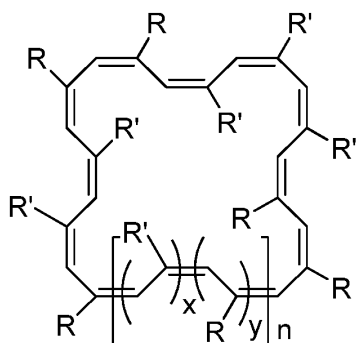


CLAIMS

What is claimed is:

1. A macrocyclic polyalkene copolymer, comprising a conjugated polyalkene having no chain ends and in the form of a macrocycle, comprising at least two different repeating units have the structure $-RC=CR-$ where R is independently: H; a substituted or unsubstituted C_1 to C_{30} alkyl, provided that when all R are an unsubstituted C_1 to C_{30} alkyl, at least one R is not a C_4 , C_6 , C_7 , or C_{13} alkyl; substituted or unsubstituted C_3 to C_{30} alkenyl having one or more alkene bonds where a plurality of alkene bonds can be non-conjugated, conjugated, or a mixture thereof; or where two R groups are combined as a C_8 - C_{30} cycloalkene where the alkylene portion of the cycloalkene is substituted or unsubstituted and/or interrupted one or more times with O, NR' , $C(O)$, $C(O)O$, and/or $C(O)NR''$, where R' and/or R'' , when present are each independently H, C_{1-30} alkyl, or C_3 to C_{30} alkenyl.

2. The macrocyclic polyalkene copolymer according to claim 1, having a structure of:



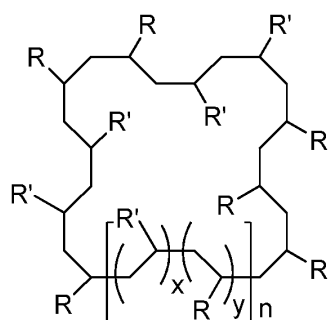
- wherein R and R' in the structure are each independently an R as defined in claim 1, and each of n, x, and y is independently an integer of 1 to 100.

3. The macrocyclic polyalkene copolymer according to claim 2, wherein each of n, x, and y is independently an integer of 1 to 50.
4. The macrocyclic polyalkene copolymer according to claim 2 or 3, wherein each of n, x, and y is independently an integer of 1 to 25.

5. The macrocyclic polyalkene copolymer according to any one of claims 1 to 4, wherein at least one R is substituted C₁ to C₃₀ alkyl, substituted C₃ to C₃₀ alkenyl, which is substituted with hydroxy, C₂-C₃₀ alkoxy, C₆-C₁₄ aryloxy, C₇-C₃₀ arylalkyloxy, C₂-C₃₀ alkenyloxy, C₂-C₃₀ alkynyloxy, C₈-C₃₀ arylalkenyloxy, C₈-C₃₀ arylalkynyloxy, CO₂H, C₂-C₃₀ alkylester, C₇-C₁₅ arylester, C₈-C₃₀ alkylarylester, C₃-C₃₀ alkenylester, NH₂, C₃-C₃₀ alkylamino, C₆-C₁₄ arylamino, C₇-C₃₀ (arylalkyl)amino, C₃-C₃₀ alkenylamino, C₃-C₃₀ alkynylamino, C₈-C₃₀ (arylalkenyl)amino, C₈-C₃₀ (arylalkynyl)amino, C₃-C₃₀ dialkylamino, C₁₂-C₂₈ diarylamino, C₄-C₃₀ dialkenylamino, C₄-C₃₀ dialkynylamino, C₇-C₃₀ aryl(alkyl)amino, C₇-C₃₀ di(arylalkyl)amino, C₈-C₃₀ alkyl(arylalkyl)amino, C₁₅-C₃₀ aryl(arylalkyl)amino, C₈-C₃₀ alkenyl(aryl)amino, C₈-C₃₀ alkynyl(aryl)amino, C(O)NH₂, C₂-C₃₀ alkylamido, C₇-C₁₄ arylamido, C₈-C₃₀ (arylalkyl)amido, C₂-C₃₀ dialkylamido, C₁₂-C₂₈ diarylamido, C₈-C₃₀ aryl(alkyl)amido, C₁₅-C₃₀ di(arylalkyl)amido, C₉-C₃₀ alkyl(arylalkyl)amido, C₁₆-C₃₀ aryl(arylalkyl)amido, thiol, C₂-C₃₀ hydroxyalkyl, C₆-C₁₄ hydroxyaryl, C₇-C₃₀ hydroxyarylalkyl, C₃-C₃₀ hydroxyalkenyl, C₃-C₃₀ hydroxyalkynyl, C₈-C₃₀ hydroxyarylalkenyl, C₈-C₃₀ hydroxyarylalkynyl, C₃-C₃₀ polyether, C₃-C₃₀ polyetherester, C₃-C₃₀ polyester, C₃-C₃₀ polyamino, C₃-C₃₀ polyaminoamido, C₃-C₃₀ polyaminoether, C₃-C₃₀ polyaminoester, or C₃-C₃₀ polyamidoester.
6. The macrocyclic polyalkene copolymer according to any one of claims 1 to 4, wherein each R is independently: H; a substituted or unsubstituted C₁ to C₃₀ alkyl; or a substituted or unsubstituted C₃ to C₃₀ alkenyl.
7. The macrocyclic polyalkene copolymer according to any one of claims 1 to 4, wherein each R is independently H or a substituted or unsubstituted C₁₋₃, C₅, C₈₋₁₂, or C₁₄₋₃₀ alkyl.
8. A macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene), comprising alkane repeating units have the structure -RHC-CHR- and, optionally, alkene repeating units have the structure -RC=CR- or -C(=CR₂)-, where, if present, the R of the -RC=CR- alkene repeating units are the same as the R units of at least one of the alkane repeating units, and where R is independently: H; a substituted or unsubstituted C₁ to C₃₀ alkyl, or, when absent an alkene repeating unit or comprising exclusively one unsubstituted alkane repeating units or a copolymer with -H₂C-CH₂- repeating units, R is C₁₋₃, C₅, C₈₋₁₂, or C₁₄₋₃₀; substituted or

