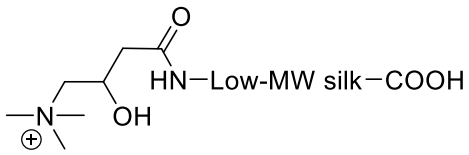
CLAIMS

1. An article comprising a coated substrate, wherein the coating comprises:

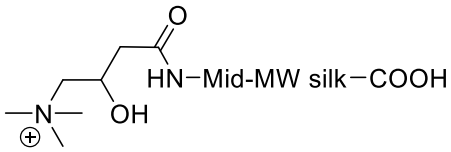
silk fibroin or silk fibroin fragments;

a chemical modifier or a physical modifier; and

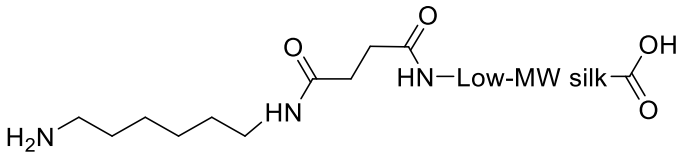
one or more compounds selected from Formulae (1)-(8):



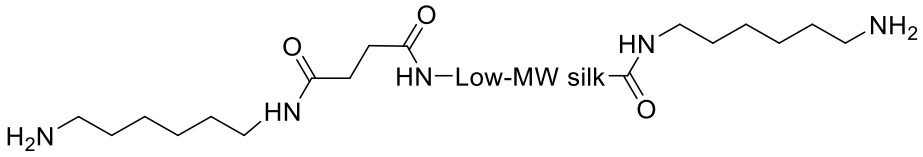
Formula (1),



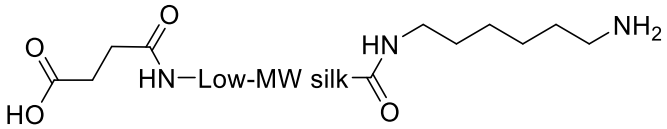
Formula (2),



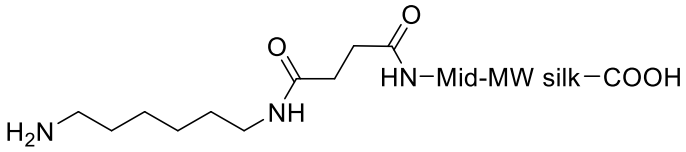
Formula (3),



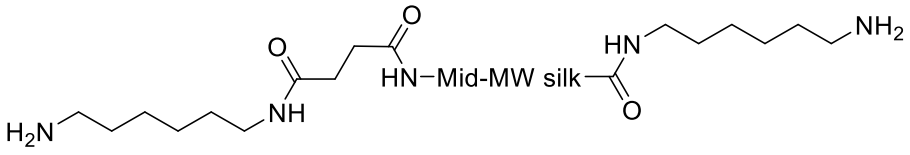
Formula (4),



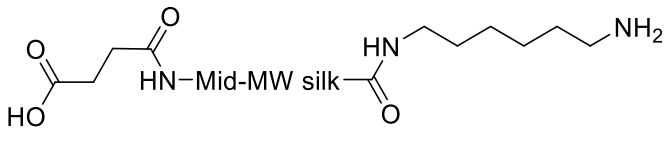
Formula (5),



Formula (6),



Formula (7),



Formula (8).

2. The article of claim 1, wherein the chemical modifier is chemically linked to one or more of a silk fibroin side group and a silk fibroin terminal group.

3. The article of claim 2, wherein the silk fibroin side group and the silk fibroin terminal group are independently selected from an amine group, a carboxyl group, a hydroxyl group, a thiol group, and a sulfhydryl group.

4. The article of any one of claims 1 to 3, wherein the chemical modifier is chemically linked to one or more functional groups on the substrate.

5. The article of any one of claims 1 to 4, wherein the chemical modifier comprises one or more of a chemically linked functional group, or functional group residue, and a linker.

6. The article of any one of claims 1 to 5, wherein the chemical modifier comprises one or more of $-CR^a_2-$, $-CR^a=CR^a-$, $-C\equiv C-$, -aryl-, -heteroaryl-, -O-, -S-, $-OC(O)-$, $-N(R^a)-$, -N=N-, =N-, -C(O)-, $-C(O)O-$, $-OC(O)N(R^a)-$, $-C(O)N(R^a)-$, $-N(R^a)C(O)O-$, $-N(R^a)C(O)-$, $-N(R^a)C(O)N(R^a)-$, $-N(R^a)C(NR^a)N(R^a)-$, $-N(R^a)S(O)_t-$, $-S(O)_tO-$, $-S(O)_tN(R^a)-$, $-S(O)_tN(R^a)C(O)-$, $-OP(O)(OR^a)O-$, wherein t is 1 or 2, and wherein at each independent occurrence R^a is selected from hydrogen, alkyl, alkenyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocycloalkyl, heterocycloalkylalkyl, heteroaryl, or heteroarylalkyl.

7. The article of any one of claims 1 to 6, wherein the coating comprises one or more of low molecular weight silk fibroin or silk fibroin fragments, medium molecular weight silk fibroin or silk fibroin fragments and high molecular weight silk fibroin or silk fibroin fragments.

8. The article of any one of claims 1 to 7, wherein the coating comprises silk fibroin or silk fibroin fragments with an average weight average molecular weight from about 5 kDa to about 144 kDa.

