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(54) Title: LUBRICIOUS COATINGS FOR SKIS AND SNOWBOARDS AND RELATED METHODS OF USE

(57) Abstract: Coatings for skis and snowboards are provided. The coatings may be lubricious coatings including one or more fluorinated compounds, adhesion agents, shape memory polymers, free-radical initiators, and/or carrying solvents. Methods of applying the coatings to skis and snowboards are also provided. The coatings may be applied in a single layer or in multiple layers.



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LUBRICIOUS COATINGS FOR SKIS AND SNOWBOARDS AND RELATED METHODS OF USE

RELATED APPLICATIONS

[0001] This application claims priority to United States Provisional Application No. 62/547,946 filed on August 21, 2017 and titled "Lubricious Coatings for Skis and Snowboards and Related Methods of Use," which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to lubricious coatings. The coatings may be applied to the base material of skis and snowboards. More specifically, the present disclosure relates to lubricious coatings including one or more adhesion agents, fluorinated compounds, shape memory polymers, free-radical initiators, and/or carrying solvents. Related methods are also disclosed.

DETAILED DESCRIPTION

[0003] The components of the embodiments as generally described and illustrated herein can be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of various embodiments is not intended to limit the scope of the present disclosure, but is merely representative of various embodiments. It will be appreciated that various features are sometimes grouped together in a single embodiment or description thereof for the purpose of streamlining the disclosure. Many of these features may be used alone and/or in combination with one another.

[0004] Skis and snowboards are generally used for gliding on snow. A ski or a snowboard may include a coating that imparts one or more characteristics or properties to the ski or the snowboard. For example, the coating can be applied to the base of the ski or the snowboard to affect, among other properties or characteristics, a level of friction between the ski or the snowboard and snow (e.g., during forward motion). Some coatings may be configured to reduce the level of friction. Some other coatings may be configured to increase the level of friction (e.g., the coatings may be applied for increased grip between the ski or snowboard and snow).

[0005] The terms "lubricious" and "lubricity," as used herein, refer to the characteristic of being smooth or slippery, or of possessing a low coefficient of friction. Higher levels of lubricity correspond to lower coefficients of friction, and lower levels of lubricity correspond to higher coefficients of friction.

[0006] The term "coating," as used herein, refers to a layer or layers of material that have been applied to a surface of a ski or snowboard. A coating may create a distinct layer over a base substrate. However, as described herein, a coating may form an

interpenetrating network where the boundaries between the coating layer and base substrate are less distinct due to overlap between the coating and the base substrate. As detailed below, the coatings disclosed herein may include one or more fluorinated compounds, adhesion agents, shape memory polymers, free-radical initiators, and/or carrying solvents.

[0007] The term “adhesion agent,” as used herein, refers to an additive that promotes the adhesion of a coating to the substrate of interest (e.g., a surface of a ski or snowboard) and has an affinity for the substrate and the applied coating.

[0008] The term “shape memory polymer,” as used herein, refers to an additive that has the ability to return from a deformed state to its original state when induced by an external stimulus (e.g., temperature, light, etc.). Shape memory polymers may be used as a thermal stabilizer for the coating compositions described herein.

[0009] In some embodiments, a coating of the present disclosure may be used for a ski or snowboard. For example, the coating may be applied to or disposed on at least a portion of a surface (e.g., a base surface) of a ski or a snowboard. A base of an uncoated or untreated ski or snowboard may be formed from ultra-high molecular weight polyethylene (UHMWPE). Other polyethylenes or polymers can also be used to form the base of a ski or snowboard. The coating may be a lubricious coating system for application to, or treatment of, a ski or snowboard. For example, the lubricity of a surface of a ski or snowboard that has been treated with the coating may be altered. Additionally, the coating may be a permanent, or substantially permanent, coating for a ski or snowboard.

[0010] Exemplary lubricious coatings described herein may create an interpenetrating polymer network with the base substrate. Such coating components may include a fluorinated compound, an adhesion agent, a shape memory polymer, a free-radical initiator, and a carrying solvent. Furthermore, such coating components may include a fluorinated compound, an adhesion agent, a shape memory polymer, a free-radical initiator, a carrying solvent, a catalyst, a water carrying agent, an antioxidant, and a surfactant. Two or more of these coating components may be present in an exemplary composition, as well as any permutations, combinations, or subcombinations thereof.

[0011] The coating compositions and systems may comprise fluorinated compounds that can affect a level of lubricity of the coating. For example, one or more fluorinated compounds in the coating may impart enhanced lubricity to a surface of a ski or snowboard that is treated with the coating. In some embodiments, the one or more fluorinated compounds may be partially fluorinated, completely fluorinated, or a combination thereof. Exemplary fluorinated compounds that may be used include, but are not limited to, fluorinated silanes, fluorinated hydrocarbons, fluorinated polymers, fluorinated silicones, or combinations thereof. Other suitable fluorinated compounds are also within the scope of this

disclosure. In various embodiments, the fluorinated compound may be a compound with fluorinated carbon side chains. Exemplary lengths of the fluorinated carbon side chains may be between about 1 and about 30 carbons. For example, the length of the fluorinated carbon side chain of the fluorinated compound may be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 carbons.

[0012] In certain embodiments, the coating may include a bi-modal distribution of two lengths of carbon side chains such that the lubricity of the coating is effective in both warm and cold temperatures. For example, the coating may be effective in a range of between about 0 and about 40 degrees Fahrenheit. In some embodiments, the fluorinated compound may include a mixture of a first fluorinated silane including a first carbon side chain and a second fluorinated silane including a second carbon side chain, wherein the length of the first carbon side chain is greater than the length of the second carbon side chain. For example, the fluorinated compound may include a first fluorinated silane having a 1- to 8-carbon side chain (or a 1- to 5-carbon side chain) and a second fluorinated silane having a 9- to 30-carbon side chain (or a 9- to 18-carbon side chain). Other combinations of carbon side chain lengths are also within the scope of this disclosure. In certain embodiments, the fluorinated compound may include a mixture of three, four, five, or more fluorinated silanes having different carbon side chain lengths. Alternatively a fluorinated compound may have more than one carbon side chain with different carbon side chain lengths within the same molecule. In some other embodiments, the coating may include a single length of fluorinated carbon side chains. For example, the fluorinated compound may include a fluorinated silane having a 3- to 20-carbon side chain (or a 5- to 18-carbon side chain).

[0013] In various embodiments, the fluorinated compound may be a fluorinated polymer. For example, the fluorinated polymer may be polytetrafluoroethylene (PTFE) or fluorinated ethylene propylene (FEP). Other suitable fluorinated polymers are also within the scope of this disclosure.

[0014] The amount of fluorinated compounds that are present in the coating composition can be between about 1.0 and about 15 weight percent of the coating composition. Alternatively, the fluorinated compounds may be present in an amount of between about 2.0 and about 12.5 weight percent of the coating composition.

[0015] In some embodiments, the coating may include one or more adhesion agents or promoters and one or more fluorinated compounds. The adhesion agent can aid in adhering, binding, and/or coupling the coating to at least a portion of a surface of a ski or snowboard. For example, the adhesion agent may chemically bind (e.g., via free radical initiators) to a portion of the surface of a ski or snowboard (e.g., a UHMWPE substrate) and provide an anchor for the fluorinated compound. In certain embodiments, the adhesion agent may be a crosslinker. For example, upon addition of the one or more adhesion agents

to a portion of the surface of a ski or snowboard the adhesion agents may promote crosslinking of the polymeric material forming a base material of the ski or snowboard. Such crosslinking can impart increased hardness and/or other desirable mechanical properties to the base material of the ski or snowboard.

