CLAIMS

1. A method for producing a polymerization catalyst composition, comprising:

mixing and aging a second element and a third element, and then adding a first element to the mixture to react the first element with the mixture,

wherein the first element is a compound that contains a rare earth element (REE-containing compound) wherein the REE-containing compound contains a rare earth element compound (REE compound) or a reactant of the REE compound with a Lewis base,

the second element contains a compound represented by the following formula (X):

$$YR^1_aR^2_bR^3_c \quad (X)$$

wherein:

Y is a metal selected from Group 1, Group 2, Group 12, and Group 13 of the periodic table; R^1 and R^2 are hydrogen atoms or hydrocarbon groups each having 1 to 10 carbon atoms; and R^3 is a hydrocarbon group having 1 to 10 carbon atoms, R^1, R^2, and R^3 are the same as or different from each other, with *a* being 1 and *b* and *c* both being 0 when Y is a metal selected from Group 1 of the periodic table, *a* and *b* being 1 and *c* being 0 when Y is a metal selected from Group 2 and Group 12 of the periodic table, and *a*, *b*, and *c* are all 1 when Y is a metal selected from Group 13 of the periodic table, and

the third element contains silica.

2. The method for producing the polymerization catalyst composition according to claim 1, wherein water content of the third element is 0.1 wt% or more.

3. The method for producing the polymerization catalyst composition according to claim 1, wherein the third element is contained in the polymerization catalyst composition in an amount of more than 0 weight parts and less than or equal to 100

weight parts per 100 weight parts of monomer constituting a polymer, when expressed in terms of dehydrated weight.

4. The method for producing the polymerization catalyst composition according to claim 1, wherein the first element contains a complex represented by the following general formula (i) or (ii):

$$MX_2 \cdot Lw \quad (i)$$

$$MX_3 \cdot Lw \quad (ii)$$

wherein:

M represents a lanthanoid element, scandium, or yttrium; X each independently represent a hydrogen atom, a halogen atom, an alkoxy group, a thiolate group, an amide group, a silyl group, an aldehyde residue, a ketone residue, a carboxylic acid residue, a thicarboxylic acid residue, a phosphorous compound residue, a substituted or unsubstituted cyclopentadienyl, or a substituted or unsubstituted indenyl; L represents a Lewis base; and w represents 0 to 3.

5. The method for producing the polymerization catalyst composition according to claim 1, wherein the REE compound or the reactant of the REE compound with the Lewis base does not have a bond between the rare earth element and the carbon.

6. The method for producing the polymerization catalyst composition according to claim 1, wherein the second element is represented by the following general formula (Xa):

$$AlR^1R^2R^3 \quad (Xa)$$

wherein:

R^1 and R^2 are hydrogen atoms or hydrocarbon groups each having 1 to 10 carbon atoms; and R^3 is a hydrocarbon group having 1 to 10 carbon atoms, in which R^1, R^2, and R^3 are the same as or different from each other.

7. A polymerization catalyst composition produced by the method for producing the polymerization catalyst composition according to any one of claims 1 to 6.

8. A method for producing a polymer composition, comprising:

forming a polymer component by polymerizing at least one of a conjugated diene compound and a unconjugated olefin in the presence of a polymerization catalyst composition obtained by

mixing and aging a second element and a third element, and then adding a first element to the mixture to react the first element with the mixture,

wherein the first element is a compound that contains a rare earth element (REE-containing compound) wherein the REE-containing compound contains a rare earth element compound (REE compound) or a reactant of the REE compound with a Lewis base,

the second element contains a compound represented by the following formula (X):

$$YR^1_aR^2_bR^3_c \quad (X)$$

wherein:

Y is a metal selected from Group 1, Group 2, Group 12, and Group 13 of the periodic table; R^1 and R^2 are hydrogen atoms or hydrocarbon groups each having 1 to 10 carbon atoms; and R^3 is a hydrocarbon group having 1 to 10 carbon atoms, R^1, R^2, and R^3 are the same as or different from each other, with *a* being 1 and *b* and *c* both being 0 when Y is a metal selected from Group 1 of the periodic table, *a* and *b* being 1 and *c* being 0 when Y is a metal selected from Group 2 and Group 12 of the periodic table, and *a*, *b*, and *c* are all 1 when Y is a metal selected from Group 13 of the periodic table, and

the third element contains silica.

9. The method for producing the polymer composition according to claim 8, wherein water content of the third element is 0.1 wt% or more.

