

CLAIMS

1. Modified diene elastomer composed:

5 a) at least 55% by weight, with respect to the total weight of the modified diene elastomer, of entity coupled by a functional group bearing a function of formula $-\text{SiOR}$, in which R is a hydrogen atom or an alkyl radical having from 1 to 10 carbon atoms, and optionally bearing another function capable of interacting with a reinforcing filler, the group being bonded to the two branches of the diene elastomer via the silicon atom,

10 b) of from 5% by weight to 30% by weight, with respect to the total weight of the modified diene elastomer, of star-branched entity having three elastomeric branches connected to one and the same silicon atom belonging to a functional group bearing or not bearing a function capable of interacting with a reinforcing filler,

15 c) of a content of less than or equal to 15% by weight, with respect to the total weight of the modified diene elastomer, of entity functionalized at the chain end by a functional group bearing a function $-\text{Si}(\text{OR})_2$, in which R is a hydrogen atom or an alkyl radical having from 1 to 10 carbon atoms, and optionally bearing another function capable of interacting with a reinforcing
20 filler, the group being bonded to the diene elastomer via the silicon atom, and

d) of a content of less than or equal to 15% by weight, with respect to the total weight of the modified diene elastomer, of non-functional diene elastomer,

the said diene elastomers a), b), c) and d) being, before modification, of the same macrostructure and the same microstructure.

25 2. Elastomer according to Claim 1, characterized in that it preferably comprises at least 10% by weight and at most 25% by weight, more preferably at most 20% by weight, with respect to the total weight of the modified diene elastomer, of the said star-branched diene elastomer b).

3. Elastomer according to Claim 1 or 2, characterized in that it comprises a content strictly of greater than 0% by weight and less than 10% by weight, with respect to the total weight of the modified diene elastomer, of the said non-functional diene elastomer d).
- 5 4. Elastomer according to any one of the preceding claims, characterized in that it comprises a content of greater than or equal to 65% by weight, with respect to the total weight of the modified diene elastomer, of the said coupled diene elastomer a).
5. Elastomer according to any one of the preceding claims, characterized in that it comprises a content of less than or equal to 10% by weight, with respect to the total weight of the modified diene elastomer, of the said entity functionalized at the chain end c).
- 10 6. Elastomer according to any one of the preceding claims, characterized in that the function capable of interacting with a reinforcing filler is a function chosen from primary, secondary or tertiary and cyclic or non-cyclic amines, isocyanates, imines, cyanos, thiols, carboxylates, epoxides or primary, secondary or tertiary phosphines.
- 15 7. Elastomer according to the preceding claim, characterized in that the function capable of interacting with a reinforcing filler is a tertiary amine function, preferably a diethylamine or dimethylamine function.
8. Elastomer according to any one of the preceding claims, characterized in that the function capable of interacting with a reinforcing filler and the silicon atom bonded to the elastomer are connected to one another via a spacer group defined as being a saturated or unsaturated, cyclic or non-cyclic, linear or branched, divalent C₁-C₁₈ aliphatic hydrocarbon radical or a divalent C₆-C₁₈ aromatic hydrocarbon radical and can comprise one or more aromatic radicals and/or one or more heteroatoms.
- 20 9. Elastomer according to the preceding claim, characterized in that the spacer group is a linear divalent C₁-C₆ aliphatic hydrocarbon radical, preferably the linear C₃ aliphatic radical.
- 25 10. Elastomer according to any one of the preceding claims, characterized in that, in the formulae -SiOR and -Si(OR)₂ representing the alkoxysilane functions of the

entities a) and c), R is an alkyl radical having from 1 to 4 carbon atoms, preferably a methyl or ethyl radical.

