[006] The disclosed anti-fogging zwitterionic-doped hydrogel compositions are directed to overcoming one or more of the problems set forth above and/or other problems of the prior art. In particular, the compositions disclosed herein have a high fogging resistance. In addition, when the composition is made into a coating it is mechanically durable, and not easily scratched, damaged, or fouled during use. Finally, in some embodiments, the composition can be made into a decal or film rendering them easy to apply, and remove, if necessary.

Summary

[007] In view of the foregoing, there is disclosed a composition for imparting anti-fog properties comprising a zwitterionic-doped hydrogel. In an aspect, there is provided a composition for forming a hydrogel that imparts anti-fog properties to the hydrogel, the composition comprising: charged monomers, at least a portion of which comprise zwitterionic monomers; and uncharged hydrophilic monomers, wherein the charged monomer and the uncharged hydrophilic monomers contain reactive groups, which react to form the hydrogel having anti-fog properties.

[008] In another aspect, there is provided an anti-fog material comprising a zwitterionic-doped hydrogel, the zwitterionic-doped hydrogel comprising: charged monomeric residues, at least a portion of which comprise zwitterionic monomeric residues; uncharged hydrophilic monomeric residues; and at least one crosslinking agent residue, wherein the anti-fog material exhibits Δ Haze values less than 5% when exposed to fog conditions.

[009] In yet another aspect, there is provided a coated article comprising: a substrate and an anti-fog coating, said anti-fog coating comprising: zwitterionic-doped hydrogel, the zwitterionic-doped hydrogel comprising: charged

monomeric residues, at least a portion of which comprise zwitterionic monomeric residues; uncharged hydrophilic monomeric residues; and at least one crosslinking agent residue.

[010] In another aspect, there is provided a method of making a surface of a substrate resistant to fogging, the method comprising: applying to the surface of the substrate a zwitterionic-doped hydrogel comprising: charged monomeric residues, at least a portion of which comprise zwitterionic monomeric residues; uncharged hydrophilic monomeric residues; and at least one crosslinking agent residue. Non-limiting examples of articles and surfaces that could benefit from the anti-fog material described herein include automotive or architectural windows, camera lenses, medical scope lenses, sensors, eye wear, mirror, refrigerator doors, or architectural structures.

[011] As described in more detail below, the various examples may include at least one additive that aids in resulting properties of the composition, hydrogel, article or method, such as an additive that aids adhesion, anti-freeze, crosslinking, film-forming, mechanical or rheological properties.

Brief Description of the Drawings

[012] The accompanying figures, which are incorporated in and constitute a part of this specification, illustrate several embodiments of the invention and together with the description, help explain the principles of the invention.

[013] **FIGS. 1A-1C** show the inventive coating swelling and sheeting water in a fogging environment. **FIG. 1A** depicts a substrate 130 with the inventive coating 120 in a fogging environment 110 laden with water vapor. **FIG. 1B** shows the inventive coating in a swelled state 140 having absorbed water from the environment

WHAT IS CLAIMED IS:

1. A composition for forming a hydrogel that imparts anti-fog properties to the hydrogel,

the composition comprising:

charged monomers, at least a portion of which comprise zwitterionic monomers; and

uncharged hydrophilic monomers,

wherein the charged monomer and the uncharged hydrophilic monomers contain reactive groups, which react to form said hydrogel having anti-fog properties.

2. The composition of claim 1, wherein the zwitterionic monomers comprise phosphorylcholines, carboxybetaines, and sulfobetaines, or combinations thereof

3. The composition of claim 2 wherein the zwitterionic monomers comprise N-(3-sulfopropyl)-N-(methacryloxyethyl)-N,N-dimethylammonium betaine, 2-Methacryloyloxyethyl phosphorylcholine, sulfobetaineacrylamide, or carboxybetaine methacrylate, or combinations thereof.

4. The composition of claim 1, wherein the concentration of zwitterionic monomer in the material is greater than 0% and less than 75% by weight.

5. The composition of claim 1, wherein the concentration of zwitterionic monomer in the material is greater than 0% and less than 50% by weight.

6. The composition of claim 1, wherein the concentration of zwitterionic monomer in the material is greater than 0% and less than 25% by weight.

7. The composition of claim 1, wherein the charged monomers further

comprise acrylates or methacrylates containing carboxylic acid, sulfonic acid, or quatenary amine functional groups.

8. The composition of claim 1, wherein the charged monomers exhibit hydrophilic properties at pH 2 to 9 or 0 M to 1 M sodium chloride solution.

