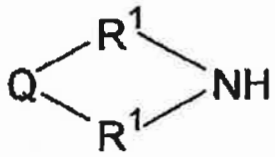
Claims

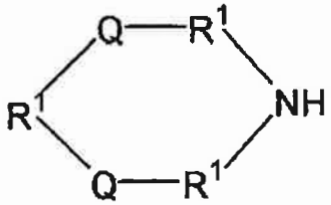
[Claim 1]

A method for producing a modified conjugated diene polymer comprising a polymerization step of polymerizing a monomer comprising a conjugated diene compound or a monomer comprising a conjugated diene compound and an aromatic vinyl compound in the presence of a compound having a structure of the following formula (1) or (2) and an alkali metal compound or an alkaline earth metal compound to obtain a conjugated diene polymer, and

a modification step of reacting the conjugated diene polymer and a compound having a structure of the following formula (3) to obtain a modified conjugated diene polymer.

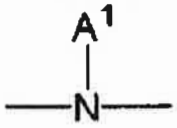


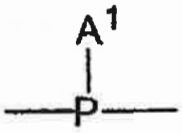
(1)

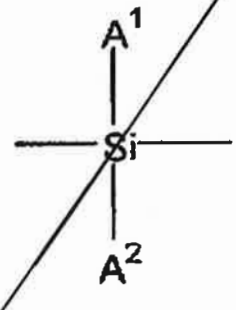


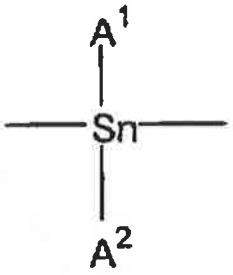
(2)

(In the formulae (1) and (2), R^1 is a hydrocarbylene group, and Q is

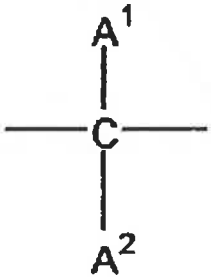




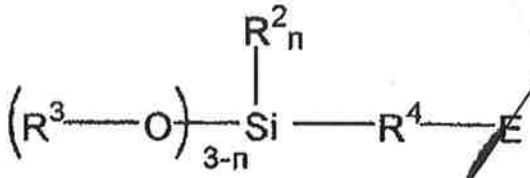




or



wherein A^1 is a substituted or unsubstituted hydrocarbyl or hydrocarbylene group which has no active hydrogen atom and may contain one or more atoms selected from the group consisting of N, P, O, S, Si and Sn; A^2 is a hydrocarbyl or hydrocarbylene group; A^1 and A^2 may combine to form a ring; and R^1 and Q which exist in plurality in the formulae may each be same or different.)



(3)

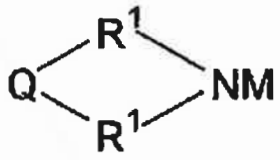
(In formula (3), E is a functional group that has one or more atoms selected from the group consisting of N, P and S; has no active hydrogen atom; and is bound by any one atom of N, P or S to R^4. Part or all of one or more atoms selected from the group consisting of N, P and S of E may be each protected with a hydrocarbylsilyl group in which three Hs (hydrogen atoms) in a structure of "-SiH_3" are each substituted with a hydrocarbyl group). R^2 and R^3 are hydrocarbyl groups. R^4 is a hydrocarbylene group. n is an integer of 0 to 2. In the formula, R^2 and R^4 which exist in plurality may each be same or different.)

[Claim 2]

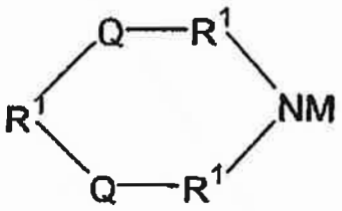
A method for producing a modified conjugated diene polymer comprising a polymerization step of polymerizing a monomer comprising a conjugated diene compound or a monomer comprising a conjugated diene compound and an aromatic vinyl compound in the presence of a compound having the following formula (4) or (5) to obtain a conjugated diene polymer, and

a modification step of reacting the conjugated diene polymer and a compound

having a structure of the following formula (3) to obtain a modified conjugated diene polymer.

