Claims:

1. A method for producing hydrogel contact lenses, comprising the steps of:
   (1) obtain a first polymerizable fluid composition and a second polymerizable fluid composition, wherein the first polymerizable fluid composition comprises at least one visible-light free-radical photoinitiator, at least one thermal free-radical initiator, at least one first polymerizable material, and at least one photochromic compound, wherein the second polymerizable fluid composition comprises said at least one thermal free-radical initiator and at least one second polymerizable material and is free of any photochromic compound, wherein the first polymerizable fluid composition has a curing time as determined in photo-rheology study using a visible light at a specified intensity;
   (2) obtaining a lens mold, wherein the lens mold comprises a female mold half having a first molding surface defining the anterior surface of a contact lens to be molded and a male mold half having a second molding surface defining the posterior surface of the contact lens to be molded, wherein the female and male mold halves are configured to receive each other such that a mold cavity is formed between the first and second molding surfaces when the mold is closed;
   (3) applying an amount of the first polymerizable fluid composition onto a central zone of the first molding surface of the female mold half to form a circular layer of the first polymerizable fluid composition, wherein the circular layer has a diameter of 13.00 mm or less;
   (4) actinically curing the circular layer of the first polymerizable fluid composition to form a disk having curved surfaces, wherein the step of actinically curing is carried out by irradiating the circular layer of the first polymerizable fluid composition with the visible light at the specified intensity for at least 50% of the curing time;
   (5) dispensing an amount of the second polymerizable fluid composition over the partially-crosslinked circular layer on the central zone of the first molding surface;
   (6) closing the female mold half with the male mold half to form a molding assembly comprising the partially crosslinked circular layer immersed in the second polymerizable fluid composition within the mold cavity;
   (7) thermally curing the second polymerizable fluid composition and the partially-crosslinked circular layer immersed therein in the molding assembly to form an unprocessed hydrogel contact lens having a central photochromic zone that has a diameter of 13 mm or less, is concentric with the central axis of the unprocessed hydrogel contact lens;

(8) separating the molding assembly into the male and female mold halves, with the unprocessed hydrogel contact lens adhered onto a lens-adhered mold half which is one of the male and female mold halves;

(9) removing the unprocessed hydrogel contact lens from the lens-adhered mold half; and

(10) subjecting the unprocessed hydrogel contact lens to post-molding processes including a hydration process and one or more other processes selected from the group consisting of extraction, surface treatment, packaging, sterilization, and combinations thereof.

2. The method of claim 1, wherein the first and second polymerizable fluid compositions both are capable of forming a non-silicone hydrogel, wherein said at least one first and second polymerizable materials independent of each other are a first monomer mixture comprising (a) at least one first hydrophilic vinylic monomer selected from the group consisting of at least one hydroxyl-containing vinylic monomer, N,N-dimethylarylamide, N-vinylpyrrolidone, at least one methylene-containing pyrrolidone monomer, and combinations thereof, and (b) at least one component selected from the group consisting of at least one non-silicone vinylic crosslinker, a non-silicone hydrophobic vinylic monomer, a UV-absorbing vinylic monomer, and combinations thereof.

3. The method of claim 2, wherein said at least one first and second polymerizable materials independent of each other comprises at least 50% by weight of at least one hydroxyl-containing vinylic monomer, relative to the total weight of all polymerizable materials present in the first polymerizable fluid composition.

4. The method of claim 1, wherein the first and second polymerizable fluid compositions both are capable of forming a non-silicone hydrogel, wherein said at least one first and second polymerizable materials independent of each other are a reactive mixture comprising (a) one or more water-soluble non-silicone prepolymers and optionally (b) at least one component selected from the group consisting of a hydrophilic vinylic monomer, a non-silicone vinylic crosslinker, a non-silicone hydrophobic vinylic monomer, a UV-absorbing vinylic monomer, and combinations thereof.

