CLAIMS

1. An article comprising a leather substrate and silk fibroin proteins or fragments thereof having an average weight average molecular weight selected from between about 1 kDa and about 5 kDa, from between about 5 kDa and about 10 kDa, from between about 6 kDa and about 17 kDa, from between about 10 kDa and about 15 kDa, from between about 14 kDa and about 30 kDa, from between about 15 kDa and about 20 kDa, from between about 17 kDa and about 39 kDa, from between about 20 kDa and about 25 kDa, from between about 25 kDa and about 30 kDa, from between about 30 kDa and about 35 kDa, from between about 35 kDa and about 40 kDa, from between about 39 kDa and about 54 kDa, from between about 39 kDa and about 80 kDa, from between about 40 kDa and about 45 kDa, from between about 45 kDa and about 50 kDa, from between about 50 kDa and about 55 kDa, from between about 55 kDa and about 60 kDa, from between about 60 kDa and about 100 kDa, or from between about 80 kDa and about 144 kDa, and a polydispersity ranging from 1 to about 5.

2. The article of claim 1, further comprising about 0.001% (w/w) to about 10% (w/w) sericin relative to the silk fibroin proteins or fragments thereof.

3. The article of claim 1 or 2, wherein the silk fibroin proteins or fragments thereof do not spontaneously or gradually gelate and do not visibly change in color or turbidity when in an aqueous solution for at least 10 days prior to being added to the leather substrate.

4. The article of any one of claims 1 to 3, wherein a portion of the silk fibroin proteins or fragments thereof is coated on a surface of the leather substrate, and/or a portion of the silk fibroin proteins or fragments thereof is infused into a layer of the leather substrate, and/or a portion of the silk fibroin proteins or fragments thereof is in a recessed portion of the leather substrate.

5. The article of any one of claims 1 to 4, the article further comprising one or more polysaccharides selected from starch, cellulose, gum arabic, guar gum, xanthan gum, alginate, pectin, chitin, chitosan, carrageenan, inulin, and gellan gum.

6. The article of any one of claims 1 to 5, the article further comprising one or more polyols, and/or one or more polyethers.

7. The article of claim 6, wherein the polyols comprise one or more of glycol, glycerol, sorbitol, D-sorbitol, glucose, sucrose, mannitol, D-mannitol, and dextrose.

8. The article of claim 6, wherein the polyethers comprise one or more polyethyleneglycols (PEGs).

9. The article of any one of claims 1 to 8, the article further comprising one or more of a silicone, a dye, a pigment, and a polyurethane.

10. The article of any one of claims 1 to 9, the article further comprising one or more of a crosslinker, a crosslinker adduct, or a crosslinker reaction derivative.

11. The article of any one of claims 1 to 9, the article further comprising one or more of: an isocyanate, isocyanate adduct, and/or isocyanate reaction derivative; a poly diisocyanate, poly diisocyanate adduct, and/or poly diisocyanate reaction derivative; an aziridine, aziridine adduct, and/or aziridine reaction derivative; a carbodiimide, carbodiimide adduct, and/or carbodiimide reaction derivative; an aldehyde, aldehyde adduct, and/or aldehyde reaction derivative; a polyisocyanate, polyisocyanate adduct, and/or polyisocyanate reaction derivative; a polyaziridine, polyaziridine adduct, and/or polyaziridine reaction derivative; a polycarbodiimide, polycarbodiimide adduct, and/or polycarbodiimide reaction derivative; a polyaldehyde, polyaldehyde adduct, and/or polyaldehyde reaction derivative; a polyurethane, polyurethane adduct, and/or polyurethane reaction derivative; a polyacrylate, polyacrylate adduct, and/or polyacrylate reaction derivative; a polyester, polyester adduct, and/or polyester reaction derivative; a wax, wax adduct, and/or wax reaction derivative; a protein, protein adduct, and/or protein reaction derivative; or an alcohol, alcohol adduct, and/or alcohol reaction derivative.

