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(54) **FORMULATION FOR DURABLE WICKING SOFTENING AND ANTI-STATIC TEXTILES**

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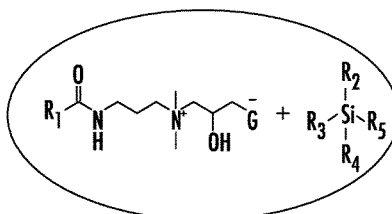
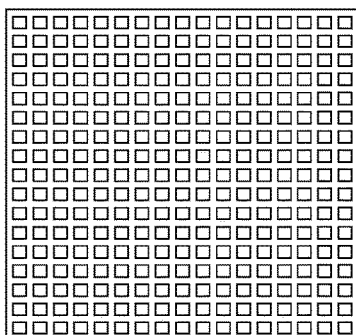
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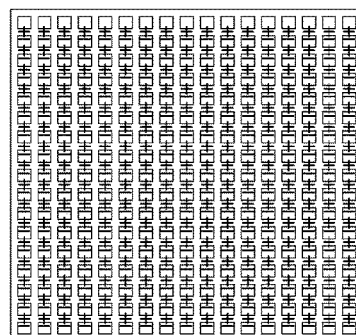
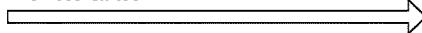
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(57) **ABSTRACT**
 A chemical formulation for imparting a textile with durable wicking, softening and antistatic properties comprising an amphoteric or betaine surfactant, and an alkoxy silane. A method of treating the textile with the chemical formulation as well as the treated textile and the articles made therefrom are provided.



R1 = ALKYL GROUP
 R2, R3, R4, R5 = ALKYL, ALKOXY, AMINOALKYL,
 QUATERNARY AMMONIUM ALKYL AND OTHER
 FUNCTIONAL ALKYL GROUPS
 G = SO3⁻ OR COO⁻