[0016] Exemplary adhesion agents that may be used include, but are not limited to, organosilanes, hexachlorodisilane, poly(4-vinylphenol), polyacrylic acids, titanates, zirconates, or combinations thereof. Other suitable adhesion agents are also within the scope of this disclosure. In certain embodiments, the adhesion agent may be an organosilane. Exemplary organosilanes that may be used include, but are not limited to, vinyltrimethoxysilane, (3-aminopropyl)triethoxysilane, methyltrichlorosilane, triethoxymethylsilane, trimethoxymethylsilane, dimethoxydimethylsilane, methoxytrimethylsilane, diethoxydimethylsilane, triethoxyvinylsilane, trichlorovinylsilane, methyldiethoxysilane, triethoxy(ethyl)silane, ethoxytrimethylsilane, dimethoxyvinylsilane, *tert*-butyltrichlorosilane, (chloromethyl)triethoxysilane, bis(trichlorosilyl)methane, 1,2-bis(triethoxysilyl)ethane, 1,2-bis(trimethoxysilyl)ethane, 1,2-bis(trichlorosilyl)ethane, trichloro(dichloromethyl)silane, diethoxy(methyl)vinylsilane, 1,3-diethoxy-1,1,3,3-tetramethyldisiloxane, or combinations thereof. In some embodiments, the adhesion agent may be any silane with an amino functional group (e.g., aminopropyltrimethoxysilane, aminopropyltriethoxysilane, etc.) or a vinyl functional group (e.g., vinyltrimethoxysilane, vinyltriethoxysilane, etc.). Other suitable organosilanes are also within the scope of this disclosure.

[0017] The amount of adhesion agent that is present in the coating composition can be between about 1.5 and about 15 weight percent of the coating composition. Alternatively, the adhesion agent may be present in an amount of between about 3.5 and about 11 weight percent of the coating composition.

[0018] In various embodiments, the coating compositions and systems may comprise bi-functional compounds that may include both a fluorinated functional group or moiety and an adhesion promoter functional group or moiety. For example, a bi-functional compound in the coating may affect a level of lubricity of the coating (i.e., due to the fluorinated functional group or moiety) and the bi-functional compound in the coating may also aid in adhering, binding, and/or coupling the coating to at least a portion of a surface of a ski or snowboard (i.e., due to the adhesion promoter functional group or moiety). Exemplary bi-functional compounds that may be used include, but are not limited to, 1,6-divinylperfluorohexane, 1,4-divinylperfluorobutane, 1,8-divinylperfluorooctane, or combinations thereof. Other suitable bi-functional compounds are also within the scope of this disclosure. In some embodiments, 1,6-divinylperfluorohexane includes vinyl end groups that can promote adhesion and/or crosslinking and a fluorinated backbone that can impart hydrophobicity.

[0019] The coating may also include one or more shape memory polymers or stabilizers. The shape memory polymer may affect performance stability of the coating, for example, across a range of temperatures. In some embodiments, the coating may include a fluorinated compound, an adhesion agent, and a shape memory polymer. Exemplary shape memory polymers that may be used include, but are not limited to, ϵ -caprolactone, polycaprolactone (PCL), polynorbomene, polyenes, nylons, polycyclooctene (PCO), polyvinyl acetate/polyvinylidene fluoride (PVAc/PVDF), PVAc/PVDF/poly-methylmethacrylate (PMMA) blends, polyurethanes, styrene-butadiene copolymers, polyethylene (PE), trans-isoprene, polyvinyl chloride (PVC), or combinations thereof. Other suitable shape memory polymers are also within the scope of this disclosure.

[0020] The amount of shape memory polymers that are present in the coating composition can be between about 1.0 and about 10 weight percent of the coating composition. Alternatively, the shape memory polymers may be present in an amount of between about 2.0 and about 7.5 weight percent of the coating composition.

[0021] The coating may also include one or more free-radical initiators. The free-radical initiator may aid in free-radical addition polymerization of at least a portion of the coating. In various embodiments, the free-radical initiator may induce coupling or "grafting" of the adhesion agent to the surface of the ski or snowboard, which can then crosslink the material forming the surface of the ski or snowboard (e.g., UHMWPE) following a moisture curing step. In some embodiments, the coating may include a fluorinated compound, an adhesion agent, and a free-radical initiator. The coating may also include a fluorinated compound, an adhesion agent, a shape memory polymer, and a free-radical initiator. Exemplary free-radical initiators that may be used include, but are not limited to, photoinitiators, thermal initiators, chemical catalysts, or combinations thereof. Other suitable free-radical initiators are also within the scope of this disclosure.

[0022] In certain embodiments, the free-radical initiator may be a photoinitiator. The photoinitiators may include, but are not limited to, benzoin ethers, benzil ketals, α -dialkoxy-aceto-phenones, α -hydroxy-alkyl-phenones, α -aminoalkyl-phenones, acyl-phosphine oxides, benzo-phenones/amines, thio-xanthenes/amines, titanocenes, or combinations thereof. Exemplary photoinitiators that may be used include, but are not limited to, acetophenone, anisoin, anthraquinone, anthraquinone-2-sulfonic acid (e.g., anthraquinone-2-sulfonic acid, sodium salt monohydrate), (benzene)tricarbonylchromium, benzil, benzoin, benzoin ethyl ether, benzoin isobutyl ether, benzoin methyl ether, benzophenone, benzophenone/1-hydroxycyclohexyl phenyl ketone (e.g., 50/50 blend), 3,3',4,4'-benzophenonetetracarboxylic dianhydride, 4-benzoylbiphenyl, 2-benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone, 4,4'-bis(diethylamino)benzophenone, 4,4'-bis(dimethylamino)benzophenone, camphorquinone, 2-chlorothioxanthen-9-one, (cumene)cyclopentadienyliiron(II)

hexafluorophosphate, dibenzosuberone, 2,2-diethoxyacetophenone, 4,4'-dihydroxybenzophenone, dimethoxyacetophenone, 2,2-dimethoxy-2-phenylacetophenone (DMPAP), 4-(dimethylamino)benzophenone, 4,4'-dimethylbenzil, 2,5-dimethylbenzophenone, 3,4-dimethylbenzophenone, diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide/2-hydroxy-2-methylpropiophenone (e.g., 50/50 blend), 4'-ethoxyacetophenone, 2-ethylanthraquinone, ferrocene, 3'-hydroxyacetophenone, 4'-hydroxyacetophenone, 3-hydroxybenzophenone, 4-hydroxybenzophenone, 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methylpropiophenone, 2-methylbenzophenone, 3-methylbenzophenone, methylbenzoylformate, 2-methyl-4'-(methylthio)-2-morpholinopropiophenone, phenanthrenequinone, 4'-phenoxyacetophenone, phenylbis(2,4,6-trimethylbenzoyl)-phosphine oxide (BAPO), thioxanthen-9-one, triarylsulfonium hexafluoroantimonate salts (e.g., mixed, 50% in propylene carbonate), thioxanthone, triarylsulfonium hexafluorophosphate salts (e.g., mixed, 50% in propylene carbonate), xanthone, or combinations thereof. Other suitable photoinitiators are also within the scope of this disclosure.

