MULTI-FUNCTIONAL COMPOSITIONS AND METHODS OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to U.S. Provisional Application Serial No. 61/696005, filed on August 31, 2012, which is incorporated herein by reference in its entirety.

BACKGROUND

The invention is directed to removing unwanted constituents from a siliceous surfaces and determining the cleanliness of a siliceous surface.

Conventional window cleaning compositions are typically designed to leave no visible residue on a glass surface when used to clean the glass surface. In other words, the glass surface should be free from a film and streaking. To achieve these properties, the level of surfactant and other additives in the cleaning composition must be low.

Organic solvents are often present in conventional window cleaning compositions to enable the composition to remove common stains and oily contaminants from glass surfaces.

Some window cleaning compositions include hydrophilic polymers or long chain alkyl sulfate surfactants, which are alleged to impart water-sheeting and anti-spotting properties to a surface cleaned therewith. Such compositions tend to leave behind a hydrophilic residue, which contributes to the water-sheeting effect and helps to remove soil from the glass surface.

Compositions that include silanes have been used to impart a hydrophilic property to a glass surface that has been cleaned and activated. The preference for some of these compositions is for the surface be activated immediately prior to, or simultaneously with, the application of the aqueous composition. Such compositions, however, typically require the surface to be pre-cleaned.

Coating compositions that include silanes have also been used to coat glass substrates to render them capable of being easily cleaned.

SUMMARY

The present disclosure is directed to multi-functional compositions and the use thereof. Such compositions have multiple functions, e.g., cleaning and protecting.

In one aspect, the disclosure features a method of removing an unwanted constituent from a siliceous surface, the method including contacting the siliceous surface and the unwanted constituent with a multi-functional composition that includes water, a hydrophilic silane, and a surfactant, and drying the surface wherein the hydrophilic silane is selected from anionic silanes, sulfonated silanes, zwitterionic silanes; and combinations thereof. In one embodiment, the method further includes rubbing the solution on the surface.

In one embodiment, the solution imparts a hydrophilic property to the surface and the dried surface exhibits a greater hydrophilicity relative to the hydrophilicity of the surface prior to the contacting.

In one embodiment, the siliceous surface is a surface of a board selected from the group consisting of a white board and a dry erase board, and the unwanted constituent includes a mark from a marker. In some embodiments, the siliceous surface is a surface of glass, such as a window or door, and the unwanted constituent includes at least one of oil and dirt.

The siliceous surface can include glass shower doors, tile walls, porcelain bathtubs, sinks, or other surfaces on which soap scum accumulates.

In some embodiments, the dried surface exhibits sufficient hydrophilicity such that at least 50 % of a mark placed on the surface with a permanent marker is wiped away from the surface within 50 wipes with a damp towel. In other embodiments, the dried surface exhibits sufficient hydrophilicity such that at least 50 % of a mark placed on the surface with a permanent marker is washed away from the surface within 2 minutes by a spray of water applied at a rate of 600 milliliters per minute. In some embodiments, the dried surface exhibits sufficient hydrophilicity such that a fingerprint of artificial sebum placed on the dried surface is washed away from the surface within 2 minutes by a spray of water applied at a rate of 600 milliliters per minute. In other embodiments, when the dried surface is contacted with moisture vapor, no condensation occurs.

The disclosure may also feature a method of removing an unwanted constituent (e.g., one or more of the components of soap scum) from a siliceous surface, the method including contacting the siliceous surface and the unwanted constituent with a multi-functional composition that includes water, a hydrophilic silane, surfactant, and at least one of water soluble alkali metal silicate, a polyalkoxy silane (such as a tetraalkoxysilane (e.g., TEOS), or a tetraalkoxysilane oligomer),and an inorganic silica sol, and drying the surface.

In another aspect, a method of cleaning and protecting a siliceous surface is provided. The method includes: applying an aqueous composition to the surface, the composition comprising: a hydrophilic silane selected from anionic silanes, sulfonated silanes, zwitterionic silanes, and combinations thereof; a surfactant; and water; wherein the ratio of the total weight of the surfactants to the total weight of the hydrophilic silane is at least 1:2; and rubbing the composition onto the surface to clean the surface (e.g., remove soap scum) and protect the surface (e.g., from the build-up of soap scum).