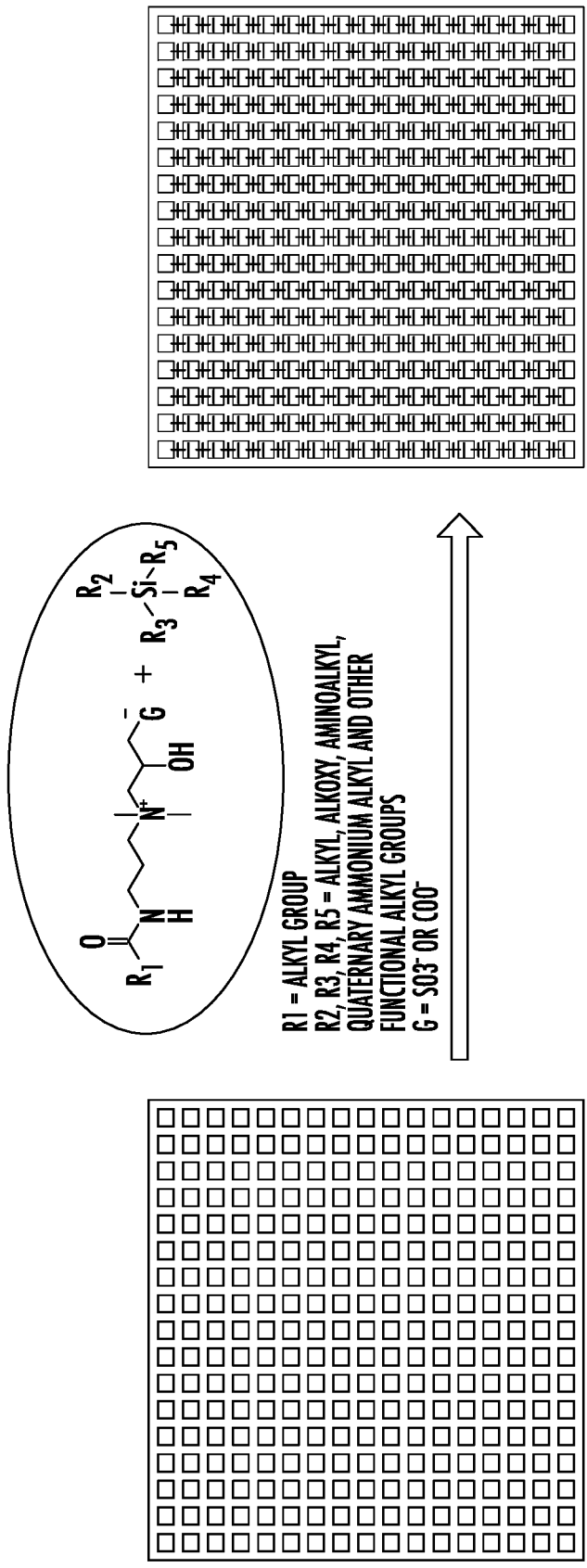


FIG. 1

FORMULATION FOR DURABLE WICKING SOFTENING AND ANTI-STATIC TEXTILES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from U.S. Provisional Patent Application No. 62/840,767, filed on Apr. 30, 2019, in the United States Patent and Trademark Office. The disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a treatment for textiles, more particularly a formulation for providing durable wicking, softening and antistatic properties to textiles.

BACKGROUND OF THE INVENTION

[0003] Wicking, softening, antistatic properties and their combinations are properties that are desirable in clothing articles to consumers, especially in the area of sportswear made of synthetics or their blends. Traditionally, multiple chemical formulations are used to treat textiles, such as wicking aids, softeners and antistatic chemicals in an attempt to obtain such properties, leading to expensive and higher operation costs in the textile industry. However, a problem exists in that these properties often disappear in the clothing articles after one or two launderings, which loses its attraction to consumers. Due to their charge, solubility, polarities and hydrophilicities, chemicals used to obtain wicking, softening, and antistatic properties are often incompatible with one other.

[0004] Thus, there is a need for a solution to this industry problem.

SUMMARY OF THE INVENTION

[0005] The present invention provides a chemical formulation for imparting a textile with durable wicking, softening and antistatic properties, a method of treating the textile with the chemical formulation as well as the treated textile and the articles made therefrom.

[0006] In an embodiment of the invention, a formulation for imparting durable wicking, softening and antistatic properties is provided. The formulation comprises a surfactant selected from the group consisting of an amphoteric surfactant, a betaine surfactant, and a combination thereof; an alkoxy silane, and a carrier.

[0007] In an embodiment of the invention, a method of textile treatment is provided. The method comprises applying the formulation to a textile, the formulation comprising a surfactant selected from the group consisting of an amphoteric surfactant, a betaine surfactant, and a combination thereof; an alkoxy silane, and a carrier.

[0008] In an embodiment of the invention, a textile having been treated with the formulation is provided. The formulation comprises a surfactant selected from the group consisting of an amphoteric surfactant, a betaine surfactant, and a combination thereof; an alkoxy silane, and a carrier.

[0009] In an embodiment of the invention, an article made from a textile having been treated with the formulation is provided. The formulation comprises a surfactant selected

from the group consisting of an amphoteric surfactant, a betaine surfactant, and a combination thereof; an alkoxy silane, and a carrier.

[0010] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention will become more fully understood from the detailed description and the accompanying drawings, which are not necessarily to scale, wherein:

[0012] FIG. 1 is a diagram illustrating a mechanism for forming a durable wicking softening and antistatic coating on a textile using a formulation in accordance with an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] The following description of the embodiments of the present invention is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. The present invention has broad potential application and utility, which is contemplated to be adaptable across a wide range of industries. The following description is provided herein solely by way of example for purposes of providing an enabling disclosure of the invention, but does not limit the scope or substance of the invention.

[0014] The formulation and method of the present invention impart a durable property to a textile or an article made therefrom. For example, durability is demonstrated by a textile withstanding at least 10 home launderings (HL) before the home launderings significantly reduce or eliminate its wicking, softening or antistatic properties. The formulation of the present invention is used to make a textile durable despite multiple launderings.

[0015] In an embodiment of the invention, the formulation comprises an amphoteric or betaine surfactant, and an alkoxy silane.