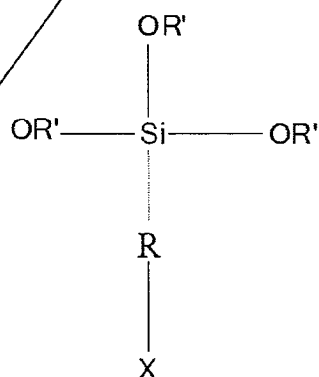
11. Elastomer according to any one of the preceding claims, characterized in that, in the formulae $-\text{SiOR}$ and $-\text{Si}(\text{OR})_2$ representing the alkoxysilane functions of the entities a) and c), R is a hydrogen atom.

12. Elastomer according to any one of the preceding claims, characterized in that the diene elastomer is chosen from polybutadienes, butadiene/styrene copolymers, butadiene/isoprene copolymers, isoprene/styrene copolymers, butadiene/styrene/isoprene terpolymers and synthetic polyisoprene, preferably a butadiene/styrene copolymer.

13. Process for the synthesis of an elastomer as defined in any one of Claims 1 to 12, characterized in that it comprises a stage of mixing at least two diene elastomers of the same nature, which are modified by one and the same functionalization agent, and exhibiting a different composition, these diene elastomers of different compositions being obtained by carrying out a modification stage, after an anionic polymerization stage, while varying the molar ratio of the functionalization agent to the polymerization initiator:

- from 0.40 to 0.75, in order to favour the formation of coupled entities,
- from 0.20 to 0.35, in order to favour the formation of star-branched entities,
- and/or
- at least equal to 0.75, in order to favour the formation of entities functionalized at the chain end,

the functionalization agent corresponding to the following formula 1:



Formula 1

in which:

- 5 ○ R is a saturated or unsaturated, cyclic or non-cyclic, divalent C₁-C₁₈ aliphatic hydrocarbon radical or divalent C₆-C₁₈ aromatic hydrocarbon radical, preferably a linear or branched, divalent C₁-C₁₀ aliphatic hydrocarbon radical, more preferably a linear divalent C₁-C₆ aliphatic hydrocarbon radical and more preferably still the linear C₃ hydrocarbon radical,
- 10 ○ X is a hydrogen atom or a function capable of interacting with a reinforcing filler,
- the R' radicals, which are substituted or unsubstituted and identical or different, represent a C₁-C₁₀, indeed even C₁-C₈, alkyl group, preferably a C₁-C₄ alkyl group, more preferably methyl and ethyl.

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14. Reinforced rubber composition based on at least one reinforcing filler and on an elastomer matrix, characterized in that the elastomer matrix comprises at least one modified diene elastomer as defined in any one of Claims 1 to 12.

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15. Reinforced rubber composition according to Claim 14, characterized in that the reinforcing filler comprises at least 50% by weight of silica, with respect to the total weight of the reinforcing filler.

16. Tyre, characterized in that one of its constituent elements comprises a crosslinkable or crosslinked rubber composition as defined in Claim 14 or 15.

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b) of from 5% by weight to 30% by weight, with respect to the total weight of the modified diene elastomer, of star-branched entity having three elastomeric branches connected to one and the same silicon atom belonging to a functional group bearing or not bearing a function capable of interacting with a reinforcing filler,

c) of a content of less than or equal to 15% by weight, with respect to the total weight of the modified diene elastomer, of entity functionalized at the chain end by a functional group bearing a function $-\text{Si(OR)}_2$, in which R is a hydrogen atom or an alkyl radical having from 1 to 10 carbon atoms, and optionally bearing another function capable of interacting with a reinforcing filler, the group being bonded to the diene elastomer via the silicon atom, and

d) of a content of less than or equal to 15% by weight, with respect to the total weight of the modified diene elastomer, of non-functional diene elastomer,

the said diene elastomers a), b), c) and d) being, before modification, of the same macrostructure and the same microstructure.

2. Elastomer according to Claim 1, characterized in that it preferably comprises at least 10% by weight and at most 25% by weight, more preferably at most 20% by weight, with

respect to the total weight of the modified diene elastomer, of the said star-branched diene elastomer b).

