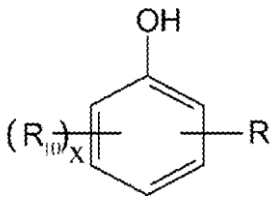
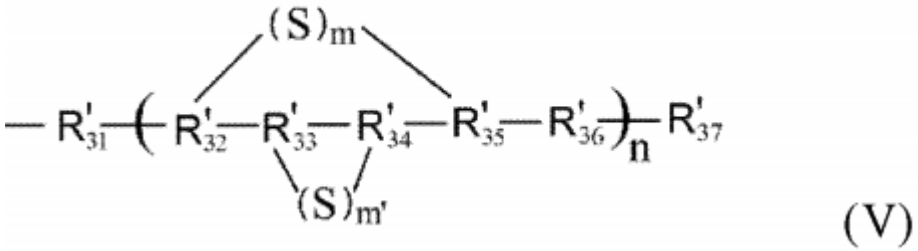
Claims

1. A phenol derivative, which is characterized in that the phenol derivative has a structure as represented by the formula (I-3):

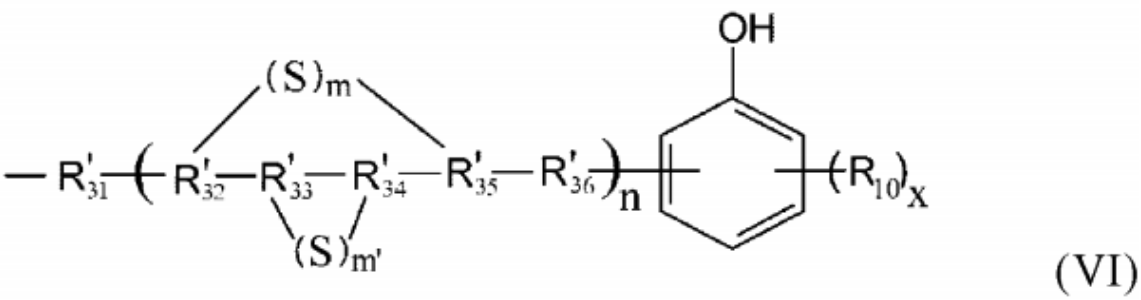


(I-3)

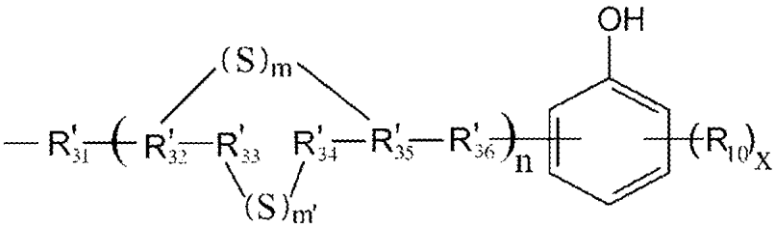
In the general formula (I-3), group R is selected from a group represented by the formula (V), a group represented by the formula (VI) and a group represented by the formula (VIII); x groups R_{10} in the general formula (I-3) are, identical to or different from each other, each independently selected from hydrogen, C_{1-50} hydrocarbyl optionally substituted by one or more substituent groups, C_{6-20} aryl substituted by one or more substituent groups, C_{3-50} hetero hydrocarbyl optionally substituted by one or more substituent groups and C_{1-50} alkoxyl optionally substituted by one or more substituent groups (preferably selected from hydrogen, C_{1-50} linear or branched alkyl, C_{1-50} linear or branched alkenyl, linear or branched C_{3-50} heteroalkyl and C_{1-50} linear or branched alkyloxy) the numbers x in the general formula (I-3) are, identical to or different from each other, each independently 0, 1, 2, 3 or 4 (preferably 0, 1 or 2);



(V)



(VI)



(VIII)

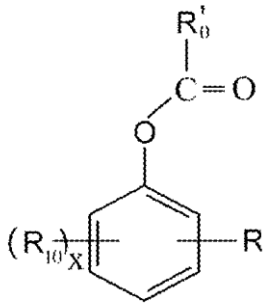
The groups in the formula (V), the formula (VI) and the formula (VIII) are defined as in claim 1;

Preferably, group R is located at the meta-position or the para-position of the phenolic hydroxyl group; x is 1 or 2, one or two groups R_{10} are located at the ortho-position of the phenolic hydroxyl group, and are each independently selected from C_{1-4} linear or branched alkyl;

More preferably, group R is located at the meta-position of the phenolic hydroxyl group; x is 1 or 2, one or two groups R_{10} are located at the ortho-position of the phenolic hydroxyl group, and are each independently selected from C_{1-4} linear or branched alkyl;