[0016] Non-limiting examples of alkoxy silanes include, but are not limited to, heneicosfluorododecyltrichlorosilane, heptadecafluorodecyltrichlorosilane, poly(tetrafluoroethylene), octadecyltrichlorosilane, methyltrimethoxysilane, nonafluorohexyltrimethoxysilane, vinyltriethoxysilane, ethyltrimethoxysilane, propyltrimethoxysilane, trifluoropropyltrimethoxysilane, 3-(2-aminoethyl)-aminopropyltrimethoxysilane, p-tolyltrimethoxysilane, cyanoethyltrimethoxysilane, aminopropyltriethoxysilane, aminopropyltrimethoxysilane, acetoxypolytrimethoxysilane, phenyltrimethoxysilane, chloropropyltrimethoxysilane, mercaptopropyltrimethoxysilane, glycidoxypolytrimethoxysilane, silane quaternary ammonium compounds, and combinations thereof.

[0017] Among them, preferred alkoxy silanes for this invention are silane quaternary ammonium compounds. Silane quaternary ammonium compounds are commercially available from companies such as Microban Products Company under the trade names AEM5772, AEM5700, and FU5700.

[0018] Non-limiting examples of amphoteric surfactants or betaine surfactants include, but are not limited to: alkyl hydroxysultaines comprised of ethyl hydroxysultaine, propyl hydroxysultaine, butyl hydroxysultaine, pentyl hydroxysultaine, hexyl hydroxysultaine, heptyl hydroxysultaine, octyl hydroxysultaine, nonyl hydroxysultaine, decyl hydroxysultaine, undecyl hydroxysultaine, dodecyl hydroxysultaine, tetradecyl hydroxysultaine, hexadecyl hydroxysultaine, coco hydroxysultaine, or a mixture(s) thereof; amidoalkyl hydroxysultaines comprised of ethyl amido-propyl hydroxysultaine, propyl-amido-propyl hydroxysultaine, butyl-amido-propyl hydroxysultaine, pentyl-amido-propyl hydroxysultaine, amido-propyl hexyl hydroxysultaine, amido-propyl-heptyl hydroxysultaine, octyl-amido-propyl hydroxysultaine, nonyl-amido-propyl hydroxysultaine, decyl-amido-propyl hydroxysultaine, undecyl-amido-propyl hydroxysultaine, dodecyl amido-propyl hydroxysultaine, tetradecyl-amido-propyl hydroxysultaine, hexadecyl-amido-propyl hydroxysultaine, octadecyl-amido-propyl hydroxysultaine, hydroxysultaine coco-amido-propyl, or mixtures thereof.

[0019] Other non-limiting examples of amphoteric surfactants or betaine surfactants include, but are not limited to: alkyl hydroxycarboxybetaines comprised of ethyl hydroxycarboxybetaine, propyl hydroxycarboxybetaine, butyl hydroxycarboxybetaine, pentyl hydroxycarboxybetaine, hexyl hydroxycarboxybetaine, heptyl hydroxycarboxybetaine, octyl hydroxycarboxybetaine, nonyl hydroxycarboxybetaine, decyl hydroxycarboxybetaine, undecyl hydroxycarboxybetaine, dodecyl hydroxycarboxybetaine, tetradecyl hydroxycarboxybetaine, hexadecyl hydroxycarboxybetaine, coco hydroxycarboxybetaine, or mixtures thereof; amidoalkyl hydroxycarboxybetaines comprised of ethyl amido-propyl hydroxycarboxybetaine, propyl-amido-propyl hydroxycarboxybetaine, butyl-amido-propyl hydroxycarboxybetaine, pentyl-amido-propyl hydroxycarboxybetaine, amido-propyl hexyl hydroxycarboxybetaine, amido-propyl-heptyl hydroxycarboxybetaine, octyl-amido-propyl hydroxycarboxybetaine, nonyl-amido-propyl hydroxycarboxybetaine, decyl-amido-propyl hydroxycarboxybetaine, undecyl-amido-propyl hydroxycarboxybetaine, dodecyl amido-propyl hydroxycarboxybetaine, tetradecyl-amido-propyl hydroxycarboxybetaine, hexadecyl-amido-propyl hydroxycarboxybetaine, octadecyl-amido-propyl hydroxycarboxybetaine, hydroxycarboxybetaine coco-amido-propyl, or a mixture(s) thereof.

