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(54) **FLAME-RETARDANT FIBER COMPOSITE AND FABRIC PRODUCED THEREFROM**

(57) The present invention relates to a flame resistant fiber composite obtained by compounding:

20 to 85% by weight of a fiber (A) containing 0.5 to 50 parts by weight of an Sb compound to 100 parts by weight of a polymer containing halogen atom of not less than 17% by weight; 5 to 80% by weight of a heat-resistant fiber (B); 0 to 40% by weight of a

cellulosic fiber (C); and 0 to 40% by weight of an inflammable fiber (D). Use of the composite in furniture, beddings, etc. in house increasingly improves flame resistance of materials, enabling use in fields requiring advanced flame resistance.

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Description

[0001] The present invention relates to an inexpensive and advanced flame resistant fiber composite for furniture and beddings that can solve difficult problems for conventional flame resistant fiber composites, that is, improved flame resistance of bedding products; further improved processability and bulkiness; and satisfactory processability, touch, feeling, and sensuousness, and to a fabric produced using the flame resistant fiber composite.

BACKGROUND ART

[0002] Flame resistance is preferably given to materials used for furniture, beddings, etc. in a house for prevention of fire. Since flammable materials, such as cotton and urethane foams, are used for comfort in use of furniture or beddings, prevention of flaming to the flammable materials over a long period of time is important for fire prevention. In addition, the flame retardant materials to be used must not impair comfort or sensuousness of the furniture or beddings in use. Although various flame resistant fibers and flame retardants have so far been examined, materials fully having these advanced flame resistance and requirements for materials for furniture and beddings have not yet been realized.

[0003] A technique of coating of flame retardants to cotton cloths, that is, what is called "additional processing flame retardation" is now being used, but there are problems, such as in uniformity of application of flame retardants, hardening of cloth by means of application, omission by washing, and safety of health. In addition, although it is known that fabrics including fibers obtained using high polymers comprising copolymerized halogen has outstanding sensuousness and flame resistance, they continue burning in the case of power burner combustion and cannot maintain the structure thereof, and as a result, they give inadequate fire-resistant performance for preventing flaming to cotton and urethane foams that are used for the above-mentioned beddings and furniture.

[0004] Although cloths obtained from the heat-resistant fibers have outstanding flame resistance, they have only poor power for preventing combustion of other non-flame resistant natural fibers and chemical fibers, and therefore materials obtained from those materials having been compounded only demonstrate inadequate flame resistance. Inevitably, there arise problems that extremely expensive materials made only from heat-resistant fibers can be used. In addition, heat-resistant fibers have problems of difficulty in production of colored patterns having high sensuousness resulting from problems of unsatisfactory processability at the time of filament opening, poor moisture absorptivity, or feeling and poor dye affinity.

[0005] Japanese Patent Laid-Open No. 61-89339 proposes a flame resistant fiber composite obtained by combination of an advanced flame resistant halogen containing fiber comprising flame retardants added in large quantities, and a non-flame resistant other fiber, as materials for improving the previously described disadvantages in furniture and materials for beddings, and materials having touch, outstanding moisture absorptivity, and outstanding feeling needed as general characteristics, and also having stable flame resistance. Furthermore, Japanese Patent Laid-Open No. 8-218259 describes that the technique can provide an advanced flame resistant fiber composite having outstanding touch and outstanding moisture absorptivity, and advanced flame resistance by means of mixing of a small amount of a heat-resistant fiber, that is, of mixing of halogen atom and Sb compounds containing fiber that can be used for work uniform usage, and cotton, etc. However, this technique has following problems as a flame resistant fiber composite: difficulty in processing in manufacturing of nonwoven fabrics, and inadequate bulkiness in a quilting process when using as a nonwoven fabric, in order to prevent flaming to urethanes used for furniture or bedding products; problems in sensuousness caused by poor feeling of gloss and poor coloring property resulting from inclusion of fibers comprising a large quantity of added flame retardant; and inadequate fire-resistant performance for preventing flaming to cotton and urethane foams used for the above-mentioned beddings and furniture, in prolonged exposure to intense flame, while having self-extinguishing property in case of a source of fire being kept away.

