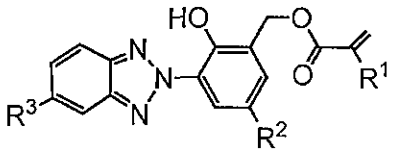
What is claimed is:

1. A method for producing UV-absorbing silicone hydrogel contact lenses which have an UVB transmittance of about 10% or less (preferably about 5% or less, more preferably about 2.5% or less, even more preferably about 1% or less) between 280 and 315 nanometers, an UVA transmittance of about 30% or less (preferably about 20% or less, more preferably about 10% or less, even more preferably about 5% or less) between 316 and 380 nanometers, and optionally (but preferably) an average violet transmittance of about 70% or less (preferably about 65% or less, more preferably about 60% or less, even more preferably about 55% or less) between 381 nm and 440 nm, the method comprising the steps of:
   (1) providing a mold for making a soft contact lens, wherein the mold has a first mold half with a first molding surface defining the anterior surface of a contact lens and a second mold half with a second molding surface defining the posterior surface of the contact lens, wherein said first and second mold halves are configured to receive each other such that a cavity is formed between said first and second molding surfaces;
   (2) introducing a pre-polymerization mixture of lens-forming materials into the cavity, wherein the pre-polymerization mixture comprises at least one hydrophilic vinylic monomer, at least one siloxane-containing vinylic monomer, at least one polysiloxane crosslinker (with two or more ethylenically-unsaturated groups), at least one UV-absorbing vinylic monomer that absorbs ultraviolet light and optionally (but preferably) high-energy violet light from 381 nm to 440 nm, at least one visibility-tinting agent, and from about 0.05% to about 1.5% by weight of at least one germanium-based Norrish Type I photoinitiator capable of initiating a free-radical polymerization under irradiation with a light source including a light in the region of about 380 to about 550 nm; and
   (3) irradiating the pre-polymerization mixture in the mold with a light in a region of from 380 to 550 nm and crosslinking the lens-forming materials to form an UV-absorbing silicone hydrogel contact lens.
2. The method of claim 1, wherein the formed UV-absorbing silicone hydrogel contact lens is substantially free of or preferably free of internal stress.
3. The method of claim 1 or 2, wherein said at least one UV-absorbing vinylic monomer comprises a first UV-absorbing vinylic monomer that absorbs UV radiation and HEVL radiation of from 381 nm to 440 nm, and wherein said at least one visibility-tinting agent comprise a violet-tinting agent (preferably Carbazole Violet pigment).

4. The method of claim 3, wherein the first UV-absorbing vinylic monomer is a benzotriazole-containing UV/HEVL vinylic monomer of formula

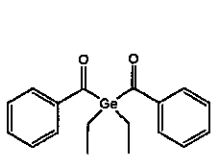
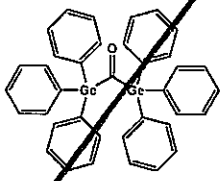
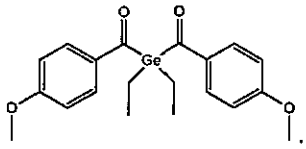


wherein R^1 = H, CH_3, CH_2CH_3, or CH_2OH; R^2 = C_1-C_4 alkyl or preferably C_1-C_4 alkoxy; and R^3 = H, CH_3, CH_3O, F, Cl, Br, I, or CF_3.

5. The method of claim 4, wherein the benzotriazole-containing UV/HEVL vinylic monomer is 2-hydroxy-5-methoxy-3-(5-(trifluoromethyl)-2H-benzo[d][1,2,3]triazol-2-yl)benzyl methacrylate, 3-(5-fluoro-2H-benzo[d][1,2,3]triazol-2-yl)-2-hydroxy-5-methoxybenzyl methacrylate, or combination thereof.

6. The method of any one of claims 1 to 5, wherein said at least one UV-absorbing vinylic monomer comprises a second UV-absorbing vinylic monomer that absorbs UV radiation and cannot absorb violet radiation of from 400 nm to 440 nm.

