Claims

1. A silicone hydrogel comprising a water content of at least about 50% and an oxygen permeability of at least about 80 barrers wherein said silicone hydrogel is formed from a reaction mixture comprising

about 37 to about 75 wt% of at least one slow-reacting hydrophilic monomer having a slow-reacting hydrophilic monomer kinetic half life;

at least one silicone-containing component having a silicone-containing component kinetic half life, which may be optionally substituted with at least one hydroxyl containing group;

at least one hydroxyl-containing component selected from said silicone-containing components substituted with at least one hydroxyl group, at least one hydroxyalkyl monomer, and mixtures thereof,

wherein ratio of said slow-reacting hydrophilic component half life to said silicone-containing component half life is at least 2, said reaction mixture comprising between 9 and 14 wt% silicon from all components and less than 15 wt% TRIS and wherein all reactive components other than said slow-reacting hydrophilic monomer and said silicone containing components in the reaction mixture are ancillary components and the hydroxyl containing components are present in an amount sufficient to provide a molar ratio of hydroxyl groups in the reaction mixture to silicon atom content between about 0.16 and about 0.4.

2. The silicone hydrogel of claim 1 wherein said silicone containing components comprise less than 10 wt% TRIS.

3. The silicone hydrogel of claim 1 wherein said silicone containing components are free of TRIS.

4. The silicone hydrogel of claim 1 wherein said ancillary components in said reaction mixture in a concentration of less than 12 wt% based upon reactive components.

5. The silicone hydrogel of claim 1 wherein said water content is at least about 55%.

6. The silicone hydrogel of claim 1 wherein said water content is at least about 60%.

7. The silicone hydrogel of claim 1, 5 or 6 wherein said oxygen permeability is at least about 90 barrers.

8. The silicone hydrogel of claim 1, 5 or 6 wherein said oxygen permeability is at least about 100 barrers.

9. The silicone hydrogel of claim 1 wherein said ancillary components in amounts between about 38 and about 76 mmol/g reactive components.

10. The silicone hydrogel of claim 1, 5 or 6 wherein said oxygen permeability is between about 85 and about 150 barrers.

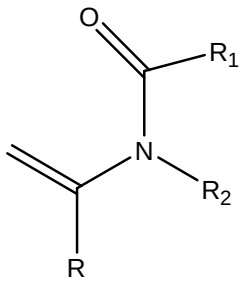
11. The silicone hydrogel of claim 1, 5 or 6 wherein said oxygen permeability is between about 85 and about 130 barrers.

12. The silicone hydrogel of claim 1, 5 or 6 further comprising a modulus of less than about 150 psi.

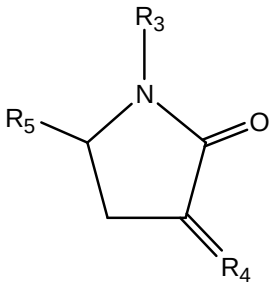
13. The silicone hydrogel of claim 1, 5 or 6 further comprising a contact angle of less than about 80˚.

14. The silicone hydrogel of claim 1, 5 or 6 further comprising an advancing contact angle of less than about 70˚.

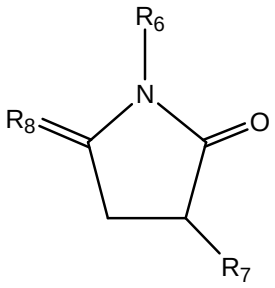
15. The silicone hydrogel of claim 1 wherein said at least one slow reacting monomer selected from the group consisting of N-vinylamide monomer of Formula I, vinyl pyrrolidone of Formula II-IV, N-vinyl piperidone of Formula V:



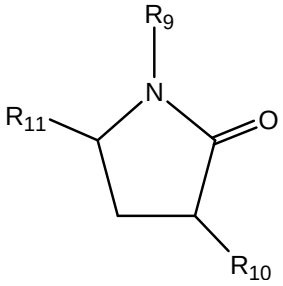
Formula I



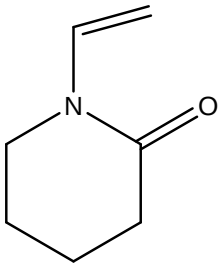
Formula II



Formula III



Formula IV



Formula V

wherein R is H or methyl;