SUMMARY OF THE INVENTION

[0006] The present invention aims at improving difficult problems for conventional flame resistant fiber composites to solve, that is, flame resistance of bedding products, and at obtaining inexpensive and advanced flame resistant fiber composites used for furniture and beddings, having more improved processability and bulkiness that found in conventional products, satisfactory touch and feeling, and sensuousness.

[0007] As a result of wholehearted investigation performed by the present inventors for solving the problems, it was found out that a flame resistant fiber composite having outstanding sensuousness, touch, and feeling, and flame resistance of durability over prolonged flaming might be obtained using a fiber composite obtained by mixing a fiber consisting of a chlorine containing polymer, and an inflammable fiber comprising other cellulosic fibers, to a heat-resistant fiber having poor ability for preventing combustion of other inflammable fibers. In addition, it was also found out that problems of processability or price as problems in independent use of heat-resistant fibers might also be improvable, leading to completion of the present invention.

[0008] That is, the present invention relates to a flame resistant fiber composite obtained by compounding so as to give 100 % by weight of a total amount of (A) to (D): 20 to 85 % by weight of a fiber (A) containing 0.5 to 50 parts by weight of an Sb compound to 100 parts by weight of a polymer containing halogen atom of not less than 17% by weight; 5 to 80 % by weight of a heat-resistant fiber (B); 0 to 40 % by weight of a cellulosic fiber (C) ; and 0 to 40 % by weight of an inflammable fiber (D), such as chemical fiber. In addition, the present invention also relates to a flame resistant fiber composite, wherein the polymer containing halogen atom of the fiber (A) is a copolymer comprising 30 to 70 % by weight of acrylonitrile, 70 to 30 % by weight of a halogen atom containing vinyl based monomer, and 0 to 10 % by weight of a vinyl monomer copolymerizable therewith; the heat-resistant fiber (B) is a fiber selected from silicic acid containing cellulosic fibers, aramid fibers, and melamine fibers; the cellulosic fiber (C) is a fiber without flame retarding treatment selected from cotton, hemp, acetate based fibers, and rayon based fibers; and the inflammable fiber (D), such as a chemical fiber, is at least one kind of fiber in polyester fibers and nylon fibers.

[0009] In the above-described composite, for touch or moisture absorptivity, preferable is a flame resistant fiber composite consisting of: 85 to 20 % by weight of the fiber (A) containing 6 to 50 parts by weight of an Sb compound to 100 parts by weight of the polymer containing halogen atom of not less than 17% by weight; 15 to 80 % by weight of a silicic acid containing cellulosic fiber as the heat-resistant fiber (B); and 0 to 40 % by weight of one or more kinds of chemical fibers as the inflammable fiber (D), such as a chemical fiber, wherein the flame resistant fiber composite is compounded so as to give contents of each fiber of (A) $\geq$ (D) or (B) $\geq$ (D), or a flame resistant fiber composite obtained by compounding 85 to 20 % by weight of a fiber (A) containing 6 to 50 parts by weight of an Sb compound to 100 parts by weight of the polymer containing halogen atom of not less than 17% by weight; 5 to 40 % by weight of the heat-resistant fiber (B); 5 to 40 % by weight of the cellulosic fiber (C); and 5 to 40 % by weight of a polyester fiber as the inflammable fiber (D), such as a chemical fiber. Moreover, for touch or sensuousness, preferable is a flame resistant fiber composite consisting of: 30 to 70 % by weight of a fiber, as the fiber (A), containing 0.5 to 5.5 parts by weight of Sb to 100 parts by weight of a polymer containing chlorine atom of not less than 25% by weight; 10 to 50 % by weight of the heat-resistant fiber (B); 5 to 40 % by weight the cellulosic fiber (C) ; and 0 to 30 % by weight of the inflammable fiber (D), such as a chemical fiber, wherein contents of fibers (A) to (D) satisfy relationships of (1) (A) $\geq$ (D) ; (2) (A) + (D) is 50 to 90% by weight; and (3) (C) + (D) is 30 to 60 % by weight.

