CLAIMS

What Is Claimed Is:

1. A method for modifying a natural feather shuttlecock, the method comprising contacting the natural feather shuttlecock with at least one or more crosslinking agents, wherein the one or more crosslinking agents crosslink the feathers of the shuttlecock.

2. The method of claim 1, wherein the contacting is performed under humid conditions in a closed chamber.

3. The method of claim 1, wherein the contacting comprises exposing the natural feather shuttlecock to vapors of one or more crosslinking agents.

4. The method of claim 1, wherein the contacting comprises contacting the natural feather shuttlecock to a solution of one or more crosslinking agents.

5. The method of claim 1, wherein the contacting is performed for about 2 minutes to 20 hours.

6. The method of claim 1, wherein the one or more crosslinking agents crosslink one or more reactive groups present on the feathers of the shuttlecock, wherein the one or more reactive groups are selected from amine, amide, sulfhydryl, carbonyl, aldehyde, hydroxyl, carboxyl, and combinations thereof.

7. The method of claim 1, wherein the one or more crosslinking agents are selected from the group consisting of a homobifunctional crosslinking agent, a heterobifunctional crosslinking agent, a trifunctional crosslinking agent, and combinations thereof.

8. The method of claim 1, wherein the one or more crosslinking agents are selected from the group consisting of NHS (N-hydroxysuccinimide); sulfo-NHS (N-hydroxysulfosuccinimide); EDC (1-Ethyl-3-[3-dimethylaminopropyl]); carbodiimide hydrochloride; SMCC (succinimidyl 4-(N-maleimidomethyl)cyclohexane-1-carboxylate); sulfo-SMCC; DSS (disuccinimidyl

suberate); DSG (disuccinimidyl glutarate); DFDNB (1,5-difluoro-2,4-dinitrobenzene); BS3 (bis(sulfosuccinimidyl)suberate); TSAT (tris-(succinimidyl)aminotriacetate); BS(PEG)5 (PEGylated bis(sulfosuccinimidyl)suberate); BS(PEG)9 (PEGylated bis(sulfosuccinimidyl)suberate); DSP(dithiobis(succinimidyl propionate)); DTSSP (3,3'-dithiobis(sulfosuccinimidyl propionate)); DST(disuccinimidyl tartrate); BSOCOES (bis(2-(succinimidooxycarbonyloxy)ethyl)sulfone); EGS (ethylene glycol bis(succinimidyl succinate)); DMA (dimethyl adipimidate); DMP (dimethyl pimelimidate); DMS (dimethyl suberimidate); DTBP (Wang and Richard's Reagent); BM(PEG)2 (1,8-bismaleimido-diethyleneglycol); BM(PEG)3 (1,11-bismaleimido-triethyleneglycol); BMB (1,4-bismaleimidobutane); DTME (dithiobismaleimidoethane); BMH (bismaleimidohexane); BMOE (bismaleimidoethane); TMEA (tris(2-maleimidoethyl)amine); SPDP (succinimidyl 3-(2-pyridyldithio)propionate); SMCC (Succinimidyl *trans*-4-(maleimidylmethyl)cyclohexane-1-Carboxylate); SIA (succinimidyl iodoacetate); SBAP (succinimidyl 3-(bromoacetamido)propionate); SIAB (succinimidyl (4-iodoacetyl)aminobenzoate); Sulfo-SIAB (sulfosuccinimidyl (4-iodoacetyl) aminobenzoate); AMAS (N-α-maleimidoacet-oxysuccinimide ester); BMPS (N-β-maleimidopropyl-oxysuccinimide ester); GMBS (N-γ-maleimidobutyryl-oxysuccinimide ester); Sulfo-GMBS (N-γ-maleimidobutyryl-oxysulfosuccinimide ester); MBS (m-maleimidobenzoyl-N-hydroxysuccinimide ester); Sulfo-MBS (m-maleimidobenzoyl-N-hydroxysulfosuccinimide ester); SMCC (succinimidyl 4-(N-maleimidomethyl)cyclohexane-1-carboxylate); Sulfo-SMCC (sulfosuccinimidyl 4-(N-maleimidomethyl)cyclohexane-1-carboxylate); EMCS (N-ε-malemidocaproyl -oxysuccinimide ester); Sulfo-EMCS (N-ε-maleimidocaproyl-oxysulfosuccinimide ester); SMPB (succinimidyl 4-(p-maleimidophenyl)butyrate); Sulfo-SMPB (sulfosuccinimidyl 4-(N-maleimidophenyl)butyrate); SMPH (Succinimidyl 6-((beta-maleimidopropionamido)hexanoate)); LC-SMCC (succinimidyl 4-(N-maleimidomethyl) cyclohexane-1-carboxy-(6-amidocaproate)); Sulfo-KMUS (N-κ-maleimidoundecanoyl-oxysulfosuccinimide ester); SPDP (succinimidyl 3-(2-pyridyldithio)propionate); LC-SPDP (succinimidyl 6-(3(2-pyridyldithio)propionamido) hexanoate); LC-SPDP (succinimidyl 6-(3(2-pyridyldithio)propionamido)hexanoate); Sulfo-LC-SPDP (sulfosuccinimidyl 6-(3'-(2-pyridyldithio)propionamido)hexanoate); SMPT (4-succinimidyloxycarbonyl-alpha-methyl-α(2-pyridyldithio)toluene); PEG4-SPDP (PEGylated, long-chain SPDP crosslinker); PEG12-SPDP (PEGylated, long-chain SPDP crosslinker); SM(PEG)2 (PEGylated SMCC crosslinker);

