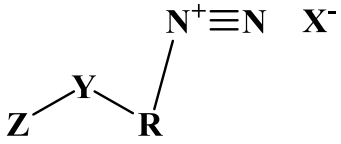
CLAIMS

1. An electroactive biocompatible polymer comprising a biocompatible polymer comprising a single strand of repeating units and up to 5,000 electroactive groups covalently attached to said strand, wherein precursors of said electroactive groups are selected from the group consisting of a diazonium derivative, an arylsulfonium derivative, a diaryliodonium derivative, and combinations thereof;
wherein the biocompatible polymer is selected from the group consisting of poly-L-lactic acid (PLLA), poly(lactide-co-glycolide) (PLGA), poly caprolactone (PCL), polyvinyl pyrrolidone (PVP), polyvinyl alcohol (PVA), collagen, hydroxy propyl cellulose, polyglycerol esters of fatty acids, polysaccharides, and combinations thereof.

2. The electroactive biocompatible polymer according to claim 1, wherein the polysaccharides are selected from the group consisting of dextran, chitosan, heparin, hyaluronic acid, alginates, starch, glycogen, amylose, amylopectin, cellulose, and xylan.

3. The electroactive biocompatible polymer according to claim 1, wherein said diazonium derivative is a compound of the following formula:



wherein

X is an inorganic or organic anion selected from the group consisting of anions of F^-, Cl^-, Br^-, I^-, BF_4^-, BF_3, $ZnCl_2$, HSO_4^-, PF_6, $HgBr_2$, $HgBr_2Cl_2$, NO_3^-, nonafluoro-1-butanesulfonate, trifluoromethanesulfonate, dimethoxy-2-anthracenesulfonate, and methylbenzenesulfonate;

R is a bond, 5-7 membered saturated cyclic ring, 5-7 membered heterocyclic ring, 5-7 membered aromatic ring or 5-7 membered heteroaromatic ring, each of which is unsubstituted, mono-, di- or tri- substituted with:

C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_2-C_8 straight-chain alkenyl group, C_3-C_8 branched-chain alkenyl group, C_2-C_8 straight-chain alkynyl group, C_3-C_8 branched-chain alkynyl group, or phenyl group substituted at any ring position with one or more

the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, phenyl ring or heterocyclic ring, each of which is optionally substituted with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_1-C_8 alkoxy group, C_1-C_8 alkoxycarbonyl group, carboxyl group, hydroxyl group, nitro group, halogen atom or amino group, each of which is optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

methyl group substituted with 1-3 halogen atoms;

amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

thiol or thioether group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

sulfone or sulfate group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

nitro, cyano, halogen, hydroxy, carboxylic acid or sulfonic acid group; or

alkoxy or alkoxycarbonyl group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

Y is a bond, saturated C_1-C_{500} straight-chain alkyl group, C_3-C_{500} branched-chain alkyl group, unsaturated C_2-C_{500} straight-chain alkyl group, unsaturated C_3-C_{500} branched-chain alkyl group, alkenyl group or alkynyl group, wherein any of said C_1-C_{500} straight-chain alkyl group, C_3-C_{500} branched-chain alkyl group, unsaturated C_2-C_{500} straight-chain alkyl group, unsaturated C_3-C_{500} branched-chain alkyl group, alkenyl group or alkynyl group optionally incorporates at least one hetero atom, and wherein any of said C_1-C_{500} straight-chain alkyl group, C_3-C_{500} branched-chain alkyl group, unsaturated C_2-C_{500} straight-chain alkyl group, unsaturated C_3-C_{500} branched-chain alkyl group, alkenyl group or alkynyl group optionally comprises at least one substituent; and

Z is any suitable functional group selected from the group consisting of halogen, amino, cyano, hydroxy, aldehyde, alkoxycarbonyl, N-amide, N-hydroxysuccinimide ester, maleimide, and thiol.

4. The electroactive biocompatible polymer according to claim 3, wherein said diazonium derivative is 4-(dimethylamino)-benzene-diazonium salt;

2-chloro-benzene-diazonium salt;

1-naphthalene-diazonium salt;

4-anilino-benzene-diazonium salt;

3,5-dichloro-benzene-diazonium salt;

1-pyrene-diazonium salt;

4-methoxy-benzene-diazonium salt;

4-bromo-benzene-diazonium salt;

4-formyl-benzene-diazonium salt;

4-nitro-benzene-diazonium salt;

Fast Red TR salt;

Variamine blue B salt;

4-[ethyl(2-hydroxyethyl)amino]-benzene-diazonium salt;

4-(diethylamino)-2-methyl-benzene-diazonium salt;

4-(ethylamino)-3-methyl-benzene-diazonium salt;

5-chloro-2-methoxy-benzene-diazonium salt;

3-methyl-4-nitro-benzene-diazonium salt;

bis[4-(diethylamino)-2-methyl-benzene-diazonium] salt;

2,4-dichloro-benzene-diazonium salt;

2-methoxy-4-nitro-benzene-diazonium salt;

2-chloro-4-nitro-benzene-diazonium 2-naphthalenesulfonate salt;

2,5-diethoxy-4-[(4-methylphenyl)sulfanyl]benzenediazonium salt;

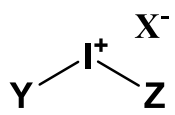
Fast Blue B salt;

9H-fluorene-2-diazonium salt;

9,10-dioxo-9,10-dihydro-1-anthracenediazonium salt; or

2-methoxy-4-morpholinobenzenediazonium salt.