10. The method for producing the polymer composition according to claim 8, wherein the third element is contained in the polymerization catalyst composition in an amount of more than 0 weight parts and less than or equal to 100 weight parts per 100 weight parts of monomer forming the polymer component, when expressed in terms of dehydrated weight.

11. The method for producing the polymer composition according to claim 8, wherein the first element contains a complex represented by the following general formula (i) or (ii):

$$MX_2 \cdot Lw \quad (i)$$

$$MX_3 \cdot Lw \quad (ii)$$

wherein:

M represents a lanthanoid element, scandium, or yttrium; X each independently represent a hydrogen atom, a halogen atom, an alkoxy group, a thiolate group, an amide group, a silyl group, an aldehyde residue, a ketone residue, a carboxylic acid residue, a thicarboxylic acid residue, a phosphorous compound residue, a substituted or unsubstituted cyclopentadienyl, or a substituted or unsubstituted indenyl; L represents a Lewis base; and w represents 0 to 3.

12. The method for producing the polymer composition according to claim 8, wherein the REE compound and the reactant of the REE compound with the Lewis base do not have a bond between the rare earth element and the carbon.

13. The method for producing the polymer composition according to claim 8, wherein the compound represented by the general formula (X) is represented by the following general formula (Xa):

$$AlR^1R^2R^3 \quad (Xa)$$

wherein:

R^1 and R^2 are hydrogen atoms or hydrocarbon groups each having 1 to 10 carbon atoms; and R^3 is a hydrocarbon group having 1 to 10 carbon atoms, in which R^1, R^2, and R^3 are the same as or different from each other.

14. A polymer composition produced by the method for producing the polymer composition according to any one of claims 8 to 13.

CLAIMS

1. A method for producing a polymer composition, comprising:

forming a polymer component by polymerizing at least one of a conjugated diene compound and a unconjugated olefin in the presence of a polymerization catalyst composition obtained by

mixing and aging a second element and a third element, and then adding a first element to the mixture to react the first element with the mixture,

wherein the first element is a compound that contains a rare earth element (REE-containing compound) wherein the REE-containing compound contains a rare earth element compound (REE compound) or a reactant of the REE compound with a Lewis base,

the second element contains a compound represented by the following formula (X):

$$YR^1_aR^2_bR^3_c \text{ (X)}$$

wherein:

Y is a metal selected from Group 1, Group 2, Group 12, and Group 13 of the periodic table; R^1 and R^2 are hydrogen atoms or hydrocarbon groups each having 1 to 10 carbon atoms; and R^3 is a hydrocarbon group having 1 to 10 carbon atoms, R^1, R^2, and R^3 are the same as or different from each other, with *a* being 1 and *b* and *c* both being 0 when Y is a metal selected from Group 1 of the periodic table, *a* and *b* being 1 and *c* being 0 when Y is a metal selected from Group 2 and Group 12 of the periodic table, and *a*, *b*, and *c* are all 1 when Y is a metal selected from Group 13 of the periodic table, and the third element contains silica;

wherein the first element contains a complex represented by the following general formula (i) or (ii):

$$MX_2 \cdot Lw \text{ (i)}$$

$$MX_3 \cdot Lw \text{ (ii)}$$

wherein:

M represents a lanthanoid element, scandium, or yttrium; X each independently represent a hydrogen atom, a halogen atom, an alkoxy group, a thiolate group, an amide group, a silyl group, an aldehyde residue, a ketone residue, a carboxylic acid residue, a thicarboxylic acid residue, a phosphorous compound residue, a substituted or unsubstituted cyclopentadienyl, or a substituted or unsubstituted indenyl; L represents a Lewis base; and w represents 0 to 3; and

wherein water content of the third element is 0.1 wt% or more.

2. The method for producing the polymer composition according to claim 1, wherein the third element is contained in the polymerization catalyst composition in an amount of more than 0 weight parts and less than or equal to 100 weight parts per 100 weight parts of monomer forming the polymer component, when expressed in terms of dehydrated weight.

3. The method for producing the polymer composition according to claim 1, wherein the REE compound and the reactant of the REE compound with the Lewis base do not have a bond between the rare earth element and the carbon.

4. The method for producing the polymerization catalyst composition according to claim 1, wherein the second element is represented by the following general formula (Xa):

$$AlR^1R^2R^3 \text{ (Xa)}$$

wherein:R^1 and R^2 are hydrogen atoms or hydrocarbon groups each having 1 to 10 carbon atoms; and R^3 is a hydrocarbon group having 1 to 10 carbon atoms, in which R^1, R^2, and R^3 are the same as or different from each other.