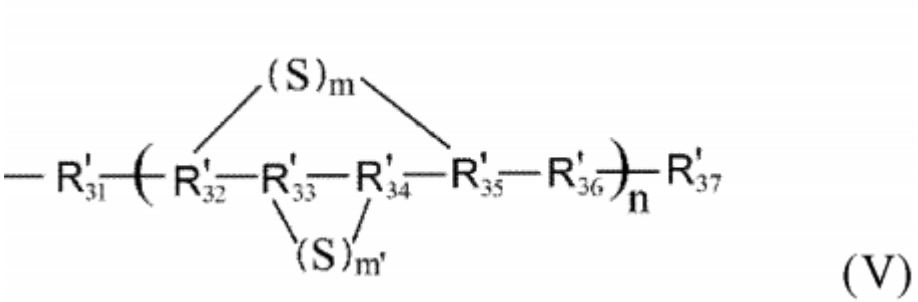
Further preferably, group R is located at the meta-position of the phenolic hydroxyl group; x is 1, group R_{10} is located at the ortho-position of the phenolic hydroxyl group and at the para-position of the group R, group R_{10} is selected from C_{1-4} linear or branched alkyl.

2. A phenol derivative, which is characterized in that the phenol derivative has a structure as represented by the formula (I-4):

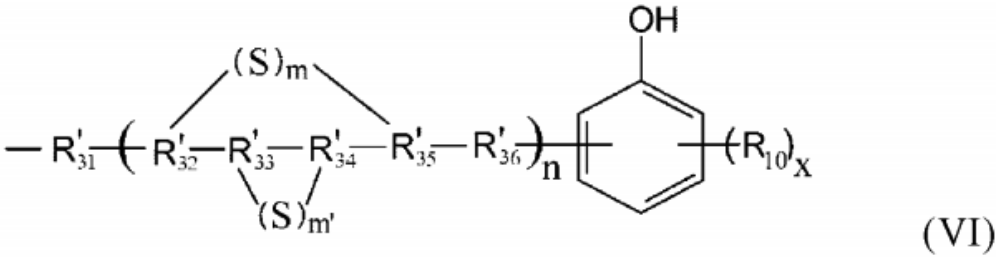


(I-4)

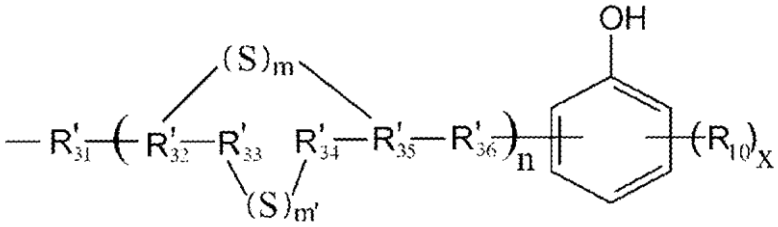
In the general formula (I-4), group R_0' is C_{1-30} linear or branched alkyl (preferably selected from C_{1-20} linear or branched alkyl); group R is selected from a group represented by the formula (V), a group represented by the formula (VI) and a group represented by the formula (VIII); x groups R_{10} in the general formula (I-4) are, identical to or different from each other, each independently selected from hydrogen, C_{1-50} hydrocarbyl optionally substituted by one or more substituent groups, C_{6-20} aryl substituted by one or more substituent groups, C_{3-50} hetero hydrocarbyl optionally substituted by one or more substituent groups and C_{1-50} alkoxyl optionally substituted by one or more substituent groups (preferably selected from hydrogen, C_{1-50} linear or branched alkyl, C_{1-50} linear or branched alkenyl, linear or branched C_{3-50} heteroalkyl and C_{1-50} linear or branched alkyloxy), the numbers x in the general formula (I-4) are, identical to or different from each other, each independently 0, 1, 2, 3 or 4 (preferably 0, 1 or 2);



(V)



(VI)



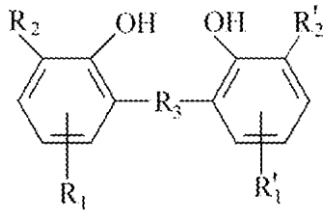
(VIII)

The groups in the formula (V), the formula (VI) and the formula (VIII) are defined as in claim 1;

Preferably, group R is located at the meta-position or the para-position of the phenolic hydroxyl group; x is 0, 1 or 2, one or two groups R_{10} that are present are located at the ortho-position of the phenolic hydroxyl group, and are each independently selected from C_{1-4} linear or branched alkyl;

More preferably, group R is located at the meta-position of the phenolic hydroxyl group; x is 0, 1 or 2, one or two groups R_{10} that are present are located at the ortho-position of the phenolic hydroxyl group, and each independently selected from C_{1-4} linear or branched alkyl.