9. The composition of claim 1, wherein the charged monomers have acidic functionality, basic functionality, or are the salt of a neutralized acid or base.

10. The composition of claim 1, wherein the uncharged hydrophilic monomers comprise vinylpyrrolidone, acrylamide, ethylene glycol containing acrylates or methacrylates, hydroxyethyl methacrylate, vinyl alcohol, vinyl acetate, diethylaminoethyl methacrylate, dimethylaminoethyl acrylate, or other acrylates or methacrylates bearing hydrophilic but uncharged moieties.

11. The composition of claim 1, further comprising at least one crosslinking agent.

12. The composition of claim 11, wherein the at least one crosslinking agent has vinyl groups capable of undergoing free radical polymerization.

13. The composition of claim 12, wherein the at least one crosslinking agent has vinyl groups capable of undergoing free radical polymerization comprise a multifunctional polyethylene glycol acrylate, or a hydrophilic urethane acrylate.

14. The composition of claim 11, wherein the at least one crosslinking agent has moieties that can react with carboxyl, alcohol, epoxy, carbonyl, or amine functional groups.

15. The composition of claim 14, wherein the moieties that can react with carboxyl, alcohol, epoxy, carbonyl, or amine functional groups comprise

carbodiimide, isocyanate, aziderines, oxazoline, amine, hydrazide, silane, epoxy, melamine, and other amino crosslinkers.

16. The composition of claim 1, further comprising at least one photoinitiator that comprises phosphine oxides, phenones, azo initiators, peroxides or benzoyls.

17. The composition of claim 16, wherein said phosphine oxides comprise 2,4,6-Trimethylbenzoyl-diphenyl phosphine oxide, said phenones comprise 2-hydroxy-2-methylpropiophenone or benzophenone, azobisisobutyronitrile, said peroxides comprise benzoyl peroxide, and said benzoyls comprise 2,2-dimethoxy-1,2-diphenyl-ethan-1-one.

18. The composition of claim 1, further comprising at least one additive that aids in adhesion, crosslinking, film-forming, anti-freeze, mechanical or rheological properties of the anti-fog material.

19. The composition of claim 18, wherein the at least one additive that aids in adhesion comprises (3-Aminopropyl)triethoxysilane or polyethylenimine.

20. The composition of claim 18, wherein the at least one additive that aids in anti-freeze properties comprises glycerol, ethylene glycol, propylene glycol, or polyethylene glycol.

21. The composition of claim 18, wherein the at least one additive that aids in mechanical properties comprises of at least one nanoparticle or polymer resin.

22. The composition of claim 21, wherein the at least one nanoparticle comprises silica nanoparticles, alumina nanoparticles, cellulose nanoparticles, or other mineral fillers

23. The composition of claim 21, wherein the at least one polymer resin comprises polyurethane, polyacrylate, polymethacrylate, polystyrene, polyethylene, polypropylene, paraffin wax, natural waxes, or combinations thereof.

24. The composition of claim 18, wherein the at least one additive that aids in film-forming comprises triton, tween, sodium dodecyl sulfate, or cetyl trimethylammonium bromide surfactants, dispersants, styrene maleic acid copolymers, leveling agents, or polyacrylates modified with silicones and/or polyethers.

25. The composition of claim 1, further comprising a carrier solvent comprising water, volatile alcohols, volatile ketones, volatile ethers, and volatile amines.

26. An anti-fog material comprising a zwitterionic-doped hydrogel, said zwitterionic-doped hydrogel comprising:

charged monomeric residues, at least a portion of which comprise zwitterionic monomeric residues;

uncharged hydrophilic monomeric residues; and

at least one crosslinking agent residue,

wherein the anti-fog material exhibits Δ Haze values less than 5% when exposed to fog conditions.

27. A coated article comprising:

a substrate and an anti-fog coating, said anti-fog coating comprising:

a zwitterionic-doped hydrogel, said zwitterionic-doped hydrogel comprising:

charged monomeric residues, at least a portion of which comprise zwitterionic monomeric residues;

uncharged hydrophilic monomeric residues; and

at least one crosslinking agent residue.

28. A method of making a surface of a substrate resistant to fogging, said method comprising:

applying to the surface of the substrate a zwitterionic-doped hydrogel comprising:

charged monomeric residues, at least a portion of which comprise zwitterionic monomeric residues;

uncharged hydrophilic monomeric residues; and

at least one crosslinking agent residue.