3. Elastomer according to Claim 1 or 2, characterized in that it comprises a content strictly of greater than 0% by weight and less than 10% by weight, with respect to the total weight of the modified diene elastomer, of the said non-functional diene elastomer d).

4. Elastomer according to any one of the preceding claims, characterized in that it comprises a content of greater than or equal to 65% by weight, with respect to the total weight of the modified diene elastomer, of the said coupled diene elastomer a).

5. Elastomer according to any one of the preceding claims, characterized in that it comprises a content of less than or equal to 10% by weight, with respect to the total weight of the modified diene elastomer, of the said entity functionalized at the chain end c).

6. Elastomer according to any one of the preceding claims, characterized in that the function capable of interacting with a reinforcing filler is a function chosen from primary, secondary or tertiary and cyclic or non-cyclic amines, isocyanates, imines, cyanos, thiols, carboxylates, epoxides or primary, secondary or tertiary phosphines.

7. Elastomer according to the preceding claim, characterized in that the function capable of interacting with a reinforcing filler is a tertiary amine function, preferably a diethylamine or dimethylamine function.

8. Elastomer according to any one of the preceding claims, characterized in that the function capable of interacting with a reinforcing filler and the silicon atom bonded to the elastomer are connected to one another via a spacer group defined as being a saturated or unsaturated, cyclic or non-cyclic, linear or branched, divalent C₁-C₁₈ aliphatic hydrocarbon radical or a divalent C₆-C₁₈ aromatic hydrocarbon radical and can comprise one or more aromatic radicals and/or one or more heteroatoms.

9. Elastomer according to the preceding claim, characterized in that the spacer group is a linear divalent C₁-C₆ aliphatic hydrocarbon radical, preferably the linear C₃ aliphatic radical.

10. Elastomer according to any one of the preceding claims, characterized in that, in the formulae –SiOR and –Si(OR)₂ representing the alkoxysilane functions of the entities a) and c), R is an alkyl radical having from 1 to 4 carbon atoms, preferably a methyl or ethyl radical.

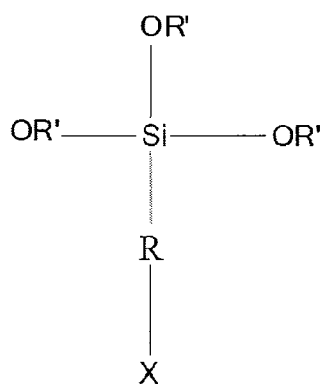
11. Elastomer according to any one of the preceding claims, characterized in that, in the formulae –SiOR and –Si(OR)₂ representing the alkoxysilane functions of the entities a) and c), R is a hydrogen atom.

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Formula 1

in which:

- R is a saturated or unsaturated, cyclic or non-cyclic, divalent C₁-C₁₈ aliphatic hydrocarbon radical or divalent C₆-C₁₈ aromatic hydrocarbon radical, preferably a linear or branched, divalent C₁-C₁₀ aliphatic hydrocarbon radical, more preferably a linear divalent C₁-C₆ aliphatic hydrocarbon radical and more preferably still the linear C₃ hydrocarbon radical,
- X is a hydrogen atom or a function capable of interacting with a reinforcing filler,
- the R' radicals, which are substituted or unsubstituted and identical or different, represent a C₁-C₁₀, indeed even C₁-C₈, alkyl group, preferably a C₁-C₄ alkyl group, more preferably methyl and ethyl.

14. Reinforced rubber composition based on at least one reinforcing filler and on an elastomer matrix, characterized in that the elastomer matrix comprises at least one modified diene elastomer as defined in any one of Claims 1 to 12.

15. Reinforced rubber composition according to Claim 14, characterized in that the reinforcing filler comprises at least 50% by weight of silica, with respect to the total weight of the reinforcing filler.
16. Tyre, characterized in that one of its constituent elements comprises a rubber composition as defined in Claim 14 or 15.
17. Tyre as claimed in claim 16 wherein the composition is crosslinkable or crosslinked.