3. A phenol derivative, which is characterized in that the phenol derivative has a structure as represented by the formula (I-5):

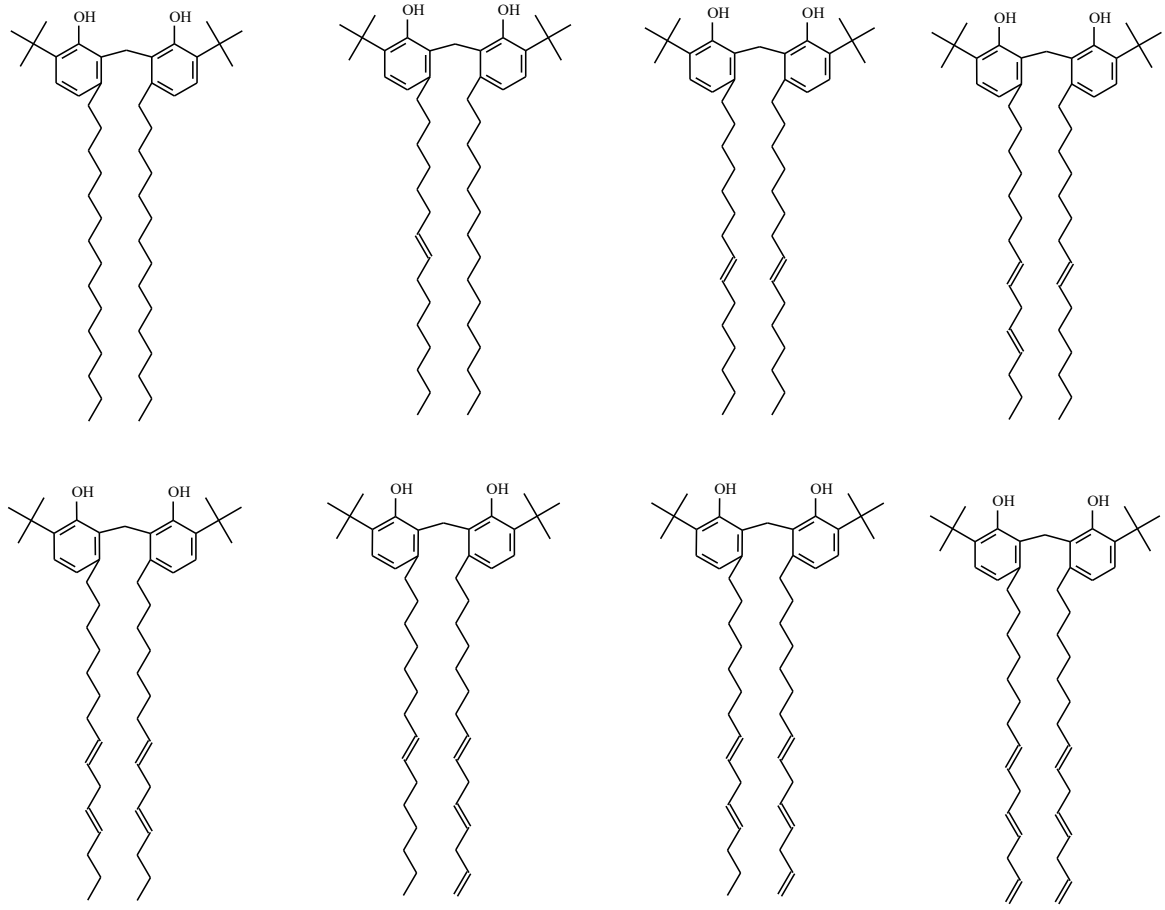


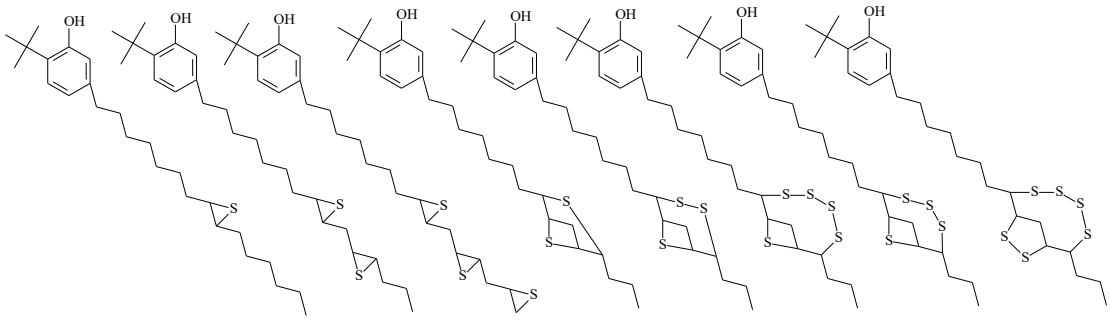
(I-5)