7. The method of claim 6, wherein the second UV-absorbing vinylic monomer is 2-(2'-hydroxy-5'-methacryloxyethylphenyl)-2H-benzotriazole.

8. The method of any one of claims 1 to 7, wherein said at least one germanium-based Norrish Type I photoinitiator comprises an acylgermanium compound preferably of formula , , or .

9. The method of any one of claims 1 to 8, wherein said at least one visibility-tinting agent comprises a blue-tinting agent (preferably Cu phthalocyanine blue).

10. The method of any one of claims 1 to 9, the pre-polymerization mixture of lens-forming materials of the invention comprises: (1) from about 10% to about 75% by weight, preferably from about 10% to about 65% by weight, even more preferably from about 15% to about 60% by weight, even more preferably from about 20% to about 55% by weight, of at least one hydrophilic vinylic monomer; (2) from about 5% to about 50% by weight, preferably from about 10% to about 40% by weight, more preferably from about 15% to about 30% by weight, of at least one siloxane-containing vinylic monomer; (3) from about 5% to about 50% by weight, preferably from about 10% to about 40% by weight, more preferably from about 15% to about 35% by weight, of at least one polysiloxane crosslinker; (4) from about 0.1% to about 4% by weight, preferably from about 0.2% to about 3% by weight, more preferably from about 0.5% to about 2.5% by weight, of at least one UV-absorbing vinylic

monomer (preferably one capable of blocking violet radiation in the region of from 380 nm to 440 nm); and (5) from about 0.05% to about 1.5% by weight, preferably from about 0.1% to 1.3% by weight, more preferably from about 0.5% to about 1.1% by weight, of at least one germanium-based Norrish Type I photoinitiator, provided that the listed components and any additional components add up to 100% by weight.

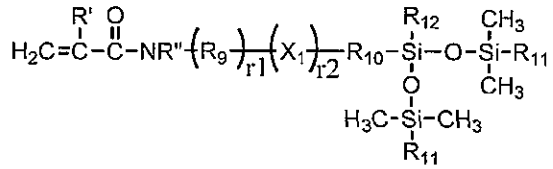
11. The method of any one of claims 1 to 10, wherein the hydrophilic vinylic monomer is a hydrophilic (meth)acrylamide-type monomer and the siloxane-containing vinylic monomer is a siloxane-containing (meth)acrylamide-type monomer, wherein the pre-polymerization mixture is characterized by having an ability to be cured within about 100 seconds by a visible light having an intensity sufficient to produce lenses of good quality (preferably a total intensity of from about 10 to about 100 mW/cm^2 in the wavelength region from 380 nm to 550 nm).

12. The method of claim 11, wherein the mold is a reusable mold suitable, wherein the step of irradiating is performed under a spatial limitation of actinic radiation, wherein the formed UV-absorbing silicone hydrogel contact lens comprises a lens edge defined by the spatial limitation of actinic radiation.

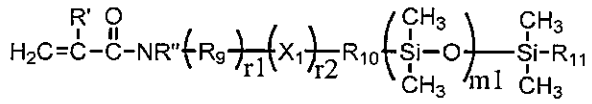
13. The method of claim 11 or 12, wherein the hydrophilic (meth)acrylamide-type monomer is N,N-dimethylacrylamide, N,N-dimethylmethacrylamide, N-(hydroxymethyl)acrylamide, N-hydroxyethyl acrylamide, N-hydroxypropyl acrylamide, N-[Tris(hydroxymethyl)methyl] acrylamide, acrylamide, methacrylamide, N-(2-aminoethyl)(meth)acrylamide, N-(3-aminopropyl)(meth)acrylamide, or a mixture thereof (preferably is N,N-dimethylacrylamide).