[0020] Non-limiting examples of commercially available amphoteric surfactants are Amphosol CS-50 by Stepan, Cola®Teric CBS by Colonial Chemical, Schercotaine™ SCAB-50 and Chembetaine™ LHS Surfactant by Lubrizol, PEL-AMPH™ LHS by Ele Corporation, Mackam® CBS 50 G E and Mackam® LHS by Solvay Novecare.

[0021] In an embodiment of the present invention, the formulation comprises an alkoxy silane in an amount in a range of 0.001% to 50% of the total formulation.

[0022] In an embodiment of the present invention, the formulation comprises an amphoteric or betaine surfactant in an amount in a range of 0.001% to 50%.

[0023] In an embodiment of the present invention, the formulation comprises a carrier. Water is a preferred carrier.

[0024] The formulation may comprise an additive. Non-limiting examples of additives include, but are not limited

to, antimicrobials, rheology modifiers, pH adjusting agents, colorants, preservatives, extenders, defoamers, brighteners, fire retardants, among others.

[0025] Non-limiting examples of pH adjusting agents include, but are not limited to, an acetic acid solution, a citric acid solution, NaOH, an ammonia solution, among others. The pH range of the formulation is preferably from 2 to 13.

[0026] The formulation may be used alone or in combination with other textile finishing agents such as odor capture moieties, antimicrobials, other moisture management agents or softeners, or brightener.

[0027] For example, an antimicrobial or combination of antimicrobials can be used to aid in making the textile fabric effective against many bacteria including *S. aureus*, *M. osloensis*, *E. coli* and *K. pneumoniae*. Non-limiting examples of antimicrobials include, but are not limited to, silver, triclosan, zinc pyrithione, metal salts and oxide, phenols, botanicals, halogens, peroxides, heterocyclic antimicrobials, other quaternary ammonium compounds, aldehydes or a combination(s) thereof.

[0028] In an embodiment of the invention, a method of treating a textile to impart durable wicking, softening, and antistatic properties to a textile is provided.

[0029] The method comprises mixing an amphoteric or betaine surfactant and an alkoxy silane with water to form the formulation.

[0030] The method further comprises applying the formulation onto a textile. Non-limiting examples of textiles are cotton, polyester, synthetics, wool, silk, or any blend of fibers or materials. The formulation may be applied to the textile by a typical textile yarn package treatment such as a wet finishing process. Non-limiting examples of a wet finishing process include, but are not limited to, foam finishing, coating, padding, exhausting, spraying, or a combination thereof. Padding is a preferred application method of the invention.

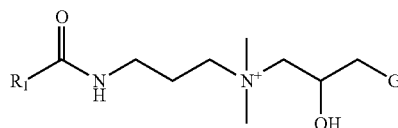
[0031] The formulation can be applied to the textile prior to an application of an antimicrobial formulation or in the same wet finishing process as the antimicrobial formulation.

[0032] After the application of the formulation to the textile, the method further comprises drying or curing the textile at an elevated temperature, preferably a temperature of 10° C. to 200° C., to finish the treatment process.

[0033] After treatment with the formulation of the invention, wicking, softening and antistatic properties are essentially locked into the textile to provide such effect to the textile material for an extended number of launderings. For example, the textile exhibits durable wicking, softening and antistatic properties from 1 and 200 home launderings (HLs), preferably after at least 10 HL.

[0034] FIG. 1 is a diagram illustrating a mechanism for forming a durable wicking softening and antistatic coating on a textile using a formulation in accordance with an embodiment of the present invention.

[0035] As shown in FIG. 1, an amphoteric surfactant having the formula of:



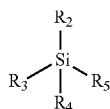
[0036] wherein

[0037] R_1 =alkyl group

[0038] $G=SO_3^-$ or COO^- (G carries a sulfonate group or a carboxylate group that carries a negative charge)

[0039] is added to water and stirred to mix.

[0040] An alkoxy silane having the chemical structure of:



[0041] wherein

[0042] R_2, R_3, R_4 and R_5 =alkyl, alkoxy, aminoalkyl, quaternary ammonium alkyl, or other functional alkyl groups

[0043] is added to the mixture. The pH is adjusted to a point in the range of 2 and 13 by acetic acid or citric acid solution or NaOH or ammonia solution. It is then stirred for at least 30 minutes if the silane is not already hydrolyzed to form the formulation of the present invention.