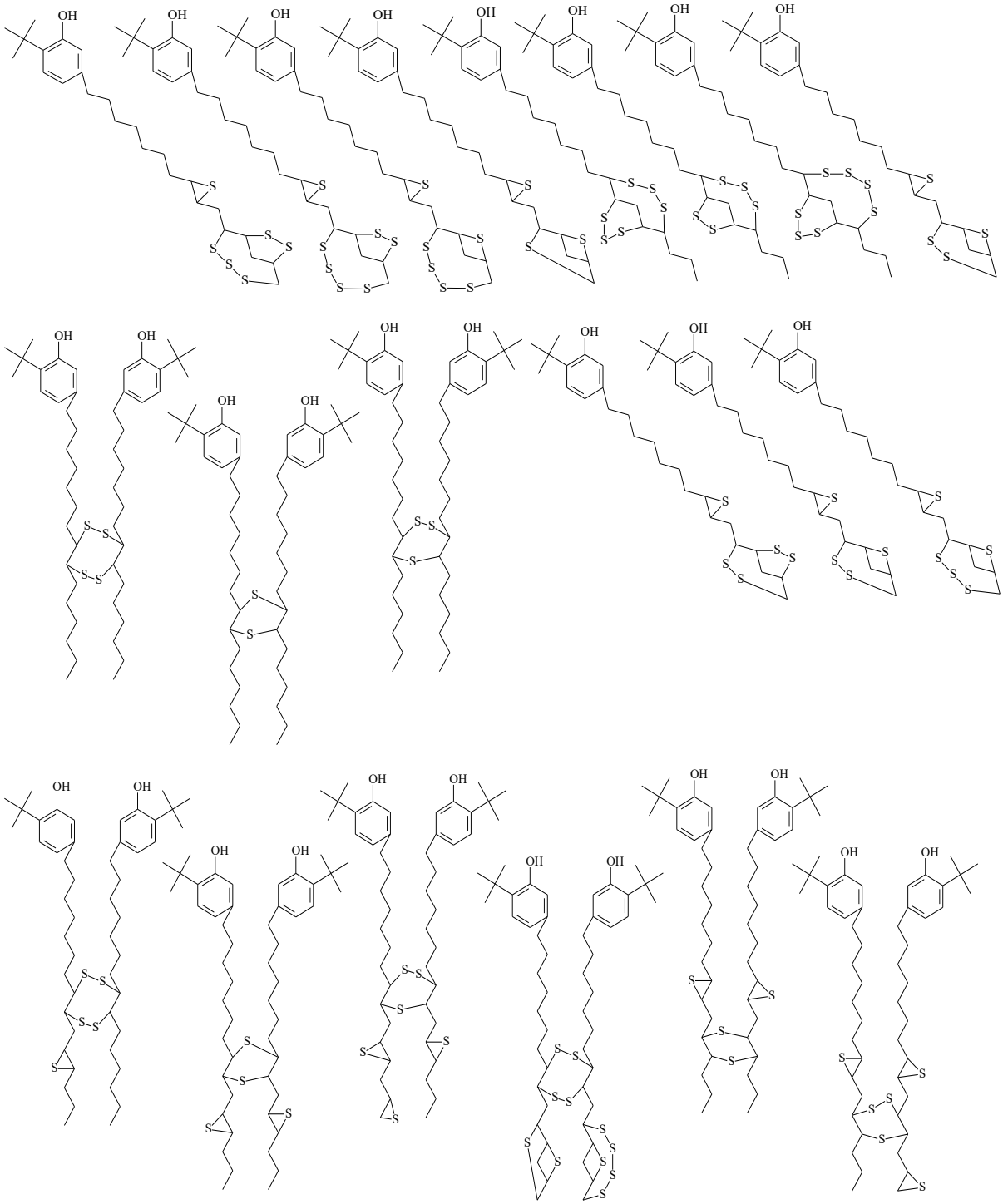
Wherein, R_1 and R_1' can be identical or different and each independently selected from $C_nH_{(2n+m)}$, n is an integral number of 3-30 (preferably an integral number of 5-20, most preferably an integral number of 10-18, for example can be 10, 11, 12, 13, 14, 15, 16, 17, 18), m is 1, -1, -3 or -5 (preferably 1, -1 or -3); R_2 and R_2' can be identical or different and each independently selected from C_{1-6} linear or branched alkyl (preferably selected from C_1-C_4 linear or branched alkyl, most preferably tert-butyl); R_3 is selected from C_1-C_6 linear or

