We claim:

1. A process for polymerizing conjugated dienes in a hydrocarbon reaction medium, comprising

a) chemically adding a lithium alkoxide complexed saline hydride LOXSH catalyst to a low boiling conjugated diene to form a polymerization initiating species,

b) co-feeding at least two gaseous and/or volatile compounds to the reaction medium, wherein the at least two gaseous and/or volatile compounds comprise hydrogen and the low boiling conjugated diene, and

c) polymerizing at least a portion of the conjugated diene,

wherein the LOXSH reagent comprises one or more σ—μ polar modifiers, and

wherein a resulting polymer of the polymerizing step is characterized by high vinyl content from 30 wt.% to 82 wt.%.

2. A process for hydrogen mediated polymerization of conjugated dienes in a hydrocarbon reaction medium, comprising chemically adding lithium alkoxide complexed saline hydride (LOXSH) catalyst to a low boiling conjugated diene to form a polymerization initiating species, and co-feeding at least two gaseous and/or volatile compounds to the reaction medium, wherein the at least two gaseous and/or volatile compounds comprise hydrogen and the low boiling conjugated diene, wherein the LOXSH catalyst comprises one or more σ—μ polar modifiers.

3. The process of Claim 1 or 2 comprising co-feeding the low boiling conjugated diene and the hydrogen in a pre-set molar ratio to the polymerization reaction mixture over the course of at least a portion of the entire co-feed wherein the reactor pressure adjusts autogenously to the condensed phase activity of hydrogen and of the conjugated diene at a relative steady state pressure and temperature.

4. The process of Claim 1 or 2 wherein the reactor pressure over the course of the process (the autogenously generated reaction pressure) is the result or product of some combination of the following: a) the relative feed rate of hydrogen to monomer; b) the feed rate of reactants relative

to catalyst concentration; c) the reaction temperature; d) the activity of a particular LOXSH catalyst; and e) the vapor pressure of the reaction medium or solvent(s).

5. The process of Claim 1 or 2 wherein the relative feed of the CD monomer to hydrogen is from 5 mole to 42 mole CD/mole H_2

6. The process of Claim 5, wherein the relative feed rate of CD/H_2/unit time is from 0.0333 mole CD/mole H_2/min to 0.6667 mole CD/mole H_2/min.

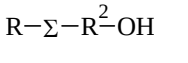
7. The process of Claim 1 or 2 wherein the relative feed of mole CD monomer to mole of saline hydride (SH) is from 70 mole to 1000 mole CD per mole SH in the LOXSH catalyst; wherein the saline hydride (SH) is one or more of LiH, and/or NaH, and/or KH, and/or MgH_2 and/or CsH.

8. The process of Claim 1 or 2 wherein the conjugated diene comprises one or more of the following: butadiene, isoprene, 2-methyl-1,3-pentadienes (E and Z isomers); piperylene; 2,3-dimethylbutadiene; 2-phenyl-1,3-butadiene; cyclohexadiene; β-myrcene; β-farnesene; and hexatriene.

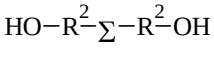
9. The process of Claim 1 or 2 wherein the conjugated diene comprises one or more of the butadiene and/or isoprene.

10. The process of Claim 1 or 2, further comprising copolymerizing anionically polymerizable hydrocarbon vinylaromatic monomer with the conjugated diene.

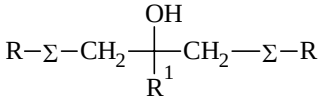
11. The process of Claim 1 or 2 wherein the one or more σ—μ polar modifiers is selected from one or more of the structures:



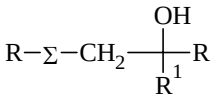
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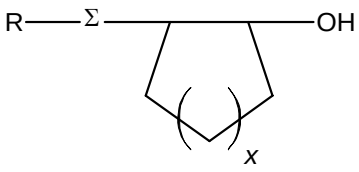
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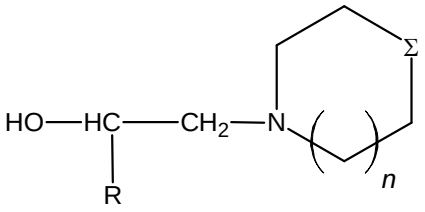
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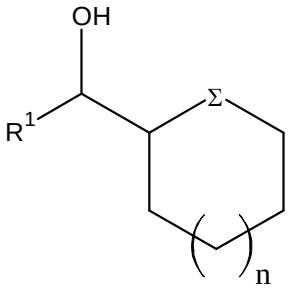
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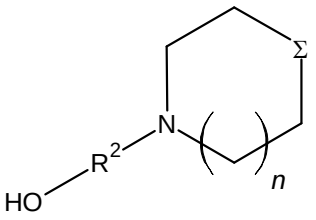
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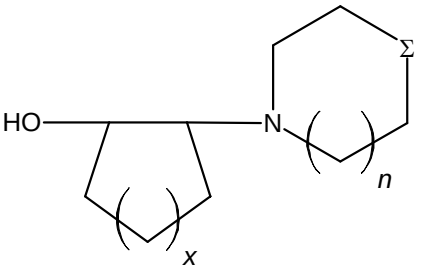
VI



