solution polymerization.

RELATED ART DOCUMENTS

PATENT DOCUMENTS

[0004] Patent Document 1: WO2013/018424

SUMMARY

PROBLEM TO BE SOLVED

[0005] In consideration of a recently increasing demand for the performance of tires for automobiles, new development of tires hereafter requires a rubber which can provide a cross-linked rubber having lower heat buildup and higher wet grip than those of conventional rubbers such as the rubber disclosed in Patent Document 1.

[0006] The present disclosure has been made in consideration of such a problem, and an object of the present disclosure is to provide a modified conjugated diene rubber which can be prepared into a rubber composition which is effectively prevented from adhering to rolls and can provide a cross-linked rubber having excellently low heat buildup, high wet grip, and high operation stability.

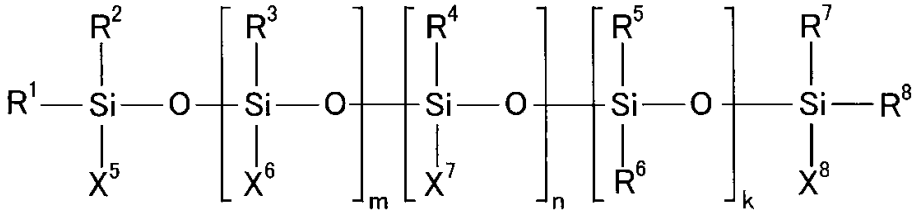
MEANS FOR SOLVING PROBLEMS

[0007] The present inventors, who have conducted extensive research to achieve the above goal, have found that the goal can be achieved by a modified conjugated diene rubber in which a modifying structure derived from a siloxane compound is introduced to at least one end of a polymer chain containing conjugated diene monomer unit and a monomer unit of a vinyl compound having a functional group interactive with silica, and thus have completed the present disclosure.

[0008] In other words, the present disclosure provides a modified conjugated diene rubber having a modifying structure derived from a

siloxane compound at at least one end of a polymer chain containing conjugated diene monomer unit and a monomer unit of a vinyl compound having a functional group interactive with silica.

[0008a] In an aspect, there is provided a modified conjugated diene rubber having a modifying structure derived from a siloxane compound on at least one terminal of a polymer chain containing conjugated diene monomer unit and a monomer unit of a vinyl compound having a functional group interactive with silica



(2)

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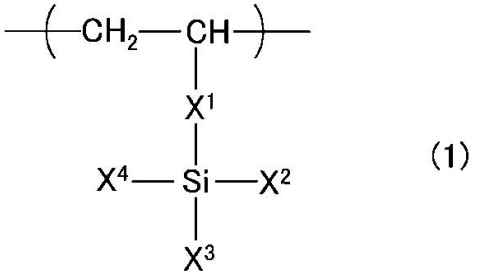
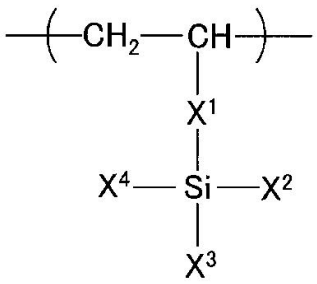
wherein the monomer unit of a vinyl compound having a functional group interactive with silica is represented by General Formula (1):



(1)

where X^1 represents a chemical single bond or a hydrocarbylene group, and X^2, X^3, and X^4 each independently represent a hydroxyl group, a substituted amino group, a hydrocarbyloxy group, or an optionally substituted hydrocarbyl group.

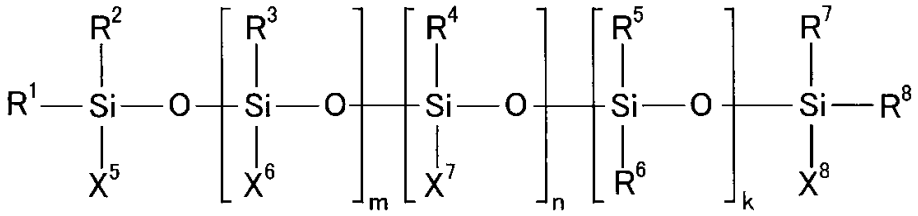
In the modified conjugated diene rubber according to the present disclosure, the monomer unit of a vinyl compound having a functional group interactive with silica are preferably unit represented by General Formula (1):



(1)

where X^1 represents a chemical single bond or a hydrocarbylene group, and X^2, X^3, and X^4 each independently represent a hydroxyl group, a substituted amino group, a hydrocarbyloxy group, or an optionally substituted hydrocarbyl group.

In the modified conjugated diene rubber according to the present disclosure, the siloxane compound is preferably a polyorganosiloxane represented by General Formula (2):



(2)

where R^1 to R^8, which may be the same or different, are a C_1 to C_6 alkyl or C_6 to C_{12} aryl group; X^5 and X^8, which may be the same or different, are any of those selected from the group consisting of C_1 to C_6 alkyl groups, C_6 to C_{12} aryl groups, C_1 to C_5 alkoxy groups, and C_4 to C_{12} groups having an epoxy group; X^6 is a C_1 to C_5 alkoxy group or a C_4 to C_{12} group having an epoxy group, and when a plurality of X^6s is present, these may be the same or

different; X^7 is a group containing 2 to 20 repeating unit of an alkylene glycol, and when a plurality of X^7s is present, these may be the same or different; m is an integer of 1 to 200; n is an integer of 0 to 200; k is an integer of 0 to 200; and m + n + k is 1 or more.