[0044] Applying the formulation to a textile fabric comprised of fibers is believed to form a thin layer of silanol dried coating on the fiber surface. After the textile fabric is dried and cured at a high temperature from 10° C. to 200° C., it is theorized that the silanols condense and polymerize to embed the amphoteric surfactant forming a solid film on

EXAMPLES

[0047] Testing showed that the formulation of the invention provided durable antistatic, wicking and softening properties after 10 HL.

[0048] Wicking and antistatic tests were conducted on women's HEATTECH fabric from Nagase before and after 10 HL using the AATCC Monograph 6 method. Room temperature and relative humidity were recorded.

[0049] Absorbency Testing Method AATCC 79-2014 was used to determine the wicking property of textile materials treated with the formulation of the present invention using the time to absorb a water droplet. Sample pieces were cut into a size of 5x5 in². A drop of de-ionized water was released onto the fabric center when the time started. When the water droplet disappeared, the time was stopped and recorded. The test was repeated 4 times on four corners. The wicking time was the average of all 5 tests.

[0050] The antistatic testing method used was adapted from AATCC 76-2011. Sample pieces were cut into a size of 5x5 in² and laid flat on an insulative bench surface. Surface Resistance Meter Victor 385 was pressed firmly on the fabric center and a "Test" button was pressed until LED light stabilized. The resistance value was recorded. The test was repeated 4 times on four corners. The resistance value was the average of all 5 tests.

[0051] The percentages of the formulation components shown in Table 1 were based on the weight of the formulation (which was in liquid form) for each of the formulations tested.

TABLE 1

Components	Functionality	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6	Formula 7
Water (g)	Carrier	99.5	99	97	196.6	196.6	194.6	194.6
Alkoxy silane (Microban AEM5700*) (g)	Crosslinker	0	0	0	0.8	0.8	0.8	0.8
Amphoteric surfactant (Amphosol CS-50**) (g)	Wicking aid, softener, antistatic	0.5	1	3	0	0	2	2
R51000* (g)	Crosslinker	0	0	0	0.6	0.6	0.6	0.6
Superfloc C-572***	Crosslinker	0	0	0	2	0	0	2
GENIOSIL® GF 96****	Crosslinker	0	0	0	0	2	2	0

*Trademark of Microban

**Trademark of Stepan

***Trademark of Kemira

****Trademark of Wacker

the fiber, resulting in highly durable amphoteric surfactant coating formulation on the textile fabric.

[0045] In an embodiment of the invention, the add on level for each of alkoxy silane and of amphoteric or betaine surfactant to the textile is at or above 0.01% by weight based on the weight of dry textile. Preferably, the add on level of alkoxy silane is at or above 0.2% by weight based on the weight of dry textile. Preferably, the add on level for amphoteric or betaine surfactant is at or above 0.5% by weight based on the weight of dry textile.

[0046] The formulation and method of the present invention are advantageous for a multitude of reasons such as reduction of cost of chemicals and waste treatment.

[0052] Treatment

[0053] A Mathis lab padder model HF-350 was used to treat a textile fabric with each formulation. The textile fabric was Nagase Women's HEATTECH fabric. The nip speed was 3.6 m/min. The pickup rate for each fabric was almost 100% so that the concentration in solution equaled to that on weight of fabric (owf). Immediately following the padding, the fabric was dried and cured in a Mathis lab LTE infrared drier. The cure temp was 150° C.; air temp was 153° C.; fan speed was 1500 rpm and dwell time was 45 s. The treated fabrics along with untreated control fabrics were laundered using an Electrolux front loader washing machine and Tide detergent.

[0054] Results of the testing are shown in Table 2.

TABLE 2

Formulation	Wicking, softness and antistatic results				
	Wicking (s)		Resistance (Ω/cm^2)		Hand Feel
	0 HL	10 HL	0 HL	10 HL	
Formula 1	<1	<1	11.6	Insulative	Soft as untreated
Formula 2	<1	<1	11.7	Insulative	Soft as untreated
Formula 3	<1	<1	10.7	Insulative	Soft as untreated
Formula 4	78	2	10.4	Insulative	Soft as untreated
Formula 5	155	>300	11.4	11.0	Soft as untreated
Formula 6	<1	4	10.0	11.0	Soft as untreated
Formula 7	<1	<1	9.0	10.0	Soft as untreated

[0055] Due to the soft hand feel of Nagase Women's HEATTECH fabric, current tested formulations were able to maintain same softness as that of untreated fabric.