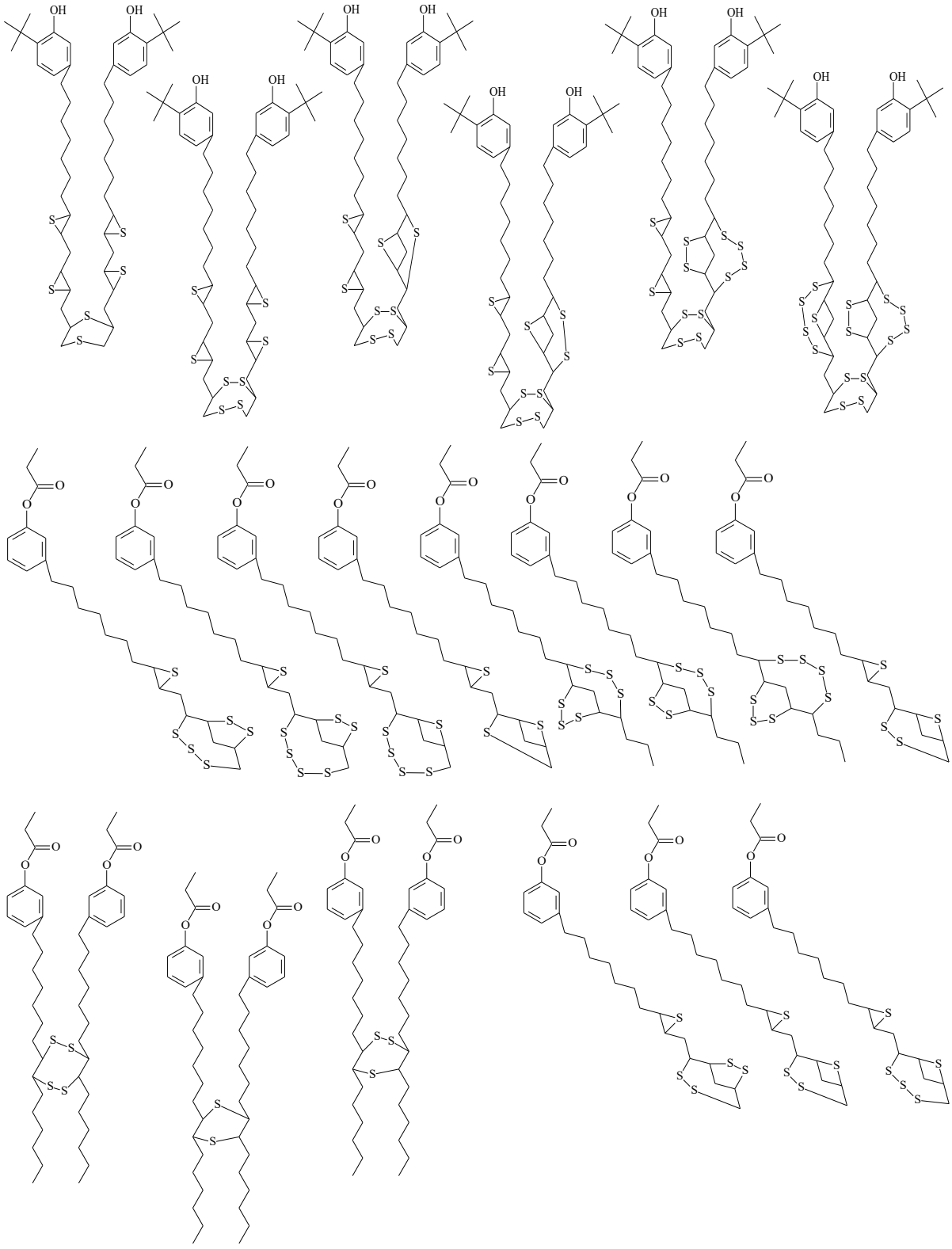
branched alkylene (preferably selected from C_1-C_4 linear or branched alkylene, most preferably methylene).