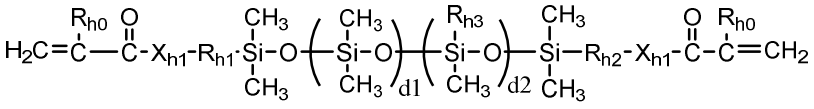
5. The method of claim 1, wherein the first and second polymerizable fluid compositions both are capable of forming a silicone hydrogel, wherein said at least one first and second polymerizable materials independent of each other are a second monomer mixture comprising (a) at least one silicone-containing vinylic monomer, (b) at least one polysiloxane vinylic crosslinker, at least one non-silicone vinylic crosslinker, or both, (c) at least one second hydrophilic vinylic monomer, and optionally (d) at least one component selected from the group consisting of a non-silicone hydrophobic vinylic monomer, a UV-absorbing vinylic monomer, and combinations thereof, wherein said at

least one second hydrophilic vinylic monomer comprises at least one hydrophilic (meth)acrylamido monomer having 3 to 8 carbon atoms, at least one hydrophilic (meth)acryloxy monomer, at least one hydrophilic N-vinyl amide monomer, at least one methylene-containing pyrrolidone monomer, at least one vinyl ether monomer, at least one allyl ether monomer, at least one phosphorylcholine-containing vinylic monomer, N-2-hydroxyethyl vinyl carbamate, N-vinyloxycarbonyl-β-alanine, N-vinyloxycarbonyl-α-alanine, or (i) combinations thereof,

wherein the sum of the amounts of components (a), (b) and (c) in the second monomer mixture is at least 60% by weight relative to the total weight of all polymerizable materials present in the second monomer mixture,

wherein said at least one silicone-containing vinylic monomer comprises (i) at least one silicone-containing vinylic monomer containing a tris(trialkylsiloxy)silyl group and one sole ethylenically-unsaturated group selected from the group consisting of a (meth)acryloyloxy group, a (meth)acryloylamino group, a vinyl carbonate group, and a vinylcarbamate group; (ii) at least one silicone-containing vinylic monomer containing a bis(trialkylsilyloxy)-alkylsilyl group and one sole ethylenically-unsaturated group selected from the group consisting of a (meth)acryloyloxy group, a (meth)acryloylamino group, a vinyl carbonate group, and a vinylcarbamate group; (iii) at least silicone-containing vinylic monomer containing a) one sole ethylenically-unsaturated group selected from the group consisting of a (meth)acryloyloxy group, a (meth)acryloylamino group, a vinyl carbonate group, and a vinylcarbamate group and b) a polysiloxane chain having 2 to 30 siloxane units and terminated with an alkyl, hydroxyalkyl or methoxyalkyl group; or (iv) combinations thereof.

6. The method of claim 5, wherein the second monomer mixture comprises at least one polysiloxane vinylic crosslinker of formula (H)



(H)

in which:

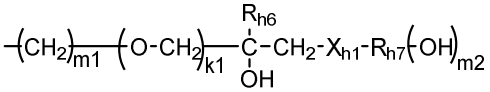
d1 is an integer of from 30 to 500 and d2 is an integer of from 1 to 75, provided that d2/d1 is from 0.035 to 0.15;

X_{h1} is O or NR_{hN} in which R_{hN} is hydrogen or C_1-C_{10}-alkyl;

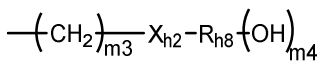
R_{h0} is hydrogen or methyl;

R_{h1} and R_{h2} independently of each other are a substituted or unsubstituted C_1–C_{10} alkylene divalent radical or a divalent radical of $–R_{h4}–O–R_{h5}–$ in which R_{h4} and R_{h5} independently of each other are a substituted or unsubstituted C_1–C_{10} alkylene divalent radical;

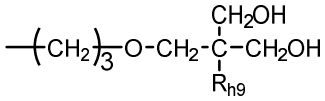
R_{h3} is a monovalent radical of any one of formula (H-a) to (H-e)



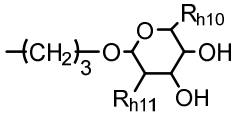
(H-a)



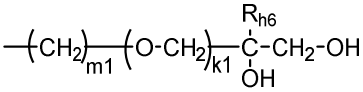
(H-b)



(H-c)



(H-d)



(H-e)

k1 is zero or 1; m1 is an integer of 2 to 4; m2 is an integer of 1 to 5; m3 is an integer of 3 to 6; m4 is an integer of 2 to 5;

R_{h6} is hydrogen or methyl;

R_{h7} is a C_2-C_6 hydrocarbon radical having (m2+1) valencies;

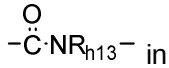
R_{h8} is a C_2-C_6 hydrocarbon radical having (m4+1) valencies;

R_{h9} is ethyl or hydroxymethyl;

R_{h10} is methyl or hydroxymethyl;

R_{h11} is hydroxyl or methoxy;

X_{h1} is a sulfur linkage of –S– or a teriary amino linkage of $–NR_{h12}–$ in which R_{h12} is C_1-C_1 alkyl, hydroxyethyl, hydroxypropyl, or 2,3-dihydroxypropyl; and

X_{h2} is a linkage of or  in which R_{h13} is hydrogen or C_1-C_{10} alkyl.