5. The electroactive biocompatible polymer according to claim 1, wherein said diaryliodonium derivative is a compound of the following formula:



wherein

X is an inorganic or organic anion selected from the group consisting of anion of F^-, Cl^-, Br^-, I^-, BF_4^-, BF_3, $ZnCl_2$, HSO_4^-, PF_6, $HgBr_2$, $HgBr_2Cl_2$, NO_3^-, nonafluoro-1-butanesulfonate, trifluoromethanesulfonate, dimethoxy-2-anthracenesulfonate, and methylbenzenesulfonate;

Y is a 5-7 membered saturated cyclic ring, 5-7 membered heterocyclic ring, 5-7 membered aromatic ring or 5-7 membered heteroaromatic ring, each of which is unsubstituted, mono-, di- or tri- substituted with:

C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_2-C_8 straight-chain alkenyl group, C_3-C_8 branched-chain alkenyl group, C_2-C_8 straight-chain alkynyl group, C_3-C_8 branched-chain alkynyl group, or phenyl group substituted at any ring position with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, phenyl ring or heterocyclic ring, each of which is optionally substituted with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_1-C_8 alkoxy group, C_1-C_8 alkoxycarbonyl group, carboxyl group, hydroxyl group, nitro group, halogen atom or amino group, each of which is optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

methyl group substituted with 1-3 halogen atoms;

amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

thiol or thioether group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

sulfone or sulfate group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

nitro, cyano, halogen, hydroxy, carboxylic acid or sulfonic acid group; or

alkoxy or alkoxycarbonyl group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group; and

Z is a 5-7 membered saturated cyclic ring, 5-7 membered heterocyclic ring, 5-7 membered aromatic ring or 5-7 membered heteroaromatic ring, each of which is unsubstituted, mono-, di- or tri- substituted with:

C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_2-C_8 straight-chain alkenyl group, C_3-C_8 branched-chain alkenyl group, alkynyl group, or phenyl group substituted

at any ring position with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, phenyl ring or heterocyclic ring, each of which is optionally substituted with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_1-C_8 alkoxy group, C_1-C_8 alkoxycarbonyl group, carboxyl group, hydroxyl group, nitro group, halogen atom or amino group, each of which is optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

methyl group substituted with 1-3 halogen atoms;

amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

thiol or thioether group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

sulfone or sulfate group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

nitro, cyano, halogen, hydroxy, carboxylic acid or sulfonic acid group; or

alkoxy or alkoxycarbonyl group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group.

6. The electroactive biocompatible polymer according to claim 5, wherein said diaryliodonium derivative is diphenyliodonium iodide salt;

bis(4-methoxyphenyl)iodonium salt;

bis(4-methylphenyl)iodonium salt;

bis(4-tert-butylphenyl)iodonium salt;

4-(phenyliodonio)benzoate salt;

bis(4-fluorophenyl)iodonium salt;

bis(4-bromophenyl)iodonium salt;

bis(4-tert-butylphenyl)iodonium salt;

mesityl(4-methylphenyl)iodonium salt;

2-(phenyliodonio)benzoate salt;

2-(phenyliodonio)benzoate;

(4-nitrophenyl)(phenyl)iodonium;

phenyl[3-(trifluoromethyl)phenyl]iodonium salt;

(3-bromophenyl)(mesityl)iodonium salt;

(2-bromophenyl)(mesityl)iodonium salt;

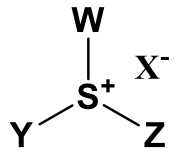
mesityl[3-(trifluoromethyl)phenyl] iodonium salt;

mesityl(4-nitrophenyl) iodonium salt;

diphenyleneiodonium salt; or

3,7-dinitrodibenziodolium salt.