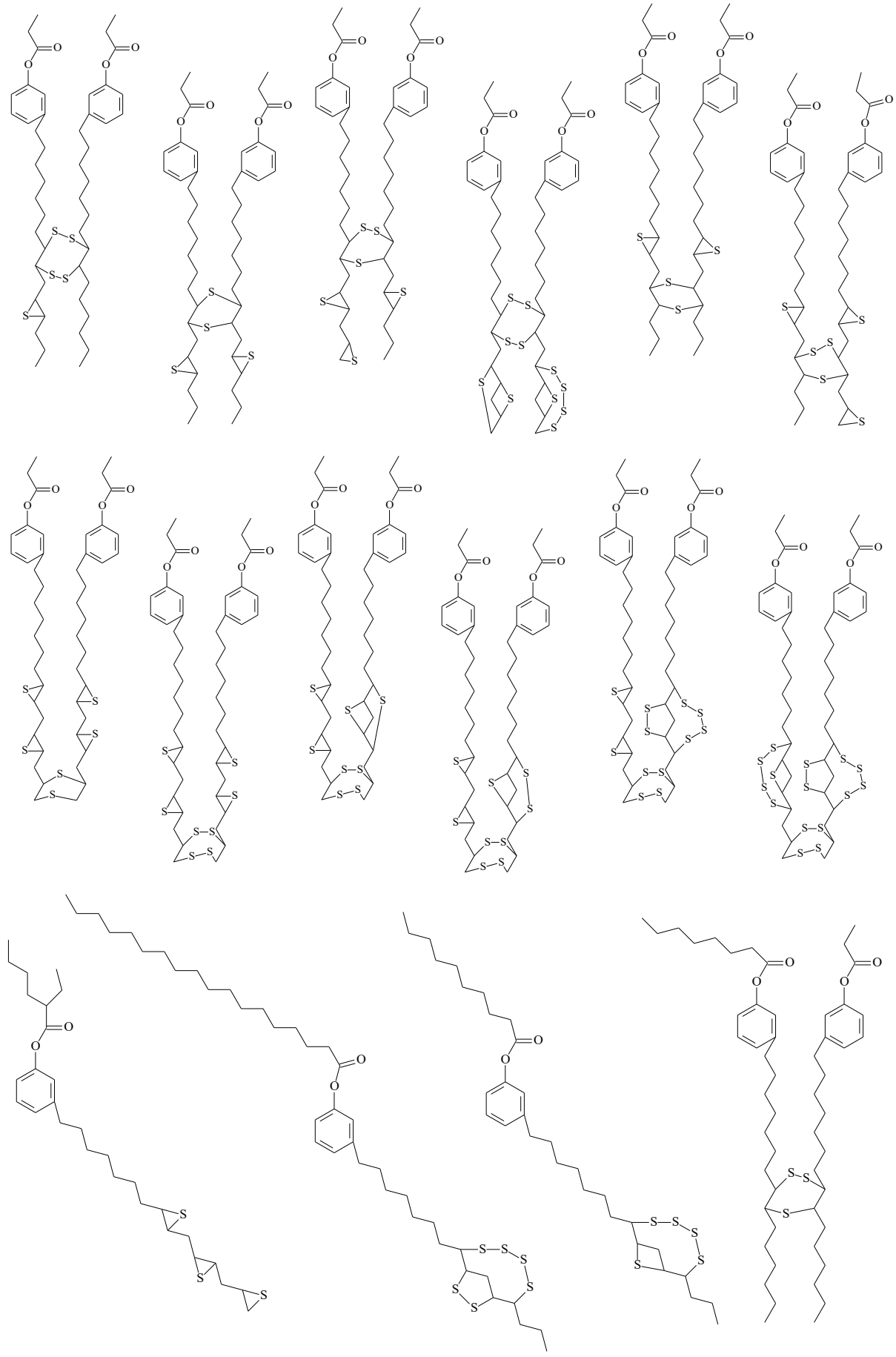
4. The phenol derivative according to any of claims 1-3, which is characterized in that the phenol derivative is selected from the following specific compounds or a mixture thereof in any proportion:





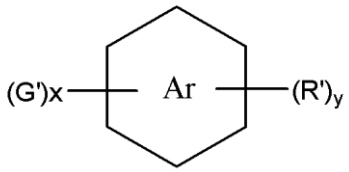






Wherein, R_0, R_2 and R_3 are defined as above (preferably, groups R_0 are ethyl, groups R_2 are each independently selected from C_2-C_{18} alkyl, groups R_3 are each independently selected from C_2-C_{18} alkyl).

5. A process of preparing a phenol derivative, comprising a first step of subjecting the compound represented by the general formula (I') to at least one reaction of an epoxidation reaction, a sulfurization reaction and a coupling reaction, and a second step of subjecting to one or more reactions of an optional esterification reaction, an optional alkylation reaction and an optional hydrogenation reaction, and a third step of subjecting to at least one reaction selected from an epoxidation reaction, a sulfurization reaction and a coupling reaction and different from the reactions in the first step;

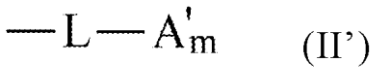


(I')

In the formula (I'), x groups G' are bonded to the ring group Ar, y groups R' are bonded to the ring group Ar;

x groups G' are, identical to or different from each other, each independently selected from -OH and H, wherein at least one group G' is-OH; x is selected from an integral number of 1-10 (preferably an integral number of 1-5);

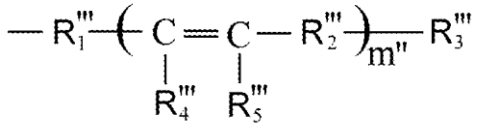
y groups R' are, identical to or different from each other, each independently selected from hydrogen, C_{1-50} hydrocarbyl optionally substituted by one or more substituent groups, C_{6-20} aryl substituted by one or more substituent groups, C_{3-50} hetero hydrocarbyl optionally substituted by one or more substituent groups, C_{1-50} alkyloxy optionally substituted by one or more substituent groups and a group represented by the formula (II') (preferably selected from hydrogen, C_{1-50} linear or branched alkyl, linear or branched C_{3-50} heteroalkyl, C_{1-50} linear or branched alkyloxy and a group represented by the formula (II')), wherein at least one group R' is selected from a group represented by the formula (II');



(II')