R_1, R_2, R_3, R_6, R_7, R_{10}, and R_{11} are independently selected from the group consisting of H, CH_3, CH_2CH_3, $CH_2CH_2CH_3$, $C(CH_3)_2$;

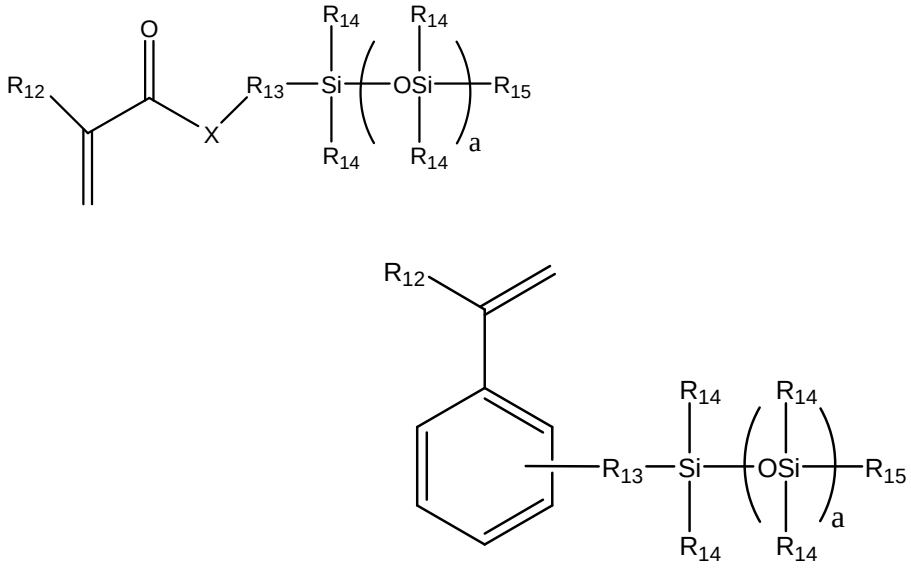
R_4 and R_8 are independently selected from the group consisting of CH_2, $CHCH_3$ and $C(CH_3)$;

R_5 is selected from H, methyl, ethyl; and

R_9 is selected from $CH=CH_2$, $C(CH_3)=CH_2$, and $CH=CHCH_3$;

wherein said silicone-containing component is selected from the group consisting of at least one mono (meth)acryloxyalkyl polydialkylsiloxane monomer of Formula VII or the styryl polydialkylsiloxane monomer of Formula VIII:

Formula VII



Formula VIII

wherein R_{12} is H or methyl;

X is O or $NR_{16;}$

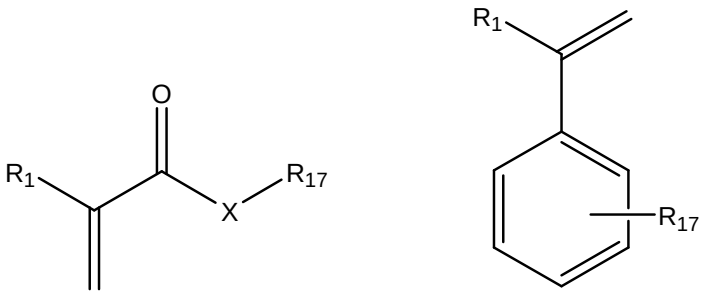
Each R_{14} is independently a C_1 to C_4 alkyl which may be fluorine substituted, or phenyl;

R_{15} is a C_1 to C_4 alkyl;

R_{13} is a divalent alkyl group, which may further be functionalized with a group selected from the group consisting of ether groups, hydroxyl groups, carbamate groups and combinations thereof;

a is 3 to 50;

R_{16} is selected from H, C1-4, which may be further substituted with one or more hydroxyl groups; and said hydroxyalkyl monomer is selected from the group consisting of at least one hydroxyalkyl (meth)acrylate or (meth)acrylamide monomer of Formula IX or a styryl compound of Formula X



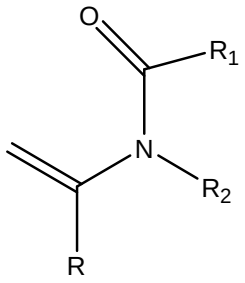
FORMULA IX FORMULA X

wherein R_1 is H or methyl,

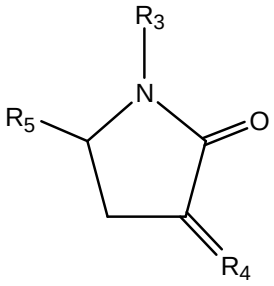
X is O or NR_{16}, R_{16} is a H, C_1 to C_4 alkyl, which may be further substituted with at least one OH;

R_{17} is selected from C_2-C_4 mono or dihydroxy substituted alkyl, and poly(ethylene glycol) having 1-10 repeating units; wherein said at least one hydroxyalkyl (meth)acrylate or (meth)acrylamide monomer and said slow reacting monomer are present in mole percents which form a molar ratio between about 0.15 and 0.4.

