We Claim

1. An entrained polymer, the entrained polymer comprising:

(a) a base polymer selected from polypropylene, polyethylene, polyisoprene, polybutadiene, polybutene, polysiloxane, polycarbonate, polyamide, ethylene-vinyl acetate copolymer, ethylene-methacrylate copolymer, poly(vinyl chloride), polystyrene, polyester, polyanhydride, polyacrylonitrile, polysulfone, polyacrylic ester, polyurethane, polyacetal, or a copolymer or mixture thereof;

(b) a channeling agent selected from polyethylene glycol, ethylene-vinyl alcohol, polyvinyl alcohol, glycerin polyamine, polyurethane, polycarboxylic acid, propylene oxide polymerisate-monobutyl ether, propylene oxide polymerisate, ethylene-vinyl acetate, nylon 6, nylon 66, or a combination thereof,

wherein the entrained polymer features channels through the base polymer formed of the channeling agent; and

(c) a chlorine dioxide gas releasing agent comprising an alkaline chlorite, wherein release of the chlorine dioxide gas is activated by contact of the entrained polymer with moisture.

2. The entrained polymer of claim 1, comprising:

(a) 10-50% by weight of the base polymer,

(b) 2-10% by weight of the channeling agent, and

(c) 40-70% by weight of the chlorine dioxide gas releasing agent.

3. The entrained polymer of claim 1 or 2, wherein the base polymer comprises ethylene-vinyl acetate copolymer and the channeling agent comprises polyethylene glycol.

4. The entrained polymer of any one of claims 1-3, wherein the chlorine dioxide gas releasing agent further comprises a moisture trigger and/or a catalyst.

5. The entrained polymer of any one of claims 1-4 formed into a pellet, a plug, a liner, a film or a sheet.

6. The entrained polymer of claim 5, wherein the film has a thickness of from 0.1 mm to 1.0 mm.

7. The entrained polymer of any one of claims 1-6, wherein the entrained polymer is formed into a packaging material or is a component of a packaging material.

8. The entrained polymer of claim 7, provided as a cover, a lid or a lidding film or as a component of a cover, a lid or a lidding film.

9. The entrained polymer of claim 1, provided in the form of a flexible bag or as a component of a flexible bag.

10. The entrained polymer of any one of claims 1-9, wherein the entrained polymer and/or the chlorine dioxide releasing agent is coated with at least one extended release coating or layer to effectuate a pre-determined release profile of the chlorine dioxide gas.

11. A container comprising the entrained polymer as defined in of any one of claims 1 to 10.

12. The container of claim 11, the container being closable and having therein chlorine dioxide gas generated by the entrained polymer in contact with moisture.

13. The container of claim 11 or 12, wherein the container is a food package.

14. A method of inhibiting or preventing growth of or killing microbes on an object in the interior space of a closable container, the method comprising the steps of:

(a) placing the object into the container, with a headspace being formed within the interior space that is not occupied by the object;

(b) providing an entrained polymer as defined in any one of claims 1 to 9, and moisture as defined in claim 1, inside the container; closing the container; and

(c) contacting the entrained polymer with the moisture to activate formation of the chlorine dioxide gas in the headspace at a concentration sufficient to inhibit, prevent or kill microbes on the object.

15. The method of claim 14, wherein the entrained polymer forms a predetermined amount of chlorine dioxide gas in the headspace in a given period of time within the closed container that is from 10 PPM to 35 PPM for a period of 16 hours to 36 hours, or from 15

PPM to 30 PPM for a period of 16 hours to 36 hours, or from 15 PPM to 30 PPM for a period of about 24 hours, or from 8 PPM to 15 PPM for a period of 13 days.

16. The method of claim 14 or 15, wherein the chlorine dioxide gas sterilizes the object.

17. The method of claim 16, wherein the object to be sterilized is a medical device.

18. The method of claim 14, wherein the entrained polymer comprises 40-70% by weight of the chlorine dioxide gas releasing agent, the entrained polymer being the film having a thickness of from 0.1 mm to 1.0 mm.

