) a C₁₋₃₀ alkoxy group, and

(4) a halo C₁₋₃₀ alkyl group.

[Claim 7]

The composition according to any one of claims 1 to 4, wherein A⁺ is a cation having a total carbon number of not less
15 than 35 and represented by the formula (2),

R⁵ is a C₆₋₁₄ aryl group optionally substituted by substituent(s) selected from the group consisting of

(1) a halogen atom,

(2) a C₁₋₃₀ alkyl group,

20 (3) a C₁₋₃₀ alkoxy group, and

(4) a halo C₁₋₆ alkyl group, and

R⁶ and R⁷ are each independently an optionally substituted C₁₋₃₀ alkyl group.

[Claim 8]

25 The composition according to any one of claims 1 to 4, wherein A⁺ is a cation having a total carbon number of not less than 35 and represented by the formula (2),

R⁵ is a C₁₋₃₀ alkyl group substituted by a C₆₋₁₄ aryl group substituted by one or more fluorine atoms, or a C₁₋₃₀ alkyl
30 group substituted by one or more fluorine atoms, and

R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group optionally substituted by substituent(s) selected from the group consisting of

(1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),

35 (2) a halogen atom, and

(3) a C₁₋₃₀ alkoxy group.

[Claim 9]

The composition according to any one of claims 1 to 4,
wherein A⁺ is a cation having a total carbon number of not less
5 than 35 and represented by the formula (2),

R⁵ is a fluoro C₁₋₆ alkyl group, and

R⁶ and R⁷ are each independently a C₁₋₃₀ alkyl group optionally
substituted by substituent(s) selected from the group
consisting of

- 10 (1) a C₆₋₁₄ aryl group optionally substituted by halogen atom(s),
(2) a halogen atom, and
(3) a C₁₋₃₀ alkoxy group.

[Claim 10]

The composition according to any one of claims 1 to 4,
15 wherein A⁺ is a cation having a total carbon number of not less
than 35 and represented by the formula (3), and

Ar¹, Ar² and Ar³ are each independently a phenyl group
optionally substituted by a C₁₋₃₀ alkyl group or a C₁₋₃₀ alkoxy
group.

20 [Claim 11]

The composition according to any one of claims 1 to 4,
wherein A⁺ is a hydrogen ion, and

R and R' are each independently a C₁₋₃₀ alkyl group optionally
substituted by substituent(s) selected from the group

25 consisting of

- (1) a halogen atom,
(2) a C₁₋₃₀ alkoxy group, and
(3) a halo C₁₋₃₀ alkoxy group;

a C₃₋₁₅ cycloalkyl group optionally substituted by
30 substituent(s) selected from the group consisting of

- (1) a halogen atom,
(2) a C₁₋₃₀ alkyl group,
(3) a C₁₋₃₀ alkoxy group,
(4) a halo C₁₋₃₀ alkyl group, and
35 (5) a halo C₁₋₃₀ alkoxy group; or

a C₆₋₁₄ aryl group optionally substituted by substituent(s)
selected from the group consisting of

- (1) a halogen atom,
- (2) a C₁₋₃₀ alkyl group,
- 5 (3) a C₁₋₃₀ alkoxy group,
- (4) a halo C₁₋₃₀ alkyl group, and
- (5) a halo C₁₋₃₀ alkoxy group.

[Claim 12]

The composition according to any one of claims 1 to 4,
10 wherein A⁺ is a hydrogen ion, and R and R' are each
independently a C₁₋₃₀ alkyl group.

[Claim 13]

The composition according to any one of claims 1 to 4,
wherein A⁺ is a hydrogen ion,
15 R and R' are each independently a C₁₄₋₃₀ alkyl group, and
the total carbon number of R and R' is not less than 28.

[Claim 14]

The composition according to any one of claims 1 to 4,
wherein A⁺ is a hydrogen ion, and
20 R and R' are the same group.

