and spray-drying steps are performed in darkness. When exposed to visible light, the powder is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, sanitation, sterilization without release of detectable amounts of chlorine gas, chlorates and/or chlorites.

[0005a] In one aspect, the present disclosure provides a method of making a light-activated powder for providing solid-state controlled release of chlorine dioxide, the method comprising admixing a light-activated catalyst, a base, sodium chlorite, and water to form an aqueous suspension, the aqueous suspension including sodium chlorite of 85-99% purity; and spray-drying the suspension at an inlet temperature ranging from about 482 to about 537 °C (900 to 1000 °F) and an outlet temperature of not more than 143 °C (290 °F) to form a powder, wherein the powder does not include sources of moisture that could initiate chlorine dioxide release, the admixing and spray-drying steps are performed in darkness, and when exposed to visible light, the powder is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, without release of detectable amounts of chlorine gas, chlorates and/or chlorites.

[0006] The aqueous suspension may include sodium chlorite of 85-99% purity.

[0007] When exposed to visible light, the powder is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, sanitation, sterilization without release of detectable amounts of toxic by-products, such as chlorine gas and/or chlorite, chlorate.

[0008] The powder prepared by this method is capable of generating the solid-state controlled release of the chlorine dioxide from the powder without exposing the powder to moisture, relative humidity, or an acid releasing agent before or during the exposure of the powder to visible light. The acid releasing agent is either an acid, a substance that can be hydrolyzed to an acid (i.e., a substance that reacts with the water that diffuses into the powder to form an acid), or a mixture thereof. The hydronium ions resulting from acid hydrolysis, if present, would diffuse through the powder and react with chlorite anions to generate chlorine dioxide.

[0009] A light-activated powder is provided as a second aspect of the invention. The light-activated powder is prepared by the methods described in the

first aspect of the invention and in the examples. The powder, when exposed to visible light, is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, sanitation, sterilization without release of detectable amounts of toxic by-products, such as chlorine gas and/or chlorites, chlorates.

[0009a] In another aspect, the present disclosure provides a light-activated spray-dried powder comprising 50 wt.% to 99.99 wt. % of a photocatalyst, and 0.01 wt. % to 50 wt. % sodium chlorite of 85-99% purity, wherein the light-activated spray-dried powder does not include sources of moisture that could initiate chlorine dioxide release; when exposed to visible light, is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, without release of detectable amounts of chlorine gas, chlorates and/or chlorites, the powder being prepared by the method described herein.

[0009b] In yet another aspect, there is provided a film comprising the light activated powder described herein and a polymer.

[0010] Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Not applicable.

WHAT IS CLAIMED IS:

1. A method of making a light-activated powder for providing solid-state controlled release of chlorine dioxide, the method comprising:

admixing a light-activated catalyst, a base, sodium chlorite, and water to form an aqueous suspension, the aqueous suspension including sodium chlorite of 85-99% purity; and

spray-drying the suspension at an inlet temperature ranging from about 482 to about 537 °C (900 to 1000 °F) and an outlet temperature of not more than 143 °C (290 °F) to form a powder,

wherein:

the powder does not include sources of moisture that could initiate chlorine dioxide release,

the admixing and spray-drying steps are performed in darkness, and

when exposed to visible light, the powder is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, without release of detectable amounts of chlorine gas, chlorates and/or chlorites.

2. The method of claim 1, further comprising admixing a dispersing agent with the catalyst, the base, the sodium chlorite and the water to form the aqueous suspension, and the dispersing agent comprises a nonionic surfactant.

3. The method of claim 2, wherein the nonionic surfactant comprises a secondary alcohol ethoxylate, an alkylphenol ethoxylate, an alkyl ethoxylate, an alkyl aryl ethoxylate, a polyethylene oxide-polypropylene oxide block copolymer, a polyethylene glycol ether of a linear alcohol, a reaction product of a fatty acid with ethylene oxide and/or propylene oxide, polyvinyl alcohol, polyvinylpyrrolidone, a copolymer of polyvinyl alcohol and polyvinylpyrrolidone, a copolymer of (meth)acrylic acid and (meth)acrylic acid ester, or any combination thereof.

