[Document Name] Claims

[Claim 1]

A production method for a branched conjugated diene-based polymer, comprising:

a polymerizing step of obtaining a conjugated diene-based polymer having an active end by polymerizing or copolymerizing a conjugated diene compound, or a conjugated diene compound and an aromatic vinyl compound with an alkali metal compound or an alkaline earth metal compound used as a polymerization initiator; and

a branching step of introducing a branch structure by reacting a styrene derivative as a branching agent with the active end of the conjugated diene-based polymer,

wherein the method further comprises a reaction step of reacting a coupling agent or a polymerization terminator with the active end of the conjugated diene-based polymer resulting from the branching step; and

wherein the coupling agent or the polymerization terminator has a nitrogen atom-containing group.

[Claim 2]

The production method for a branched conjugated diene-based polymer according to claim 1, further comprising:

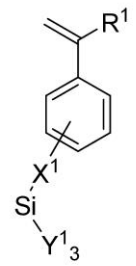
a step of adding a conjugated diene compound and/or an aromatic vinyl compound to a reaction system during and/or after the branching step.

[Claim 3]

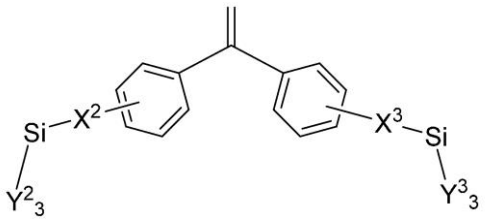
The production method for a branched conjugated diene-based polymer according to claim 1, wherein the polymerization terminator is an alkoxy compound having a nitrogen atom-containing group.

[Claim 4]

The production method for a branched conjugated diene-based polymer according to any one of claims 1 to 3, wherein the styrene derivative is a compound represented by the following formula (1) and/or formula (2):



(1)



(2)

wherein R^1 represents any one selected from the group consisting of a hydrogen atom, an alkyl group having 1 to 20 carbon atoms, and an aryl group having 6 to 20 carbon atoms, and may have a branch structure in a part thereof;

X^1, X^2 and X^3 represent a single bond, or an organic group containing any one selected from the group

consisting of carbon, hydrogen, nitrogen, sulfur, and oxygen; and

Y^1, Y^2 and Y^3 represent any one selected from the group consisting of an alkyl group having 1 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, and a halogen atom, are respectively independent, and may be the same or different.

[Claim 5]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (1), R^1 represents a hydrogen atom, and Y^1 represents any one selected from the group consisting of an alkyl group having 1 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, and a halogen atom.

[Claim 6]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (2), X^1 represents a single bond, and Y^2 represents any one selected from the group consisting of an alkyl group having 1 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, and a halogen atom.

[Claim 7]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (1), R^1 represents a hydrogen atom, and Y^1 represents an alkoxy group having 1 to 20 carbon atoms, or a halogen atom.

[Claim 8]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (2), Y^2 represents an alkoxy group having 1 to 20 carbon atoms, or a halogen atom, and Y^3 represents an alkoxy group having 1 to 20 carbon atoms, or a halogen atom.

[Claim 9]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (1), R^1 represents a hydrogen atom, and Y^1 represents an alkoxy group having 1 to 20 carbon atoms.

[Claim 10]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (1), R^1 represents a hydrogen atom, X^1 represents a single bond, and Y^1 represents an alkoxy group having 1 to 20 carbon atoms.

[Claim 11]

The production method for a branched conjugated diene-based polymer according to claim 4, wherein, in the formula (2), X^2 represents a single bond, Y^2 represents an alkoxy group having 1 to 20 carbon atoms, or a halogen atom, X^3 represents a single bond, and Y^3 represents an alkoxy group having 1 to 20 carbon atoms, or a halogen atom.

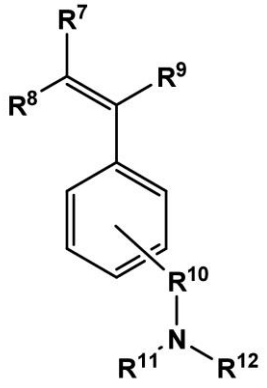
[Claim 12]

The production method for a branched conjugated diene-based polymer according to any one of claims 1 to 11, further comprising:

a step of copolymerizing a nitrogen atom-containing vinyl compound, or copolymerizing a conjugated diene compound and a nitrogen atom-containing vinyl compound, or a conjugated diene compound, a vinyl aromatic compound, and a nitrogen atom-containing vinyl compound, in the polymerizing step.