19. A package for inhibiting or preventing growth of microbes and/or for killing microbes in a closed container having a product located therein, the package comprising:

a. a closed container defining an interior space therein;

b. a product provided within the interior space;

c. a headspace formed within a volume of the interior space that is not occupied by the product; and

d. an antimicrobial releasing agent disposed within the interior space, the antimicrobial releasing agent releasing chlorine dioxide gas into the headspace by reaction of moisture with the antimicrobial releasing agent,

wherein the antimicrobial releasing agent is provided in at least one entrained polymer article located within the interior space in contact with the moisture, the entrained polymer article comprising a monolithic material that comprises a base polymer, the antimicrobial releasing agent and a channeling agent; wherein the monolithic material features channels through the entrained polymer formed of the channeling agent. wherein the base polymer is a polypropylene, polyethylene, polyisoprene, polybutadiene, polybutene, polysiloxane, polycarbonate, polyamide, ethylene-vinyl acetate copolymer, ethylene-methacrylate copolymer, poly(vinyl chloride), polystyrene, polyester, polyanhydride, polyacrylonitrile, polysulfone,

polyacrylic ester, polyurethane, polyacetal, or a copolymer or mixture thereof, and wherein the channeling agent is a polyethylene glycol (PEG), ethylene-vinyl alcohol (EVOH), polyvinyl alcohol (PVOH), glycerin polyamine, polyurethane, polycarboxylic acid, propylene oxide polymerisate-monobutyl ether, propylene oxide polymerisate, ethylene-vinyl acetate, nylon 6, nylon 66, or a mixture thereof, and

wherein the releasing of chlorine dioxide gas is activated by contact of the entrained polymer with the moisture.

20. The package of claim 19, wherein the antimicrobial releasing agent is provided in an amount that releases the chlorine dioxide gas to provide a headspace concentration of from 10 parts per million (PPM) to 35 PPM for a period of 16 hours to 36 hours.

21. The package of claim 19 or 20, wherein at the time the product is provided within the interior space, the product is contaminated by at least one type of pathogen, the antimicrobial releasing agent providing a controlled release of chlorine dioxide gas to effectuate, after a span of 13 days from when the product is provided within the interior space and under storage conditions of 7° C, at least a 2 log base 10 reduction in colony forming units per gram (CFU/g) of the at least one type of pathogen.

22. The package of claim 21, wherein the at least one type of pathogen is selected from the group consisting of: Salmonella, E. Coli, Listeria and Geotrichum.

23. The package of any one of claims 19 to 22, wherein the product is a food product.

24. The package of claim 21 or 22, wherein the product is a food product and the amount of antimicrobial releasing agent and/or chlorine dioxide gas being present is an amount sufficient to effectuate the atleast 2 log base 10 reduction in CFU/g of the at least one type of pathogen, without causing organoleptic degradation of the food product.

25. The package of any one of claims 19 to 24, wherein the entrained polymer article is a film having a thickness of from 0.1 mm to 1.0 mm.

26. The package of any one of claims 19 to 25, wherein the container comprises a base and one or more sidewalls extending vertically from the base leading to a top opening and a cover that closes and/or seals the top opening to make the closed container.

27. The package of claim 26, wherein the entrained polymer article is the film disposed on at least one sidewall, the at least one sidewall having a sidewall midline that is equidistant from the base and the opening, the film having a film midline that is equidistant from a top edge and a bottom edge of the film, wherein the film midline is located at least as high as the sidewall midline.

28. The package of claim 27, wherein the film is positioned at a vertical height that is 80% to 100% of the total height of the sidewall measured from the bottom surface of the base.

29. The package of any one of claims 19 to 28, wherein the antimicrobial releasing agent is a powdered mixture comprising an alkaline metal chlorite, a catalyst, and a humidity trigger.

30. The package of claim 29, wherein the alkaline metal chlorite is sodium chlorite or potassium chlorite, the catalyst is sulfuric acid clay, and the humidity trigger is calcium chloride.

31. The package of any one of claims 19 to 30, wherein the entrained polymer article is coated with a polymer liner configured to control moisture uptake into the entrained polymer.

32. The package of any one of claims 19 to 31, wherein the base polymer is a polypropylene, polyethylene, polyisoprene, polybutadiene, polybutene, ethylene-vinyl acetate

copolymer, ethylene-methacrylate copolymer, poly(vinyl chloride), polystyrene, or a copolymer or mixture thereof.

33. The package of any one of claims 19 to 32, wherein the channeling agent is a polyethylene glycol (PEG), ethylene-vinyl alcohol (EVOH), polyvinyl alcohol (PVOH), or a mixture thereof.