[Claim 15]

The composition according to any one of claims 1 to 4 and
6 to 10, wherein A⁺ is a cation represented by the formula (2)
or the formula (3), R and R' are each independently a C₁₋₃₀
25 alkyl group, and the total carbon number of R and R' is not
less than 8.

[Claim 16]

The composition according to any one of claims 1 to 4, 6
to 10, and 15, wherein a content of the compound represented by
30 the formula (4) with respect to 1 mol of the compound
represented by the formula (1) (wherein A⁺ is a cation
represented by the formula (2) or the formula (3)) is within
the range of 0.01 - 10 mol.

[Claim 17]

35 The composition according to any one of claims 1 to 4, 6

to 10, and 15, wherein a content of the compound represented by the formula (4) with respect to 1 mol of the compound represented by the formula (1) (wherein A^+ is a cation represented by the formula (2) or the formula (3)) is within
 5 the range of 0.01 - 3 mol.

[Claim 18]

The composition according to any one of claims 1 to 17, having a solubility of not less than 5 wt% in n-hexane, isohexane, n-heptane, n-octane, cyclohexane, methylcyclohexane,
 10 or a mixed solvent thereof at 25°C.

[Claim 19]

The composition according to any one of claims 1 to 18, substantially free of an ether having a total carbon number of not more than 7.

15 [Claim 20]

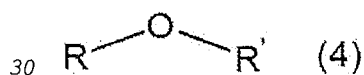
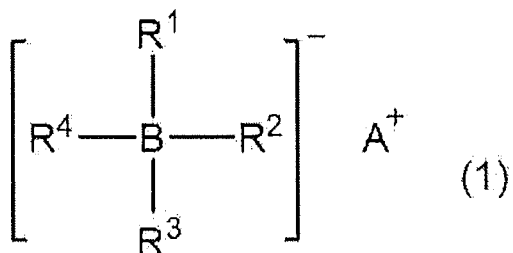
A cocatalyst for polymerization of at least one kind of monomer selected from the group consisting of an olefin and a diene, consisting of the composition according to any one of claims 1 to 19.

20 [Claim 21]

A method for producing a polymer, comprising polymerizing at least one kind of monomer selected from the group consisting of an olefin and a diene by using the composition according to any one of claims 1 to 19 as a cocatalyst.

25 [Claim 22]

A composition comprising a compound represented by the following formula (1) and a compound represented by the following formula (4):



wherein

R^1 , R^2 , R^3 and R^4 are each independently a C_{6-14} aryl group substituted by one or more fluorine atoms or one or more fluoro C_{1-4} alkyl groups,

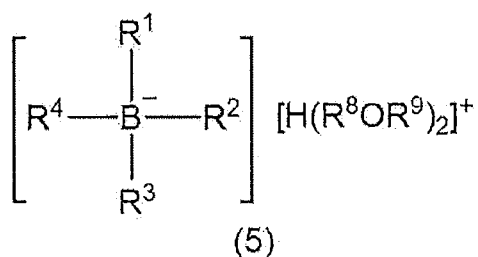
5 A^+ is a hydrogen ion (H^+),

R and R' are each independently an optionally substituted C_{1-30} alkyl group, an optionally substituted C_{3-15} cycloalkyl group, or an optionally substituted C_{6-14} aryl group,

a total carbon number of R and R' is not less than 20, and

10 a content of the compound represented by the formula (4) with respect to 1 mol of the compound represented by the formula (1) is not less than 2 mol,

comprising a step of reacting a compound represented by the following formula (5):



15

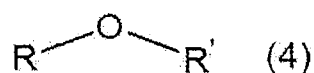
wherein

R^1 , R^2 , R^3 and R^4 are as defined above,

R^8 and R^9 are each independently a C_{1-6} alkyl group, and

a total carbon number of R^8OR^9 is not more than 7,

20 with a compound represented by the following formula (4):



wherein R and R' are as defined above.

[Claim 23]

The production method according to claim 22, wherein both

25 R^8 and R^9 are ethyl groups.