CLAIMS

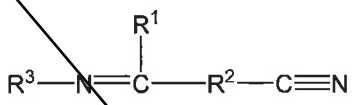
What is claimed is:

1. A method for preparing a functionalized polymer, the method comprising the steps of:

(i) polymerizing monomer to form a reactive polymer, and

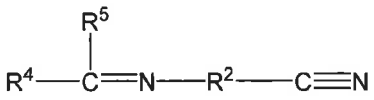
(ii) reacting the reactive polymer with an imine compound containing a cyano group.

2. The method of claim 1, where the imine compound containing a cyano group is defined by the formula I:



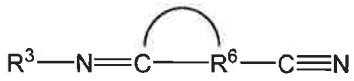
where R^1 is a hydrogen atom or a monovalent organic group, R^2 is a bond or a divalent organic group, and R^3 is a monovalent organic group, or where R^1 and R^2 join to form a trivalent organic group.

3. The method of claim 1, where the imine compound containing a cyano group is defined by the formula II:



where R^4 and R^5 are each independently a hydrogen atom or a monovalent organic group, and R^2 is a bond or a divalent organic group, or where R^4 and R^5 join to form a divalent organic group.

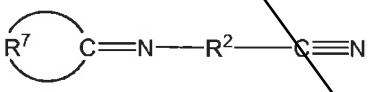
4. The method of claim 2, where the imine compound containing a cyano group is defined by the formula III:



where R^3 is a monovalent organic group, and R^6 is a trivalent organic group.

5. The method of claim 2, where R^1, R^2, and R^3 are devoid of heterocyclic groups.

6. The method of claim 3, where the imine compound containing a cyano group is defined by the formula IV:



where R^2 is a bond or a divalent organic group, and R^7 is a divalent organic group.

7. The method of claim 3, where R^2, R^4, and R^5 are devoid of heterocyclic groups.

8. The method of claim 4, where R^3 and R^6 are devoid of heterocyclic groups.

9. The method of claim 6, where R^2 and R^7 are devoid of heterocyclic groups.

10. The method of claim 1, where the imine compound containing a cyano group is an N-(cyanohydrocarbylidene)hydrocarbylamine, N-hydrocarbylidene(cyanohydrocarbyl)amine, N-(cyanocyclohydrocarbylidene)hydrocarbylamine, or N-cyclohydrocarbylidene(cyanohydrocarbyl)amine.

11. The method of claim 10, where the imine compound containing a cyano group is an N-(cyanohydrocarbylidene)hydrocarbylamine selected from the group consisting of N-[α-(cyanoaryl)hydrocarbylidene]arylamine, N-(cyanoalkylidene)alkylamine, N-[α-(cyanoaryl)hydrocarbylidene]alkylamine, and N-(cyanoalkylidene)arylamine.

12. The method of claim 10, where the imine compound containing a cyano group is an N-hydrocarbylidene(cyanohydrocarbyl)amine selected from the group consisting of N-(α-arylhydrocarbylidene)(cyanoaryl)amine, N-alkylidene(cyanoalkyl)amine, N-(α-arylhydrocarbylidene)(cyanoalkyl)amine, and N-alkylidene(cyanoaryl)amine.

13. The method of claim 10, where the imine compound containing a cyano group is an N-(cyanocyclohydrocarbylidene)hydrocarbylamine selected from the group consisting of N-(cyanocyclohydrocarbylidene)alkylamine and N-(cyanocyclohydrocarbylidene)arylamine.

14. The method of claim 10, where the imine compound containing a cyano group is an N-cyclohydrocarbylidene(cyanohydrocarbyl)amine selected from the group consisting of N-cyclohydrocarbylidene(cyanoalkyl)amine and N-cyclohydrocarbylidene(cyanoaryl)amine.

15. The method of claim 1, where the monomer includes conjugated diene monomer.

16. The method of claim 15, where said step of polymerizing employs a coordination catalyst.

17. The method of claim 16, where the coordination catalyst is a lanthanide-based catalyst.

18. The method of claim 17, where the lanthanide-based catalyst includes (a) a lanthanide-containing compound, (b) an alkylating agent, and (c) a halogen source.

19. The method of claim 18, where the alkylating agent includes an aluminoxane and an organoaluminum compound represented by the formula AlR_nX_{3-n}, where each R, which may be the same or different, is a monovalent organic group that is attached to the aluminum atom via a carbon atom, where each X, which may be the same or different, is a hydrogen atom, a halogen atom, a carboxylate group, an alkoxide group, or an aryloxide group, and where n is an integer of 1 to 3.

20. The method of claim 17, where said step of polymerizing monomer takes place within a polymerization mixture including less than 20% by weight of organic solvent.

21. The method of claim 15, where said step of polymerizing employs an anionic initiator.

22. The method of claim 21, where the anionic initiator is an organolithium compound.

23. A method for preparing a functionalized polymer, the method comprising the steps of:
(i) polymerizing conjugated diene monomer, and optionally monomer copolymerizable therewith, to form a polymer having a reactive chain end; and
(ii) reacting the reactive chain end of the polymer with an imine compound containing a cyano group.

24. The method of claim 23, where said step of polymerizing employs a coordination catalyst or an anionic initiator.

25. The method of claim 24, further comprising the step of protonating the polymer after said step of reacting.

26. A functionalized polymer prepared by the steps of:
(i) polymerizing conjugated diene monomer, and optionally monomer copolymerizable therewith, to form a polymer having a reactive chain end; and
(ii) reacting the reactive chain end of the polymer with an imine compound containing a cyano group.