The disclosure may also feature a method of determining the cleanliness of a previously cleaned substrate (e.g., one cleaned by a method of the present disclosure or cleaned with a composition of the present disclosure), the method including exposing the previously cleaned surface, which is at a temperature of from 0°C to about 25°C, to moisture vapor, observing whether or not condensation occurs, and if fogging is present, determining that the surface is dirty, and if fogging does not occur or is not present more than 30 seconds after exposure to the moisture vapor, determining that the surface is clean.

The disclosure may also feature a method of determining the cleanliness of a previously cleaned substrate (e.g., one cleaned by a method of the present disclosure or cleaned with a composition of the present disclosure), the method including placing a mark with a permanent marker on the previously cleaned surface of the substrate, saturating the mark with water, wiping the mark with a paper towel, and determining whether or not at least 90 % of the mark has been washed away by the spray of

water, and if at least 90 % of the mark has been washed away by the spray of water, then determining that the surface is clean. In some embodiments, the method further includes determining that the surface is not clean if at least 50 % of the mark has not been washed away by the spray of water.

The disclosure may also feature a method of determining the cleanliness of a previously cleaned substrate (e.g., one cleaned by a method of the present disclosure or cleaned with a composition of the present disclosure), the method including placing a fingerprint of artificial sebum on the previously cleaned surface of the substrate, spraying the fingerprint and the substrate with a stream of deionized water at a flow rate of no greater than 600 milliliters per min for no greater than 30 seconds, and determining whether or not at least 50 % of the fingerprint has been washed away by the spray of water, if at least 50 % of the fingerprint has been washed away by the spray of water, then determining that the surface is clean, and if at least 50 % of the fingerprint has not been washed away by the spray of water, then determining that the surface is not clean.

In another aspect, there is provided a liquid multi-functional aqueous composition comprising: a hydrophilic silane selected from anionic silanes, sulfonated silanes, zwitterionic silanes, and combinations thereof; a surfactant; at least one of a water soluble alkali metal silicate, a polyalkoxy silane, and an inorganic silica sol; and water.

The disclosure may also feature a multi-functional solution that includes a first hydrophilic silane, surfactant, the ratio of the weight of the hydrophilic silane to the weight of the surfactant being at least 1:1, and water. In one embodiment, the solution further includes at least one of a water soluble alkali metal silicate and a polyalkoxy silane (such as a tetraalkoxysilane (e.g., TEOS), or a tetraalkoxysilane oligomer). In some embodiments, the solution further includes a second surfactant different from the first surfactant. In one embodiment, the solution further includes a second hydrophilic silane different from the first hydrophilic silane.

In another embodiment, the solution includes a water soluble alkali metal silicate comprising at least one of lithium silicate, sodium silicate, and potassium silicate.

In some embodiments, the solution passes Permanent Marker Removal Test Method I. In other embodiments, the solution passes Artificial Sebum Removal Test Method I. In some embodiments, the solution passes the Fog Test Method.

In another embodiment, the solution includes from at least 0.01 % by weight to no greater than 3 % by weight hydrophilic silane. In some embodiments, the solution includes no greater than 0.5 % by weight hydrophilic silane. In other embodiments, the solution includes no greater than 2 % by weight solids. In one embodiment, the solution includes no greater than 1 % by weight solids.

In some embodiments, the hydrophilic silane includes a zwitterionic silane. In other embodiments, the solution includes from about 0.01 % by weight to about 5 % by weight zwitterionic silane. In another embodiment, the solution includes from about 0.1 % by weight to about 2 % by weight zwitterionic silane.

In some embodiments, the surfactant includes at least one of anionic surfactant, nonionic surfactant, cationic surfactant, amphoteric betaine surfactant, amphoteric sultaine surfactant, amphoteric imidazoline surfactant, amine oxide surfactant, and quaternary cationic surfactant. In other embodiments, the first surfactant includes a nonionic surfactant and the second surfactant includes an anionic surfactant.

In some embodiments, the hydrophilic silane has a molecular weight up to 5000 grams per mole, or up to 3000 grams per mole. In some embodiments, the hydrophilic silane has a molecular weight no greater than 1000 grams per mole. In another embodiment, the hydrophilic silane has a molecular weight no greater than 500 grams per mole.