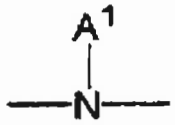


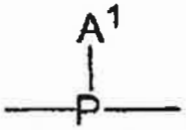
(4)

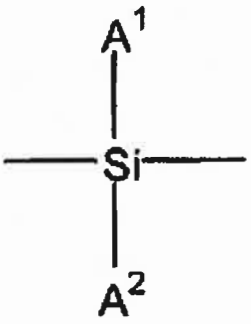


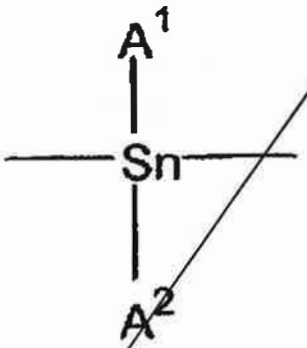
(5)

(In formulae (4) and (5), M is an alkali metal atom or an alkaline earth metal atom. R^1 is a hydrocarbylene group. Q is

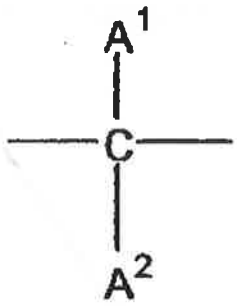




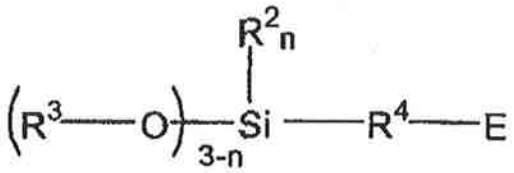




or



wherein A^1 is a substituted or unsubstituted hydrocarbyl or hydrocarbylene group which has no active hydrogen atom and may contain one or more atoms selected from the group consisting of N, P, O, S, Si and Sn; A^2 is a hydrocarbyl or hydrocarbylene group; A^1 and A^2 may combine to form a ring; and R^1 and Q which exist in plurality in the formulae may each be same or different.)



(3)

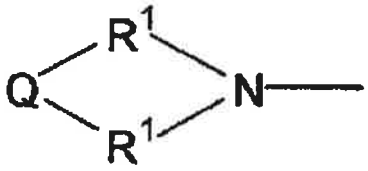
(In formula (3), E is a functional group which has one or more atoms selected from the group consisting of N, P and S; has no active hydrogen atom; and is bound by any one atom of N, P or S to R^4. Part or all of one or more atoms selected from the group consisting of N, P and S of E may be each protected with a hydrocarbylsilyl group in which three Hs (hydrogen atoms) in a structure of "$-SiH_3$" are each substituted with a hydrocarbyl group. R^2 and R^3 are hydrocarbyl groups. R^4 is a hydrocarbylene group. n is an integer of 0 to 2. In the formula, R^2 and R^3 which exist in plurality may each be same or different.)

[Claim 3]

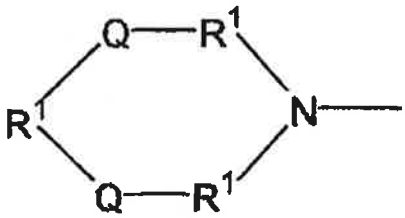
The method for producing a modified conjugated diene polymer according to claim 1 or 2, comprising a step of reacting the modified conjugated diene polymer and an onium forming agent to introduce an onium structure into the modified conjugated diene polymer.

[Claim 4]

A modified conjugated diene polymer having the following formula (6) or (7) at one end and having a structure of the following formula (8) at the other end.

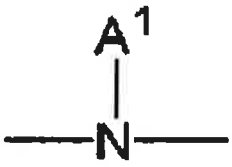


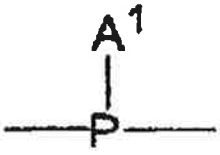
(6)

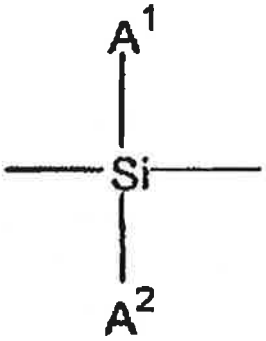


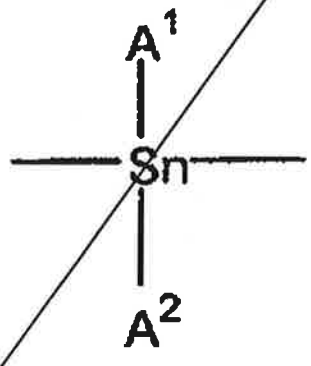
(7)