[0010] Furthermore, the present invention relates to a fabric and nonwoven fabric produced using the flame resistant fiber composite.

[0011] In a flame resistant fiber composite of the present invention, as the fiber (A), used is a fiber containing 0.5 to 50 parts of an Sb compound to a polymer containing halogen atom of not less than 17%, and used is a fiber containing 0.5 to 5.5 parts by weight of an Sb compound to a polymer, as one example, containing chlorine atom of not less than 25% by weight.

[0012] A lower limit value of a halogen atom content in the polymer containing halogen atom of not less than 17% is preferably 20%, and more preferably 26%, and an upper limit value is preferably 86% more preferably 73%, and especially preferably 48%. A halogen content of less than 17% disadvantageously gives difficulty in rendering the fiber flame resistant. A lower limit of chlorine content in the polymer containing chlorine atom of not less than 25% by weight is preferably 26%, and an upper limit value is preferably 73 % by weight, and especially preferably 48 to 58% by weight. A chlorine content of less than 25% by weight disadvantageously gives difficulty in rendering a fiber composite with inflammable fibers flame resistant.

[0013] The above-mentioned polymer containing halogen atom of not less than 17% includes, for example, but not limited to, polymers of monomers containing halogen; copolymers of the monomers containing halogen and monomers containing no halogen; mixtures of polymers containing halogen and polymers containing no halogen; or halogen containing polymer with halogen introduced during or after polymerization of monomers or polymers containing no halogen.

[0014] Examples of such a polymer containing halogen atom of not less than 17% include, for example, but not limited to: homopolymers of halogen atom containing vinyl based monomers, such as vinyl chloride, vinylidene chloride, vinyl bromide, and vinylidene bromide, or copolymers of two or more kinds thereof; copolymers of halogen atom containing vinyl based monomers and acrylonitrile, such as, acrylonitrile-vinyl chloride, acrylonitrile-vinylidene chloride, acrylonitrile-vinyl bromide, acrylonitrile-vinyl chloride-vinylidene chloride, acrylonitrile-vinyl chloride-vinyl bromide, acrylonitrile-vinylidene chloride-vinyl bromide; copolymers of one or more kinds of vinyl monomers including halogen, such as vinyl chloride, vinylidene chloride, vinyl bromide, and vinylidene bromide, and vinyl monomers copolymerizable with acrylonitrile and the vinyl monomers including halogen; polymers obtained by adding or polymerizing halogen containing compounds in acrylonitrile homopolymers; halogen containing polyesters etc. In addition, the above-mentioned homopolymers and copolymers may be used in an appropriate combination.

[0015] Examples of the copolymerizable vinyl monomer include, for example: acrylic acid, and esters thereof; methacrylic acid, and esters thereof; acrylamide; methacryl amide; vinyl acetate; vinyl sulfonic acid, and salts thereof; methallyl sulfonic acid, and salts thereof; styrene sulfonic acid, and salts thereof; 2-acrylamide-2-methylsulfonic acid, and salts thereof. These may be used independently or two kinds or more may be used in combination.

[0016] When the polymer containing halogen atom of not less than 17% is a polymer consisting of 30 to 70% of

acrylonitrile, 70 to 30% of a halogen containing vinyl based monomer, and 0 to 10% of a vinyl monomer copolymerizable therewith, and preferably consisting of 40 to 60% of acrylonitrile, 60 to 40% of a halogen containing vinyl based monomer, and 0 to 10% of a vinyl monomer copolymerizable therewith, a fiber obtained advantageously has excellent touch as found in acrylic fibers, while having desired performances (strength, flame resistance, dye affinity, etc.). In addition, when at least one kind of the copolymerizable vinyl monomer is a sulfonic group containing vinyl monomer, dye affinity advantageously improves.

