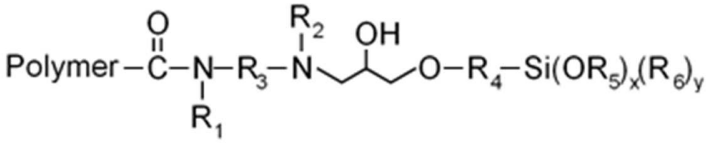
Patent claims:

1. An 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to general formula (I),



(I),

wherein

the polymer contains at least one carbon-carbon double bond and is a diene rubber obtainable by a homo- or copolymerization of one or more conjugated dienes,

wherein

- R_1 is selected from the group consisting of

  (i) a -C_1-C_{24}-alkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted;

  (ii) a -C_1-C_{24}-heteroalkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted;

  (iii) a 6-24-membered aryl that is unsubstituted, mono- or polysubstituted, wherein said 6-24-membered aryl is optionally connected through a -C_1-C_6-alkylene- or a -C_1-C_6-heteroalkylene-, which in each case is either saturated or unsaturated, and which is unsubstituted, mono- or polysubstituted;

  (iv) a 5-24-membered heteroaryl that is unsubstituted, mono- or polysubstituted; wherein said 5-24-membered heteroaryl is optionally connected through a -C_1-C_6-alkylene- or a -C_1-C_6-heteroalkylene-, which in each case is saturated or unsaturated and which is unsubstituted, mono- or polysubstituted;

  (v) a 3-24-membered cycloalkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted; wherein said 3-24-membered cycloalkyl is optionally connected through a -C_1-C_6-alkylene- or a -C_1-C_6-heteroalkylene-, which in each case saturated or unsaturated and which is unsubstituted, mono- or polysubstituted; and

(vi) a 3-24-membered heterocycloalkyl that is saturated or unsaturated and is unsubstituted, mono- or polysubstituted; wherein said 3-24-membered heterocycloalkyl is optionally connected through a -C_1-C_6-alkylene- or a -C_1-C_6-heteroalkylene-, which in each case is saturated or unsaturated and which is unsubstituted, mono- or polysubstituted;

- R_2 is selected from the group consisting of

(i) -C_1-C_{24}-alkyl, saturated or unsaturated, unsubstituted, mono- or polysubstituted;

(ii) -C_1-C_{24}-heteroalkyl, saturated or unsaturated, unsubstituted, mono- or polysubstituted;

(iii) 6-24-membered aryl, unsubstituted, mono- or polysubstituted, wherein said 6-24-membered aryl is optionally connected through -C_1-C_6-alkylene- or -C_1-C_6-heteroalkylene-, in each case saturated or unsaturated, unsubstituted, mono- or polysubstituted;

(iv) 5-24-membered heteroaryl, unsubstituted, mono- or polysubstituted; wherein said 5-24-membered heteroaryl is optionally connected through -C_1-C_6-alkylene- or -C_1-C_6-heteroalkylene-, in each case saturated or unsaturated, unsubstituted, mono- or polysubstituted;

(v) 3-24-membered cycloalkyl, saturated or unsaturated, unsubstituted, mono- or polysubstituted; wherein said 3-24-membered cycloalkyl is optionally connected through -C_1-C_6-alkylene- or -C_1-C_6-heteroalkylene-, in each case saturated or unsaturated, unsubstituted, mono- or polysubstituted; and

(vi) 3-24-membered heterocycloalkyl, saturated or unsaturated, unsubstituted, mono- or polysubstituted; wherein said 3-24-membered heterocycloalkyl is optionally connected through -C_1-C_6-alkylene- or -C_1-C_6-heteroalkylene-, in each case saturated or unsaturated, unsubstituted, mono- or polysubstituted;

- R_3 is selected from the group consisting of

(i) a -C_1-C_6-alkylene- that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted;

(ii) a -C_1-C_6-heteroalkylene- that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted; and

(iii) a 6-14-membered arylene that is unsubstituted, mono- or polysubstituted;