(In formulae (6) and (7), R^1 is a hydrocarbylene group, and Q is

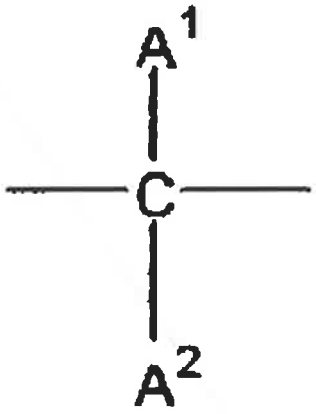




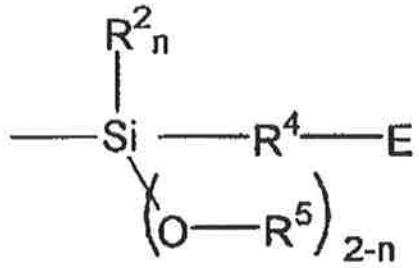




or



wherein A^1 is a substituted or unsubstituted hydrocarbyl or hydrocarbylene group which has no active hydrogen atom and may contain one or more atoms selected from the group consisting of N, P, O, S, Si and Sn; A^2 is a hydrocarbyl or hydrocarbylene group; A^1 and A^2 may combine to form a ring; and R^1 and Q which exist in plurality in the formulae may each be same or different.)



(8)

(In formula (8), E is a functional group which has one or more atoms selected from the group consisting of N, P and S; has no active hydrogen atom; and is bound by any one atom of N, P or S to R^4. Part or all of one or more atoms selected from the group consisting of N, P and S of E may be each protected with a hydrocarbylsilyl group in which three Hs (hydrogen atoms) in a structure of "-SiH_3" are each substituted with a hydrocarbyl group. R^2 is a hydrocarbyl group. R^4 is a hydrocarbylene group. R^5 is a hydrogen atom or a hydrocarbyl group. n is an integer of 0 to 2. In the formula, R^2 and R^5 which exist in plurality may each be same or different.)

[Claim 5]

A modified conjugated diene polymer in which part or all of ends are converted into oniums by reacting the modified conjugated diene polymer according to claim 4 and an onium forming agent.

[Claim 6]

A polymer composition comprising the modified conjugated diene polymer

according to claim 4 or 5, carbon black and/or silica and a cross-linking agent.

[Claim 7]

A cross-linked polymer obtained by cross-linking the polymer composition according to claim 6.

[Claim 8]

A tire using the cross-linked polymer according to claim 7 at least as a material of a tread or a side wall.

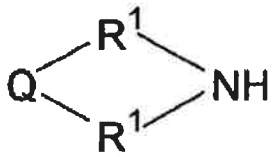
Claims

[Claim 1]

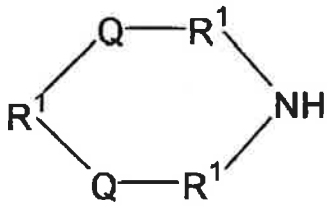
A method for producing a modified conjugated diene polymer comprising a polymerization step of polymerizing a monomer comprising a conjugated diene compound or a monomer comprising a conjugated diene compound and an aromatic vinyl compound in the presence of a compound having a structure of the following formula (1) or (2) and an alkali metal compound or an alkaline earth metal compound to obtain a conjugated diene polymer,

a modification step of reacting the conjugated diene polymer and a compound having a structure of the following formula (3) to obtain a modified conjugated diene polymer, and

a step of reacting the modified conjugated diene polymer and an onium forming agent to obtain the modified conjugated diene polymer in which part or all of ends are converted into oniums.

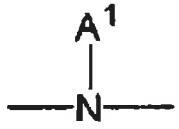


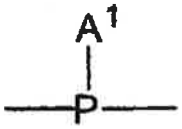
(1)

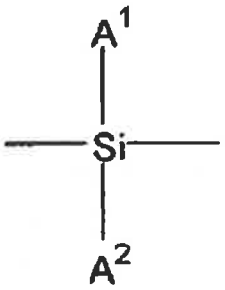


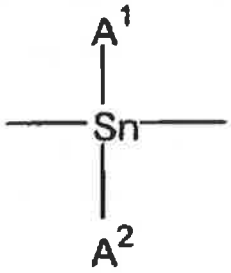
(2)

(In the formulae (1) and (2), R^1 is a hydrocarbylene group, and Q is

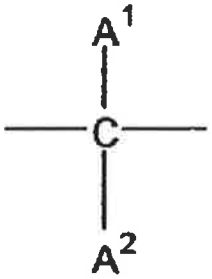




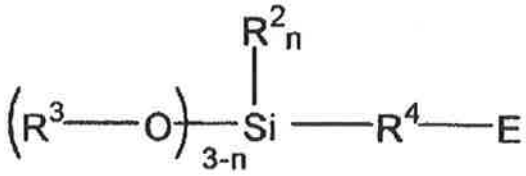




or



wherein A^1 is a substituted or unsubstituted hydrocarbyl or hydrocarbylene group which has no active hydrogen atom and may contain one or more atoms selected from the group consisting of N, P, O, S, Si and Sn; A^2 is a hydrocarbyl or hydrocarbylene group; A^1 and A^2 may combine to form a ring; and R^1 and Q which exist in plurality in the formulae may each be same or different.)