[0017] Examples of a copolymer containing units originated from the halogen containing vinyl based monomer and acrylonitrile include, for example, a copolymer consisting of 50 parts of vinyl chloride, 49 parts of acrylonitrile, and 1 part of sodium styrene sulfonate; a copolymer consisting of 43.5 parts of vinylidene chloride, 55 parts of acrylonitrile, and 1.5 parts of sodium styrene sulfonate; a copolymer consisting of 41 parts of vinylidene chloride, 56 parts of acrylonitrile, and 3 parts of sodium 2-acrylamide-2-methylsulfonate etc.

[0018] Sb compounds used for the present invention are used as flame retardants, and examples of the compounds include, for example, but not limited to, inorganic antimony compounds, such as, antimony oxides (Sb_2O_3 , Sb_2O_4 , Sb_2O_5 , etc.), antimononic acid and salts thereof, antimony oxychloride etc. These may be used independently and may be used in combination of two or more kinds.

[0019] Moreover, a particle diameter of the Sb compound is preferably uniformly adjusted to give not more than 2 micrometers, in order to avoid troubles, such as nozzle clogging on a process for producing a fiber obtained by adding the Sb compound to a halogen containing polymer, and to improve strength of the fiber, etc.

[0020] A percentage of the Sb compound to 100 parts by weight of the polymer containing halogen atom of not less than 17% by weight is 6 to 50 parts, preferably 8 to 40 parts, and more preferably 10 to 30 parts. In the case where the amount is less than 6 parts, for obtaining flame resistance necessary as a flame resistant fiber composite, a mixing percentage, in the flame resistant fiber composite, of a fiber (A) (hereinafter referred to as fiber (A)) having the Sb compound contained in the polymer containing halogen atom of not less than 17% is necessarily increased. In this case, however, characteristics other than the flame resistance as a flame resistant fiber composite, for example, excellent performances, such as touch, moisture absorptivity, and feeling, may be hard to be obtained. When the amount exceeding 50%, on the other hand, induces nozzle clogging at the process of fiber manufacturing, and impair of physical properties of the fibers (strength, elongation, etc.), leading to disadvantageous problems in respect of manufacturing, and quality of the fiber highly rendered flame resistant.

[0021] In the present invention, as long as an amount of the Sb compound to the polymer containing halogen atom of not less than 17% is maintained to 6 to 50 parts, a combination with other flame retardants may be used.

[0022] As other flame retardants usable in combination with the Sb compounds, for example, include aromatic halogenated compounds, such as hexabromobenzene; aliphatic halogenated compounds, such as chloroparaffins; halogen-containing phosphorus compounds, such as tris(2,3-dichloropropyl) phosphate; inorganic phosphorus compounds, such as ammonium polyphosphate; inorganic magnesium compounds, such as MgO , $\text{Mg}(\text{OH})_2$, and MgCO_3 ; and inorganic tin compounds, such as stannic oxide, stannic oxy-halides, stannous hydroxide, ZnSnO_3 , and $\text{ZnSn}(\text{OH})_6$ etc. An amount of the other flame retardants used preferably is not less than 1 part and not more than 10 parts to 100 parts by weight of the polymer containing halogen atom of not less than 17% by weight. In addition, a total amount of the flame retardant is not more than 50 parts to the polymer containing halogen atom of not less than 17%, and preferably not more than 40 parts, in consideration of troubles on manufacturing process of the fiber and avoidance of physical properties impair as strength reduction of fiber etc.