- R_4 is selected from the group consisting of
  - (i) a -C_1-C_6-alkylene- that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted;
  - (ii) a -C_1-C_6-heteroalkylene- that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted; and
  - (iii) a 6-14-membered arylene that is unsubstituted, mono- or polysubstituted;
- R_5 is selected from the group consisting of
  - (i) a -C_1-C_6-alkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted;
  - (ii) a -C_1-C_6-heteroalkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted; and
  - (iii) a 6-14-membered aryl that is unsubstituted, mono- or polysubstituted;
- R_6 is selected from the group consisting of
  - (i) a -C_1-C_6-alkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted;
  - (ii) a -C_1-C_6-heteroalkyl that is saturated or unsaturated and that is unsubstituted, mono- or polysubstituted; and
  - (iii) a 6-14-membered aryl that is unsubstituted, mono- or polysubstituted;

wherein "*substituted"* means substituted with a substituent selected from -F, -Cl, -Br, -I, -CN, =O, -CF_3, -CF_2H, -CFH_2, -CF_2Cl, -$CFCl_2$, a -C_1-C_{18}-alkyl that is saturated or unsaturated, or a -C_1-C_{18}-heteroalkyl that is saturated or unsaturated, and wherein "*monosubstituted*" means substituted with one substitutent and "*polysubstituted*" means substituted more than one substituent and wherein the more than one substituents are selected independently from each other from -F, -Cl, -Br, -I, -CN, =O, -CF_3, -CF_2H, -CFH_2, -CF_2Cl, -$CFCl_2$, a -C_1-C_{18}-alkyl that is saturated or unsaturated, or a -C_1-C_{18}-heteroalkyl that is saturated or unsaturated;
and wherein

$x+y = 3$ with $1 \leq x \leq 3$ and $0 \leq y \leq 2$.

2. The 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to claim 1, wherein the polymer is obtainable by a copolymerization of one or more conjugated dienes with one or more vinylaromatic monomers.

3. The 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to claim 2, wherein the polymer is obtainable by a homo- or copolymer of 1,3-butadiene, isoprene, 1,3-pentadiene, 2,3-dimethylbutadiene, 1-phenyl-1,3-butadiene, myrcene, farnecenes, ocimenes, 1,3-hexadiene or a combination thereof; or a copolymer of (i) 1,3-butadiene, isoprene, 1,3-pentadiene, 2,3-dimethylbutadiene, 1-phenyl-1,3-butadiene, 1,3-hexadiene,myrcene, farnecenes, ocimenes, or a combination thereof with (ii) styrene, o-, m- and/or p-methylstyrene, p-tert-butylstyrene, methylstyrene, vinylnaphthalene, divinylbenzene, trivinylbenzene, divinylnaphthalene or a combination thereof.

4. The 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to claim 3, wherein the polymer is obtainable by copolymerization of 1,3-butadiene with styrene or isoprene with styrene; preferably of 1,3-butadiene with styrene.

5. The 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to claim 1, wherein

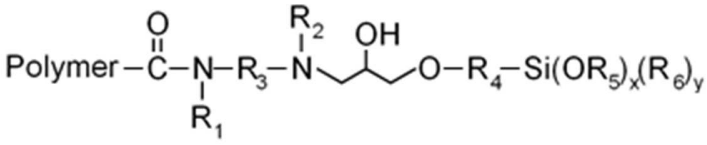
   - R_1 is (i) a -C_1-C_6-alkyl that is saturated or unsaturated and that is unsubstituted
   - R_2 is a (i) a -C_1-C_6-alkyl that is saturated or unsaturated and that is unsubstituted
   - R_3 is a (i) -C_1-C_6-alkylene- that is saturated or unsaturated and that is unsubstituted
   - R_4 is a -C_1-C_6-alkylene- that is saturated or unsaturated and that is unsubstituted
   - R_5 is a -C_1-C_6-alkyl that is saturated or unsaturated and that is unsubstituted and R_6 is a -C_1-C_6-alkyl that is saturated or unsaturated and that is unsubstituted;, x is 3 and y is 0.

