CLAIMS

1. An article comprising a leather substrate, a plasticizer comprising one or more polyols or one or more polyethers, and silk fibroin proteins or fragments thereof having an average weight average molecular weight in a range selected from between 1 kDa and 5 kDa, between 5 kDa and 10 kDa, between 6 kDa and 17 kDa, between 10 kDa and 15 kDa, between 15 kDa and 20 kDa, between 17 kDa and 39 kDa, between 20 kDa and 25 kDa, between 25 kDa and 30 kDa, between 30 kDa and 35 kDa, between 35 kDa and 40 kDa, between 39 kDa and 80 kDa, between 40 kDa and 45 kDa, between 45 kDa and 50 kDa, between 60 kDa and 100 kDa, and between 80 kDa and 144 kDa, and a polydispersity between 1 and 5.

2. The article of claim 1, wherein the silk fibroin proteins or fragments thereof have a polydispersity between 1 and 1.5, between 1.5 and 2, between 2 and 2.5, between 2.5 and 3, between 3 and 3.5, between 3.5 and 4, between 4 and 4.5, or between 4.5 and 5.

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

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.

5. The article of any one of claims 1 to 4, wherein a portion of the silk fibroin proteins or fragments thereof is infused into a layer of the leather substrate.

6. The article of any one of claims 1 to 5, wherein a portion of the silk fibroin proteins or fragments thereof is in a recessed portion.

7. The article of any one of claims 1 to 6, 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.

8. The article of any one of claims 1 to 7, the article further comprising one or more of a silicone, a dye, a pigment, and a polyurethane.

9. The article of any one of claims 1 to 8, comprising one or more polyols and one or more polyethers.

10. The article of any one of claims 1 to 9, wherein the polyols comprise one or more of glycol, glycerol, sorbitol, glucose, sucrose, and dextrose.

11. The article of any one of claims 1 to 10, wherein the polyethers comprise one or more polyethyleneglycols (PEGs).

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

13. The method of claim 12, wherein the silk fibroin proteins or fragments thereof have a polydispersity between 1 and 1.5, between 1.5 and 2, between 2 and 2.5, between 2.5 and 3, between 3 and 3.5, between 3.5 and 4, between 4 and 4.5, or between 4.5 and 5.

14. The method of claim 12 or 13, wherein the silk formulation further comprises 0.001% (w/w) to 10% (w/w) sericin relative to the silk fibroin proteins or fragments thereof, or wherein the silk formulation further comprises 0.001% (w/v) to 10% (w/v) sericin.

15. The method of any one of claims 12 to 14, wherein a portion of the silk formulation is coated on a surface of the leather substrate.

16. The method of any one of claims 12 to 15, wherein a portion of the silk formulation is infused into a layer of the leather substrate.

17. The method of any one of claims 12 to 16, wherein a portion of the silk formulation enters a recessed portion of the leather substrate.

18. The method of any one of claims 12 to 17, wherein the silk formulation further comprises a rheology modifier.

19. The method of claim 18, 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.

20. The method of claim 19, wherein the gellan gum comprises low-acyl content gellan gum.

21. The method of any one of claims 18 to 20, wherein the w/v concentration of the rheology modifier in the silk formulation is between 0.01% and 5%, or between 0.1% and 1%.

22. The method of any one of claims 12 to 21, comprising applying to a surface of the leather one or more polyols and one or more polyethers.

23. The method of any one of claims 12 to 22, wherein the one or more polyols or one or more polyethers are comprised in the silk formulation.

24. The method of any one of claims 12 to 23, wherein the polyols are selected from one or more of glycol, glycerol, sorbitol, glucose, sucrose, and dextrose.

25. The method of any one of claims 12 to 24, wherein the polyethers comprise one or more polyethyleneglycols (PEGs).

26. The method of any one of claims 23 to 25, wherein the w/v concentration of the one or more polyols and/or one or more polyethers in the silk formulation is between 0.01% and 10%.

27. The method of any one of claims 12 to 26, wherein the silk formulation further comprises a defoaming agent at a concentration between 0.001% and 1%.

28. The method of claim 27, wherein the defoaming agent comprises a silicone.

29. The method of any one of claims 12 to 28, wherein the silk formulation is a liquid, a gel, a paste, a wax, or a cream.

30. The method of any one of claims 12 to 29, wherein the concentration of silk fibroin proteins or fragments thereof in the silk formulation is between 0.1% w/v and 15% w/v, or between 0.5% w/v and 12% w/v, or between 5 mg/mL and 125 mg/mL.

31. The method of any one of claims 12 to 30, wherein the silk formulation further comprises a pH adjusting agent.

32. The method of any one of claims 12 to 31, wherein treating the leather substrate with the silk formulation improves one or more of gloss and/or color saturation.

33. The method of any one of claims 12 to 32, the method further comprising one or more additional steps selected from dyeing the leather, drying the leather, water annealing, mechanically stretching the leather, trimming the leather, performing one or more polishing steps of the leather, applying a pigment to the leather, applying a colorant to the leather, applying an acrylic formulation to the leather, chemically fixing the leather, stamping the leather, applying a silicone finish to the leather, 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.

34. The method of any one of claims 12 to 33, the method further comprising:

compressing a first half of leather by a rotating heated metallic wheel; and

compressing a second half of the leather by a rotating heated metallic wheel.

35. The method of any one of claims 12 to 33, the method further comprising:

feeding leather onto a feeder belt into two pressing cylinders,

wherein a top cylinder is heated and a bottom cylinder is unheated.