[0023] In various embodiments, the free-radical initiator may be a thermal initiator. The thermal initiators may include, but are not limited to, *tert*-amyl peroxybenzoate, 4,4'-azobis(4-cyanovaleric acid), 1,1'-azobis(cyclohexanecarbonitrile), 2,2'-azobisisobutyronitrile (AIBN), benzoyl peroxide, 2,2-bis(*tert*-butylperoxy)butane, 1,1-bis(*tert*-butylperoxy)cyclohexane, 2,5-bis(*tert*-butylperoxy)-2,5-dimethylhexane, 2,5-bis(*tert*-butylperoxy)-2,5-dimethyl-3-hexyne, bis(1-(*tert*-butylperoxy)-1-methylethyl)benzene, 1,1-bis(*tert*-butylperoxy)-3,3,5-trimethylcyclohexane, *tert*-butyl hydroperoxide, *tert*-butyl peracetate, *tert*-butyl peroxide, *tert*-butyl peroxybenzoate, *tert*-butylperoxy isopropyl carbonate, cumene hydroperoxide, cyclohexanone peroxide, dicumyl peroxide, lauroyl peroxide, 2,4-pentanedione peroxide, peracetic acid, potassium persulfate, or combinations thereof. Other suitable thermal initiators are also within the scope of this disclosure.

[0024] The amount of free-radical initiators that are present in the coating composition can be between about 0.01 and about 20 weight percent of the coating composition. Alternatively, the free-radical initiators may be present in an amount of between about 0.01 and about 10 weight percent of the coating composition, between about 0.02 and about 10 weight percent of the coating composition, or between about 0.5 and about 5 weight percent of the coating composition.

[0025] The coating may also include one or more carrying solvents. For example, the coating may include a fluorinated compound, an adhesion agent, and a carrying solvent. In some embodiments, the coating may include a fluorinated compound, an adhesion agent, a shape memory polymer, and a carrying solvent. In yet other embodiments, the coating may include a fluorinated compound, an adhesion agent, a free-radical initiator, and a carrying

solvent. Moreover, in certain embodiments, the coating may include at least one of a fluorinated compound, an adhesion agent, a shape memory polymer, a free-radical initiator, and/or a carrying solvent. Exemplary carrying solvents that may be used include, but are not limited to, water, methanol, ethanol, ethylene glycol, propylene glycol, polyols, polar aprotic solvents, hydrocarbon solvents (aliphatic or aromatic), amine-based solvents, or combinations thereof. In some embodiments, the polyols may include 5 or fewer carbons. For example, the polyols may include, but are not limited to, 1,3-propanediol, polyethylene glycol (PEG), or combinations thereof. Exemplary polar aprotic solvents that may be used include, but are not limited to, acetone, dimethylformamide (DMF), acetonitrile, dimethyl sulfoxide (DMSO), dichloromethane, tetrahydrofuran (THF), ethyl acetate, hexamethylphosphoric triamide (HMPT), or combinations thereof. Other suitable carrying solvents that promote the miscibility of the polymer components and the polymeric substrate (e.g., ski or snowboard base) are also within the scope of this disclosure.

[0026] The amount of carrying solvent that is present in the coating composition can be between about 25 and about 95 weight percent of the coating composition. Alternatively, the carrying solvent may be present in an amount of between about 40 and about 80 weight percent of the coating composition or between about 60 and about 70 weight percent of the coating composition.

[0027] The coating may also include one or more catalysts. The catalysts may be used to accelerate the process of moisture curing or water curing a fluorinated silane to form a fluorinated silicone. In some embodiments, the fluorinated compound may be a fluorinated silane. Accordingly, the fluorinated silane may be moisture cured to form a fluorinated silicone. For example, the fluorinated silane may undergo hydrolysis to form a fluorinated silanol and the fluorinated silanol may then undergo condensation to form a fluorinated silicone. The moisture curing process can be pH dependent. As such, exemplary catalysts that may be used include, but are not limited to, pH modifiers (e.g., acids or bases) such as acetic acid, hydrochloric acid, *p*-toluenesulfonic acid, ammonia water, sodium hydroxide, monoisopropanolamine, diisopropanolamine, triisopropanolamine, or combinations thereof.

[0028] The pH modifiers may control the hydrolysis and/or the condensation reactions. Other catalysts may also be used to control the hydrolysis and/or the condensation reactions including, for example, dibutyltin dilaurate, dibutyl bis(acetylacetonate), or combinations thereof. In some embodiments, catalysts such as dibutyltin dilaurate may enhance reactions between the adhesion agent and the polymeric substrate (e.g., ski or snowboard base). Other suitable catalysts are also within the scope of this disclosure. In some other embodiments, the pH modifier can act as an inhibitor. The pH modifiers can act as a catalyst at certain pH levels to enhance or increase the rate of conversion of fluorinated silanes to fluorinated silanols and of fluorinated silanols to fluorinated silicones. However,

pH modifiers may also act to minimize the conversion of fluorinated silanes to fluorinated silanols and of fluorinated silanols to fluorinated silicones. Stated another way, the pH modifiers may act as an inhibitor. These processes (i.e., enhancing or inhibiting) can have different pH optimums. In certain embodiments, a pH modifier may be used to accelerate or enhance curing (e.g., for quick curing). In certain other embodiments, a pH modifier may be used to inhibit or minimize curing. For example, inhibition of curing may increase or maximize the shelf life of the coating system or composition (e.g., the pH modifier may limit or prevent curing of the coating system or composition before it is obtained by a user, technician, or manufacturer).

[0029] The coating may also include one or more water carrying agents. The water carrying agents may be used to aid or enhance the moisture curing process. Exemplary water carrying agents that may be used include, but are not limited to, calcium oxalate hydrate, calcium chloride hydrate, sodium carbonate hydrate, aluminum potassium sulfate dodecahydrate (alum), or combinations thereof. Other suitable water carrying agents are also within the scope of this disclosure.

[0030] The coating may also include one or more antioxidants. The antioxidant may scavenge free radicals. For example, the antioxidant can scavenge free radicals that may be generated by the one or more photoinitiators. Scavenging of the free radicals can limit or prevent oxidation of the material used to form the base of a ski or snowboard (e.g., polyethylene). In some embodiments, the coating may include a fluorinated compound, an adhesion agent, a free-radical initiator, and an antioxidant. In certain embodiments, the coating may include a fluorinated compound, an adhesion agent, a free-radical initiator, a carrying solvent, and an antioxidant. Moreover, in various embodiments, the coating may include at least one of a fluorinated compound, an adhesion agent, a shape memory polymer, a free-radical initiator, a carrying solvent, and/or an antioxidant. Exemplary antioxidants that may be used include, but are not limited to, carotenes, xanthophylls, flavonoids, curcuminoids, tocopherols (e.g., vitamin E), phenolic acids, lignins, tannins, or combinations thereof. Other suitable antioxidants that promote the stabilization of the polymer components and/or the polymeric substrate (e.g., ski or snowboard base) are also within the scope of this disclosure.

[0031] The coating may also include one or more surfactants. The surfactant may be used to form stable emulsions for fluorinated compounds that have low or poor solubility in certain carrying solvents. Furthermore, the surfactant may be used to enhance or improve wetting properties of the coating. In some embodiments, the coating may include a fluorinated compound, a carrying solvent, and a surfactant. In certain embodiments, the coating may include a fluorinated compound, an adhesion agent, a carrying solvent, and a surfactant. Moreover, in various embodiments, the coating may include at least one of a

fluorinated compound, an adhesion agent, a shape memory polymer, a free-radical initiator, a carrying solvent, an antioxidant, and/or a surfactant. Exemplary surfactants that may be used include, but are not limited to, silicone surfactants, fluorinated surfactants, anionic surfactants, nonionic surfactants, cationic surfactants, zwitterionic surfactants, or combinations thereof. Other suitable surfactants that promote the miscibility of the coating components are also within the scope of this disclosure.