(3)

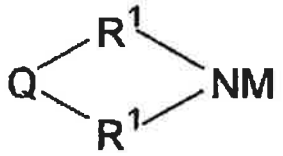
(In formula (3), E is a functional group that has one or more atoms selected from the group consisting of N, P and S; has no active hydrogen atom; and is bound by any one atom of N, P or S to R^4. Part or all of one or more atoms selected from the group consisting of N, P and S of E may be each protected with a hydrocarbylsilyl group in which three Hs (hydrogen atoms) in a structure of "-SiH_3" are each substituted with a hydrocarbyl group. R^2 and R^3 are hydrocarbyl groups. R^4 is a hydrocarbylene group. n is an integer of 0 to 2. In the formula, R^2 and R^3 which exist in plurality may each be same or different.)

[Claim 2]

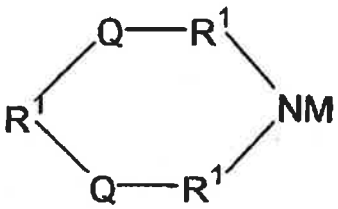
A method for producing a modified conjugated diene polymer comprising a polymerization step of polymerizing a monomer comprising a conjugated diene compound or a monomer comprising a conjugated diene compound and an aromatic vinyl compound in the presence of a compound having the following formula (4) or (5) to obtain a conjugated diene polymer,

a modification step of reacting the conjugated diene polymer and a compound having a structure of the following formula (3) to obtain a modified conjugated diene polymer, and

a step of reacting the modified conjugated diene polymer and an onium forming agent to obtain the modified conjugated diene polymer in which part or all of ends are converted into oniums.

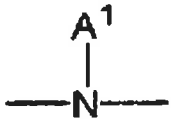


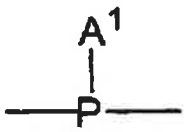
(4)

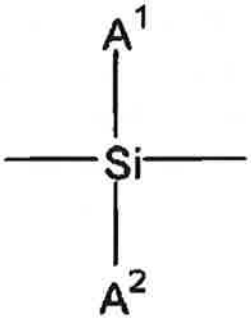


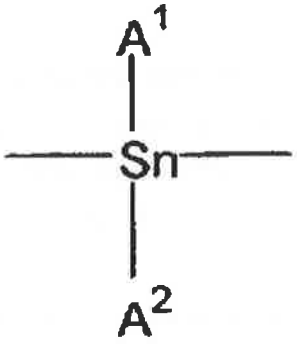
(5)

(In formulae (4) and (5), M is an alkali metal atom or an alkaline earth metal atom. R^1 is a hydrocarbylene group. Q is

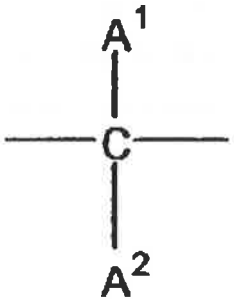




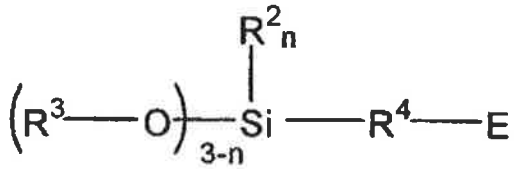




or



wherein A^1 is a substituted or unsubstituted hydrocarbyl or hydrocarbylene group which has no active hydrogen atom and may contain one or more atoms selected from the group consisting of N, P, O, S, Si and Sn; A^2 is a hydrocarbyl or hydrocarbylene group; A^1 and A^2 may combine to form a ring; and R^1 and Q which exist in plurality in the formulae may each be same or different.)