7. The electroactive biocompatible polymer according to claim 1, wherein said arylsulfonium derivative is a compound of the following formula:



wherein

X is an inorganic or organic anion selected from the group consisting of anion of F^-, Cl^-, Br^-, I^-, BF_4^-, BF_3, $ZnCl_2$, HSO_4^-, PF_6, $HgBr_2$, $HgBr_2Cl_2$, NO_3^-, nonafluoro-1-butanesulfonate, trifluoromethanesulfonate, dimethoxy-2-anthracenesulfonate, and methylbenzenesulfonate;

Y is a bond, C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, 5-7 membered saturated cyclic ring, 5-7 membered heterocyclic ring, 5-7 membered aromatic ring or 5-7 membered heteroaromatic ring, each of which is unsubstituted, mono-, di- or tri- substituted with:

C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_2-C_8 straight-chain alkenyl group, C_3-C_8 branched-chain alkenyl group, C_2-C_8 straight-chain alkynyl group, C_3-C_8 branched-chain alkynyl group, or phenyl group substituted at any ring position with one or more the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group, phenyl ring or heterocyclic ring, each of which is optionally substituted with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_1-C_8 alkoxy group, C_1-C_8 alkoxycarbonyl group, carboxyl group, hydroxyl group, nitro group, halogen atom or amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

methyl group substituted with 1-3 halogen atoms;

amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

thiol or thioether group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

sulfone or sulfate group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

nitro, cyano, halogen, hydroxy, carboxylic acid or sulfonic acid group; or

alkoxy or alkoxycarbonyl group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

Z is a bond, C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, 5-7 membered saturated cyclic ring, 5-7 membered heterocyclic ring, 5-7 membered aromatic ring or 5-7 membered heteroaromatic ring, each of which is unsubstituted, mono-, di- or tri- substituted with:

C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_2-C_8 straight-chain alkenyl group, C_3-C_8 branched-chain alkenyl group, C_2-C_8 straight-chain alkynyl group, C_3-C_8 branched-chain alkynyl group, or phenyl group substituted at any ring position with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, phenyl ring or heterocyclic ring, each of which is optionally substituted with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_1-C_8 alkoxy group, C_1-C_8 alkoxycarbonyl group, carboxyl group, hydroxyl group, nitro group, halogen atom or amino group, each of which is optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

methyl group substituted with 1-3 halogen atoms;

amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

thiol or thioether group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

sulfone or sulfate group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

nitro, cyano, halogen, hydroxy, carboxylic acid or sulfonic acid group; or

alkoxy or alkoxycarbonyl group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group; and

W is a bond, C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, 5-7 membered saturated cyclic ring, 5-7 membered heterocyclic ring, 5-7 membered aromatic ring or 5-7 membered heteroaromatic ring, each of which is unsubstituted, mono-, di- or tri- substituted with:

C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_2-C_8 straight-chain alkenyl group, C_3-C_8 branched-chain alkenyl group, C_2-C_8 straight-chain alkynyl group, C_3-C_8 branched-chain alkynyl group, or phenyl group substituted at any ring position with one or more the same or different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, phenyl ring or heterocyclic ring, each of which is optionally substituted with one or more the same or a different C_1-C_8 straight-chain alkyl group, C_3-C_8 branched-chain alkyl group, C_1-C_8 alkoxy group, C_1-C_8 alkoxycarbonyl group, carboxyl group, hydroxyl group, nitro group, halogen atom or amino group, each of which is optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

methyl group substituted with 1-3 halogen atoms;

amino group optionally mono or di-substituted with the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

thiol or thioether group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

sulfone or sulfate group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

nitro, cyano, halogen, hydroxy, carboxylic acid or sulfonic acid group; or

alkoxy or alkoxycarbonyl group having the same or a different C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group;

wherein at least two of **W**, **Y** and **Z** are not a bond, C_1-C_8 straight-chain alkyl group or C_3-C_8 branched-chain alkyl group.

8. The electroactive biocompatible polymer according to claim 7, wherein said arylsulfonium derivative is triphenylsulfonium salt;

diphenyl[4-(phenylsulfanyl) phenyl] sulfonium salt;

(4-fluorophenyl)(diphenyl)sulfonium salt;
tris(4-tert-butylphenyl)sulfonium salt;
tris(4-chlorophenyl)sulfonium salt;
(4-chlorophenyl)diphenylsulfonium salt;
tri-p-tolylsulfonium salt;
tris(4-methoxyphenyl)sulfonium salt;
(4-methoxyphenyl)diphenylsulfonium salt;
ethyl(4-methoxyphenyl)(phenyl)sulfonium salt;
(3-chloropropyl)diphenylsulfonium salt; or
(5-chloropentyl)diphenylsulfonium salt.

9. The electroactive biocompatible polymer according to claim 1, wherein the electroactive biocompatible polymer forms covalent crosslinking groups thereon once the electroactive biocompatible polymer is activated with a voltage potential ranging from negative 10 Volts to positive 10 Volts.

10. The electroactive biocompatible polymer according to claim 1, wherein the electroactive biocompatible polymer forms covalent crosslinking groups thereon once the electroactive biocompatible polymer is activated with a voltage potential applied constantly.

11. The electroactive biocompatible polymer according to claim 1, wherein the electroactive biocompatible polymer forms covalent crosslinking groups thereon once the electroactive biocompatible polymer is activated with a voltage potential applied variably.

12. The electroactive biocompatible polymer according to claim 1, wherein the diazonium derivative, arylsulfonium derivative, diaryliodonium derivative, and combinations thereof comprise Cl^-, Br^-, I^-, trifluoromethanesulfonate, dimethoxy-2-anthracenesulfonate, or methylbenzenesulfonate.