[0032] An aspect of the disclosure relates to compositions for application to a substrate. Such coating compositions may include one or more of the following: fluorinated compounds, adhesion agents, shape memory polymers or stabilizers, free-radical initiators, carrying solvents, catalysts, water carrying agents, antioxidants, and surfactants. All combinations and permutations of each of these components disclosed above with respect to ski or snowboard base coating systems may also be present in the coating compositions disclosed herein. Furthermore, all preceding examples of fluorinated compounds, adhesion agents, shape memory polymers or stabilizers, free-radical initiators, carrying solvents, catalysts, water carrying agents, antioxidants, and surfactants may also be used with the coating compositions contemplated herein. In certain situations, the substrate to which such coating compositions may be applied may also include polymeric substrates.

[0033] Methods related to use of the coatings are also disclosed herein. In some embodiments, a method of coating a ski or snowboard may optionally include combining a first fluorinated compound and a first adhesion agent to form a first liquid mixture. The first liquid mixture can then be obtained by the user, technician, or manufacturer. The method may further include applying the first liquid mixture on at least a portion of a surface of a ski or snowboard to form a first layer. For example, the first liquid mixture can be sprayed and/or spread on at least a portion of a base of the ski or snowboard to form the first layer.

[0034] The method of coating the ski or snowboard may also include combining and/or obtaining a first liquid mixture that includes one or more of the following: a first shape memory polymer, a first free-radical initiator, and a first carrying solvent with the first fluorinated compound and the first adhesion agent. Stated another way, in some embodiments, the first liquid mixture may include a first adhesion agent, a first fluorinated compound, a first shape memory polymer, a first free-radical initiator, and a first carrying solvent, wherein the constituents are optionally mixed together. Furthermore, the first free-radical initiator may be activated to convert at least a portion of the first liquid mixture to a first interpenetrating polymer network. The first free-radical initiator may also induce chemical bonding of the first adhesion agent to at least a portion of the base of the ski or snowboard (e.g., the UHMWPE surface).

[0035] In certain embodiments, the method of coating the ski or snowboard may optionally include combining a second fluorinated compound and a second adhesion agent

to form a second liquid mixture. The second liquid mixture may then be obtained by the user, technician, or manufacturer. The second liquid mixture can be applied (e.g., via spraying, spreading, etc.) on at least a portion of the first layer to form a second layer. The method can also include combining and/or obtaining one or more of the following: a second shape memory polymer, a second free-radical initiator, and a second carrying solvent with the second fluorinated compound and the second adhesion agent in a second liquid mixture. In other words, in various embodiments, the second liquid mixture can include a second adhesion agent, a second fluorinated compound, a second shape memory polymer, a second free-radical initiator, and a second carrying solvent. Furthermore, the second free-radical initiator can be activated to convert at least a portion of the second liquid mixture to a second interpenetrating polymer network.

[0036] In some embodiments, each of the first and second fluorinated compounds can include carbon side chains, wherein the length of the carbon side chain of the first fluorinated compound is greater than the length of the carbon side chain of the second fluorinated compound.

[0037] In various embodiments, the method of coating the ski or snowboard may include combining and/or obtaining a third fluorinated compound and a third adhesion agent to form a third liquid mixture and applying the third liquid mixture on at least a portion of the second layer to form a third layer. The method may also include combining and/or obtaining one or more of the following: a third shape memory polymer, a third free-radical initiator, and a third carrying solvent with the third fluorinated compound and the third adhesion agent in a third liquid mixture. Furthermore, the third free-radical initiator may be activated to convert at least a portion of the third liquid mixture to a third interpenetrating polymer network. In certain embodiments, the third fluorinated compound may include a carbon side chain, wherein the length of the carbon side chain of the third fluorinated compound is different than the length of the carbon side chains of the first and/or second fluorinated compounds.

[0038] In some embodiments, the method of coating the ski or snowboard may include curing the first layer, the second layer, the third layer, and/or any additional layers. Stated another way, in certain embodiments, the method of coating the ski or snowboard may include curing a coating or layer, which has been applied to a portion of a surface of the ski or snowboard. Upon application of the coating or the layer to the surface of the ski or snowboard, the user, technician, or manufacturer may expose the coating or layer to light energy. In various embodiments, the coating may be exposed to light having a wavelength between about 250 and about 400 nm. In some embodiments, the coating may be exposed to ultraviolet (UV) light (e.g., UVA, UVB, and/or UVC light), visible light, or combinations thereof.

[0039] In certain embodiments, the user, technician, or manufacturer may expose the coating or layer to sunlight for up to about 3 hours, between about 1 and about 3 hours, between about 2 and about 3 hours, or another suitable time period to cure the coating or layer. In certain other embodiments, the user, technician, or manufacturer may expose the coating or layer to UV light, visible light, or a combination thereof in a light box. In comparison to sunlight, it can be faster to cure the coating or layer in a light box. The light box may include or utilize LEDs, or any other suitable light-emitting technology, to provide light energy (e.g., UV light, visible light, etc.). For example, the user, technician, or manufacturer may expose the coating or layer to light energy for up to about 20 minutes, up to about 15 minutes, between about 5 and about 20 minutes, between about 10 and about 20 minutes, between about 15 and about 20 minutes, or another suitable time period. In some other embodiments, the user, technician, or manufacturer may expose the coating or layer to light energy for up to about 5 minutes, less than about 5 minutes, or another suitable time period.

[0040] The user, technician, or manufacturer may also expose the coating or layer to heat. In various embodiments, a light box may also provide heat (e.g., in addition to light energy). For example, the user, technician, or manufacturer may expose the coating or layer to heat (e.g., in a light box) between about 70 and about 120 degrees Fahrenheit, between about 70 and about 105 degrees Fahrenheit, or another suitable temperature. The wavelength of light and/or the amount of heat may be modified by the user, technician, or manufacturer according to the composition of the coating, the composition of the ski or snowboard, weather and/or snow conditions, or any other relevant variable.

[0041] In some embodiments, a method of coating a ski or snowboard may optionally include combining an adhesion agent and a free-radical initiator to form a first liquid mixture. The first liquid mixture can then be obtained by the user, technician, or manufacturer. The method may further include applying the first liquid mixture on at least a portion of a surface of a ski or snowboard to form a first layer. For example, the first liquid mixture can be sprayed and/or spread on at least a portion of a base of the ski or snowboard to form the first layer.

[0042] The method of coating the ski or snowboard may also include combining and/or obtaining a first liquid mixture that includes one or more of the following: an adhesion agent and a free-radical initiator with a fluorinated silane, a shape memory polymer, and a carrying solvent. Stated another way, in some embodiments, the first liquid mixture may include an adhesion agent, a fluorinated silane, a free-radical initiator, a shape memory polymer, and a carrying solvent, wherein the constituents are optionally mixed together. Furthermore, the first layer may be light cured as described above.