[0056] In Table 2, the wicking time for Formula 7 was less than 1 s before and after 10 HL, compared to 78 s before wash and 2 s after wash of Formula 4. Comparison of Formula 5 and Formula 6, illustrated wicking time decreased from 155 s to less than 1 s before wash, and >300 s to 4 s.

[0057] Formulations 1, 2, and 3 in Table 2 showed the resistances of fabric treated with only CS-50 at 0.5%, 1% and 3% were $10^{11.7} \Omega/\text{cm}^2$ before washes which meant antistatic. However, after 10 HL their resistance increased and the fabrics turned insulative, suggesting CS-50 only was unable to retain antistatic properties after laundering.

[0058] Formula 4 without CS-50 showed treated fabric turned insulative after wash, while Formula 7 with CS-50 remained antistatic.

[0059] As demonstrated by Formula 6 and Formula 7, when hand, wicking and antistatic properties are considered, only the combination of alkoxy silane AEM5700 and amphoteric surfactant CS-50 made durable wicking and antistatic properties to Women's HEATTECH fabric for at least 10 HL.

[0060] It was noted that an amphoteric surfactant had no durability on fabrics when used alone while the alkoxy silane had no combined wicking, softening and antistatic properties when used alone.

[0061] It will therefore be readily understood by those persons skilled in the art that the present invention is susceptible of broad utility and application. Many embodiments and adaptations of the present invention other than those herein described, as well as many variations, modifications and equivalent arrangements, will be apparent from or reasonably suggested by the present invention and the foregoing description thereof, without departing from the substance or scope of the present invention. Accordingly, while the present invention has been described herein in detail in relation to its preferred embodiment, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for purposes of providing a full and enabling disclosure of the invention. The foregoing disclosure is not intended or to be construed to limit the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications and equivalent arrangements.

What is claimed is:

1. A formulation for imparting durable wicking, softening and antistatic properties, the formulation comprising:

a surfactant selected from the group consisting of an amphoteric surfactant, a betaine surfactant, and a combination thereof;

an alkoxy silane, and

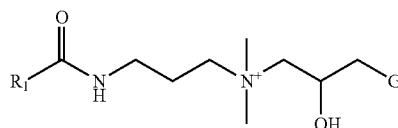
a carrier.

2. The formulation according to claim 1, wherein the alkoxy silane is selected from the group consisting of heneicosaffluorododecyltrichlorosilane, heptadecafluorodecyltrichlorosilane, poly(tetrafluoroethylene), octadecyltrichlorosilane, methyltrimethoxysilane, nonafluorohexyltrimethoxysilane, vinyltriethoxysilane, ethyltrimethoxysilane, propyltrimethoxysilane, trifluoropropyltrimethoxysilane, 3-(2-aminoethyl)-aminopropyltrimethoxysilane, p-tolyltrimethoxysilane, cyanoethyltrimethoxysilane, aminopropyltriethoxysilane, aminopropyltrimethoxysilane, acetoxypolytrimethoxysilane, phenyltrimethoxysilane, chloropropyltrimethoxysilane, mercaptopropyltrimethoxysilane, glycidoxypolytrimethoxysilane, a silane quaternary ammonium compound, and a combination thereof.

3. The formulation according to claim 2, wherein the alkoxy silane is a silane quaternary ammonium compound.

4. The formulation according to claim 1, wherein the amphoteric surfactant or betaine surfactant is selected from the group consisting of an alkyl hydroxysultaines comprised of ethyl hydroxysultaine, propyl hydroxysultaine, butyl hydroxysultaine, pentyl hydroxysultaine, hexyl hydroxysultaine, heptyl hydroxysultaine, octyl hydroxysultaine, nonyl hydroxysultaine, decyl hydroxysultaine, undecyl hydroxysultaine, dodecyl hydroxysultaine, tetradecyl hydroxysultaine, hexadecyl hydroxysultaine, coco hydroxysultaine, or a mixture(s) thereof; amidoalkyl hydroxysultaines comprised of ethyl amido-propyl hydroxysultaine, propyl-amido-propyl hydroxysultaine, butyl-amido-propyl hydroxysultaine, pentyl-amido-propyl hydroxysultaine, amido-propyl hexyl hydroxysultaine, amido-propyl-heptyl hydroxysultaine, octyl-amido-propyl hydroxysultaine, nonyl-amido-propyl hydroxysultaine, decyl-amido-propyl hydroxysultaine, undecyl-amido-propyl hydroxysultaine, dodecyl amido-propyl hydroxysultaine, tetradecyl-amido-propyl hydroxysultaine, hexadecyl-amido-propyl hydroxysultaine, octadecyl-amido-propyl hydroxysultaine, hydroxysultaine coco-amido-propyl, and a combination thereof.