unsubstituted C₃ to C₃₀ alkenyl having one or more alkene bonds where a plurality of alkene bonds can be non-conjugated, conjugated, or a mixture thereof; or where two R groups are combined as a C₈-C₃₀ cycloalkane and/or cycloalkene where the alkylene portion of the cycloalkane and/or alkene is substituted or unsubstituted and/or interrupted one or more times with O, NR', C(O), C(O)O, and/or C(O)NR'', where R' and/or R'', when present, are each independently H, C₁₋₃₀ alkyl, C₃ to C₃₀ alkenyl.

9. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to



claim 8, having a structure of $\left[\text{R} - \left(\text{CH}_2 \right)_x - \left(\text{CH}_2 \right)_y - \text{R}' \right]_n$, wherein R and R' in the structure are each independently an R as defined in claim 8, and each of n, x, and y is an integer of 1 to 100.

10. The macrocyclic polyalkene copolymer according to claim 9, wherein each of n, x, and y is independently an integer of 1 to 50.

11. The macrocyclic polyalkene copolymer according to claim 9 or 10, wherein each of
5 n, x, and y is independently an integer of 1 to 25.

12. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 11, wherein at least one R is substituted C₁ to C₃₀ alkyl, or substituted C₃ to C₃₀ alkenyl, which is substituted singularly or plurally and each substitution is independently hydroxy, C₂-C₃₀ alkoxy, C₆-C₁₄ aryloxy, C₇-C₃₀ arylalkyloxy, C₂-C₃₀ alkenyloxy, C₂-C₃₀ alkynyloxy, C₈-C₃₀ arylalkenyloxy, C₈-C₃₀ arylalkynyloxy, CO₂H, C₂-C₃₀ alkylester, C₇-C₁₅ arylester, C₈-C₃₀ alkylarylester, C₃-C₃₀ alkenylester, NH₂, C₃-C₃₀ alkylamino, C₆-C₁₄ arylamino, C₇-C₃₀ (arylalkyl)amino, C₃-C₃₀ alkenylamino, C₃-C₃₀ alkynylamino, C₈-C₃₀ (arylalkenyl)amino, C₈-C₃₀ (arylalkynyl)amino, C₃-C₃₀ dialkylamino, C₁₂-C₂₈ diarylamino, C₄-C₃₀ dialkenylamino, C₄-C₃₀ dialkynylamino, C₇-C₃₀ aryl(alkyl)amino,