14. The method of any one of claims 11 to 13, wherein the siloxane-containing (meth)acrylamide-type monomer is selected from the group consisting of N-[tris(trimethylsiloxy)silylpropyl] (meth)acrylamide, N-[tris(dimethylethylsiloxy)-silylpropyl] (meth)acrylamide, N-[tris(dimethylpropylsiloxy)silylpropyl]acrylamide, N-[tris(dimethylphenylsiloxy)silylpropyl] (meth)acrylamide, N-(2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)propyl)-2-methyl acrylamide, N-(2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)propyl)acrylamide, N,N-bis[2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)propyl]-2-methyl acrylamide, and N,N-bis[2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl)propyloxy)propyl]acrylamide, N-(2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl)-2-methyl acrylamide, N-(2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl) acrylamide, N,N-bis[2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl]-2-methyl acrylamide, N,N-bis[2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl] acrylamide, N-[2-hydroxy-3-(3-(t-butyldimethylsilyl)propyloxy)propyl]-2-methyl

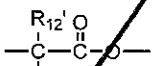
acrylamide, a siloxane-containing (meth)acrylamide-type monomer of formula (I), a siloxane-containing (meth)acrylamide-type monomer of formula (II), and combinations thereof,



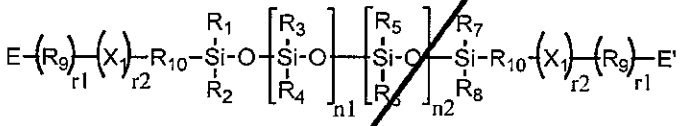
(I)



(II)

in which R' is hydrogen or methyl, R", R_{11} and R_{12} independent of one another are C_1-C_6 alkyl (preferably methyl), r1 and r2 independent of each other are integer of 0 or 1, m1 is an integer of 3 to 10 (preferably 3 to 8, more preferably 3 to 5), R_9 and R_{10} independent of each other are a substituted or unsubstituted C_1–C_{10} alkylene divalent group, X_1 is a linkage of –NR"-C-,–C-NR"–, or  in which R" is as defined above and R_{12}" and R_{12}' independent of each other are C_1-C_6 alkyl (preferably methyl).

15. The method of any one of claims 11 to 14, wherein said at least one polysiloxane crosslinker comprises a polysiloxane crosslinker of formula (III)



(III)

in which E and E' independent of each other are methacryloxy, (meth)acrylamide, or N-C_1-C_6 alkyl (meth)acrylamido group, R_9, R_{10}, X_1, r1, r2 are as defined above, n1 and n2 independently of each other are an integer of from 0 to 200 and (n1+n2) is from 10 to 200, and R_1, R_2, R_3, R_4, R_5, R_6, R_7, and R_8 independently of one another, are C_1-C_{10} alkyl, C_1-C_4 alkyl- or C_1-C_4- alkoxy-substituted phenyl, C_1-C_{10} fluoroalkyl, C_1-C_{10} fluoroether, C_6-C_{18} aryl radical, –alk–$(OC_2H_4)_{n3}$–OR^o (in which alk is C_1-C_6-alkylene divalent radical, R^o is H or C_1-C_6 alkyl and n3 is an integer from 1 to 10), or a linear hydrophilic polymer chain (preferably, R_1 to R_8 are methyl; or R_1 to R_4 and R_6 to R_8 are methyl whereas R_5 is –alk–$(OC_2H_4)_{n3}$–OR^o in which alk is C_1-C_6-alkylene divalent radical, R^o is H or C_1-C_{10} alkyl and n3 is an integer from 1 to 10).

16. The method of any one of claims 1 to 15, wherein the light source is a light-emitting-device having a peak wavelength of from 410 nm to 480 nm.

17. The method of any one of claims 10 to 16, wherein the intensity of the light source is from about 4 to about 80 mW/cm^2 (preferably from about 20 to about 60 mW/cm^2) in the 380 nm to 550 nm region, wherein the pre-polymerization mixture in the mold is irradiated under the spatial limitation of actinic radiation for a time period of about 50 seconds or less (even more preferably in ≤ about 30 seconds, and most preferably in 5 to 30 seconds).