12. A method of treating a leather substrate with a silk formulation, the method comprising applying on a surface of the leather a silk formulation comprising silk fibroin proteins or fragments thereof having an average weight average molecular weight selected from between about 1 kDa and about 5 kDa, from between about 5 kDa and about 10 kDa, from between about 6 kDa and about 17 kDa, from between about 10 kDa and about 15 kDa, from between about 14 kDa and about 30 kDa, from between about 15 kDa and about 20 kDa, from between about 17 kDa and about 39 kDa, from between about 20 kDa and about 25 kDa, from between about 25 kDa and about 30 kDa, from between about 30 kDa and about 35 kDa, from between about 35 kDa and about 40 kDa, from between about 39 kDa and about 54 kDa, from between about 39 kDa and about 80 kDa, from between about 40 kDa and about 45 kDa, from between about 45 kDa and about 50 kDa, from between about 50 kDa and about 55 kDa, from between about 55 kDa and about 60 kDa, from between about 60 kDa and about 100 kDa, or from between about 80 kDa and about 144 kDa, and a polydispersity ranging from 1 to about 5.

13. The method of claim 12, wherein the silk fibroin proteins or fragments thereof do not spontaneously or gradually gelate and do not visibly change in color or turbidity when in an aqueous solution for at least 10 days prior to being formulated and applied to the leather substrate.

14. The method of claim 12 or 13, wherein a portion of the silk formulation is coated on a surface of the leather substrate, and/or a portion of the silk formulation is infused into a layer of the leather substrate, and/or a portion of the silk formulation enters a recessed portion of the leather substrate.

15. The method of any one of claims 12 to 14, wherein the silk formulation further comprises a rheology modifier.

16. The method of claim 15, wherein the rheology modifier comprises one or more polysaccharides selected from starch, cellulose, gum arabic, guar gum, xanthan gum, alginate, pectin, chitin, chitosan, carrageenan gum, inulin, and gellan gum.

17. The method of any one of claims 12 to 16, wherein the silk formulation further comprises a plasticizer.

18. The method of claim 17, wherein the plasticizer comprises one or more polyols, and/or one or more polyethers.

19. The method of claim 18, wherein the polyols are selected from one or more of glycol, glycerol, sorbitol, D-sorbitol, glucose, sucrose, mannitol, mannitol, D-mannitol, and dextrose.

20. The method of claim 18, wherein the polyethers are one or more polyethyleneglycols (PEGs).

21. The method of any one of claims 12 to 20, wherein the silk formulation further comprises a defoaming agent at a concentration between about 0.001% and about 1%.

22. The method of claim 21, wherein the defoaming agent comprises a silicone.

23. The method of any one of claims 12 to 22, wherein the silk formulation further comprises one or more of an isocyanate, a poly diisocyanate, an aziridine, a carbodiimide, an aldehyde, a polyisocyanate, a polyaziridine, a polycarbodiimide, a polyaldehyde, a polyurethane, a polyacrylate, a polyester, a wax, a protein, and/or an alcohol.

24. The method of any one of claims 12 to 23, wherein the silk formulation is a liquid, a gel, a paste, a wax, or a cream.

25. The method of any one of claims 12 to 24, wherein the silk formulation comprises one or more sub-formulations to be applied at the same time or at different times.

26. The method of any one of claims 12 to 25, wherein the concentration of silk fibroin proteins or fragments thereof in the silk formulation is between about 0.1% w/v and about 15% w/v.

27. The method of any one of claims 12 to 25, wherein the concentration of silk fibroin proteins or fragments thereof in the silk formulation is between about 5 mg/mL and about 125 mg/mL.

28. The method of any one of claims 12 to 27, the method further comprising one or more additional steps selected from dyeing, drying, water annealing, mechanical stretching, trimming, polishing, applying a pigment, applying a colorant, applying an acrylic formulation, applying an urethane formulation, chemical fixing, stamping, applying a silicone finish, providing a Uniflex treatment, and/or providing a Finiflex treatment, wherein the step of applying the silk formulation on a surface of the leather is performed before, during, or after the one or more additional steps.

29. The method of any one of claims 12 to 28, wherein treating the leather substrate with the silk formulation results in one or more of the following: increase in gloss, increase in color saturation, color enhancement, increase in color fixation, reduced dye use, and/or improved colorfastness, wherein the improvement is as to a leather substrate not similarly treated with a silk formulation.