9. The article of any one of claims 1 to 7, wherein the coating comprises silk fibroin or silk fibroin fragments with an average weight average molecular weight from about 1 kDa to about 5 kDa, from about 5 kDa to about 10 kDa, from about 6 kDa to about 17 kDa, from about 10 kDa to about 15 kDa, from about 15 kDa to about 20 kDa, from about 17 kDa to about 39 kDa, from about 20 kDa to about 25 kDa, from about 25 kDa to about 30 kDa, from about 30 kDa to about 35 kDa, from about 35 kDa to about 40 kDa, from about 39 kDa to about 80 kDa, from about 40 kDa to about 45 kDa, from about 45 kDa to about 50 kDa, from about 60 kDa to about 100 kDa, or from about 80 kDa to about 144 kDa.

10. The article of any one of claims 1 to 9, wherein the coating comprises silk fibroin or silk fibroin fragments with a polydispersity between 1 and about 5.0.

11. The article of any one of claims 1 to 10, wherein the coating comprises silk fibroin or silk fibroin fragments which prior to coating the substrate are stable in a solution.

12. The article of any one of claims 1 to 11, wherein the coating comprises silk fibroin or silk fibroin fragments which prior to coating the substrate do not spontaneously or gradually gelate and do not visibly change in color or turbidity when in a solution for at least 10 days.

13. The article of any one of claims 1 to 12, wherein the substrate includes one or more of a fiber, a thread, a yarn, a fabric, a textile, a cloth, or a hide.

14. The article of claim 13, wherein the fabric, textile, or cloth is woven or nonwoven.

15. The article of claim 13 or 14, wherein the fiber, thread, or yarn comprises one or more of polyester, recycled polyester, Mylar, cotton, nylon, recycled nylon, polyester-polyurethane copolymer, rayon, acetate, aramid (aromatic polyamide), acrylic, ingeo

(polylactide), lurex (polyamide-polyester), olefin (polyethylene-polypropylene), and combinations thereof.

16. The article of claim 13, 14 or 15 wherein the fiber, thread, or yarn comprises one or more of alpaca fiber, alpaca fleece, alpaca wool, lama fiber, lama fleece, lama wool, cotton, cashmere, sheep fiber, sheep fleece, sheep wool, byssus, chiengora, qiviut, yak, rabbit, lambswool, mohair wool, camel hair, angora wool, silkworm silk, abaca fiber, coir fiber, flax fiber, jute fiber, kapok fiber, kenaf fiber, raffia fiber, bamboo fiber, hemp, modal fiber, pina, ramie, sisal, and soy protein fiber.

17. The article of any one of claims 13 to 16, wherein the fiber, thread, or yarn comprises one or more of mineral wool, mineral cotton, man-made mineral fiber, fiberglass, glass, glasswool, stone wool, rock wool, slagwool, glass filaments, asbestos fibers, and ceramic fibers.

18. A method of coating a substrate with a coating comprising silk fibroin or silk fibroin fragments and a chemical modifier or a physical modifier, the method comprising applying to the substrate at least one composition comprising silk fibroin or silk fibroin fragments with an average weight average molecular weight from about 1 kDa to about 144 kDa, and a polydispersity between 1 and about 5.0.

19. The method of claim 18, further comprising applying to the substrate a chemical modifier or a physical modifier selected from a wetting agent, a detergent, a sequestering or dispersing agent, an enzyme, a bleaching agent, an antifoaming agent, an anti-creasing agent, a dye dispersing agent, a dye leveling agent, a dye fixing agent, a dye special resin agent, a dye anti-reducing agent, a pigment dye system anti-migrating agent, a pigment dye system binder, a delave agent, a wrinkle free treatment, a softener, a handle modifier, a waterborne polyurethane dispersion, a finishing resin, an oil or water repellant, a flame retardant, a crosslinker, an activator, a thickener for technical finishing, or any combination thereof.

20. The method of claim 19, wherein the crosslinker or the activator are independently selected from a N-hydroxysuccinimide ester crosslinker, an imidoester crosslinker, a

sulfosuccinimidyl aminobenzoate, a methacrylate, a silane, a silicate, an alkyne compound, an azide compound, an aldehyde, a carbodiimide crosslinker, a dicyclohexyl carbodiimide activator, a dicyclohexyl carbodiimide crosslinker, a maleimide crosslinker, a haloacetyl crosslinker, a pyridyl disulfide crosslinker, a hydrazide crosslinker, an alkoxyamine crosslinker, a reductive amination crosslinker, an aryl azide crosslinker, a diazirine crosslinker, an azide-phosphine crosslinker, a transferase crosslinker, a hydrolase crosslinker, a transglutaminase crosslinker, a peptidase crosslinker, an oxidoreductase crosslinker, a tyrosinase crosslinker, a laccase crosslinker, a peroxidase crosslinker, a lysyl oxidase crosslinker, and combinations thereof.

21. The method of claim 18, 19 or 20 wherein the composition comprises low molecular weight silk fibroin or silk fibroin fragments.

22. The method of any one of claims 18 to 21, wherein the composition comprises medium molecular weight silk fibroin or silk fibroin fragments.

23. The method of any one of claims 18 to 22, wherein the composition comprises high molecular weight silk fibroin or silk fibroin fragments.

24. The method of any one of claims 18 to 23, wherein the composition comprises a chemical fabric softener.

25. The method of any one of claims 18 to 24, wherein the composition comprises a Brønsted acid.

26. The method of any one of claims 18 to 25, further comprising dyeing the substrate prior to applying to the substrate the at least one composition comprising silk fibroin or silk fibroin fragments.

27. The method of any one of claims 18 to 26, further comprising dyeing the substrate after applying to the substrate the at least one composition comprising silk fibroin or silk fibroin fragments.