[0043] In some embodiments, the method of coating a ski or snowboard may optionally include combining an adhesion agent and a free-radical initiator to form a second liquid mixture. The second liquid mixture can then be obtained by the user, technician, or manufacturer. The method can further include applying the second liquid mixture on at least a portion of a surface of the first layer to form a second layer. For example, the second liquid mixture can be sprayed and/or spread on at least a portion of a base of the first layer to form the second layer.

[0044] The method of coating the ski or snowboard may also include combining and/or obtaining a second liquid mixture that includes one or more of the following: an adhesion agent and a free-radical initiator with a fluorinated silane, a shape memory polymer, and a carrying solvent. Stated another way, in some embodiments, the second liquid mixture may include an adhesion agent, a fluorinated silane, a free-radical initiator, a shape memory polymer, and a carrying solvent, wherein the constituents are optionally mixed together. Furthermore, the second layer may also be light cured as described above.

[0045] In some embodiments, a method of coating a ski or snowboard may optionally include combining an adhesion agent and a free-radical initiator to form a first liquid mixture. The first liquid mixture can then be obtained by the user, technician, or manufacturer. The method may further include applying the first liquid mixture on at least a portion of a surface of a ski or snowboard to form a first layer. For example, the first liquid mixture can be sprayed and/or spread on at least a portion of a base of the ski or snowboard to form the first layer.

[0046] The method of coating the ski or snowboard may also include combining and/or obtaining a first liquid mixture that includes one or more of the following: a shape memory polymer and a carrying solvent with the adhesion agent and the free-radical initiator. Stated another way, in some embodiments, the first liquid mixture may include an adhesion agent, a free-radical initiator, a shape memory polymer, and a carrying solvent, wherein the constituents are optionally mixed together. Furthermore, the first layer may be light cured as described above.

[0047] In certain embodiments, the method of coating a ski or snowboard may optionally include obtaining a fluorinated compound or second liquid mixture including the fluorinated compound. The fluorinated compound or the second liquid mixture can then be obtained by the user, technician, or manufacturer. The method can further include applying the fluorinated compound on at least a portion of a surface of the first layer to form a second layer. For example, the fluorinated compound can be sprayed and/or spread on at least a portion of a surface of the first layer to form the second layer.

[0048] The method of coating the ski or snowboard may also include combining and/or obtaining a second liquid mixture that includes one or more of the following: a shape

memory polymer and a carrying solvent with the fluorinated compound. Stated another way, in some embodiments, the second liquid mixture may include a fluorinated compound, a shape memory polymer, and a carrying solvent, wherein the constituents are optionally mixed together. In some embodiments, the second liquid mixture may include the shape memory polymer and/or the carrying solvent. In some other embodiments, the second liquid mixture may include the shape memory polymer and/or the carrying solvent. In yet other embodiments, both the first liquid mixture and the second liquid mixture may include the shape memory polymer and/or the carrying solvent. Additionally, the second layer may be moisture cured or water cured. As discussed above, one or more catalysts may be used to accelerate the process of moisture curing. Water carrying agents may also be used to aid the moisture curing process.

[0049] In certain embodiments, the method of coating the ski or snowboard may optionally include obtaining a catalyst or a third liquid mixture including the catalyst. The catalyst or the third liquid mixture can then be obtained by the user, technician, or manufacturer. The method can further include applying the catalyst on at least a portion of the second layer. In some embodiments, the third liquid mixture can promote the polymerization of the fluorinated compound. For example, the fluorinated compound may include fluorinated silanes, and the catalyst may promote the polymerization of the fluorinated silanes to fluorinated silicones. Such a configuration can decouple or separate the catalyst from the first and/or second liquid mixtures, for example, if there are difficulties in generating a stable solution that includes both the catalyst and the adhesion agent, fluorinated compound, shape memory polymer, free-radical initiator, and/or carrying solvent. In some embodiments, the third liquid mixture may also include a pH modifier and/or a surfactant. Application of the third liquid mixture to the second layer may be a final step that can induce conversion of the fluorinated silanes to fluorinated silicones. In certain embodiments, the conversion of the fluorinated silanes to fluorinated silicones may be quick or rapid.

[0050] Application of a liquid mixture including a catalyst as described above may be incorporated into any of the methods provided herein. For example, upon application of liquid mixture including a fluorinated compound (e.g., a fluorinated silane) to form a layer, a liquid mixture including a catalyst may then be applied (e.g., as a second liquid mixture, a third liquid mixture, a fourth liquid mixture, etc.) to the layer including the fluorinated compound.

[0051] Each of the fluorinated compounds (e.g., the first fluorinated compound, the second fluorinated compound, and the third fluorinated compound) may be independently selected from at least one of a fluorinated silane, a fluorinated hydrocarbon, a fluorinated polymer, or a fluorinated silicone. For example, the first fluorinated compound may be a

fluorinated silicone, the second fluorinated compound may be a fluorinated ethylene propylene (or other fluorinated polymer), and the third fluorinated compound may be a fluorinated silane, or other iterations and permutations.

[0052] Each of the adhesion agents (e.g., the first adhesion agent, the second adhesion agent, and the third adhesion agent) may be independently selected from at least one of an organosilane, hexachlorodisilane, poly(4-vinylphenol), a polyacrylic acid, a titanate, or a zirconate. For example, the first adhesion agent may be an organosilane, the second adhesion agent may be a hexachlorodisilane, and the third adhesion agent may be a polyacrylic acid, or other iterations and permutations.

[0053] Each of the shape memory polymers (e.g., the first shape memory polymer, the second shape memory polymer, and the third shape memory polymer) may be independently selected from at least one of ϵ -caprolactone, polycaprolactone (PCL), polynorbomene, a polyene, a nylon, polycyclooctene (PCO), polyvinyl acetate/polyvinylidene fluoride (PVAc/PVDF), a PVAc/PVDF/poly-methylmethacrylate (PMMA) blend, a polyurethane, a styrene-butadiene copolymer, polyethylene (PE), trans-isoprene, or polyvinyl chloride (PVC). For example, the first shape memory polymer may be PCO and each of the second and third shape memory polymers may be polyurethanes, or other iterations and permutations.

[0054] Each of the free-radical initiators (e.g., the first free-radical initiator, the second free-radical initiator, and the third free-radical initiator) may be independently selected from at least one of a photoinitiator, a thermal initiator, or a chemical catalyst. For example, the first free-radical initiator may be a photoinitiator, the second free-radical initiator may be a chemical catalyst, and the third free-radical initiator may be a thermal initiator, or other iterations and permutations. Exemplary photoinitiators are described above.

[0055] Furthermore, each of the carrying solvents (e.g., the first carrying solvent, the second carrying solvent, and the third carrying solvent) may be independently selected from at least one of water, methanol, ethanol, ethylene glycol, propylene glycol, a polyol, a polar aprotic solvent, a hydrocarbon solvent, an amine-based solvent, or other suitable carrying solvent that promotes the miscibility of the polymer coating components and the polymeric substrate (of the ski or snowboard). For example, the first carrying solvent and the second carrying solvent may be ethanol and the third carrying solvent may be ethylene glycol, or other iterations and permutations.