Groups L in y groups R' are each independently selected from single bond, (m+1)-valent C_{1-50} hydrocarbyl optionally substituted by one or more substituent groups and (m+1)-valent C_{3-50} hetero hydrocarbyl optionally substituted by one or more substituent groups (preferably selected from single bond, (m+1)-valent C_{1-50} linear or branched alkyl and (m+1)-valent linear or branched C_{3-50} heteroalkyl); y is selected from an integral number of 1-10 (preferably an integral number of 1-5);

m groups A' in the formula (II') are each independently selected from a group represented by the formula (III'); the numbers m in the formula (II') are each independently selected from an integral number of 1-10 (preferably an integral number of 1-5);



(III')

Wherein group R_1''' is selected from single bond and C_{1-20} linear or branched alkylene (preferably selected from single bond and C_{1-4} linear or branched alkylene); groups R_2''' in m'' repeating units are, identical to or different from each other, each independently selected from single bond and C_{1-20} linear or branched alkylene (preferably each independently selected from single bond and C_{1-4} linear or branched alkylene); group R_3''' is selected from hydrogen and C_{1-20} linear or branched alkyl (preferably selected from hydrogen and C_{1-4} linear or branched alkyl); groups R_4''' in m'' repeating units are, identical to or different from each other, each independently selected from hydrogen and C_{1-20} linear or branched alkyl (preferably each independently selected from hydrogen and C_{1-4} linear or branched alkyl); groups R_5''' in m'' repeating units are, identical to or different from each other, each independently selected from hydrogen and C_{1-20} linear or branched alkyl (preferably each independently selected from hydrogen and C_{1-4} linear or branched alkyl); m'' is an integral number of 1-10 (preferably an

integral number of 1-5, more preferably an integral number of 1-3);

The ring group 

is selected from (x+y)-valent C_{3-20} cycloalkyl (preferably C_{3-6} cycloalkyl, more preferably cyclopentyl, cyclohexyl) and (x+y)-valent C_{6-20} aryl (preferably C_{6-14} aryl, more preferably phenyl, biphenylyl, naphthyl, anthryl, phenanthryl);

The above-mentioned "substituent group" is selected from C_{1-20} alkyl, C_{1-20} alkoxyl, C_{6-10} aryl, hydroxy, amino, mercapto and halogen atom.

6. The preparation process according to claim 5, which is characterized in that the compound represented by the general formula (I') can be subjected to at least one reaction of an epoxidation reaction, a sulfurization reaction and a coupling reaction in the first step, followed by one or more reactions of an optional esterification reaction, an optional alkylation reaction and an optional hydrogenation reaction in the second step; or the compound represented by the general formula (I') can be subjected to one or more reactions of an optional esterification reaction, an optional alkylation reaction and an optional hydrogenation reaction in the second step, followed by at least one reaction of an epoxidation reaction, a sulfurization reaction and a coupling reaction in the first step.

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7. The preparation process according to any of claims 5-6, which is characterized in that the epoxidation reaction is to react -C=C- in the compound represented by the formula (I') with an epoxidizing agent, or to react a product obtained from subjecting the compound represented by the formula (I') to one or more reactions of an optional esterification reaction, an optional alkylation reaction and an optional hydrogenation reaction in the second step with an epoxidizing agent, preferably, the epoxidizing agent is preferably a peroxide, for example can be selected from one or more of hydrogen peroxide, peroxyformic acid, peroxyacetic acid, peroxysulfonic acid, m-chloro peroxybenzoic acid, tert-butyl hydroperoxide, tert-butyl peroxyacetate, methyl ethyl ketone peroxide, dibenzoyl peroxide and cyclohexanone peroxide.

8. The preparation process according to any of claims 5-6, which is characterized in that in the epoxidation reaction, based on the compound represented by the formula (I') or the product of the second step, the molar ratio of the compound represented by the formula (I') or the product

of the second step to the epoxidizing agent is 1:1-10 (preferably 1:2-5); the epoxidation reaction temperature is 0°C-100°C (preferably 10°C-80°C).

9. The preparation process according to any of claims 5-6, which is characterized in that the sulfurization reaction is to react -C=C- in the compound represented by the formula (I') with a sulfurizing agent, or to react a product obtained from subjecting the compound represented by the formula (I') to one or more reactions of an optional esterification reaction, an optional alkylation reaction and an optional hydrogenation reaction in the second step with a sulfurizing agent, preferably, the sulfurizing agent is selected from an inorganic sulfurizing agent and/or an organic sulfurizing agent, more preferably, the inorganic sulfurizing agent can be selected from one or more of sulphur, Na_2S, K_2S, ZnS, H_2S and SCl; the organic sulfurizing agent can be selected from one or more of ditertbutyl polysulfide (DBPS), dimethyl disulphide (DMDS), dimethyl sulfide (DMS), ethyl mercaptan (EM), n-butyl mercaptan (NBM) and tert-nonyl polysulfide (TNPS).

10. The preparation process according to any of claims 5-6 and 9, which is characterized in that in the sulfurization reaction, based on the compound represented by the formula (I') or the product of the second step, the molar ratio of the compound represented by the formula (I') or the product of the second step to the sulfurizing agent is 1:1-6 (preferably 1:2-4); the sulfurization reaction temperature is 100°C-240°C (preferably 140°C-190°C).