C₇-C₃₀ di(arylalkyl)amino, C₈-C₃₀ alkyl(arylalkyl)amino, C₁₅-C₃₀ aryl(arylalkyl)amino, C₈-C₃₀ alkenyl(aryl)amino, C₈-C₃₀ alkynyl(aryl)amino, C(O)NH₂, C₂-C₃₀ alkylamido, C₇-C₁₄ arylamido, C₈-C₃₀ (arylalkyl)amido, C₂-C₃₀ dialkylamido, C₁₂-C₂₈ diarylamido, C₈-C₃₀ aryl(alkyl)amido, C₁₅-C₃₀ di(arylalkyl)amido, C₉-C₃₀ alkyl(arylalkyl)amido, C₁₆-C₃₀ aryl(arylalkyl)amido, thiol, C₂-C₃₀ hydroxyalkyl, C₆-C₁₄ hydroxyaryl, C₇-C₃₀ hydroxyarylalkyl, C₃-C₃₀ hydroxyalkenyl, C₃-C₃₀ hydroxyalkynyl, C₈-C₃₀ hydroxyarylalkenyl, C₈-C₃₀ hydroxyarylalkynyl, C₃-C₃₀ polyether, C₃-C₃₀ polyetherester, C₃-C₃₀ polyester, C₃-C₃₀ polyamino, C₃-C₃₀ polyaminoamido, C₃-C₃₀ polyaminoether, C₃-C₃₀ polyaminoester, C₃-C₃₀ polyamidoester.

13. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 11, wherein each R is independently: H; a substituted or unsubstituted C₁ to C₃₀ alkyl; or a substituted or unsubstituted C₃ to C₃₀ alkenyl; provided that when all R are an unsubstituted C₁ to C₃₀ alkyl, at least one R is not a C₄, C₆, C₇, or C₁₃ alkyl.

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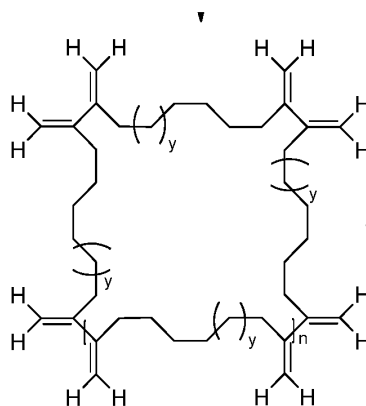
14. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 11, wherein each R is independently H or a substituted or unsubstituted C₁₋₃, C₅, C₈₋₁₂, or C₁₄₋₃₀ alkyl.

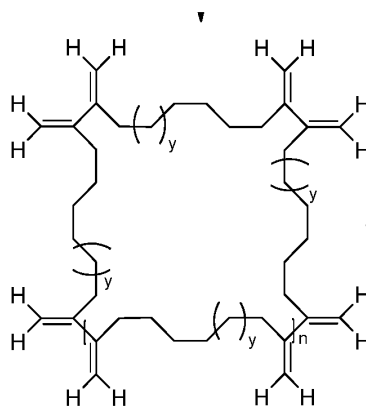
15. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 11, wherein the macrocyclic polyalkane has C₈-C₃₀ cycloalkane repeating units.

16. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 11, wherein the macrocyclic polyalkane is macrocyclic polypropylene.

17. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any
10 one of claims 8 to 11, wherein the macrocyclic poly(alkane-co-alkene) comprises vicinal – C(=CR₂)- groups.

18. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to



claim 17, having a structure , wherein the H atoms depicted in the structure can be H or another R group as defined in claim 8, and each of n and y is an integer of 1 to 100.

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19. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to claim 18, wherein each y is independently an integer of 1 to 20 and n is an integer of 1 to 50.

20. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to claim 18 or claim 19, wherein each y is independently an integer of 1 to 10 and n is an integer of 1 to 25.

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21. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 18 to 20, wherein each y is independently an integer of 1 to 5 and n is an integer of 1 to 10.

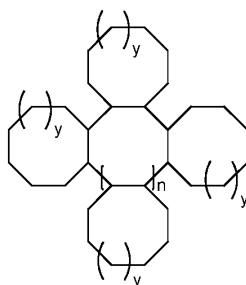
22. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 21, wherein the macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) comprises vicinal $-C(CH_2R)_2-$ groups.

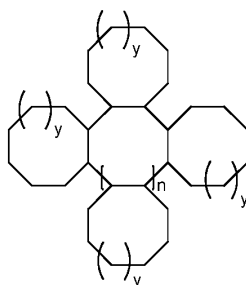
15 23. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 18 to 22, wherein each R is independently: H; a substituted or unsubstituted C_1 to C_{30} alkyl; or a substituted or unsubstituted C_3 to C_{30} alkenyl.

24. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 18 to 22, wherein each R is independently H or a substituted or unsubstituted C₁₋₃, C₅, C₈₋₁₂, or C₁₄₋₃₀ alkyl.

25. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 18 to 22, wherein the macrocyclic polyalkane has C₈-C₃₀ cycloalkane repeating units in the polymer backbone.

26. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to



claim 25 having a structure: , wherein each y and n are independently integers from 1 to 100.

27. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to claim 26, wherein each y is independently an integer of 1 to 20 and n is an integer of 1 to 50.

28. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to claim 26 or claim 27, wherein each y is independently an integer of 1 to 10 and n is an integer of 1 to 25.

29. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 26 to 28, wherein each y is independently an integer of 1 to 5 and n is an integer of 1 to 10.

30. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 24, further comprising C=C bridges between a plurality of macrocyclic poly(alkane-co-alkene)s to form a poly(macrocyclic poly(alkane-co-alkene)).

31. The macrocyclic polyalkane or macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 24, further comprising one or more C=C bridges between alkene repeating units of the macrocyclic poly(alkane-co-alkene)s, in the form of bi-macrocyclic, tri-macrocyclic and/or multi-macrocyclic poly(alkane-co-alkene)s.

32. A method of forming a macrocyclic polyalkane or a macrocyclic poly(alkane-co-alkene) according to any one of claims 8 to 31 comprising:

reacting a macrocyclic polyalkene and hydrogen in the presence of a hydrogenation catalyst to form the polyalkane or poly(alkane-co-alkene); and

isolating the macrocyclic polyalkane or a macrocyclic poly(alkane-co-alkene).

33. The method of claim 32, wherein the hydrogen is provided in an amount of at least a molar equivalent of the macrocyclic polyalkene, thereby forming a polyalkane.

34. The method of claim 32, wherein the hydrogen is provided in an amount of less than a molar equivalent of the macrocyclic polyalkene, thereby forming a poly(alkane-co-alkene).

35. A method of forming a macrocyclic polyalkane or a macrocyclic poly(alkane-co-alkene) according to any one of claims 17 to 24 comprising:

reacting a macrocyclic poly(cycloalkene) with an excess of an alkene and an olefin metathesis catalyst thereby forming a macrocyclic poly(alkane-co-alkene) comprising vicinal $-C(=CR_2)-$ groups; and

optionally isolating the macrocyclic polyalkane or the macrocyclic poly(alkane-co-alkene) comprising $-C(=CR_2)-$ groups.

36. The method of claim 35, further comprising:

reacting the macrocyclic poly(alkane-co-alkene) comprising vicinal $-C(=CR_2)-$ groups and hydrogen in the presence of a hydrogenation catalyst thereby forming a macrocyclic polyalkane or a macrocyclic poly(alkane-co-alkene) comprising isolated $-C(C=CR_2)$ groups; and

optionally isolating the macrocyclic polyalkane or the macrocyclic poly(alkane-co-alkene) comprising isolated $-C(=CR_2)-$ groups.

37. The method according to claim 36, further comprising:
combining the macrocyclic poly(alkane-co-alkene) comprising isolated $-C(=CR_2)-$ groups with an olefin metathesis catalyst; and
condensing isolated $-C(=CR_2)-$ groups to form a poly(macrocyclic poly(alkane-co-alkene)) comprising C=C links between macrocyclic poly(alkane-co-alkene) repeating units to form a poly(macrocyclic poly(alkane-co-alkene)); and
optionally isolating the poly(macrocyclic poly(alkane-co-alkene)).
38. The method according to claim 37, further comprising:
combining the poly(macrocyclic poly(alkane-co-alkene)) with hydrogen in the presence of a hydrogenation catalyst, thereby
hydrogenating the poly(macrocyclic poly(alkane-co-alkene)) to form a poly(macrocyclic poly(alkane)).
39. The method according to claim 36, further comprising:
combining a dilute solution of the macrocyclic poly(alkane-co-alkene) comprising isolated $-C(=CR_2)-$ groups with an olefin metathesis catalyst; and
condensing isolated $-C(=CR_2)-$ groups to form bi-macrocyclic, tri-macrocyclic and/or multi-macrocyclic poly(alkane-co-alkene)s.
40. The method according to claim 39, further comprising:
combining the bi-macrocyclic, tri-macrocyclic and/or multi-macrocyclic poly(alkane-co-alkene)s with hydrogen in the presence of a hydrogenation catalyst, thereby hydrogenating the bi-macrocyclic, tri-macrocyclic and/or multi-macrocyclic poly(alkane-co-alkene)s to form bi-macrocyclic, tri-macrocyclic and/or multi-macrocyclic poly(alkane)s.