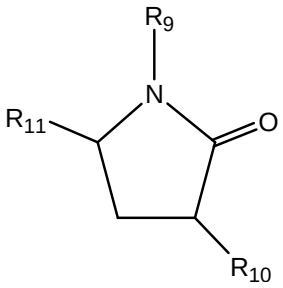
16. The silicone hydrogel of claim 1 wherein said at least one slow reacting hydrophilic monomer is selected from the group consisting of N-vinylamide monomer of Formula I, vinyl pyrrolidone of Formula II or IV:



Formula I



Formula II



Formula IV

wherein R is H or methyl;

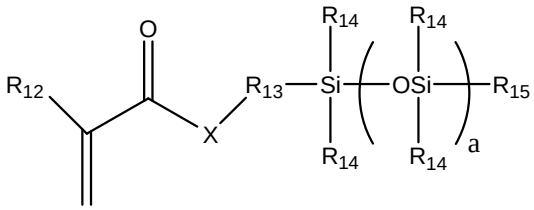
R_1, R_2, R_3, R_{10}, and R_{11} are independently selected from the group consisting of H, CH_3, CH_2CH_3 , $CH_2CH_2CH_3$, $C(CH_3)_2$;

R_4 is selected from the group consisting of CH_2, $CHCH_3$ and $C(CH_3)$;

R_5 is selected from H, methyl, ethyl; and

R_9 is selected from $CH=CH_2$, $C(CH_3)=CH_2$, and $CH=CHCH_3$;

(b) said at least one silicone-containing component is selected from the group consisting of at least one mono (meth)acryloxyalkyl polydialkylsiloxane monomer of Formula VII:



Formula VII

wherein R_{12} is H or methyl;

X is O or NR_{16};

Each R_{14} is independently a C_1 to C_4 alkyl which may be fluorine substituted, or phenyl;

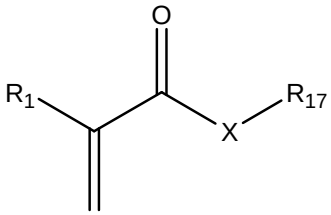
R_{15} is a C_1 to C_4 alkyl;

R_{13} is a divalent alkyl group, which may further be functionalized with a group selected from the group consisting of ether groups, hydroxyl groups, carbamate groups and combinations thereof;

a is 3 to 50;

R_{16} is selected from H, C_{1-4}, which may be further substituted with one or more hydroxyl groups;

(c) at least one hydroxylalkyl monomer is selected from the group consisting of hydroxyalkyl (meth)acrylate or (meth)acrylamide monomer of Formula IX



FORMULA IX

wherein R_1 is H or methyl,

X is O or NR_{16}, R_{16} is a H, C_1 to C_4 alkyl, which may be further substituted with at least one OH;

R_{17} is selected from C_2-C_4 mono or dihydroxy substituted alkyl, and poly(ethylene glycol) having 1-10 repeating units; wherein said at least one hydroxyalkyl (meth)acrylate or (meth)acrylamide monomer and said slow reacting monomer are present in mole percents which form a molar ratio between about 0.15 and 0.4.

17. The silicone hydrogel of claim 15 or 16 wherein each R_3 is independently selected from ethyl and methyl groups.

18. The silicone hydrogel of claim 15 or 16 wherein all R_3 are methyl.

19. The silicone hydrogel of claim 15 or 16 wherein R_{13} is selected from the group consisting of C_1-C_6 alkylene group which may be substituted with ether, hydroxyl and combinations thereof.

20. The silicone hydrogel of claim 15 or 16 wherein R_{13} is selected from the group consisting of C_1 or C_3-C_6 alkylene groups which may be substituted with ether, hydroxyl and combinations thereof.