18. A UV-absorbing silicone hydrogel contact lens obtained according to a method of any one of claims 1 to 17, wherein the contact lens has: an oxygen permeability of at least about 40 barrers (preferably at least about 60 barrers, more preferably at least about 80 barrers) (at about 35°C); an elastic modulus of about 2.0 MPa or less (preferably about 1.5 MPa or less, more preferably about 1.2 or less, even more preferably from about 0.4 MPa to about 1.0 MPa) (at room temperature, about 22°C to 28°C); and/or a water content of from about 15% to about 70% (preferably from about 20% to about 50% by weight) (at room temperature, about 22°C to 28°C) when fully hydrated.

What is claimed is:

1. A method for producing UV-absorbing silicone hydrogel contact lenses which have an UVB transmittance of about 10% or less between 280 and 315 nanometers, an UVA transmittance of about 30% or less between 316 and 380 nanometers, and an average violet transmittance of about 70% or less between 381 nm and 440 nm, the method comprising the steps of:

(1) providing a mold for making a soft contact lens, wherein the mold has a first mold half with a first molding surface defining the anterior surface of a contact lens and a second mold half with a second molding surface defining the posterior surface of the contact lens, wherein said first and second mold halves are configured to receive each other such that a cavity is formed between said first and second molding surfaces;

(2) introducing a UV-absorbing pre-polymerization mixture of lens-forming materials into the cavity, wherein the pre-polymerization mixture comprises

(a) at least one hydrophilic vinylic monomer,

(b) at least one siloxane-containing vinylic monomer,

(c) at least one polysiloxane crosslinker with two or more ethylenically-unsaturated groups,

(d) a first UV-absorbing vinylic monomer and a second UV-absorbing vinylic monomer, wherein the first UV-absorbing vinylic monomer absorbs UV radiation and high-energy-violet-light radiation of from 380 nm to 440 nm, wherein the second UV-absorbing vinylic monomer absorbs UV radiation, wherein the first and second vinylic monomers are present in the UV-absorbing pre-polymerization mixture in an amount sufficient to render a contact lens formed from the curing of the UV-absorbing pre-polymerization mixture an ability of blocking at least 90% of UVB light between 280 and 315 nanometers, at least 70% of UVA light between 316 and 380 nanometers, and at least 30% of high-energy violet light between 381 nm and 440 nm,

(e) at least one visibility-tinting agent, and

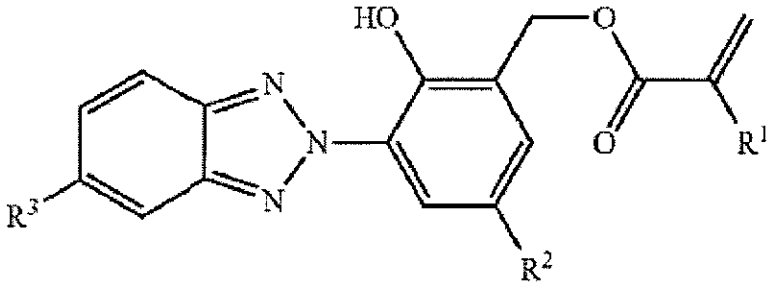
(f) from about 0.05% to about 1.5% by weight of at least one germanium-based Norrish Type I photoinitiator capable of initiating a free-radical polymerization under irradiation with a light source including a light in the region of about 380 to about 550 nm; and

(3) irradiating the pre-polymerization mixture in the mold with a light in a region of from 380 to 550 nm and crosslinking the lens-forming materials to form an UV-absorbing silicone hydrogel contact lens,

wherein the formed UV-absorbing silicone hydrogel contact lens is substantially free of internal stress and has an UVB transmittance of about 10% or less between 280 and 315 nanometers, an UVA transmittance of about 30% or less between 316 and 380 nanometers, and an average violet transmittance of about 70% or less between 381 nm and 440 nm.

