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 sulfonate-functional zwitterionic silane selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied; a surfactant selected to provide cleaning properties, wetting properties, or both to the composition; at least one of a water soluble alkali metal silicate, a polyalkoxy silane, and an inorganic silica sol; and water; wherein the liquid multi-functional aqueous composition is a hard surface cleaning and protecting composition.

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 selected from sulfonate-functional silanes, zwitterionic silanes, and combinations thereof, which are selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied; at least two different surfactants selected to provide cleaning properties, wetting properties, or both to the composition; and water; wherein the multi-functional aqueous composition is a hard surface cleaning and protecting composition.

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 selected from sulfonate-functional silanes, zwitterionic silanes, and combinations thereof, which are selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied;

at least two different surfactants selected to provide cleaning properties, wetting properties, or both to the composition; and

water;

wherein the multi-functional aqueous composition is a hard surface cleaning and protecting composition.

2. The multi-functional composition of claim 1 wherein the hydrophilic silane is selected from sulfonate-functional anionic silanes, sulfonate-functional zwitterionic silanes, and combinations thereof selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied.

3. The multi-functional composition of claim 2 wherein the hydrophilic silane is a sulfonate-functional zwitterionic silane selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied.

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 sulfonate-functional zwitterionic silane selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied;

a surfactant selected to provide cleaning properties, wetting properties, or both to the composition;

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

applying an aqueous composition to the surface, the composition of any one of claims 1 through 13 and claims 21 through 24; 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 10 wherein the hydrophilic silane comprises a sulfonate-functional zwitterionic silane selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied.

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

$$(R1O)p\text{-}Si(R2)q\text{-}W\text{-}N^{+}(R3)(R4)\text{-}(CH2)m\text{-}SO3^{-} \quad (I)$$

or

$$(R1O)p\text{-}Si(R2)q\text{-}CH2CH2CH2\text{-}N^{+}(CH3)2\text{-}(CH2)m\text{-}SO3^{-} \quad (II)$$

wherein:

each Rl 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 is an integer of from 1 to 3;

m is an integer of from 1 to 4;

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 selected to provide protectant properties to a substrate surface to which the multi-functional aqueous composition is applied.

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 Rl 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 is an integer of from 1 to 3;

m is an integer of from 1 to 4;

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.