21. The silicone hydrogel of claim 15 or 16 wherein R_{16} is H or methyl.

22. The silicone hydrogel of claim 15 or 16 wherein R_{12} and each R_{14} are methyl.

23. The silicone hydrogel of claim 15 or 16 wherein at least one R_{14} is 3,3,3-trifluoropropyl.

24. The silicone hydrogel of claim 15 or 16 wherein R_4 is methyl or 2-hydroxyethyl.

25. The silicone hydrogel of claim 15 wherein a is 5 to 15.

26. The silicone hydrogel of claim 15 or 16 wherein the slow-reacting hydrophilic monomer is selected from the vinyl pyrrolidone of Formula II or IV or the N-vinyl amide monomer of Formula I, having a total number of carbon atoms in R_1 and R_2 of 4 or less.

27. The silicone hydrogel of claim 15 or 16 wherein the slow-reacting hydrophilic monomer is selected from a vinyl pyrrolidone of Formula III or IV and R_6 is methyl, R_7 is hydrogen, R_9 is $CH=CH_2$, R_{10} and R_{11} are H.

28. The silicone hydrogel of claim 15 or 16 wherein the slow-reacting hydrophilic monomer is selected from ethylene glycol vinyl ether (EGVE), di(ethylene glycol) vinyl ether (DEGVE), N-vinyl pyrrolidone (NVP), 1-methyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone; 1-ethyl-5-methylene-2-pyrrolidone, N-methyl-3-methylene-2-pyrrolidone, 5-ethyl-3-methylene-2-pyrrolidone, 1-n-propyl-3-methylene-2-pyrrolidone, 1-n-propyl-5-methylene-2-pyrrolidone, 1-isopropyl-3-methylene-2-pyrrolidone, 1-isopropyl-5-methylene-2-pyrrolidone, N-vinyl-N-methyl acetamide (VMA), N-vinyl-N-ethyl acetamide, N-vinyl-N-ethyl formamide, N-vinyl formamide, N-vinyl acetamide, N-vinyl isopropylamide, allyl alcohol, N-vinyl caprolactam, N-2-hydroxyethyl vinyl carbamate, N-carboxy-ß-alanine N-vinyl ester; N-carboxyvinyl-β-alanine (VINAL), N-carboxyvinyl-α-alanine and mixtures thereof.

29. The silicone hydrogel of claim 15 or 16 wherein the slow-reacting hydrophilic monomer is selected from the group consisting of N-vinylpyrrolidone, N-vinylacetamide, 1-methyl-3-methylene-2-pyrrolidone, 1-methyl-5-methylene-2-pyrrolidone, 5-methyl-3-methylene-2-pyrrolidone, and mixtures thereof

30. The silicone hydrogel of claim 15 or 16 wherein the slow-reacting hydrophilic monomer is selected from the group consisting of NVP, VMA and 1-methyl-5-methylene-2-pyrrolidone.

31. The silicone hydrogel of claim 15 or 16 wherein the slow-reacting hydrophilic monomer comprises NVP.

32. The silicone hydrogel of claim 15 or 16 wherein R_1 is H or methyl, X is oxygen and R is selected from C_2-C_4 mono or dihydroxy substituted alkyl, and poly(ethylene glycol) having 1-10 repeating units.

33. The silicone hydrogel of claim 15 or 16 wherein R_1 methyl, X is oxygen and R is selected from C_2-C_4 mono or dihydroxy substituted alkyl, and poly(ethylene glycol) having 2-20 repeating units.

34. The silicone hydrogel of claim 15 or 16 wherein at least one R_{14} is 3,3,3-trifluoropropyl.

35. The silicone hydrogel of claim 15 or 16 wherein R_{13} is selected from C_1-C_6 alkylene groups which may be substituted with ether, hydroxyl and combinations thereof.

36. The silicone hydrogel of claim 15 or 16 wherein R_{13} is selected from C_1 or C_{3-6} alkylene groups which may be substituted with ether, hydroxyl and combinations thereof.