2. The method of claim **1**, wherein said at least one visibility-tinting agent comprise a violet-tinting agent.

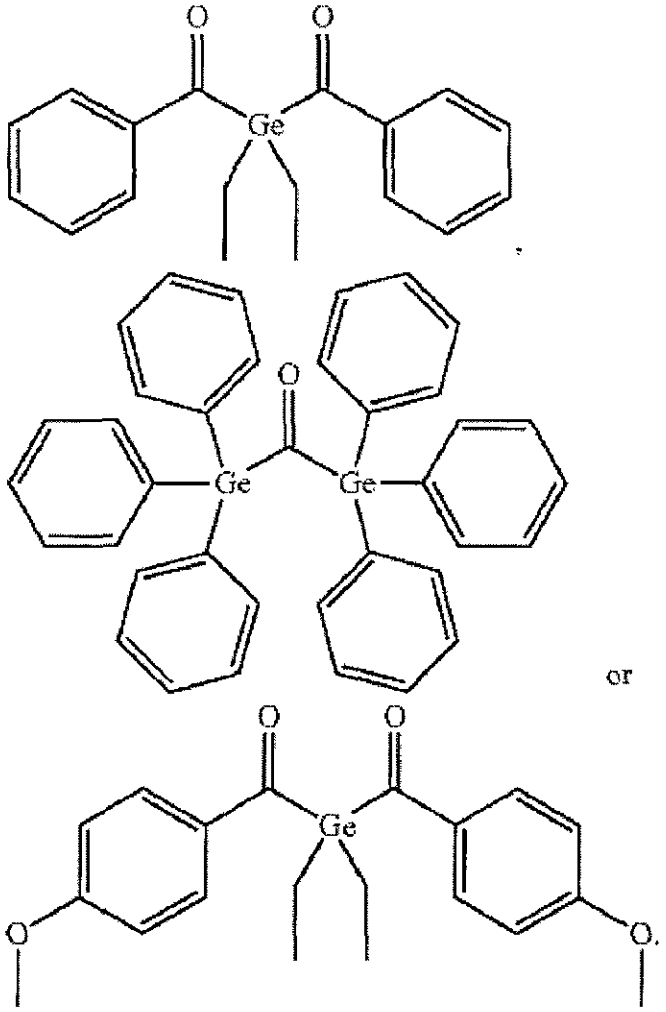
3. The method of claim **1**, wherein the first UV-absorbing vinylic monomer is a benzotriazole-containing UV/HEVL vinylic monomer of formula



wherein R^1=H, CH_3, CH_2CH_3, or CH_2OH; R^2=C_1-C_4 alkyl or C_1-C_4 alkoxy; and R^3=H, CH_3, CH_3O, F, Cl, Br, I, or CF_3.

4. The method of claim 3, wherein in the formula of the benzotriazole-containing UV/HEVL vinylic monomer, R^1=CH_3; R^2=CH_3O; and R^3=H, CH_3, CH_3O, F, or CF_3.

5. The method of claim 1, wherein the second UV-absorbing vinylic monomer is 2-(2'-hydroxy-5'-methacryloxyethylphenyl)-2H-benzotriazole.



7. The method of claim 2, wherein said at least one visibility-tinting agent comprises a blue-tinting agent.

8. The method of claim 1, the pre-polymerization mixture of lens-forming materials of the invention comprises: (1) from about 10% to about 75% by weight of at least one hydrophilic vinylic monomer; (2) from about 5% to about 50% by weight of at least one siloxane-containing vinylic monomer; (3) from about 5% to about 50% by weight of at least one polysiloxane crosslinker; (4) from about 0.1% to about 4% by weight of the first and second UV-absorbing vinylic monomers; and (5) from about 0.05% to about 1.5%

by weight of at least one germanium-based Norrish Type I photoinitiator, provided that the listed components and any additional components add up to 100% by weight.

9. The method of claim **1**, wherein the hydrophilic vinylic monomer is a hydrophilic (meth)acrylamide-type monomer and the siloxane-containing vinylic monomer is a siloxane-containing (meth)acrylamide-type monomer, wherein the pre-polymerization mixture is characterized by having an ability to be cured within about 100 seconds by a visible light having a total intensity of from about 10 to about 100 mW/cm^2 in the wavelength region from 380 nm to 550 nm.