VII



VIII



IX

wherein R is independently an alkyl group which may also be further substituted by other tertiary amines or ethers, R^1 is independently a hydrogen atom or an alkyl group which may also be further substituted by other tertiary amines or ethers, R^2 is $–(CH_2)_y–$, wherein y = 2, 3, or 4, Σ can include: i) O or NR for I, II, III, IV, and V ; ii) and for VI, VII, VIII and IX can include O or NR or CH_2; n is independently a whole number equal to or greater than 0, and x is independently a whole number equal to or greater than 1.

12. The process of Claim 1 or 2 wherein the hydrocarbon reaction medium is a hydrocarbon solvent with a pK_a greater than that of H_2.

13. The process of Claim 1 or 2 wherein the hydrocarbon reaction medium includes molecular hydrogen and the partial pressure of molecular hydrogen is maintained at pressures between 0.01 Bar to 19.0 Bar.

14. The process of Claim 3 or 4, wherein the autogenous reaction pressure is between 0.01 Bar to 19.0 Bar.

15. The process of Claim 1 or 2 wherein the process includes a temperature and the temperature is maintained between 20°C to 130°C.

16. The process of Claim 1 or 2 wherein the molar ratio of the total charge of monomer to saline hydride catalyst is 10:1 to 1000:1.

17. The process of Claim 1 or 2, wherein the saline hydride catalyst is a one or more of 1) LOXLiH reagent; 2) LOXNaH reagent; 3) LOXMgH_2; and/or 4) LOXKH reagent.

18. The process of Claim 1 or 2, wherein the σ—μ polar modifier is one more of *N,N*-dimethylethanolamine, 1-(dimethylamino)-2-propanol, 1-(dimethylamino)-2-butanol, *trans*-2-(dimethylamino)cyclohexanol; 2-piperidinoethanol; 1-piperidino-2-propanol; 1-piperidino-2-butanol, *trans*-2-piperidinocyclohexan-1-ol, 1-pyrrolidinoethanol, pyrrolidinylpropan-2-ol, 1-(1-pyrolidinyl)-2-butanol, 2-pyrolidinocyclohexanol, 4-methyl-1-piperazineethanol, 1-(4-methyl-1-piperazinyl)-2-propanol; 1-(4-methyl-1-piperazinyl)-2-butanol; *trans*-2-(4-methyl-1-piperazinyl)-cyclohexanol, 2-morpholinoethanol, 1-(4-morpholinyl)-2-propanol, 1-(4-morpholinyl)-2-butanol, *trans*-2-morpholin-4-ylcyclohexanol, 1-methyl-2-piperidinemethanol, 1-methyl-2-pyrrolidinemethanol, dimethylaminoethanol, *N*-methyl-diethanolamine, 3-dimethylamino-1-propanol, 1,3-bis(dimethylamino)-2-propanol, 2-{[2-dimethylamino)ethyl]methylamino}ethanol, 2-[2-(dimethylamino)ethoxy]ethanol, 2-(2-(piperidyl)ethoxy)ethanol, 2-[2-(4-morpholinyl)ethoxy]ethanol, 2-[2-(1-pyrrolidinyl)ethoxy]ethanol, 2-[2-(4-methyl-1-piperazinyl)ethoxy]ethanol.

19. The process of Claim 18, further comprising one or more 2-methoxyethanol, 1-methoxypropan-2-ol, 1-methoxybutan-2-ol, 2-methoxycyclohexan-1-ol, tetrahydrofurfuryl alcohol, tetrahydropyran-2-methanol, diethylene glycol monomethyl ether.