11. The preparation process according to any of claims 5-6, which is characterized in that the esterification reaction is to react a hydroxy group on the ring group of the compound represented by the formula (I') with an esterifying agent, or to react the reaction product obtained from subjecting the compound represented by the formula (I') to at least one reaction of an epoxidation reaction, a sulfurization reaction and a coupling reaction in the first step and/or to one or more reactions of an optional alkylation reaction and an optional hydrogenation reaction in the second step with an esterifying agent, preferably, the esterifying agent can be one or more of fatty acid, fatty acid anhydride and alkyl halide, wherein the alkyl is C_1-C_{30} linear or branched alkyl.

12. The preparation process according to any of claims 5-6 and 11, which is characterized in

that in the esterification reaction, based on the compound represented by the formula (I') or the above-mentioned reaction product, the molar ratio of the compound represented by the formula (I') or the above-mentioned reaction product to the esterifying agent is 1:1-10 (preferably 1:2-8); the reaction temperature is 80°C-260°C (preferably 120°C-210°C).

13. The preparation process according to any of claims 5-6, which is characterized in that the alkylation reaction is to react ortho-and para-position hydrogens of the hydroxy groups on the ring group present in the compound represented by the formula (I') with an alkylating agent, or to react ortho-and para-position hydrogens of the hydroxy groups on the ring group present in the reaction product obtained from subjecting the compound represented by the formula (I') to at least one reaction of an epoxidation reaction, a sulfurization reaction and a coupling reaction in the first step and/or to one or more reactions of an optional esterification reaction and an optional hydrogenation reaction in the second step with an alkylating agent, preferably, the alkylating agent is selected from one or more of halohydrocarbon, fatty alcohol and alkene, more preferably alkyl halide and/or alkene, for example can be selected from one or more of tert-butyl chloride, tert-butyl bromide, isobutylene and isopropylene.

14. The preparation process according to any of claims 5-6 and 13, which is characterized in that in the alkylation reaction, based on the compound represented by the formula (I') or the above-mentioned reaction product, the molar ratio of the compound represented by the formula (I') or the above-mentioned reaction product to the alkylating agent is 1:1-5 (preferably 1:1-2.5); the reaction temperature is 20°C-100°C (preferably 40°C-70°C).

15. The preparation process according to any of claims 5-6, which is characterized in that the hydrogenation reaction is to react the unsaturated bond (-C=C-) in the compound represented by the formula (I') with a hydrogenating agent, or to react the unsaturated bond (-C=C-) present in the reaction product obtained from subjecting the compound represented by the formula (I') to at least one reaction of an epoxidation reaction, a sulfurization reaction and a coupling reaction in the first step and/or to one or more reactions of an optional esterification reaction and an optional alkylation reaction in the second step with a hydrogenating agent, the hydrogenating agent is preferably hydrogen gas.

16. The preparation process according to any of claims 5-6 and 15, which is characterized in that in the hydrogenation reaction, based on the compound represented by the formula (I') or the above-mentioned reaction product, the molar ratio of the compound represented by the formula (I') to the hydrogenating agent is 1:1-10 (preferably 1:2-5); the reaction temperature is 60°C-260°C (preferably 180°C-220°C).

17. The preparation process according to any of claims 5-6, which is characterized in that the coupling reaction is to react the compound represented by the formula (I') with a coupling agent, or to react the product obtained from subjecting the compound represented by the formula (I') to at least one reaction of an epoxidation reaction, and a sulfurization reaction in the first step and/or one or more reactions of an optional esterification reaction, an optional alkylation reaction and an optional hydrogenation reaction in the second step with a coupling agent, preferably, the coupling agent is preferably C_1-C_6 aldehyde, more preferably, the coupling agent is selected from formaldehyde, acetaldehyde, propionaldehyde, butyraldehyde, valeraldehyde or hexaldehyde.

18. The preparation process according to any of claims 5-6 and 17, which is characterized in that in the coupling reaction, based on the compound represented by the formula (I') or the reaction product, the molar ratio of the compound represented by the formula (I') or the reaction product to the coupling agent is 1-10:1 (preferably 2-5:1); the reaction temperature is 20°C-120°C (preferably 50°C-100°C).

19. The preparation process according to any of claims 5-18, which is characterized in that the phenol compound represented by the general formula (I') is derived from natural plant cashew.

20. A composition, which contains a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19.

21. A lubricating oil, which contains a base oil and a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19.

22. A lubricating grease, which contains a base oil and a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19.

23. Use of a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19 in the base oil of the lubricating oil.

24. Use of a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19 in the antioxidant.

25. Use of a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19 in the antiwear additive.

26. Use of a phenol derivative according to any of claims 1-4 or a phenol derivative prepared by the preparation process according to any of claims 5-19 in the lubricant.