27. A tire component prepared by employing the functionalized polymer of claim 26.

28. A vulcanizable composition comprising:
the functionalized polymer of claim 26, a filler, and a curative.

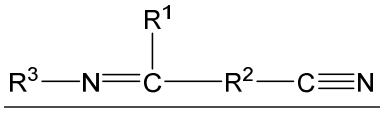
CLAIMS

What is claimed is:

1. A method for preparing a functionalized polymer, the method comprising the steps of:

(i) polymerizing monomer to form a reactive polymer, and

(ii) reacting the reactive polymer with an imine compound containing a cyano group where the imine compound containing a cyano group is defined by the formula I:



where R^1 is a hydrocarbyl group devoid of heteroatoms, R^2 is a bond or a divalent organic group, and R^3 is a hydrocarbyl group devoid of heteroatoms.

2. The method of claim 1, where the monomer includes conjugated diene monomer.

3. The method of claim 2, where said step of polymerizing employs a coordination catalyst.

4. The method of claim 3, where the coordination catalyst is a lanthanide-based catalyst.

5. The method of claim 4, where the lanthanide-based catalyst includes (a) a lanthanide-containing compound, (b) an alkylating agent, and (c) a halogen source.

6. The method of claim 5, where the alkylating agent includes an aluminoxane and an organoaluminum compound represented by the formula AlR_nX_{3-n}, where each R, which may be the same or different, is a monovalent organic group that is attached to the aluminum atom via a carbon atom, where each X, which may be the same or different, is a hydrogen atom, a halogen atom, a carboxylate group, an alkoxide group, or an aryloxide group, and where n is an integer of 1 to 3.

7. The method of claim 4, where said step of polymerizing monomer takes place within a polymerization mixture including less than 20% by weight of organic solvent.

8. The method of claim 1, where the imine compound containing a cyano group is an N-(cyanohydrocarbylidene)hydrocarbylamine selected from the group consisting of N-[α-(cyanoaryl)hydrocarbylidene]arylamine, N-(cyanoalkylidene)alkylamine, N-[α-(cyanoaryl)hydrocarbylidene]alkylamine, and N-(cyanoalkylidene)arylamine.

9. The method of claim 8, where the N-[α-(cyanoaryl)hydrocarbylidene]arylamine is selected from the group consisting of cis and trans isomers of N-(2-cyanobutylidene)-n-butylamine, N-(3-cyanobutylidene)-n-butylamine, N-(4-cyanobutylidene)-n-butylamine, N-(2-cyanobutylidene)-n-pentylamine, N-(3-cyanobutylidene)-n-pentylamine, N-(4-cyanobutylidene)-n-pentylamine, N-(2-cyanobutylidene)-n-hexylamine, N-(3-cyanobutylidene)-n-hexylamine, N-(4-cyanobutylidene)-n-hexylamine, N-(2-cyanobutylidene)cyclohexylamine, N-(3-cyanobutylidene)cyclohexylamine, and N-(4-cyanobutylidene)cyclohexylamine.

10. The method of claim 8, where the N-(cyanoalkylidene)alkylamine is selected from the group consisting of cis and trans isomers of N-(2-cyanobenzylidene)-n-butylamine, N-(3-cyanobenzylidene)-n-butylamine, N-(4-cyanobenzylidene)-n-butylamine, N-(2-cyanobenzylidene)-n-pentylamine, N-(3-cyanobenzylidene)-n-pentylamine, N-(4-cyanobenzylidene)-n-pentylamine, N-(2-cyanobenzylidene)-n-hexylamine, N-(3-cyanobenzylidene)-n-hexylamine, N-(4-cyanobenzylidene)-n-hexylamine, N-(2-cyanobenzylidene)cyclohexylamine, N-(3-cyanobenzylidene)cyclohexylamine, and N-(4-cyanobenzylidene)cyclohexylamine.

11. The method of claim 8, where the N-[α-(cyanoaryl)hydrocarbylidene]alkylamine is selected from the group consisting of cis and trans isomers of N-(2-cyanobutylidene)aniline, N-(3-cyanobutylidene)aniline, N-(4-cyanobutylidene)aniline, N-(2-cyanobutylidene)-2-methylaniline, N-(3-cyanobutylidene)-2-methylaniline, N-(4-cyanobutylidene)-2-methylaniline, N-(2-

cyanobutylidene)-3-methylaniline, N-(3-cyanobutylidene)-3-methylaniline, N-(4-cyanobutylidene)-3-methylaniline, N-(2-cyanobutylidene)-4-methylaniline, N-(3-cyanobutylidene)-4-methylaniline, and N-(4-cyanobutylidene)-4-methylaniline.

12. The method of claim 8, where the N-(cyanoalkylidene)arylamine is selected from the group consisting of cis and trans isomers of N-benzylidene-2-cyanoaniline, N-benzylidene-3-cyanoaniline, N-benzylidene-4-cyanoaniline, N-(2-methylbenzylidene)-2-cyanoaniline, N-(2-methylbenzylidene)-3-cyanoaniline, N-(2-methylbenzylidene)-4-cyanoaniline, N-(3-methylbenzylidene)-2-cyanoaniline, N-(3-methylbenzylidene)-3-cyanoaniline, N-(3-methylbenzylidene)-4-cyanoaniline, N-(4-methylbenzylidene)-2-cyanoaniline, N-(4-methylbenzylidene)-3-cyanoaniline, and N-(4-methylbenzylidene)-4-cyanoaniline.