20. The process of Claim 1 or 2, wherein the LOXSH catalyst comprises
between 50 mole% to less than 100 mole % of an tertiary amino-alcohol or a tertiary amino-ether-alcohol σ—μ polar modifier selected from one or more of *N,N*-dimethylethanolamine, 1-(dimethylamino)-2-propanol, 1-(dimethylamino)-2-butanol, *trans*-2-(dimethylamino)cyclohexanol; 2-piperidinoethanol; 1-piperidino-2-propanol; 1-piperidino-2-butanol, *trans*-2-piperidinocyclohexan-1-ol, 1-pyrrolidinoethanol, pyrrolidinylpropan-2-ol, 1-(1-

pyrolidinyl)-2-butanol, 2-pyrolidinocyclohexanol, 4-methyl-1-piperazineethanol, 1-(4-methyl-1-piperazinyl)-2-propanol; 1-(4-methyl-1-piperazinyl)-2-butanol; *trans*-2-(4-methyl-1-piperazinyl)-cyclohexanol, 2-morpholinoethanol, 1-(4-morpholinyl)-2-propanol, 1-(4-morpholinyl)-2-butanol, *trans*-2-morpholin-4-ylcyclohexanol, 1-methyl-2-piperidinemethanol, 1-methyl-2-pyrrolidinemethanol, dimethylaminoethanol, *N*-methyl-diethanolamine, 3-dimethylamino-1-propanol, 1,3-bis(dimethylamino)-2-propanol, 2-{[2-dimethylamino)ethyl]methylamino}ethanol, 2-[2-(dimethylamino)ethoxy]ethanol, 2-(2-(piperidyl)ethoxy)ethanol, 2-[2-(4-morpholinyl)ethoxy]ethanol, 2-[2-(1-pyrrolidinyl)ethoxy]ethanol, 2-[2-(4-methyl-1-piperazinyl)ethoxy]ethanol; and from 50 mole% to greater than 0 mole% of an ether-alcohol σ—μ polar modifier selected from one or more of 2-methoxyethanol, 1-methoxypropan-2-ol, 1-methoxybutan-2-ol, 2-methoxycyclohexan-1-ol, tetrahydrofurfuryl alcohol, tetrahydropyran-2-methanol, diethylene glycol monomethyl ether.

21. The process of Claim 1 or 2, further comprising either or both of a σ type polar modifier and/or a μ type polar modifier.

22. A hydrogen mediated anionic poly(conjugated diene) composition characterized by high vinyl content from 74 wt.% to 82 wt.% (as determined by C-13 NMR analyses) wherein the: 1) number average molecular weight distribution (M_n) is from 500 to 2600 Daltons; 2) Brookfield viscosity (@ 25°C) is from 50 to 32,000 cP; 3) glass transition temperature T_g is from -95°C to -45°C; and 4) molar ratio of vinyl-1,2-BD:VCP is from 7:1 to 15:1 (based on ^{1}HNMR analysis).

23. The composition of Claim 22, wherein the composition is a hydrogen mediated polybutadiene (HMPBD) distribution having a high vinyl content from 75 wt.% to 82 wt.% (total vinyl content as determined by C-13 NMR analyses) wherein the: 1) number average molecular weight distribution (M_n) is from 650 to 2200 Daltons; 2) Brookfield viscosity (@ 25°C) is from 300 to about 11,000 cP; 3) glass transition temperature T_g is from -84°C to -50°C; and 4) molar ratio of vinyl-1,2-BD:VCP is from 6.5:1 to 14.5:1 (based on ^{1}HNMR analysis).

24. The composition of Claim 22, wherein the composition is a hydrogen mediated polybutadiene (HMPBD) distribution having an intermediate vinyl content from 55 wt.% to 70

wt.% (total vinyl content as determined by C-13 NMR analyses) wherein the: 1) number average molecular weight distribution (M_n) is from 700 to 1600 Daltons; 2) Brookfield viscosity (@ 25°C) is from 95 to 2000 cP; 3) glass transition temperature T_g is from -92°C to -75°C; and 4) molar ratio of vinyl-1,2-BD:VCP is from 4.5:1 to 12:1 (based on ^{1}HNMR analysis).

25. The composition of Claim 22, wherein the composition is a hydrogen mediated polybutadiene (HMPBD) distribution having a reduced vinyl content from 30 wt.% to 54 wt.% (total vinyl content as determined by C-13 NMR analyses) wherein the: 1) number average molecular weight distribution (M_n) is from 750 to 1600 Daltons; 2) Brookfield viscosity (@ 25°C) is from 80 to 1000 cP; 3) glass transition temperature T_g is from -106°C to -70°C; and 4) molar ratio of vinyl-1,2-BD:VCP is from 3.3:1 to 7:1 (based on ^{1}HNMR analysis).