[0009] In another aspect, the present disclosure provides a method for producing the modified conjugated diene rubber as defined above, the method comprising the steps of:

polymerizing monomers including a conjugated diene compound and the vinyl compound having a functional group interactive with silica in an inert solvent, thereby providing a conjugated diene polymer chain having an active terminal; and

reacting the siloxane compound with the active terminal of the conjugated diene polymer chain having an active terminal.

[0010] In another aspect, the present disclosure also provides a rubber composition comprising a rubber ingredient containing the modified conjugated diene rubber according to any of the examples above, and silica.

Preferably, the rubber composition according to the present disclosurefurther comprises a cross-linking agent.

[0011] Furthermore, in other aspects, the present disclosure provides a cross-linked rubber prepared by cross-linking the rubber composition as defined above, and a tire comprising the cross-linked rubber as defined above.

EFFECTS

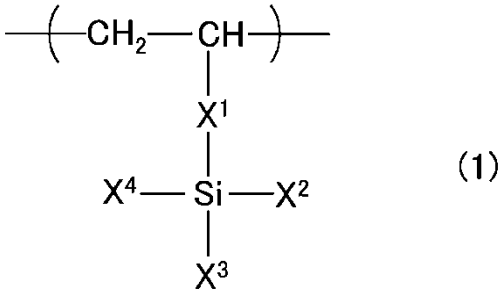
[0012] The present disclosure can provide a modified conjugated diene rubber which can be prepared into a rubber composition which is effectively prevented from adhering to rolls and can provide a cross-linked rubber having excellently low heat buildup, high wet grip, and high operation stability. The present disclosure can also

provide a method of producing such a modified conjugated diene rubber, and a rubber composition, a cross-linked rubber, and a tire comprising such a modified conjugated diene rubber.

CLAIMS

1. A modified conjugated diene rubber having a modifying structure derived from a siloxane compound on at least one terminal of a polymer chain containing conjugated diene monomer unit and a monomer unit of a vinyl compound having a functional group interactive with silica,

wherein the monomer unit of a vinyl compound having a functional group interactive with silica is represented by General Formula (1):

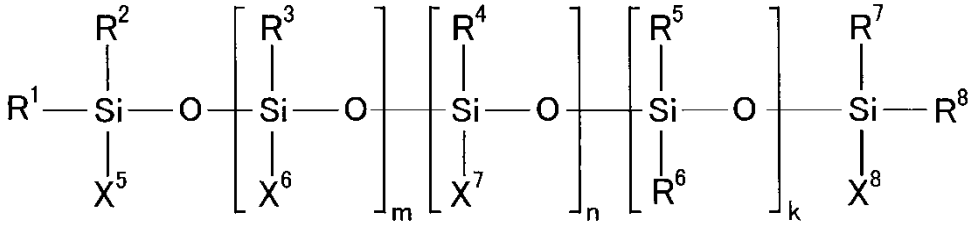


(1)

where X^1 represents a chemical single bond or a hydrocarbylene group, and X^2, X^3, and X^4 each independently represent a hydroxyl group, a substituted amino group, a hydrocarbyloxy group, or an optionally substituted hydrocarbyl group.

2. The modified conjugated diene rubber according to claim 1,

wherein the siloxane compound is a polyorganosiloxane represented by General Formula (2):



(2)

where R^1 to R^8, which may be the same or different, are a C_1 to C_6 alkyl or C_6 to C_{12} aryl group; X^5 and X^8, which may be the same or different, are any of those selected from the group consisting of C_1 to C_6 alkyl groups, C_6 to C_{12} aryl groups, C_1 to C_5 alkoxy groups, and C_4 to C_{12} groups having an epoxy

group; X^6 is a C_1 to C_5 alkoxy group or a C_4 to C_{12} group having an epoxy group, and when a plurality of X^6s is present, these may be the same or different; X^7 is a group containing 2 to 20 repeating unit of an alkylene glycol, and when a plurality of X^7s is present, these may be the same or different; m is an integer of 1 to 200; n is an integer of 0 to 200; k is an integer of 0 to 200; and m + n + k is 1 or more.

3. A method for producing the modified conjugated diene rubber according to claim 1, comprising the steps of:

polymerizing monomers including a conjugated diene compound and the vinyl compound having a functional group interactive with silica in an inert solvent, thereby providing a conjugated diene polymer chain having an active terminal; and

reacting the siloxane compound with the active terminal of the conjugated diene polymer chain having an active terminal.

4. A rubber composition comprising:

a rubber ingredient containing the modified conjugated diene rubber according to claim 1; and

silica.

5. The rubber composition according to claim 4, further comprising a cross-linking agent.

6. A cross-linked rubber prepared by cross-linking the rubber composition according to claim 4.

7. A tire comprising the cross-linked rubber according to claim 6.