ABSTRACT

A flame resistant textile is provided. The textile is a sateen weave fabric containing cellulosic fibers, where the sateen weave fabric has a thickness of at least 19.5 mils, a thickness of at least 25 mils after 3 home washes at 120°F, an air permeability of at least 60 cfm, and a weight of less than about 7 oz/yd^2. The sateen weave fabric also contains a treatment, where the treatment contains a tetramethylhydroxy phosphonium salt or its condensate and chemical selected from the group consisting of urea, guanidines, guanyl urea, glycoluril, and polyamines. When the sateen weave fabric to which the treatment has been applied has been heat-cured and oxidized at least a portion of the cellulosic fibers have a pentavalent phosphate compound polymerized therein. The method for producing the flame resistant textile is also provided.

We claim:

1. A flame resistant textile comprising:

a sateen weave fabric comprising cellulosic fibers, wherein the sateen weave fabric has an as received thickness of at least 19.5 mils, a thickness of at least 25 mils after 3 home washes at 120°F, an air permeability of at least 60 cfm, and a weight of less than about 7 oz/yd^2;

a treatment applied to the sateen weave fabric, wherein the treatment comprises a tetramethylhydroxy phosphonium salt or its condensate and a chemical selected from the group consisting of urea, NH_3, guanidines, guanyl urea, glycoluril, and polyamines;

such that, when the sateen weave fabric to which the treatment has been applied has been heat-cured and oxidized at least a portion of the cellulosic fibers have a pentavalent phosphate compound polymerized therein.

2. The flame resistant textile of claim 1, wherein the flame resistant textile meets the HRC 2 protection level requirements according to NFPA 70E / ASTM F 1506 and also meets the requirements of NFPA 2112 as tested in accordance with ASTM F 1930.

3. The flame resistant textile of claim 1, wherein the sateen weave fabric further comprises thermoplastic synthetic fibers.

4. The flame resistant textile of claim 3, wherein the sateen weave fabric comprises between about 70-100% by weight cellulosic fibers and between about 0 and 30% by weight thermoplastic synthetic fibers.

5. The flame resistant textile of claim 1, wherein the sateen woven fabric has a weight of less than 6.5 oz/yd^2.

6. The flame resistant textile of claim 1, wherein the treatment comprises tetrahydroxymethyl phosphonium salt or its condensate, urea, and a cationic softening agent.

7. The flame resistant textile of claim 1, wherein the pentavalent phosphate compound includes amide linking groups.

8. The flame resistant textile of claim 1, wherein the pentavalent phosphate compound includes amine linking groups.

9. The flame resistant textile of claim 1, further comprising a hydrazide compound at an amount not less than about 0.5% by weight of the fabric.

10. The flame resistant textile of claim 9, wherein the hydrazide compound is a chemical selected from the group consisting of carbohydrazide, semicarbohydrazide, adipic hydrazide, oxalic hydrazide, maleic hydrazide, halo-substituted benoic hydrazide, benzhydrazide, hydroxybenoic hydrazide, dihydroxybenzoic hydrazide, aminobenzoic hydrazide, alkyl substituted benzoic hydrazide, acethydrazide, caprylic hydrazide, decanoic hydrazide, hexanoic hydrazide, malonic hydrazide, formic hydrazide, oxamic acid hydrazide, toluenesulfonyl hydrazide, propionic acid hydrazide, salicyloyl hydrazide, and thiosemicarbohydrazide.

11. The flame resistant textile of claim 9, wherein the hydrazide comprises carbohydrazide.

12. The flame resistant textile of claim 9, wherein the fabric has a releasable formaldehyde content of 100 ppm or less tested according to AATCC Test Method 112.

13. The method of forming a flame resistant textile comprising:

a) providing a sateen weave fabric, the fabric comprising a first plurality of yarns in a first direction and a second plurality of yarns in a second direction substantially perpendicular to the first direction, wherein the fabric comprises cellulosic fibers;

b) applying to the fabric a treatment, the treatment comprising tetrakis (hydroxymethyl) phosphonium salt or its condensate and a chemical selected from the group consisting of urea, NH_3, guanidines, guanyl urea, glycoluril, and polyamines;

c) curing the treatment on the fabric by subjecting the fabric to temperatures from about 130 °C to about 190 °C;

d) immersing the cured fabric in a peroxide bath to oxidize the phosphorous compound into a pentavalent phosphate compound within the cellulosic fibers;

e) subjecting the fabric to a mechanical treatment, wherein after the mechanical treatment the sateen weave fabric has a thickness of at least 19.5 mils, an air permeability of at least 60 cfm, and a weight of less than about 7 oz/yd^2.

14. The method of claim 13, wherein the flame resistant textile pass meets the HRC 2 protection level requirements according to NFPA 70E / ASTM F 1506 and NFPA 2112 as tested in accordance with ASTM F 1930.

15. The method of claim 13, wherein the sateen weave fabric further comprises thermoplastic synthetic fibers.

16. The method of claim 13, wherein the sateen woven fabric has a weight of less than 6.5 oz/yd^2.

17. The method of claim 13, wherein the pentavalent phosphate compound includes amide linking groups.

18. The method of claim 13, further comprising applying a solution or dispersion of hydrazide compound to the fabric and drying the fabric such that the fabric temperature does not reach above about 300°F.