37. The silicone hydrogel of claim 15 or 16 wherein a is 7 to 30.

38. The silicone hydrogel of claim 15 or 16 wherein R_{16} is H or methyl.

39. The silicone hydrogel of claim 1 wherein said silicone-containing component comprises at least one monomethacryloxyalkylpolydimethylsiloxane methacrylate is selected from the group consisting of monomethacryloxypropyl terminated mono-n-butyl terminated polydimethylsiloxane, monomethacryloxypropyl terminated mono-n-methyl terminated polydimethylsiloxane, monomethacryloxypropyl terminated mono-n-butyl terminated polydiethylsiloxane, monomethacryloxypropyl terminated mono-n-methyl terminated polydiethylsiloxane, N-(2,3-dihydroxypropane)-N'-(propyl tetra(dimethylsiloxy) dimethylbutylsilane)acrylamide; α-(2-hydroxy-1-methacryloxypropyloxypropyl)-ω-butyl-octamethylpentasiloxane and mixtures thereof.

40. The silicone hydrogel of claim 1 wherein said silicone-containing component comprises at least one monomethacryloxyalkylpolydimethylsiloxane methacrylate is selected from the group consisting of monomethacryloxypropyl terminated mono-n-butyl terminated polydimethylsiloxane, monomethacryloxypropyl terminated mono-n-methyl terminated polydimethylsiloxane, _ N-(2,3-dihydroxypropane)-N'-(propyl tetra(dimethylsiloxy) dimethylbutylsilane)acrylamide .

41. The silicone hydrogel of claim 15 or 16 wherein R_1 is H or methyl, X is oxygen and R is selected from C_2-C_4 mono or dihydroxy substituted alkyl, and poly(ethylene glycol) having 1-10 repeating units.

42. The silicone hydrogel of claims 15 or 16 wherein R_1 methyl, X is oxygen and R is selected from C_2-C_4 mono or dihydroxy substituted alkyl, and poly(ethylene glycol) having 2-20 repeating units.

43. The silicone hydrogel of claim 15 or 16 wherein R is 2-hydroxyethyl, 2,3-dihydroxypropyl, 2-hydroxypropyl.

44. The silicone hydrogel of claim 1 wherein said hydroxyalkyl monomer is selected from the group consisting of 2-hydroxyethyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 1-hydroxypropyl-2-(meth)acrylate, 2-hydroxy-2-methyl-propyl (meth)acrylate, 3-hydroxy-2,2-dimethyl-propyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, glycerol (meth)acrylate, 2-hydroxyethyl (meth)acrylamide, polyethyleneglycol monomethacrylate, bis-(2-hydroxyethyl) (meth)acrylamide, 2,3-dihydroxypropyl (meth)acrylamide, and mixtures thereof.

45. The silicone hydrogel of claim 1 wherein said hydroxyalkyl monomer is selected from the group consisting of 2-hydroxyethyl methacrylate, glycerol methacrylate, 2-hydroxypropyl methacrylate, hydroxybutyl methacrylate, 3-hydroxy-2,2-dimethyl-propyl methacrylate, and mixtures thereof.

46. The silicone hydrogel of claim 1 wherein said hydroxyalkyl monomer comprises 2-hydroxyethyl methacrylate, 3-hydroxy-2,2-dimethyl-propyl methacrylate, glycerol methacrylate and mixtures comprising them.

47. The silicone hydrogel of claim 1 further comprising a contact angle of less than about 80°.

48. The silicone hydrogel of claim 1 further comprising a %haze of less than about 50%.

49. The silicone hydrogel of claim 1 further comprising a %haze of less than about 10%.

50. The silicone hydrogel of claim 1 wherein said reaction mixture further comprises at least one slow reacting crosslinker and at least one fast reacting crosslinker.

51. The silicone hydrogel of claim 50 wherein said at least one slow reacting crosslinker and at least one fast reacting crosslinker are each present in said reaction mixture in amounts between about 0.05 to about 0.3 wt%.

52. The silicone hydrogel of claim 50 wherein said at least one slow reacting crosslinker and at least one fast reacting crosslinker are each present in said reaction mixture in amounts between about 0.1 to about 0.2 wt%.

53. The silicone hydrogel of claim 1 wherein said at least one silicone-containing component and said at least one hydroxyl-containing component have the same reactive functionality.

54. The silicone hydrogel of claim 1 wherein the at least one hydroxyalkyl monomer does not contain any silicone and is present in the reactive mixture in an amount sufficient such that the molar ratio of hydroxyl groups in non-silicone containing hydroxyalkyl monomer to silicon atom is between about 0.13 and about 0.35.