6. The 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to any of the preceding claims, wherein

   - the polymer is obtainable by copolymerization of 1,3-butadiene with styrene;
   - R_1 is a -C_1-C_2-alkyl that is saturated or unsaturated and that is unsubstituted;

- R_2 is a -C_1-C_2-alkyl that is saturated or unsaturated and that isunsubstituted;
- R_3 is a -C_1-C_2-alkylene- that issaturated or unsaturated and that is unsubstituted;
- R_4 is a -C_3-alkylene- that issaturated or unsaturated and that is unsubstituted;
- R_5 and R_6 are independently of one another a -C_1-C_2-alkyl that is saturated or unsaturated and that is unsubstituted; and
- $x+y = 3$ with $1 \leq x \leq 3$ and $0 \leq y \leq 2$.

7. A method for manufacturing a 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to general formula (I),

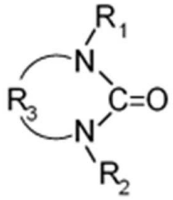


(I),

comprising the following steps:

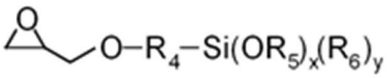
(a) providing a polymer containing at least one carbon-carbon double bond;

(b) providing a cyclic urea derivative of the general formula (II)



(II);

(c) providing a glycidoxyalkylsilane of the general formula (III)



(III);

(d) adding the cyclic urea derivative of the general formula (II) to the polymer as a first functionalization reagent to form a functionalized polymer intermediate; and

(e) subsequently adding the glycidoxyalkylsilane of the general formula (III) to the functionalized polymer intermediate as a second functionalization reagent to form the 1-amino-3-(oxyalkylalkoxysilyl)-2-propanol-terminated polymer according to general formula (I);

wherein the polymer, x, y, R_1, R_2, R_3, R_4, R_5 and R_6 are as defined in any of claims 1 to 6.

8. The method according to claim 7, wherein step (a) is performed by an anionic solution polymerization, or a polymerization using a coordination catalyst, wherein the coordination catalyst is preferably a Ziegler-Natta catalyst or a monometallic catalyst system.

9. The method according to claims 7 or 8, wherein step (a) is performed in the presence of a solvent, wherein the solvent is preferably selected from the group consisting of cyclohexane, methylcyclopentane, n-hexane and mixtures thereof; and/or an initiator, which is preferably n-butyllithium or sec-butyllithium.

10. The method according to any one of claims 7 to 9, wherein step (a) is performed within a period of 10 minutes to 8 hours, preferably 20 minutes to 4 hours.

11. The method according to any one of claims 7 to 9, which comprises the additional step(s) of adding

    (f) a coupling reagent before, together with or after addition of the cyclic urea derivative of the general formula (III), wherein the coupling reagent is preferably selected from the group consisting of silicon tetrachloride, methyltrichlorosilane, dimethyldichlorosilane, tin tetrachloride, dibutyltin dichloride, tetraalkoxysilanes, ethylene glycol diglycidyl ether and 1,2,4-tris(chloromethyl)benzene; and/or

    (g) an antioxidant after the cyclic urea derivative of the general formula (III) and the cyclic carboxylic anhydride of the general formula (IV) have been added, wherein the antioxidant is preferably selected from the group consisting of sterically hindered phenols, aromatic amines, phosphites and thioethers; and/or

    (h) an extender oil, wherein the extender oil is preferably selected from the group consisting of a TDAE (Treated Distillate Aromatic Extract)-, a MES (Mild Extraction Solvates)-, a RAE (Residual Aromatic Extract)-, a TRAE (Treated Residual Aromatic Extract)-, a naphthenic and a heavy naphthenic oil; and/or

    (i) a filler, which is preferably carbon black or silica; and/or

    (j) rubbers and/or rubber additives.

12. A molded article prepared from a vulcanizable composition comprising the polymer according to any one of claims 1 to 6 wherein the preparation comprises vulcanization of the vulcanizable composition.

13. The molded article of claim 12 being selected from cable sheaths, hoses, drive belts, conveyor belts, roll linings, shoe soles, sealing rings, damping elements.

14. The molded article of claim 12 being selected from a tire.

15. The molded article of claim 12 being selected from a tire tread.