19. The method of claim 18, wherein the solution or dispersion further comprising a buffer compound and the pH of the fabric after drying is between about 4 and 8.

20. A method of forming a flame resistant and electric arc protective textile comprising:

a) providing a sateen weave fabric, the fabric comprising a first plurality of yarns in a first direction and a second plurality of yarns in a second direction substantially perpendicular to the first direction, wherein the fabric comprises cellulosic fibers;
b) applying to the fabric a treatment, the treatment comprising tetrakis (hydroxymethyl) phosphonium salt or its condensate with a chemical selected from the group consisting of urea, NH_3, guanidines, guanyl urea, glycoluril, and polyamines;
c) subsequently drying the fabric at a temperature less than about 270°F to a fabric moisture content between about 10% and 20% by weight;
d) placing the dried fabric in an atmosphere comprising ammonia gas to cause reaction between the ammonia and the salt or precondensate to form an insoluble product;
e) immersing the fabric in step d) in a peroxide bath to oxidize the phosphorous compound into a pentavalent phosphate compound within the cellulosic fibers, and;
f) subjecting the fabric to a mechanical treatment, wherein after the mechanical treatment the sateen weave fabric has a thickness of at least 19.5 mils, an air permeability of at least 60 cfm, and a weight of less than about 7 oz/yd^2.

21. The method of claim 20, wherein the pentavalent phosphate compound includes amine linking groups.

22. The method of claim 20, wherein the flame resistant textile pass meets the HRC 2 protection level requirements according to NFPA 70E / ASTM F 1506 and NFPA 2112 as tested in accordance with ASTM F 1930.

23. The method of claim 20, wherein the sateen weave fabric further comprises thermoplastic synthetic fibers.

24. The method of claim 20, wherein the sateen woven fabric has a weight of less than 6.5 oz/yd^2.

25. A flame resistant textile comprising:
(a) a textile substrate comprising cellulosic fibers;
(b) a finish applied to the textile substrate, the finish comprising:
    (i) a tetramethylhydroxy phosphonium salt or its condensate; and
    (ii) a chemical selected from the group consisting of urea, guanidines, guanyl urea, glycoluril, polyamines, and mixtures thereof;

wherein, when the textile substrate to which the finish has been applied has been heat-cured and oxidized, the cellulosic fibers have a pentavalent phosphate compound polymerized therein, the pentavalent phosphate compound comprising amide linking groups; and

(c) a hydrazide compound applied to the textile substrate.

26. The flame resistant textile of claim 25, wherein the hydrazide compound is a chemical selected from the group consisting of carbohydrazide, semicarbohydrazide, adipic hydrazide, oxalic hydrazide, maleic hydrazide, halo-substituted benzoic hydrazide, benzhydrazide, hydroxybenzoic hydrazide, dihydroxybenzoic hydrazide, aminobenzoic hydrazide, alkyl substituted benzoic hydrazide, acethydrazide, caprylic hydrazide, decanoic hydrazide, hexanoic hydrazide, malonic hydrazide, formic hydrazide, oxamic acid hydrazide, toluenesulfonyl hydrazide, propionic acid hydrazide, salicyloyl hydrazide, and thiosemicarbohydrazide.

27. The flame resistant textile of claim 26, wherein the hydrazide comprises carbohydrazide.

28. The flame resistant textile of claim 26, wherein the hydrazide compound is applied to the textile substrate in an amount not less than about 0.5% by weight of the fabric.

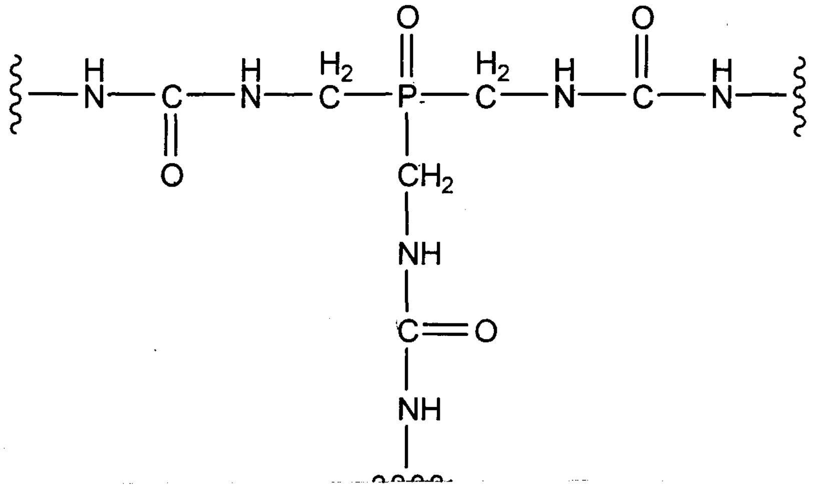
29. A flame resistant textile comprising:

(a) a textile substrate comprising cellulosic fibers;

(b) a finish applied to the textile substrate, the finish comprising a phosphorous-containing compound, the phosphorous-containing compound comprising a plurality of pentavalent phosphine oxide groups having amide linking groups covalently bonded thereto, at least a portion of the pentavalent phosphine oxide groups having three amide linking groups covalently bonded thereto; and

(c) a hydrazide compound applied to the textile substrate.

30. The flame resistant textile of claim 29, wherein at least a portion of the pentavalent phosphine oxide groups conform to the following structure:



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