SM(PEG)4 (PEGylated SMCC crosslinker); SM(PEG)6 (PEGylated, long-chain SMCC crosslinker); SM(PEG)8 (PEGylated, long-chain SMCC crosslinker); SM(PEG)12 (PEGylated, long-chain SMCC crosslinker); SM(PEG)24 (PEGylated, long-chain SMCC crosslinker) BMPH (N-β-maleimidopropionic acid hydrazide); EMCH (N-ε-maleimidocaproic acid hydrazide); MPBH (4-(4-N-maleimidophenyl)butyric acid hydrazide); KMUH (N-κ-maleimidoundecanoic acid hydrazide); PDPH (3-(2-pyridyldithio)propionyl hydrazide); ATFB-SE (4-Azido-2,3,5,6-Tetrafluorobenzoic Acid, Succinimidyl Ester); ANB-NOS (N-5-azido-2-nitrobenzoyloxysuccinimide); SDA (NHS-Diazirine) (succinimidyl 4,4'-azipentanoate); LC-SDA (NHS-LC-Diazirine) (succinimidyl 6-(4,4'-azipentanamido)hexanoate); SDAD (NHS-SS-Diazirine) (succinimidyl 2-((4,4'-azipentanamido)ethyl)-1,3'-dithiopropionate); Sulfo-SDA (Sulfo-NHS-Diazirine) (sulfosuccinimidyl 4,4'-azipentanoate); Sulfo-LC-SDA (Sulfo-NHS-LC-Diazirine) (sulfosuccinimidyl 6-(4,4'-azipentanamido)hexanoate); Sulfo-SDAD (Sulfo-NHS-SS-Diazirine) (sulfosuccinimidyl 2-((4,4'-azipentanamido)ethyl)-1,3'-dithiopropionate); SPB (succinimidyl-[4-(psoralen-8-yloxy)]-butyrate); Sulfo-SANPAH (sulfosuccinimidyl 6-(4'-azido-2'-nitrophenylamino)hexanoate); DCC (dicyclohexylcarbodiimide); EDC (1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride); gluteraldehyde,; formaldehyde; and any combination thereof.

9. The method of claim 1, wherein the one or more crosslinking agents are a chemical crosslinking agent or a UV-inducible crosslinking agent.

10. The method of claim 9, wherein the chemical crosslinking agent is formaldehyde, gluteraldehyde, or a combination thereof.

11. A modified natural feather shuttlecock formed by the process comprising contacting the natural feather shuttlecock with at least one or more crosslinking agents, wherein the one or more crosslinking agents crosslink the feathers of the shuttlecock.

12. The modified natural feather shuttlecock of claim 11, wherein the contacting is performed under humid conditions in a closed chamber.

13. The modified natural feather shuttlecock of claim 11, wherein the contacting comprises exposing the natural feather shuttlecock to vapors of one or more crosslinking agents.

14. The modified natural feather shuttlecock of claim 11, wherein the contacting comprises contacting the natural feather shuttlecock to a solution of one or more crosslinking agents.

15. The modified natural feather shuttlecock of claim 11, wherein the one or more crosslinking agents are selected from the group consisting of a homobifunctional crosslinking agent, a heterobifunctional crosslinking agent, a trifunctional crosslinking agent, and combinations thereof.

16. The modified natural feather shuttlecock of claim 11, wherein the crosslinking agent is formaldehyde, gluteraldehyde, or a combination thereof.

17. The modified natural feather shuttlecock of claim 11, wherein one or more reactive groups present on the feathers of the shuttlecock are crosslinked, wherein the one or more reactive groups are selected from amine, amide, sulfhydryl, carbonyl, aldehyde, hydroxyl, carboxyl, and combinations thereof.

18. A kit for modifying a natural feather shuttlecock comprising one or more crosslinking agents in a solution form, and a container for spraying the one or more crosslinking agents.

19. The kit of claim 18, further comprising instructions for treating the natural feather shuttlecock with the one or more crosslinking agents.

20. The kit of claim 18, wherein the crosslinking agent is formaldehyde, gluteraldehyde, or a combination thereof.