4. The method of any one of claims 1-3, wherein the pH of the aqueous suspension is from about 9 to about 14.

5. The method of any one of claims 1-3, wherein the pH of the aqueous suspension is from about 9 to about 11.

6. The method of any one of claims 1-5, wherein the aqueous suspension is an azeotrope, and:

the azeotrope in the aqueous suspension comprises acetone, acetonitrile, acrylonitrile, an alcohol, an alkenol, an alkane, an alkenal, a haloalkane, aniline, a cycloalkane, benzene, an alkylbenzene, a halobenzene, carbon disulfide, carbon tetrachloride, chloroform, epichlorohydrin, an alkylamine, a dialkylamine, an alkyl halide, an alkyl ether, an alkyl acetate, a haloalkene, an alkenyl chloride, toluene, or xylene; or

the azeotrope comprises acetone and one or more solvents comprising ethanol, methanol, isopropanol, tert-butanol, hexane, 2-methylpentane, dichloromethane, trichlorotrifluoroethane, nitromethane, cyclopentane, cyclohexane, carbon disulfide, carbon tetrachloride, chloroform, methyl iodide, ethyl iodide, isopropyl ether, methyl acetate, or trifluoroacetic acid.

7. The method of anyone of claims 1-6, further comprising admixing the powder with a desiccant.

8. The method of claim 7, wherein the desiccant comprises a silica, a silicate, a borosilicate, an aluminosilicate, a zeolite, sodium sulfide, or any combination thereof.

9. The method of any one of claims 1-8, wherein the catalyst comprises a metal oxide, a metal sulfide, a metal chalcogenide, a metal phosphide, a metal arsenide, a non-metallic semiconductor, a polymeric semiconductor, a photoactive homopoly anion, a photoactive heteropoly ion, or a combination thereof.

10. The method of claim 9, wherein the metal oxide comprises titanium dioxide, zinc oxide, tungsten trioxide, ruthenium dioxide, iridium dioxide, tin dioxide, strontium titanate, barium titanate, tantalum oxide, calcium titanate, iron (III) oxide, molybdenum trioxide, niobium pentoxide, indium trioxide, cadmium oxide, hafnium oxide, zirconium oxide, manganese dioxide, copper oxide, vanadium pentoxide, chromium trioxide, yttrium trioxide, silver oxide, or $Ti_xZr_{1-x}O_2$ wherein x is between 0 and 1; the metal sulfide comprises cadmium sulfide, zinc sulfide, indium sulfide, copper sulfide, tungsten disulfide, bismuth trisulfide, or zinc cadmium disulfide; the metal chalcogenide comprises zinc selenide, cadmium selenide, indium selenide, tungsten selenide, or cadmium telluride; the metal phosphide comprises indium phosphide; the metal arsenide comprises gallium arsenide; the non-metallic semiconductor comprises silicon, silicon carbide, diamond, germanium, germanium dioxide, or germanium telluride; the polymeric semiconductor comprises polyacetylene; the photoactive homopoly anion comprises $W_{10}O_{32}^{-4}$; and the photoactive heteropoly ion comprises $XM_{12}O_{40}^{-n}$ or $X_2M_{18}O_{62}^{-7}$ wherein x is Bi, Si, Ge, P or As, M is Mo or W, and n is an integer from 1 to 12.

11. The method of claim 10, wherein the metal oxide comprises titanium dioxide.

12. The method of claim 11, wherein the titanium dioxide comprises rutile titanium dioxide.

13. The method of any one of claims 1-12, wherein the powder comprises between about 50 wt. % and about 99.99 wt. % of the light-activated catalyst, and between about 0.01 wt. % and about 50 wt. % sodium chlorite.

14. The method of any one of claims 1-12, wherein the powder comprises between about 70 wt. % and about 97 wt. % of the light-activated catalyst, and between about 3 wt. % and about 30 wt. % sodium chlorite.

15. The method of any one of claims 1-12, wherein the powder comprises between about 80 wt. % and about 95 wt. % of the light-activated catalyst, and between about 5 wt. % and about 20 wt. % sodium chlorite.

16. The method of any one of claims 1-15, wherein the amount effective for disinfection ranges from about 0.08 ppm/minute to about 8.0 ppm/minute over a period of about 2 to about 72 hours.

17. The method of any one of claims 1-16, wherein the powder is capable of generating the solid-state controlled release of the chlorine dioxide from the powder without exposing the powder to moisture, relative humidity, or an acid before or during the exposure of the powder to visible light.

18. The method of any one of claims 1-17, wherein the admixing and/or spray drying steps are performed under an inert atmosphere.

19. A light-activated spray-dried powder comprising 50 wt.% to 99.99 wt. % of a photocatalyst, and 0.01 wt. % to 50 wt. % sodium chlorite of 85-99% purity, wherein:

the light-activated spray-dried powder does not include sources of moisture that could initiate chlorine dioxide release;

when exposed to visible light, is capable of generating the solid-state controlled release of chlorine dioxide from the powder in an amount effective for disinfection, without release of detectable amounts of chlorine gas, chlorates and/or chlorites;

the powder being prepared by the method of any one of claims 1-18.

20. A film comprising the light-activated powder of claim 19 and a polymer.