[0023] Sb compounds used for the polymer containing chlorine atom of not less than 25% by weight in the fiber (A) is not especially limited. For improvement of flame resistance, as the above-mentioned flame retardants, preferable are publicly known antimony oxides (Sb_2O_3 , Sb_2O_4 , Sb_2O_5 , etc.); antimononic acid and salts thereof; inorganic antimony compounds, such as antimony oxychloride; inorganic magnesium compounds, such as MgO , $\text{Mg}(\text{OH})_2$, and MgCO_3 ; and inorganic tin compounds, such as stannic oxide, stannic oxy-halides, and stannous hydroxide. In order to give gloss, or coloring property in dyeing, and flame resistance to fibers the compound having a particle diameter uniformly adjusted to not more than 2 micrometers is independently included, or in combination of two or more kinds thereof in an amount of 0.5 to 5.5 parts by weight. For gloss or coloring property, the content is preferably 0.5 to 3.5 parts by weight.

[0024] The fiber (A) containing 0.5 to 50 parts of the Sb compound to the polymer containing halogen atom of not less than 17% may be used in either form of staple fiber, or filament, and in case of processing in compounded form with the heat-resistant fiber (B), the cellulosic fiber (C), and the inflammable fiber (D), such as chemical fiber, which are used for the present invention, fibers having similar property to fibers to be compounded are preferably selected. In accordance with heat-resistant fibers, natural fibers and chemical fibers to be used for textiles usage, the staple fiber preferably has a size of a fiber of 1.7 to 3.3 dtex, and a cut length of approximately 38 to 64 mm. However, in order to obtain a flame resistant fiber composite with bulkiness or stiffness for usage of nonwoven fabrics etc., the staple fiber preferably has a size of a fiber of 7.8 dtex to 12 dtex, and a cut length of approximately 51 to 102 mm.

[0025] The heat-resistant fiber (B) (hereinafter referred to as fiber (B)) used for the present invention is a component is for formation of a backbone structure for maintenance of a shape of the flame resistant fiber composite in burning of

the inflammable component in the flame resistant fiber composite. When the heat-resistant fiber (B) has a melting point, the melting point is not less than 350 degrees C, and when it does not have a melting point, the heat-resistant fiber (B) is a fiber having heat-resisting property with a decomposition temperature of not less than 300 degrees C.

[0026] As examples of the fiber (B) include, for example, the fibers obtained from aromatic polyamides, melamine, polyamidoimides, poly benzimidazoles, etc., silicic acid containing fibers, phenolic fibers, carbon fibers, etc. and the fiber (B) may be used independently and two or more kinds may be used in combination.

[0027] Examples of the aromatic polyamide fiber include, for example, para-aromatic polyamide fibers having a degradation starting temperature of not less than 450 degrees C (for example, Kevlar manufactured by E. I. du Pont de Nemours & Co.), Technora manufactured by Teijin, Ltd., Twaron manufactured by Teijin Twaron B.V. etc.; meta aromatic polyamide fibers having a decomposition temperature of about 550 degrees C (for example, Nomex manufactured by E. I. du Pont de Nemours & Co.), Conex manufactured by Teijin, Ltd., and Apyeil manufactured by Unitika, Ltd. etc. Examples of the melamine fibers, for example, include a melamine fiber Basofil having a degradation starting temperature of approximately 370 degrees C manufactured by Basofil Fibers etc.

In addition, examples of the polyamidoimide fibers include a polyamidoimide fiber (for example, Kermel manufactured by Rhone Poulenc) having a degradation starting temperature of approximately 380 degrees C etc. Furthermore, examples of the poly benzimidazole fibers include a poly benzimidazole fiber (for example, PBI manufactured by Celanese etc.) having a degradation starting temperature of approximately 450 degrees C. Examples of the phenolic fibers include novoloid fibers (for example, Kynol manufactured by Kynol com. etc.) having a degradation starting temperature of approximately 370 degrees C. Examples of the silicic acid containing cellulosic fibers include, for example, Visil containing approximately 30% of silicic acid manufactured by SATERI INTERNATIONAL.