5. The formulation according to claim 1, wherein the amphoteric surfactant has a formula of:

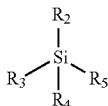


wherein

R_1 =alkyl group, and

$G = \text{SO}_3^-$ or COO^- where G carries a sulfonate group or a carboxylate group that carries a negative charge.

6. The formulation according to claim 1, wherein the alkoxy silane has a chemical structure of:



wherein

R_2 , R_3 , R_4 and R_5 =alkyl, alkoxy, aminoalkyl, quaternary ammonium alkyl, or other functional alkyl group.

7. The formulation according to claim 1, wherein the formulation comprises the alkoxy silane in an amount in a range of 0.001% to 50% by weight of the formulation.

8. The formulation according to claim 1, wherein the formulation comprises the amphoteric or betaine surfactant in an amount in a range of 0.001% to 50% by weight of the formulation.

9. The formulation according to claim 1, wherein the carrier is water.

10. The formulation according to claim 1, further comprising an additive selected from the group consisting of an antimicrobial, rheology modifier, pH adjusting agent, colorant, preservative, extender, defoamer, brightener, fire retardant, a softener, a brightener, and a combination thereof.

11. The formulation according to claim 1, wherein the pH adjusting agent is selected from the group consisting of an acetic acid solution, a citric acid solution, NaOH, an ammonia solution, and a combination thereof.

12. The formulation according to claim 1, wherein the formulation has a pH in a range of from 2 to 13.

13. The formulation according to claim 10, wherein the antimicrobial is effective against a bacteria selected from the group consisting of *S. aureus*, *M. osloensis*, *E. coli*, *K. pneumoniae*, and a combination thereof.

14. The formulation according to claim 10, wherein the antimicrobial is selected from the group consisting of silver, triclosan, zinc pyrithione, metal salts and oxide, phenols, botanicals, halogens, peroxides, heterocyclic antimicrobials, other quaternary ammonium compounds, aldehydes, and a combination(s) thereof.

15. A method of textile treatment, the method comprising: applying a formulation to a textile, the formulation comprising:

a surfactant selected from the group consisting of an amphoteric surfactant, a betaine surfactant, and a combination thereof;

an alkoxy silane, and

a carrier.

16. The method according to claim 15, wherein the formulation is applied to the textile prior to an application of an antimicrobial or in a wet finishing process with application of an antimicrobial.

17. The method according to claim 15, wherein the method further comprises drying the textile at a temperature of 10° C. to 200° C.

18. The method according to claim 15, wherein an add on level for each of alkoxy silane and of the amphoteric or betaine surfactant to the textile is at or above 0.01% by weight based on the weight of dry textile.

19. The method according to claim 15, wherein an add on level of alkoxy silane is at or above 0.2% by weight based on the weight of dry textile.

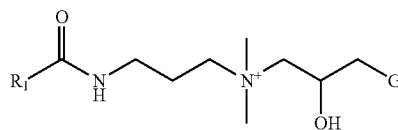
20. The method according to claim 15, wherein an add on level for amphoteric or betaine surfactant is at or above 0.5% by weight based on the weight of dry textile.