[0056] In certain embodiments, the coating can include one or more fluorinated compounds, adhesion agents, shape memory polymers, free-radical initiators, carrying solvents, catalysts, water carrying agents, antioxidants, and/or surfactants in a single mixture that can be later applied to at least a portion of a surface of a ski or snowboard by a user, technician, or manufacturer. Additionally, components of the coating may be applied

successively. Alternatively, subcombinations of the coating can be applied simultaneously while other components are applied successively/serially. In certain other embodiments, the coating can be applied to at least a portion of the surface of the ski or snowboard in two or more layers. For example, a first mixture including a first adhesion agent, a first fluorinated compound, a first shape memory polymer, a first free-radical initiator, and a first carrying solvent can be applied to at least a portion of the surface of a ski or snowboard and a first interpenetrating polymer network can be formed. A second mixture including a second adhesion agent, a second fluorinated compound, a second shape memory polymer, a second free-radical initiator, and a second carrying solvent can then be applied to at least a portion of the first layer and a second interpenetrating polymer network can be formed. In various embodiments, the first fluorinated compound may include a longer carbon side chain than the second fluorinated compound. The layering process described above and/or additional mixtures (e.g., a third mixture including a third fluorinated compound) may be used to form additional layers.

[0057] The various mixtures (e.g., the first mixture, the second mixture, etc.) can begin in a liquid form that may allow for penetration and/or saturation of the coating into a porous (or micro- or nano-porous) surface of a ski or snowboard (e.g., a porous base of the ski or snowboard). In some embodiments, the liquid mixtures may allow for full, or substantially full, penetration and/or saturation of the coating into a porous surface of a ski or snowboard.

[0058] In certain embodiments, wherein the free-radical initiator is a photoinitiator, upon the application of light energy (e.g., UV light) the photoinitiator may initiate a free-radical polymerization process to at least partially polymerize the components (e.g., the fluorinated compound, the adhesion agent, etc.) of the coating and permanently, or semi-permanently, associate with the base substrate. By using a liquid form of the various mixtures to achieve full, or substantially full, saturation of the coating into the base material and then inducing polymerization within the liquid mixtures, a polymer network can be formed that fills or penetrates a greater portion of a ski or snowboard base than traditional waxes or other coatings.

[0059] The use of an adhesion agent, as discussed above, can result in the formation of a permanent, or semi-permanent, association between the fluorinated compound and the ski or snowboard base. Additionally, the adhesion agent may result in the formation of a stronger association between the base material and the fluorinated compound as compared to traditional waxes and some other coatings. Filling the pores of a ski or snowboard surface with a polymer coating or system as provided herein, which incorporates fluorinated compounds, can impart the surface of the ski or snowboard with enhanced durability and/or permanent, or substantially permanent, enhanced lubricity.

[0060] The lubricious coating system provided herein does not include wax or waxy components. In contrast to a wax or wax-like treatment, the lubricious coating system includes an interpenetrating polymer network that is absorbed into the material of the ski or snowboard and then polymerized via a free-radical polymerization method. Furthermore, the lubricious coating system is chemically bound (e.g., via the free radical initiators and the adhesion agent) to the surface of the ski or snowboard. As can be appreciated, additional methods and/or method steps can be derived from the present disclosure.

[0061] References to approximations are made throughout this specification, such as by use of the term “substantially.” For each such reference, it is to be understood that, in some embodiments, the value, feature, or characteristic may be specified without approximation. For example, where qualifiers such as “about” and “substantially” are used, these terms include within their scope the qualified words in the absence of their qualifiers. For example, where the term “substantially full” is recited with respect to a feature, it is understood that in further embodiments, the feature can have a precisely full configuration.

[0062] Any methods disclosed herein include one or more steps or actions for performing the described method. The method steps and/or actions may be interchanged with one another. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order and/or use of specific steps and/or actions may be modified. Moreover, sub-routines or only a portion of a method described herein may be a separate method within the scope of this disclosure. Stated otherwise, some methods may include only a portion of the steps described in a more detailed method.

[0063] Reference throughout this specification to “an embodiment” or “the embodiment” means that a particular feature, structure, or characteristic described in connection with that embodiment is included in at least one embodiment. Thus, the quoted phrases, or variations thereof, as recited throughout this specification are not necessarily all referring to the same embodiment.

[0064] Similarly, it should be appreciated that in the above description of embodiments, various features are sometimes grouped together in a single embodiment or description thereof for the purpose of streamlining the disclosure. This method of disclosure, however, is not to be interpreted as reflecting an intention that any claim require more features than those expressly recited in that claim. Rather, as the following claims reflect, inventive aspects lie in a combination of fewer than all features of any single foregoing disclosed embodiment.

[0065] The claims following this written disclosure are hereby expressly incorporated into the present written disclosure, with each claim standing on its own as a separate embodiment. This disclosure includes all permutations of the independent claims with their dependent claims. Moreover, additional embodiments capable of derivation from the

independent and dependent claims that follow are also expressly incorporated into the present written description.

[0066] Without further elaboration, it is believed that one skilled in the art can use the preceding description to utilize the invention to its fullest extent. The claims and embodiments disclosed herein are to be construed as merely illustrative and exemplary, and not a limitation of the scope of the present disclosure in any way. It will be apparent to those having ordinary skill in the art, with the aid of the present disclosure, that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the disclosure herein. In other words, various modifications and improvements of the embodiments specifically disclosed in the description above are within the scope of the appended claims. Moreover, the order of the steps or actions of the methods disclosed herein may be changed by those skilled in the art without departing from the scope of the present disclosure. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order or use of specific steps or actions may be modified. The scope of the invention is therefore defined by the following claims and their equivalents.

CLAIMS

1. A lubricious coating system for application to a ski or snowboard, comprising:
a fluorinated compound; and
an adhesion agent configured to promote adhesion of the fluorinated compound to the ski or snowboard.
2. The lubricious coating system of claim 1, wherein the fluorinated compound is present in an amount of between 1.0 and 15 weight percent and the adhesion agent is present in an amount of between 1.5 and 15 weight percent of the coating system.
3. The lubricious coating system of claim 1 or 2, wherein the adhesion agent is selected from at least one of an organosilane, hexachlorodisilane, poly(4-vinylphenol), a polyacrylic acid, a titanate, or a zirconate.
4. The lubricious coating system of claim 3, wherein the adhesion agent is an organosilane selected from at least one of vinyltrimethoxysilane, (3-aminopropyl)triethoxysilane, methyltrichlorosilane, triethoxymethylsilane, trimethoxymethylsilane, dimethoxydimethylsilane, methoxytrimethylsilane, diethoxydimethylsilane, triethoxyvinylsilane, trichlorovinylsilane, methyldiethoxysilane, triethoxy(ethyl)silane, ethoxytrimethylsilane, dimethoxyvinylsilane, *tert*-butyltrichlorosilane, (chloromethyl)triethoxysilane, bis(trichlorosilyl)methane, 1,2-bis(triethoxysilyl)ethane, 1,2-bis(trimethoxysilyl)ethane, 1,2-bis(trichlorosilyl)ethane, trichloro(dichloromethyl)silane, diethoxy(methyl)vinylsilane, or 1,3-diethoxy-1,1,3,3-tetramethyldisiloxane.
5. The lubricious coating system of any one of claims 1–4, wherein the fluorinated compound is selected from at least one of a fluorinated silane, a fluorinated hydrocarbon, a fluorinated polymer, or a fluorinated silicone.
6. The lubricious coating system of claim 5, wherein the fluorinated compound comprises a fluorinated silane that includes a carbon side chain, and wherein a length of the carbon side chain of the fluorinated silane is between 1 and 30 carbons.
7. The lubricious coating system of claim 5, wherein the fluorinated compound comprises a first fluorinated silane including a first carbon side chain and a second fluorinated silane including a second carbon side chain, and wherein the length of the first carbon side chain of the first fluorinated silane is greater than the length of the second carbon side chain of the second fluorinated silane.
8. The lubricious coating system of claim 7, wherein the first carbon side chain has between 9 and 30 carbons and the second carbon side chain has between 1 and 8 carbons.
9. The lubricious coating system of claim 5, wherein the fluorinated compound comprises a fluorinated polymer that is at least one of polytetrafluoroethylene (PTFE) or fluorinated ethylene propylene (FEP).