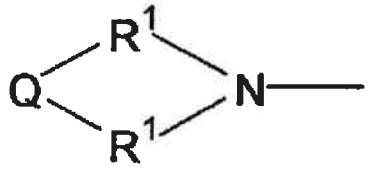
(3)

(In formula (3), E is a functional group which has one or more atoms selected from the group consisting of N, P and S; has no active hydrogen atom; and is bound by any one atom of N, P or S to R^4. Part or all of one or more atoms selected from the group consisting of N, P and S of E may be each protected with a hydrocarbylsilyl group in which three Hs (hydrogen atoms) in a structure of "-SiH_3" are each substituted with a hydrocarbyl group. R^2 and R^3 are hydrocarbyl groups. R^4 is a hydrocarbylene group. n is an integer of 0 to 2. In the formula, R^2 and R^3 which exist in plurality may each be same or different.)

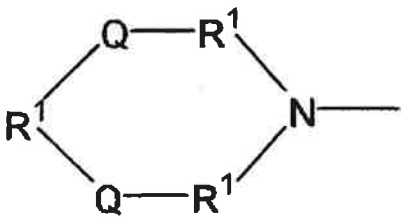
[Claim 3]

A modified conjugated diene polymer having the following formula (6) or (7) at

one end and having a structure of the following formula (8) at the other end in which part or all of ends thereof are converted into oniums.

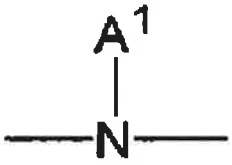


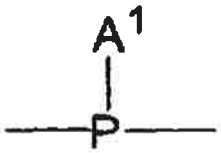
(6)

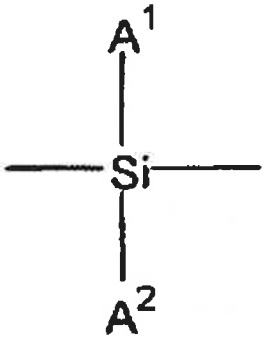


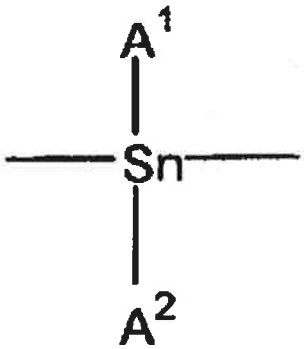
(7)

(In formulae (6) and (7), R^1 is a hydrocarbylene group, and Q is

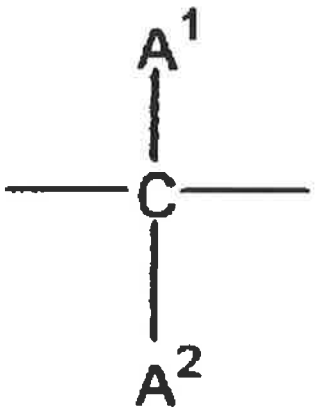




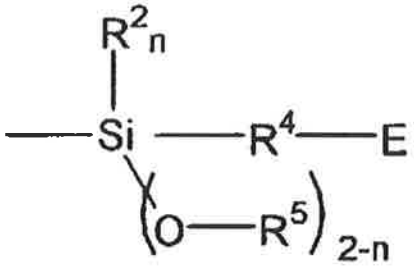




or



wherein A^1 is a substituted or unsubstituted hydrocarbyl or hydrocarbylene group which has no active hydrogen atom and may contain one or more atoms selected from the group consisting of N, P, O, S, Si and Sn; A^2 is a hydrocarbyl or hydrocarbylene group; A^1 and A^2 may combine to form a ring; and R^1 and Q which exist in plurality in the formulae may each be same or different.)



(8)

(In formula (8), E is a functional group which has one or more atoms selected from the group consisting of N, P and S; has no active hydrogen atom; and is bound by any one atom of N, P or S to R^4. Part or all of one or more atoms selected from the group consisting of N, P and S of E may be each protected with a hydrocarbylsilyl group in which three Hs (hydrogen atoms) in a structure of "-SiH_3" are each substituted with a hydrocarbyl group. R^2 is a hydrocarbyl group. R^4 is a hydrocarbylene group. R^5 is a hydrogen atom or a hydrocarbyl group. n is an integer of 0 to 2. In the formula, R^2 and R^5 which exist in plurality may each be same or different.)

[Claim 4]

A polymer composition comprising the modified conjugated diene polymer according to claim 3, carbon black and/or silica and a cross-linking agent.

[Claim 5]

A cross-linked polymer obtained by cross-linking the polymer composition

according to claim 4.

[Claim 6]

A tire using the cross-linked polymer according to claim 5 at least as a material of a tread or a side wall.