21. The method according to claim 15, wherein the alkoxy silane is selected from the group consisting of heneicosaffluorododecyltrichlorosilane, heptadecafluorodecyltrichlorosilane, poly(tetrafluoroethylene), octadecyltrichlorosilane, methyltrimethoxysilane, nonafluorohexyltrimethoxysilane, vinyltriethoxysilane, ethyltrimethoxysilane, propyltrimethoxysilane, trifluoropropyltrimethoxysilane, 3-(2-aminoethyl)-aminopropyltrimethoxysilane, p-tolyltrimethoxysilane, cyanoethyltrimethoxysilane, aminopropyltriethoxysilane, aminopropyltrimethoxysilane, acetoxypolytrimethoxysilane, phenyltrimethoxysilane, chloropropyltrimethoxysilane, mercaptopropyltrimethoxysilane, glycidoxypolytrimethoxysilane, a silane quaternary ammonium compound, and a combination thereof.

22. The method according to claim 15, wherein the alkoxy silane is a silane quaternary ammonium compound.

23. The method according to claim 15, wherein the amphoteric surfactant or betaine surfactant is selected from the group consisting of an alkyl hydroxysultaines comprised of ethyl hydroxysultaine, propyl hydroxysultaine, butyl hydroxysultaine, pentyl hydroxysultaine, hexyl hydroxysultaine, heptyl hydroxysultaine, octyl hydroxysultaine, nonyl hydroxysultaine, decyl hydroxysultaine, undecyl hydroxysultaine, dodecyl hydroxysultaine, tetradecyl hydroxysultaine, hexadecyl hydroxysultaine, coco hydroxysultaine, or a mixture(s) thereof; amidoalkyl hydroxysultaines comprised of ethyl amido-propyl hydroxysultaine, propyl-amido-propyl hydroxysultaine, butyl-amido-propyl hydroxysultaine, pentyl-amido-propyl hydroxysultaine, amido-propyl hexyl hydroxysultaine, amido-propyl-heptyl hydroxysultaine, octyl-amido-propyl hydroxysultaine, nonyl-amido-propyl hydroxysultaine, decyl-amido-propyl hydroxysultaine, undecyl-amido-propyl hydroxysultaine, dodecyl amido-propyl hydroxysultaine, tetradecyl-amido-propyl hydroxysultaine, hexadecyl-amido-propyl hydroxysultaine, octadecyl-amido-propyl hydroxysultaine, hydroxysultaine coco-amido-propyl, and a combination thereof.

24. The method according to claim 15, wherein the amphoteric surfactant has a formula of:

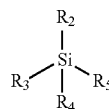


wherein

R_1 =alkyl group, and

$G=SO_3^-$ or COO^- where G carries a sulfonate group or a carboxylate group that carries a negative charge.

25. The method according to claim 15, wherein the alkoxy silane has a chemical structure of:



wherein

R₂, R₃, R₄ and R₅=alkyl, alkoxy, aminoalkyl, quaternary ammonium alkyl, or other functional alkyl group.

26. The method according to claim **15**, wherein the formulation comprises the alkoxysilane in an amount in a range of 0.001% to 50% by weight of the formulation.

27. The method according to claim **15**, wherein the formulation comprises the amphoteric or betaine surfactant in an amount in a range of 0.001% to 50% by weight of the formulation.

28. The method according to claim **15**, wherein the carrier is water.

29. The method according to claim **15**, further comprising an additive selected from the group consisting of an antimicrobial, rheology modifier, pH adjusting agent, colorant, preservative, extender, defoamer, brightener, fire retardant, a softener, a brightener, and a combination thereof.

30. The method according to claim **29**, wherein the pH adjusting agent is selected from the group consisting of an acetic acid solution, a citric acid solution, NaOH, an ammonia solution, and a combination thereof.

31. The method according to claim **15**, wherein the formulation has a pH in a range of from 2 to 13.

32. The method according to claim **15**, wherein the antimicrobial is effective against a bacteria selected from the group consisting of *S. aureus*, *M. osloensis*, *E. coli*, *K. pneumoniae*, and a combination thereof.

33. The method according to claim **29**, wherein the antimicrobial is selected from the group consisting of silver, triclosan, zinc pyrithione, metal salts and oxide, phenols, botanicals, halogens, peroxides, heterocyclic antimicrobials, other quaternary ammonium compounds, aldehydes, and a combination(s) thereof.

34. The method according to claim **15**, wherein the textile having the formulation applied thereon has durable wicking, softening and antistatic properties from 1 and 200 home launderings (HLs).

35. A textile having been treated with the formulation according to claim **1**.

36. An article made from a textile having been treated with the formulation according to claim **1**.

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