10. The lubricious coating system of any one of claims 1–9, further comprising a shape memory polymer.

11. The lubricious coating system of claim 10, wherein the shape memory polymer is present in an amount of between 1.0 and 10 weight percent of the coating system.

12. The lubricious coating system of claim 10 or 11, wherein the shape memory polymer is selected from at least one of ϵ -caprolactone, polycaprolactone (PCL), polynorbomene, a polyene, a nylon, polycyclooctene (PCO), polyvinyl acetate/polyvinylidene fluoride (PVAc/PVDF), a PVAc/PVDF/poly-methylmethacrylate (PMMA) blend, a polyurethane, a styrene-butadiene copolymer, polyethylene (PE), trans-isoprene, or polyvinyl chloride (PVC).

13. The lubricious coating system of any one of claims 1–12, further comprising a free-radical initiator.

14. The lubricious coating system of claim 13, wherein the free-radical initiator is present in an amount of between 0.01 and 10 weight percent of the coating system.

15. The lubricious coating system of claim 13 or 14, wherein the free-radical initiator is selected from at least one of a photoinitiator, a thermal initiator, or a chemical catalyst.

16. The lubricious coating system of claim 15, wherein the free radical initiator comprises a photoinitiator selected from at least one of acetophenone, anisoin, anthraquinone, anthraquinone-2-sulfonic acid, (benzene)tricarboxylchromium, benzil, benzoin, benzoin ethyl ether, benzoin isobutyl ether, benzoin methyl ether, benzophenone, benzophenone/1-hydroxycyclohexyl phenyl ketone, 3,3',4,4'-benzophenonetetracarboxylic dianhydride, 4-benzoylbiphenyl, 2-benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone, 4,4'-bis(diethylamino)benzophenone, 4,4'-bis(dimethylamino)benzophenone, camphorquinone, 2-chlorothioxanthen-9-one, (cumene)cyclopentadienyliron(II) hexafluorophosphate, dibenzosuberenone, 2,2-diethoxyacetophenone, 4,4'-dihydroxybenzophenone, dimethoxyacetophenone, 2,2-dimethoxy-2-phenylacetophenone (DMPAP), 4-(dimethylamino)benzophenone, 4,4'-dimethylbenzil, 2,5-dimethylbenzophenone, 3,4-dimethylbenzophenone, diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide/2-hydroxy-2-methylpropiophenone, 4'-ethoxyacetophenone, 2-ethylanthraquinone, ferrocene, 3'-hydroxyacetophenone, 4'-hydroxyacetophenone, 3-hydroxybenzophenone, 4-hydroxybenzophenone, 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methylpropiophenone, 2-methylbenzophenone, 3-methylbenzophenone, methylbenzoylformate, 2-methyl-4'-(methylthio)-2-morpholinopropiophenone, phenanthrenequinone, 4'-phenoxyacetophenone, phenylbis(2,4,6-trimethylbenzoyl)-phosphine oxide (BAPO), thioxanthen-9-one,

triarylsulfonium hexafluoroantimonate salts, thioxanthone, triarylsulfonium hexafluorophosphate salts, or xanthone.

17. The lubricious coating system of any one of claims 1–16, further comprising a carrying solvent.

18. The lubricious coating system of claim 17, wherein the carrying solvent is present in an amount of between 25 and 95 weight percent of the coating system.

19. The lubricious coating system of claim 17 or 18, wherein the carrying solvent is selected from at least one of water, methanol, ethanol, ethylene glycol, propylene glycol, a polyol, a polar aprotic solvent, a hydrocarbon solvent, or an amine-based solvent.

20. The lubricious coating system of any one of claims 1–19, wherein the coating system is free of wax.

21. A method of coating a ski or snowboard, the method comprising:
obtaining a first liquid mixture comprising a first fluorinated compound and a first adhesion agent; and
applying the first liquid mixture on a portion of a surface of a base of a ski or snowboard to form a first layer.

22. The method of claim 21, wherein applying the first liquid mixture comprises applying the first liquid mixture to a ski or snowboard base comprising ultra-high molecular weight polyethylene.

23. The method of claim 21 or 22, wherein the first liquid mixture further comprises a first shape memory polymer, a first free-radical initiator, and a first carrying solvent.

24. The method of claim 23, further comprising:
mixing the first fluorinated compound, the first adhesion agent, the first shape memory polymer, the first free-radical initiator, and the first carrying solvent to form the first liquid mixture.

25. The method of claim 23 or 24, further comprising:
activating the first free-radical initiator to convert a portion of the first liquid mixture to a first interpenetrating polymer network.

26. The method of any one of claims 21–25, further comprising:
obtaining a second liquid mixture comprising a second fluorinated compound and a second adhesion agent; and
applying the second liquid mixture on a portion of the first layer to form a second layer.

27. The method of claim 26, wherein the second liquid mixture further comprises a second shape memory polymer, a second free-radical initiator, and a second carrying solvent.

28. The method of claim 27, further comprising:
activating the second free-radical initiator to convert a portion of the second liquid mixture to a second interpenetrating polymer network.
29. The method of any one of claims 26–28, wherein the first and second fluorinated compounds each include carbon side chains, and wherein a length of the carbon side chain of the first fluorinated compound is greater than a length of the carbon side chain of the second fluorinated compound.
30. The method of any one of claims 26–29, further comprising:
obtaining a third liquid mixture comprising a third fluorinated compound, a third adhesion agent, a third shape memory polymer, a third free-radical initiator, and a third carrying solvent; and
applying the third liquid mixture on a portion of the second layer to form a third layer.
31. The method of claim 30, further comprising:
activating the third free-radical initiator to convert a portion of the third liquid mixture to a third interpenetrating polymer network.
32. A coating composition for application to a substrate, comprising:
a fluorinated compound;
an adhesion agent configured to promote the adhesion of the fluorinated compound to the substrate;
a shape memory polymer;
a free-radical initiator; and
a carrying solvent.
33. The coating composition of claim 32, wherein the fluorinated compound is present in an amount of between 1.0 and 15 weight percent, the adhesion agent is present in an amount of between 1.5 and 15 weight percent, the shape memory polymer is present in an amount of between 1.0 and 10 weight percent, the free-radical initiator is present in an amount of between 0.01 and 10 weight percent, and the carrying solvent is present in an amount of between 25 and 95 weight percent.
34. The coating composition of claim 32 or 33, wherein the fluorinated compound is selected from at least one of a fluorinated silane, a fluorinated hydrocarbon, a fluorinated polymer, or a fluorinated silicone.
35. The coating composition of claim 34, wherein the fluorinated compound comprises a fluorinated silane that includes a fluorinated carbon side chain, and wherein a length of the carbon side chain of the fluorinated silane is between 1 and 30 carbons.
36. The coating composition of claim 35, wherein the fluorinated compound comprises a first fluorinated silane including a first fluorinated carbon side chain having a length of between 9 and 30 carbons and a second fluorinated silane including a second fluorinated carbon side chain with a length of between 1 and 8 carbons.