7. The method of claim 5 or 6, wherein the second monomer mixture comprises (i) at least one polysiloxane vinylic crosslinker having one sole polydiorganosiloxane segment and two terminal ethylenically-unsaturated groups selected from the group consisting of (meth)acryloyloxy groups, (meth)acryloylamino groups, vinyl carbonate groups, vinylcarbamate groups; and/or (ii) at least one chain-extended polysiloxane vinylic crosslinker having at least two polydiorganosiloxane segment and a covalent linker between each pair of polydiorganosiloxane segments and two terminal ethylenically-unsaturated groups selected from the group consisting of (meth)acryloyloxy groups, (meth)acryloylamino groups, vinyl carbonate groups, vinylcarbamate groups.
8. The method of any one of claims 5 to 7, wherein said at least one first and second polymerizable materials independent of each other comprise: (i) at least one non-silicone vinylic crosslinker selected from the group consisting of ethyleneglycol di-

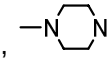
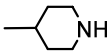
(meth)acrylate, diethyleneglycol di-(meth)acrylate, triethyleneglycol di-(meth)acrylate, tetraethyleneglycol di-(meth)acrylate, glycerol di-(meth)acrylate, 1,3-propanediol di-(meth)acrylate, 1,3-butanediol di-(meth)acrylate, 1,4-butanediol di-(meth)acrylate, glycerol 1,3-diglycerolate di-(meth)acrylate, ethylenebis[oxy(2-hydroxypropane-1,3-diyl)] di-(meth)acrylate, bis[2-(meth)acryloxyethyl] phosphate, trimethylolpropane di-(meth)acrylate, and 3,4-bis[(meth)acryloyl]tetrahydrofuan, diacrylamide (i.e., N-(1-oxo-2-propenyl)-2-propenamide), dimethacrylamide (i.e., N-(1-oxo-2-methyl-2-propenyl)-2-methyl-2-propenamide), N,N-di(meth)acryloyl-N-methylamine, N,N-di(meth)acryloyl-N-ethylamine, N,N'-methylene bis(meth)acrylamide, N,N'-ethylene bis(meth)acrylamide, N,N'-dihydroxyethylene bis(meth)acrylamide, N,N'-propylene bis(meth)acrylamide, N,N'-2-hydroxypropylene bis(meth)acrylamide, N,N'-2,3-dihydroxybutylene bis(meth)acrylamide, 1,3-bis(meth)acrylamide-propane-2-yl dihydrogen phosphate (i.e., N,N'-2-phophonyloxypropylene bis(meth)acrylamide), piperazine diacrylamide (or 1,4-bis(meth)acryloyl piperazine), tetraethyleneglycol divinyl ether, triethyleneglycol divinyl ether, diethyleneglycol divinyl ether, ethyleneglycol divinyl ether, triallyl isocyanurate, triallyl cyanurate, trimethylopropane trimethacrylate, pentaerythritol tetramethacrylate, bisphenol A dimethacrylate, and combinations thereof; (ii) at least one non-silicone hydrophobic vinylic monomer which comprises at least one C_1-C_8 alkyl (meth)acrylate, at least one C_5-C_{16} cycloalkyl (meth)acrylate, at least one aryl methacrylate, (meth)acrylonitrile, at least one fluorine-containing acrylic monomer, at least one vinyl alkanoate, at least one vinyloxyalkane, at least one substituted or unsubstituted styrene, vinyl toluene, vinyl chloride, vinylidene chloride, 1-butene, or combinations thereof; (iii) at least one UV-absorbing vinylic monomer; or (iv) combinations thereof.

9. The method of any one of claims 1 to 8, wherein said at least one first and second polymerizable materials independent of each other comprises at least one UV-absorbing vinylic monomer.