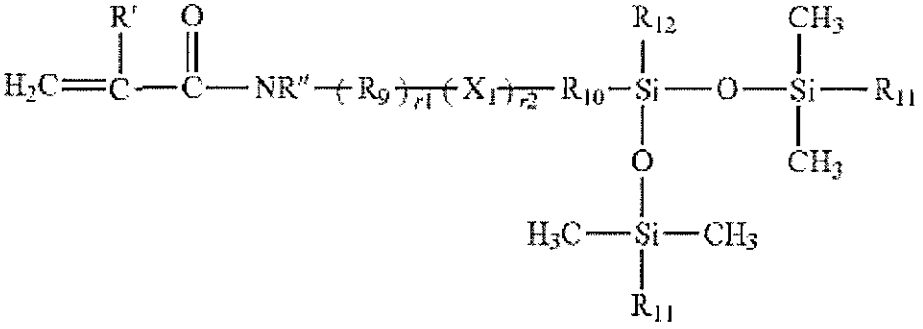
10. The method of claim **9**, wherein the mold is a reusable mold suitable, wherein the step of irradiating is performed under a spatial limitation of actinic radiation, wherein the formed UV-absorbing silicone hydrogel contact lens comprises a lens edge defined by the spatial limitation of actinic radiation.

11. The method of claim **9**, wherein the hydrophilic (meth) acrylamide-type monomer is N,N-dimethylacrylamide, N,N-dimethylmethacrylamide, N-(hydroxymethyl)acrylamide, N-hydroxyethyl acrylamide, N-hydroxypropyl acrylamide, N-[Tris(hydroxymethyl)methyl]acrylamide, acrylamide, methacrylamide, N-(2-aminoethyl)(meth)acrylamide, N-(3-aminopropyl)(meth)acrylamide, or a mixture thereof.

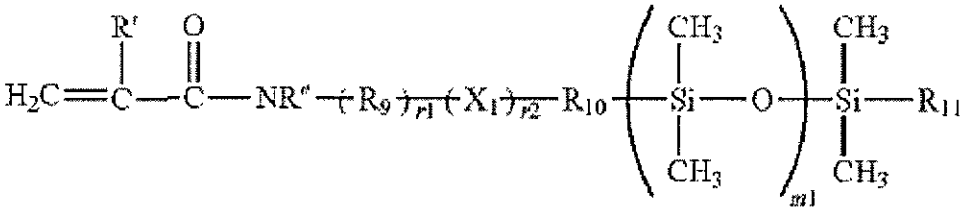
12. The method of claim **11**, wherein the siloxane-containing (meth)acrylamide-type monomer is selected from the group consisting of N-[tris(trimethylsiloxy)silylpropyl] (meth)acrylamide, N-[tris(dimethylethylsiloxy)-silylpropyl] (meth)acrylamide, N-[tris(dimethylpropylsiloxy)silylpropyl]acrylamide, N-[tris(dimethylphenylsiloxy)silylpropyl] (meth)acrylamide, N-(2-hydroxy-3-(3-(tris (trimethylsilyloxy)silyl)propyloxy)propyl)-2-methyl acrylamide, N-(2-hydroxy-3-(3-(tris(trimethylsilyloxy)silyl) propyloxy)propyl)acrylamide, N,N-bis[2-hydroxy-3-(3-(tris (trimethylsilyloxy)silyl)propyloxy)propyl]-2-methyl acrylamide, and N,N-bis[2-hydroxy-3-(3-(tris(trimethylsilyloxy) silyl)propyloxy)propyl]acrylamide, N-(2-hydroxy-3-(3-(bis

(trimethylsilyloxy)methylsilyl)propyloxy)propyl)-2-methyl acrylamide, N-(2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl) acrylamide, N,N-bis[2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl]-2-methyl acrylamide, N,N-bis[2-hydroxy-3-(3-(bis(trimethylsilyloxy)methylsilyl)propyloxy)propyl] acrylamide, N-[2-hydroxy-3-(3-(t-butyldimethylsilyl) propyloxy)propyl]-2-methyl acrylamide, a siloxane-containing (meth)acrylamide-type monomer of formula (I), a siloxane-containing (meth)acrylamide-type monomer of formula (II), and combinations thereof,