34. A method for inhibiting or preventing the growth of microbes and/or for killing microbes in a closed container having a food product located therein, the method comprising:

a. providing the closed container defining an interior space therein;

b. providing the food product and moisture within the interior space;

c. providing a headspace formed within a volume of the interior space that is not occupied by the product; and

d. providing an antimicrobial releasing agent within the interior space that releases chlorine dioxide into the headspace by reaction of the moisture with the antimicrobial releasing agent, wherein the antimicrobial releasing agent is provided in an amount sufficient to release the chlorine dioxide gas to provide a desired headspace concentration of the chlorine dioxide gas over a predetermined amount of time;

wherein the antimicrobial releasing agent is provided in at least one entrained polymer article located within the interior space, the entrained polymer article comprising a monolithic material that comprises a base polymer, the antimicrobial releasing agent and a channeling agent, wherein the monolithic material features channels through the entrained polymer formed of the channeling agent, wherein the base polymer is a polypropylene, polyethylene, polyisoprene, polybutadiene, polybutene, polysiloxane, polycarbonate, polyamide, ethylene-vinyl acetate copolymer, ethylenemethacrylate copolymer, poly(vinyl chloride), polystyrene, polyester, polyanhydride, polyacrylonitrile, polysulfone, polyacrylic ester, polyurethane, polyacetal, or a copolymer or mixture thereof, and wherein the channeling agent is a polyethylene glycol (PEG), ethylene-vinyl alcohol (EVOH), polyvinyl alcohol (PVOH), glycerin polyamine, polyurethane,

polycarboxylic acid, propylene oxide polymerisate-monobutyl ether, propylene oxide polymerisate, ethylenevinyl acetate, nylon 6, nylon 66, or a mixture thereof;

wherein the release of the chlorine dioxide gas is activated by contact of the entrained polymer with the moisture, and

wherein if the product is contaminated by at least one type of pathogen at the time the product is provided within the interior space, the antimicrobial releasing agent providing a controlled release of chlorine dioxide gas to effectuate, after a span of 13 days under storage conditions of 7° C, at least a 2 log base 10 reduction in CFU/g of the at least one type of pathogen.

35. The method of claim 34, wherein the controlled release of the chlorine dioxide gas effectuates the reduction without causing organoleptic degradation of the food product.

36. The method of claim 34 or 35, wherein the antimicrobial releasing agent is a powdered mixture comprising an alkaline metal chlorite, a catalyst, and a humidity trigger.

37. The method of claim 36, wherein the alkaline metal chlorite is sodium chlorite or potassium chlorite, the catalyst is sulfuric acid clay, and the humidity trigger is calcium chloride.

38. The method of any one of claims 34 to 37, wherein the antimicrobial releasing agent releases chlorine dioxide gas into the headspace by reaction of the moisture with the antimicrobial releasing agent, wherein the antimicrobial releasing agent is provided in an amount sufficient to release chlorine dioxide gas to provide a headspace concentration of from 10 parts per million (PPM) to 35 PPM for a period of 16 hours to 36 hours, or from 15 PPM to 30 PPM for a period of 16 hours to 36 hours.

39. The method of any one of claims 34 to 38, wherein the food product is sliced, diced or cut and is selected from the group consisting of: tomatoes, washed peppers, washed onions, water melon, honey dew, cantaloupe, strawberries, peaches, pineapple, oranges, seafood, meat and poultry, or wherein the food product is whole or minimally processed produce selected from the group consisting of: broccoli, brussel sprouts, cabbage, cucumbers, bananas, herbs, whole peppers, carrots, root vegetables and potatoes.

40. The method of any one of claims 34 to 37 and claim 39, wherein the antimicrobial releasing agent releases chlorine dioxide gas into the headspace by reaction of the moisture with the antimicrobial releasing agent, wherein the antimicrobial releasing agent is provided in an amount sufficient to release the chlorine dioxide gas to provide a headspace concentration of from 8 PPM to 15 PPM for a period of 13 days.

41. The method of any one of claims 34 to 40, wherein the at least one type of pathogen is selected from the group consisting of: Salmonella, E. Coli, Listeria and Geotrichum.

42. The method of any one of claims 34-41, wherein the base polymer is a polypropylene, polyethylene, polyisoprene, polybutadiene, polybutene, ethylene-vinyl acetate copolymer, ethylene-methacrylate copolymer, poly(vinyl chloride), polystyrene, or a copolymer or mixture thereof.

43. The method of any one of claims 34-42, wherein the channeling agent is a polyethylene glycol (PEG), ethylene-vinyl alcohol (EVOH), polyvinyl alcohol (PVOH), or a mixture thereof.