10. The method of any one of claims 1 to 9, wherein said at least one photochromic compound comprises a naphthopyran, an indeno-fused naphthopyran, a heterocyclic ring-fused naphthopyrian, a benzopyran, a phenanthropyran, a quinopyran, a quinolinopyran, a fluoroanthenopyran, an anthracene-fused pyran, a tetracene-fused pyran, a spiro(benzindoline) naphthopyran, a spiro(indoline)naphthopyran, a spiro(indoline)benzopyran, a spiro(indoline)quinopyran, a spiro(indoline)pyran, a naphthoxazine, a spirobenzopyran, a spirobenzothiopyran, a naphthacenedione, a benzoxazine, a spirooxazine, a naphthoxazine, a spiro(benzindoline)naphthoxazine, a spiro(indoline)naphthoxazine, a spiro(indoline)pyrido-benzoxazine, a spiro(indoline)-benzoxazine, a spiro(benzindoline) benzoxazine, a spiro(benzindoline)pyridobenzoxazine, a spiro(indoline) fluoranthenoxazine, a

spiro(indoline)-quinoxazine, a spiropiperidine-naphthopyran, a piro(indoline)pyronobenzoxazinone, a benzospiropyran, a naphtho-spiropyran, a spirobenzoxazine-pyrrolopyridine, a spironaphthoxazine-pyrrolopyrridine, a spiro-oxazepin-benzoxazine, a spiro-oxazepin-naphthoxazine, a spiro(indoline) benzothiazoloxazine, a spiro(indoline)benzopyrroloxazine, a spiro(indoline)quinazolino-oxazine, a spiro(indoline)-anthracenobenzoxazine, a benzofurobenzopyran, a benzothienobenzopyran, a naphthofurobenzopyran, a benzopyrano-fused naphthopyran, a spiro(isoindoline)-naphthoxazine, a spiro(isoindoline)benzoxazine, or a mixture thereof.

11. The method of any one of claims 1 to 10, wherein said at least one photochromic compound is polymerizable and comprises an ethylenicaly-unsaturated group.

12. The method of claim 11, wherein said at least one photochromic compound is a coupling reaction product of a reactive (meth)acrylamido or (meth)acryloxy monomer having a first reactive functional group and a reactive photochromic compound have a second reactive functional group in the absence or presence of a coupling agent under coupling reaction, wherein the first reactive functional group is selected from the group consisting of –COCl, –COBr, –COOH, –NHR_{N2}, –NCO, –OH, –CHO, , , or ; wherein the second reactive functional group is selected from the group consisting of –COOH, –NHR_{N2}, , , , –NCO, –OH, –SH, –CHO, , , or , wherein R_0 is hydrogen or methyl and R_{N2} is hydrogen, a linear or branched C_1-C_{15} alkyl, cyclohexyl, cyclopentyl, a substituted or unsubstituted phenyl, or a substituted- or unsubstituted-phenyl-C_1-C_6 alkyl,
wherein the reactive (meth)acrylamido or (meth)acryloxy monomer is selected from the group consisting of (meth)acryloyl halides (CH_2=CH–COX or CH_2=CCH_3–COX, X= Cl or Br), N-hydroxysuccinimide ester of (meth)acrylic acid, glycidyl (meth)acrylate, isocyanato- C_2-C_6 alkyl (meth)acrylate, amino–C_2-C_6 alkyl (meth)acrylamide, C_1-C_6 alkylamino–C_2-C_6 alkyl (meth)acrylamide, (meth)acrylic acid, C_2-C_4 alkylacrylic acid (e.g., ethylacrylic acid, propylacrylic acid, butylacrylic acid), N-2-acrylamidoglycolic acid, 3-(acryloylxy)propanoic acid, C_2-C_6 hydroxylalkyl (meth)acrylate, C_2-C_6 hydroxyalkyl (meth)acrylamide, an azlactone-containing vinylic monomer, an aziridinyl C_1-C_{12} alkyl (meth)acrylate, acrolein, methacrolein, crotonaldehyde, and combinations thereof.

13. The method of any one of claims 1 to 12, wherein said at least one first and second polymerizable materials independent of each other comprises at least one polymerizable UV/HEVL-absorbing compound.

14. The method of any one of claims 1 to 13, wherein said at least one visible light free

radical initiator comprises a benzoylphosphine initiator and/or an acylgermanium photoinitiator.

15. The method of claim 14, wherein the visible light is a visible light in a region of from 420 nm to 500 nm.