37. The coating composition of claim 34, wherein the fluorinated compound comprises a fluorinated polymer that is at least one of polytetrafluoroethylene (PTFE) or fluorinated ethylene propylene (FEP).

38. The coating composition of any one of claims 32–37, wherein the adhesion agent is selected from at least one of an organosilane, hexachlorodisilane, poly(4-vinylphenol), a polyacrylic acid, a titanate, or a zirconate.

39. The coating composition of claim 38, wherein the adhesion agent is an organosilane selected from at least one of vinyltrimethoxysilane, (3-aminopropyl)triethoxysilane, methyltrichlorosilane, triethoxymethylsilane, trimethoxymethylsilane, dimethoxydimethylsilane, methoxytrimethylsilane, diethoxydimethylsilane, triethoxyvinylsilane, trichlorovinylsilane, methyl diethoxysilane, triethoxy(ethyl)silane, ethoxytrimethylsilane, dimethoxyvinylsilane, *tert*-butyltrichlorosilane, (chloromethyl)triethoxysilane, bis(trichlorosilyl)methane, 1,2-bis(triethoxysilyl)ethane, 1,2-bis(trimethoxysilyl)ethane, 1,2-bis(trichlorosilyl)ethane, trichloro(dichloromethyl)silane, diethoxy(methyl)vinylsilane, or 1,3-diethoxy-1,1,3,3-tetramethyldisiloxane.

40. The coating composition of any one of claims 32–39, wherein the shape memory polymer is selected from at least one of ϵ -caprolactone, polycaprolactone (PCL), polynorbomene, a polyene, a nylon, polycyclooctene (PCO), polyvinyl acetate/polyvinylidene fluoride (PVAc/PVDF), a PVAc/PVDF/poly-methylmethacrylate (PMMA) blend, a polyurethane, a styrene-butadiene copolymer, polyethylene (PE), trans-isoprene, or polyvinyl chloride (PVC).

41. The coating composition of any one of claims 32–40, wherein the free-radical initiator is selected from at least one of a photoinitiator, a thermal initiator, or a chemical catalyst.

42. The coating composition of claim 41, wherein the free radical initiator comprises a photoinitiator selected from at least one of acetophenone, anisoin, anthraquinone, anthraquinone-2-sulfonic acid, (benzene)tricarboxylchromium, benzil, benzoin, benzoin ethyl ether, benzoin isobutyl ether, benzoin methyl ether, benzophenone, benzophenone/1-hydroxycyclohexyl phenyl ketone, 3,3',4,4'-benzophenonetetracarboxylic dianhydride, 4-benzoylbiphenyl, 2-benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone, 4,4'-bis(diethylamino)benzophenone, 4,4'-bis(dimethylamino)benzophenone, camphorquinone, 2-chlorothioxanthen-9-one, (cumene)cyclopentadienyliiron(II) hexafluorophosphate, dibenzosuberenone, 2,2-diethoxyacetophenone, 4,4'-dihydroxybenzophenone, dimethoxyacetophenone, 2,2-dimethoxy-2-phenylacetophenone (DMPAP), 4-(dimethylamino)benzophenone, 4,4'-dimethylbenzil, 2,5-dimethylbenzophenone, 3,4-dimethylbenzophenone, diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide/2-hydroxy-2-methylpropiophenone, 4'-

ethoxyacetophenone, 2-ethylanthraquinone, ferrocene, 3'-hydroxyacetophenone, 4'-hydroxyacetophenone, 3-hydroxybenzophenone, 4-hydroxybenzophenone, 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methylpropiophenone, 2-methylbenzophenone, 3-methylbenzophenone, methylbenzoylformate, 2-methyl-4'-(methylthio)-2-morpholinopropiophenone, phenanthrenequinone, 4'-phenoxyacetophenone, phenylbis (2,4,6-trimethylbenzoyl)-phosphine oxide (BAPO), thioxanthen-9-one, triarylsulfonium hexafluoroantimonate salts, thioxanthone, triarylsulfonium hexafluorophosphate salts, or xanthone.

43. The coating composition of any one of claims 32–42, wherein the carrying solvent is selected from at least one of water, methanol, ethanol, ethylene glycol, propylene glycol, a polyol, a polar aprotic solvent, a hydrocarbon solvent, or an amine-based solvent.

44. The coating composition of any one of claims 32–43, wherein the coating system is free of wax.

45. A method of coating a ski or snowboard, the method comprising:
obtaining a first liquid mixture comprising an adhesion agent and a free-radical initiator;

applying the first liquid mixture on a portion of a surface of a base of a ski or snowboard to form a first layer;

obtaining a second liquid mixture comprising a fluorinated compound; and
applying the second liquid mixture on a portion of the first layer to form a second layer.

46. The method of claim 45, further comprising:
light curing the first layer; and
moisture curing the second layer.

47. The method of claim 46, wherein light curing comprises exposing the first layer to light energy.

48. The method of any one of claims 45–47, wherein applying the first liquid mixture comprises applying the first liquid mixture to a ski or snowboard base comprising ultra-high molecular weight polyethylene.

49. The method of any one of claims 45–48, wherein the first liquid mixture or the second liquid mixture further comprises a shape memory polymer and a first carrying solvent.

50. The method of claim 45, further comprising:
mixing the adhesion agent and the free-radical initiator to form the first liquid mixture.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/047094**A. CLASSIFICATION OF SUBJECT MATTER****C09G 3/00(2006.01)i, C09D 127/12(2006.01)i, C09D 7/63(2018.01)i, C09D 7/40(2018.01)i, B05D 7/24(2006.01)i, B05D 7/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C09G 3/00; A63C 5/056; B05D 3/02; B32B 17/10; B32B 27/00; C10M 105/54; C10M 131/02; C10M 131/08; C09D 127/12; C09D 7/63; C09D 7/40; B05D 7/24; B05D 7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: lubricious coating, fluorinated, silane, adhesion, shape memory polymer, free-radical initiator, ultra-high molecular weight polyethylene

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 07-000791 B2 (ASICS CORP. et al.) 11 January 1995 See claim 1; column 8, lines 11-20.	1-4, 21, 22 23, 24, 32-37, 45-48, 50
Y A	US 4338376 A (KRITZLER, S.) 06 July 1982 See claim 1; column 2, lines 53-66.	1-4, 21, 22
A	US 2004-0091714 A1 (GUNN, R. T.) 13 May 2004 See the whole document.	1-4, 21-24, 32-37, 45-48, 50
A	US 2006-0270570 A1 (GROTTENMUELLER, R. et al.) 30 November 2006 See the whole document.	1-4, 21-24, 32-37, 45-48, 50
A	WO 2006-018210 A1 (HOLMENKOL SPORT-TECHNOLOGIES GMBH & CO. KG) 23 February 2006 See the whole document.	1-4, 21-24, 32-37, 45-48, 50

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

20 December 2018 (20.12.2018)

Date of mailing of the international search report

20 December 2018 (20.12.2018)

Name and mailing address of the ISA/KR

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: 6-9, 11, 14, 16, 18, 27, 28, 31, 39, 42
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 6-9, 11, 14, 16, 18, 27, 28, 31, 39 and 42 are unclear because they refer to one of multiple dependent claims which do not comply with PCT Rule 6.4(a).

3. Claims Nos.: 5, 10, 12, 13, 15, 17, 19, 20, 25, 26, 29, 30, 38, 40, 41, 43, 44, 49
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2018/047094

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