[Claim 13]

The production method for a branched conjugated diene-based polymer according to claim 12, wherein the nitrogen atom-containing vinyl compound is a compound represented by the following formula (3) or (4):

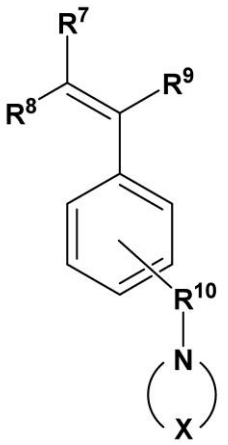


(3)

wherein R^7 to R^9 each independently represent any one selected from the group consisting of hydrogen, an alkyl group having 1 to 20 carbon atoms, and an aryl group having 6 to 20 carbon atoms;

R^{10} represents a single bond, or a divalent hydrocarbon group having 1 to 6 carbon atoms, in which the chain is optionally interrupted by any of NR^{13}, O, and S; and

R^{11} to R^{13} each independently represent any one selected from the group consisting of an alkyl group having 1 to 30 carbon atoms, an aryl group having 6 to 30 carbon atoms, and a trisubstituted silyl group having, on silicon, an alkyl group having 1 to 30 carbon atoms and/or an aryl group having 6 to 30 carbon atoms;



(4)

wherein R^7 to R^9 each independently represent any one selected from the group consisting of hydrogen, an alkyl group having 1 to 20 carbon atoms, and an aryl group having 6 to 20 carbon atoms;

R^{10} represents a single bond, or a divalent hydrocarbon group having 1 to 6 carbon atoms, in which the chain is optionally interrupted by any of NR^{13}, O, and S;

R^{13} each independently represents any one selected from the group consisting of an alkyl group having 1 to

30 carbon atoms, an aryl group having 6 to 30 carbon atoms, and a trisubstituted silyl group having, on silicon, an alkyl group having 1 to 30 carbon atoms and/or an aryl group having 6 to 30 carbon atoms;

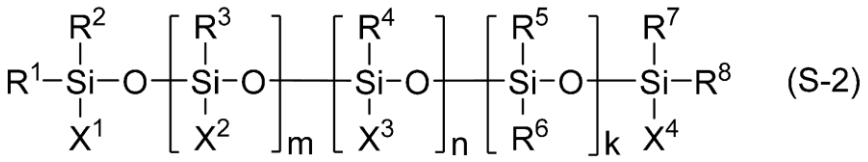
X represents a divalent hydrocarbon group having 3 to 10 carbon atoms, in which the chain is optionally interrupted by any of NR^{14}, O, and S and which corresponds to a saturated ring-forming moiety in which all carbon-carbon bonds are single bonds or an unsaturated ring-forming moiety in which at least some of carbon-carbon bonds are double bonds; and

R^{14} represents an alkyl group having 1 to 30 carbon atoms or an aryl group having 6 to 30 carbon atoms.

[Claim 14]

The production method for a branched conjugated diene-based polymer according to any one of claims 1 to 13, wherein, in the reaction step,

the active end of the conjugated diene-based polymer resulting from the branching step is reacted with a coupling agent represented by the following formula (S-2):



(S-2)

wherein R^1 to R^8 each independently represent any one selected from the group consisting of an alkyl group

having 1 to 20 carbon atoms and an aryl group having 6 to 20 carbon atoms, and may be the same or different;

X^1 and X^4 satisfy the following (i) or (ii):

(i) one of X^1 and X^4 represents a group selected from the group consisting of an alkoxysilyl group having 1 to 5 carbon atoms, a 2-pyrrolidonyl group-containing hydrocarbon group, and an epoxy group-containing group having 4 to 12 carbon atoms, and the other represents a group derived from such a group, or a single bond; or

(ii) X^1 and X^4 represent an alkyl group having 1 to 6 carbon atoms or an aryl group having 6 to 12 carbon atoms, and X^1 and X^4 may be the same or different;

some of X^2 represent a group selected from the group consisting of an alkoxysilyl group having 1 to 5 carbon atoms, a 2-pyrrolidonyl group-containing hydrocarbon group, and an epoxy group-containing group having 4 to 12 carbon atoms, and the others represent a group derived from such a group, or a single bond;

X^3 represents a group containing 2 to 20 alkylene glycol repeating units; and

m represents an integer of 3 to 200, n represents an integer of 0 to 200, and k represents an integer of 0 to 200.

[Claim 15]

A branched conjugated diene-based polymer produced by the method according to any one of claims 1 to 14, wherein said polymer is a copolymer of a conjugated diene compound, or a conjugated diene compound and an aromatic

vinyl compound, with a nitrogen atom-containing vinyl compound, and which has a main chain branch structure derived from a styrene derivative, in a polymer main chain.

[Claim 16]

A rubber composition comprising:

a rubber component comprising 10% by mass or more of the branched conjugated diene-based polymer according to claim 15, and

5.0 parts by mass or more and 150 parts by mass or less of a filler with respect to 100 parts by mass of the rubber component.

[Claim 17]

A production method for a rubber composition, comprising:

a step of obtaining a branched conjugated diene-based polymer by the production method according to any one of claims 1 to 14;

a step of obtaining a rubber component containing 10% by mass or more of the branched conjugated diene-based polymer; and

a step of obtaining a rubber composition by causing 5.0 parts by mass or more and 150 parts by mass or less of a filler to be contained with respect to 100 parts by mass of the rubber component.

[Claim 18]

A production method for a tire, comprising:

a step of obtaining a rubber composition by the production method for a rubber composition according to claim 17; and

a step of obtaining a tire by molding the rubber composition.