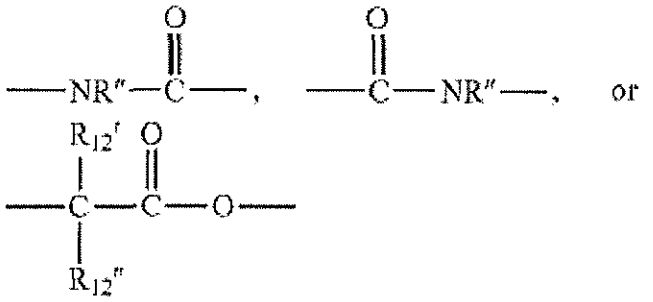
(I)



(II)

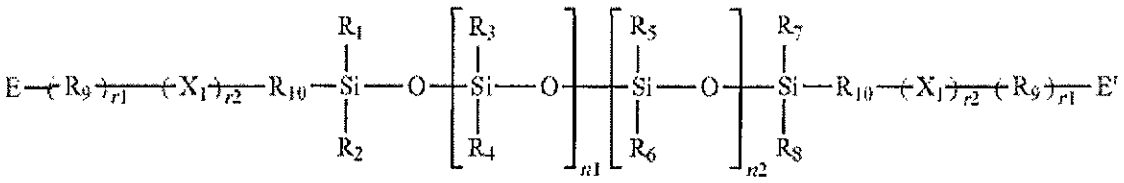


in which R' is hydrogen or methyl, R", R_{11} and R_{12} independent of one another are C_1-C_6 alkyl, r1 and r2 independent of each other are integer of 0 or 1, m1 is an integer of 3 to 10, R_9 and R_{10} independent of each other are a substituted or unsubstituted C_1-C_{10} alkylene divalent group, X_1 is a linkage of



in which R" is as defined above and R_{12}" and R_{12}' independent of each other are C_1-C_6 alkyl.

13. The method of claim **12**, wherein said at least one polysiloxane crosslinker comprises a polysiloxane crosslinker of formula (III)



(III)

in which E and E' independent of each other are methacryloxy, (meth)acrylamide, or N—C_1-C_6 alkyl (meth)acrylamido group, R_9, R_{10}, X_1, r1, r2 are as defined above, n1 and n2 independently of each other are an integer of from 0 to 200 and (n1+n2) is from 10 to 200, and R_1, R_2, R_3, R_4, R_5, R_6, R_7, and R_8 independently of one another, are C_1-C_{10} alkyl, C_1-C_4 alkyl- or C_1-C_4-alkoxy-substituted phenyl, C_1-C_{10} fluoroalkyl, C_1-C_{10} fluoroether, C_6-C_{18} aryl radical, -alk-$(OC_2H_4)_{n3}$—OR° in which alk is C_1-C_6-alkylene divalent radical, R° is H or C_1-C_6 alkyl and n3 is an integer from 1 to 10, or a linear hydrophilic polymer chain.

14. The method of claim **1**, wherein the light source is a light-emitting-device having a peak wavelength of from 410 nm to 480 nm.

15. The method of claim **9**, wherein the intensity of the light source is from about 4 to about 80 mW/cm^2 in the 380

nm to 550 nm region, wherein the pre-polymerization mixture in the mold is irradiated under the spatial limitation of actinic radiation for a time period of about 50 seconds or less.

16. The method of claim **3**, wherein the second UV-absorbing vinylic monomer is 2-(2'-hydroxy-5'-methacryloxyethylphenyl)-2H-benzotriazole.

17. A UV-absorbing silicone hydrogel contact lens obtained according to a method of claim **1**, wherein the contact lens has: an oxygen permeability of at least about 40 barrers at about 35° C.; an elastic modulus of about 2.0 MPa or less at room temperature; and/or a water content of from about 15% to about 70% at room temperature when fully hydrated.