In one embodiment, the solution includes at least 60 % by weight water. This is typically for a ready-to-use formulation. In other embodiments, the composition includes no greater than 30 % by weight water. This is typically for a concentrated formulation.

In one aspect, there is provided a multi-functional aqueous composition comprising: a hydrophilic silane from anionic silanes, sulfonated silanes, zwitterionic silanes, and combinations thereof; at least two different surfactants; and water.

The disclosure may also feature a liquid multi-functional composition that includes a hydrophilic silane, a first surfactant, at least one of a water soluble alkali metal silicate and a polyalkoxy silane (such as a tetraalkoxysilane (e.g., TEOS), or a tetraalkoxysilane oligomer), and an inorganic silica sol, and water. In one embodiment, the hydrophilic silane includes a zwitterionic hydrophilic silane. In some embodiments, the hydrophilic silane is selected from the group consisting of zwitterionic silane, hydroxyl sulfonate silane, phosphonate silane, carboxylate silane, glucanamide silane, polyhydroxyl alkyl silane, hydroxyl polyethyleneoxide silanes, polyethyleneoxide silanes, and combinations thereof. In some embodiments, the composition passes Permanent Marker Removal Test Method I. In other embodiments, the composition passes Artificial Sebum Removal Test Method I. In another embodiment, the composition passes the Fog Test Method.

In other embodiments, the composition further includes water insoluble particles. In one embodiment, the composition further includes abrasive particles.

In some embodiments, the composition further includes a second surfactant different from the first surfactant.

The disclosure may also feature a multi-functional liquid composition that includes a hydrophilic silane, a first surfactant, a second surfactant different from the first surfactant, and water. In one embodiment, the hydrophilic silane is selected from the group consisting of zwitterionic silane, hydroxyl sulfonate silane, phosphonate silane, carboxylate silane, glucanamide silane, polyhydroxyl alkyl silane, hydroxyl polyethyleneoxide silane, polyethyleneoxide silane, and combinations thereof. In another embodiment, the composition passes Permanent Marker Removal Test Method I. In some embodiments, the composition passes Artificial Sebum Removal Test Method I. In other embodiments, the composition passes the Fog Test Method. In some embodiments, the composition further includes water insoluble particles. In one embodiment, the composition further includes abrasive particles.

The disclosure may also feature a method of using a multi-functional solution, the method includes diluting a concentrated solution with water to form a diluted solution, the concentrated solution comprising a first hydrophilic silane and surfactant where the ratio of the weight of the hydrophilic silane to the weight of the surfactant is at least 1:1, and contacting a siliceous surface with the diluted solution.

What is claimed is:

1. A multi-functional aqueous composition comprising:

a hydrophilic silane from anionic silanes, sulfonated silanes, zwitterionic silanes, and combinations thereof;

at least two different surfactants; and

water.

2. The multi-functional composition of claim 1 wherein the ratio of the total weight of the hydrophilic silane to the total weight of the surfactants is at least 1:2.

3. The multi-functional composition of claim 1 or 2 wherein the ratio of the total weight of the surfactants to the total weight of the hydrophilic silane is at least 1:2.

4. The multi-functional composition of any one of claims 1 through 3 further comprising at least one of a water soluble alkali metal silicate and a polyalkoxy silane.

5. The multi-functional composition of claim 4 comprising at least 0.0001 % by weight to no greater than 10 % by weight of at least one of a water soluble alkali metal silicate and a polyalkoxy silane.

6. The multi-functional composition of any one of claims 1 through 3 comprising 0.0001 % by weight to 10 % by weight hydrophilic silane and 0.03 % by weight to 0.4 % by weight surfactants.

7. The multi-functional composition of any one of claims 1 through 6 in a ready-to-use formulation.

8. The multi-functional composition of any one of claims 1 through 7 in a concentrated formulation.

9. The multi-functional composition of any one of claims 1 through 8 wherein the hydrophilic silane comprises a zwitterionic silane, and the at least two surfactants comprise a nonionic surfactant and an anionic surfactant.

10. The multi-functional composition of any one of claims 1 through 9 wherein the composition passes at least one of the following tests: Permanent Marker Removal Test Method I; Artificial Sebum Removal Test Method I; and Fog Test Method.

11. A liquid multi-functional aqueous composition comprising:

a hydrophilic silane selected from anionic silanes, sulfonated silanes, zwitterionic silanes, and combinations thereof;

a surfactant;

at least one of a water soluble alkali metal silicate, a polyalkoxy silane, and an inorganic silica sol; and

water.

12. The multi-functional composition of claim 11 wherein the ratio of the total weight of the hydrophilic silane to the total weight of the surfactants is at least 1:2.

13. The multi-functional composition of claim 11 wherein the ratio of the total weight of the surfactants to the total weight of the hydrophilic silane is at least 1:2.

14. A method of removing an unwanted constituent from a siliceous surface, the method comprising:

contacting the siliceous surface and the unwanted constituent with a multi-functional composition comprising water, a hydrophilic silane, and a surfactant; and

drying the surface;

wherein the hydrophilic silane is selected from anionic silanes, sulfonated silanes, zwitterionic silanes; and combinations thereof.

15. The method of claim 14 further comprising rubbing the composition on the surface.

16. The method of claim 14 or 15 further comprising providing a concentrated composition and diluting it with water to provide a multi-functional composition.

17. The method of any one of claims 14 through 16 wherein the ratio of the weight of the hydrophilic silane to the weight of the surfactant is at least 1:1.

18. The method of any one of claim 15 through 17 wherein the dried surface exhibits sufficient hydrophilicity such that at least one of the following is true:

at least 50 % of a mark placed on the surface with a permanent marker is wiped away from the surface within 50 wipes with a damp towel;

at least 50 % of a mark placed on the surface with a permanent marker is washed away from the surface within two minutes by a spray of water applied at a rate of 600 milliliters per minute; and

a fingerprint of artificial sebum placed on the dried surface is washed away from the surface within 2 minutes by a spray of water applied at a rate of 600 milliliters per minute.

19. The method of any one of claims 14 through 18 wherein when the dried surface is contacted with moisture vapor, no condensation occurs.

20. A method of cleaning and protecting a siliceous surface, the method comprising:

applying an aqueous composition to the surface, the composition comprising:

a hydrophilic silane selected from anionic silanes, sulfonated silanes, zwitterionic silanes, and combinations thereof;

a surfactant; and

water;

wherein the ratio of the total weight of the surfactant to the total weight of the hydrophilic silane is at least 1:2; and

rubbing the composition onto the surface to clean and protect the surface.

21. The multi-functional composition of any one of claims 1 through 13 wherein the hydrophilic silane comprises a sulfonate-functional zwitterionic silane.

22. The multi-functional composition of claim 21 wherein the sulfonate-functional zwitterionic silane has the following formula (I) or formula (II):

(R1O)p-Si(R2)q-W-N+(R3)(R4)-(CH2)m-SO3- (I)

or

(R1O)p-Si(R2)q-CH2CH2CH2-N+(CH3)2-(CH2)m-SO3- (II)

wherein:

each R1 is independently a hydrogen, methyl group, or ethyl group;

each R2 is independently a methyl group or an ethyl group;

each R3 and R4 is independently a saturated or unsaturated, straight chain, branched, or cyclic organic group, which may be joined together, optionally with atoms of the group W, to form a ring;

W is an organic linking group;

p and m are integers of from 1 to 3;

q is 0 or 1; and

p+q=3.

23. The multi-functional composition of any one of claims 4 through 13, 21, and 22 comprising lithium silicate.

24. The method of any one of claims 14 through 20 wherein the hydrophilic silane comprises a sulfonate-functional zwitterionic silane.

25. The method of claim 24 wherein the sulfonate-functional zwitterionic silanes has the following formula (I) or formula (II):

(R1O)p-Si(R2)q-W-N+(R3)(R4)-(CH2)m-SO3- (I)

or

(R1O)p-Si(R2)q-CH2CH2CH2-N+(CH3)2-(CH2)m-SO3- (II)

wherein:

each R1 is independently a hydrogen, methyl group, or ethyl group;

each R2 is independently a methyl group or an ethyl group;

each R3 and R4 is independently a saturated or unsaturated, straight chain, branched, or cyclic organic group, which may be joined together, optionally with atoms of the group W, to form a ring;

W is an organic linking group;

p and m are integers of from 1 to 3;

q is 0 or 1; and

p+q = 3.

26. The method of any one of claims 14 through 20 and claims 24 through 26 wherein the multi-functional composition comprises lithium silicate.