The silicic acid containing cellulosic fiber used for the present invention is a component used for improvement of flame resistance and maintenance of strength of fabrics of the flame resistant fiber composite, and is a component effective for formation of carbonized films in combustion while giving outstanding comfortable properties, such as touch and moisture absorptivity. The fiber is cellulose fibers containing 20 to 50% of silicic acid therein, and usually has a size of a fiber of about 1.7 to 8 dtex, and a cut length of approximately 38 to 128 mm.

[0028] The cellulosic fiber (C) used for the present invention (hereinafter referred to as fiber (C)) is a component for giving outstanding comfortable properties, such as touch and moisture absorptivity, to the flame resistant fiber composite of the present invention. Furthermore, the fiber (C) is a component for carbonizing, and forms carbonized materials hardly being decomposed by high temperatures in the flame resistant fiber composite, in combustion together with the polymer containing halogen atom (A).

[0029] Examples of the fiber (C) include fibers, such as cotton, hemp, acetate fibers, and rayon, and these may be used independently and two or more kinds may be used in combination.

[0030] Examples of the inflammable fiber (D), such as a chemical fibers (hereinafter referred to as fiber (D)) include synthetic fibers, such as semi-synthetic fibers, such as promix, polyester fibers, nylon fibers, acrylic fibers etc., and these may be used independently and two or more kinds may be used in combination. Fusible fibers, such as the polyester fibers and nylon fibers, are preferable among them. Polyester fibers and nylon fibers form fused materials in combustion, and the fused material covers the flame resistant fiber composite, and increases strength of the carbonized film formed from the flame resistant fiber composite. Thereby the polyester fibers and nylon fibers can advantageously attain fire-resistant performance for preventing flaming to the cotton and urethane foam to be used for beddings or furniture, also in the case where the flame resistant fiber composite is exposed to intense flame for a prolonged period of time. The reason is believed that the fused material formed by these fibers in combustion process permeates into the flame resistant fiber composite to fill openings between fibers, and to strengthen structures thereof. Polyester fibers have a high softening point and a high melting point, and improve still more preferably the heat-resisting property of the flame resistant fiber composite among them.

Furthermore, polyester fibers have low cost and strong stiffness; this strong stiffness may easily give bulkiness when processed into nonwoven fabrics, resulting in excellent sensuousness when processed into quilted products. For example, the polyester fibers advantageously can give excellent looks, bulkiness, touch, etc. after finished into beds mats, bed pads, etc.

[0031] In the present invention, 100 % by weight of the flame resistant fiber composite of the present invention are produced from: 85 to 20 parts of the fiber (A) ; 15 to 80 % by weight of a silicic acid containing cellulosic fiber as the fiber (B); and 0 to 40 % by weight of the fiber (D) in case of 2 to 3 component system according to claim 8. A blending ratio of the above-described fibers may be determined according to quality, such as water absorptivity, touch, moisture absorptivity, feeling, sensuousness, product strength, washing resistance, and durability, as well as flame resistance necessary for final products produced from the flame resistant fiber composite obtained. In general, the component fibers are compounded so as to give 100 % by weight of a sum total of: 85 to 20 % by weight of the fiber (A), and preferably 75 to 25 % by weight ; 15 to 80 % by weight of the silicic acid containing cellulose fiber, and preferably 20 to 70 % by weight ; and 0 to 40 % by weight of the fiber (D), and preferably 5 to 35 % by weight.

[0032] An amount of the fiber (A) less than 20 % by weight gives unsatisfactory flame resistance to the flame resistant

fiber composite obtained. On the other hand, an amount exceeding 80 % by weight gives outstanding flame resistance, but decreases a ratio of the silicic acid containing cellulose fiber as the fiber (B), resulting in insufficient fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame.

[0033] In addition, an amount of the fiber (D) exceeding 40 % by weight relatively decreases amounts of the fiber (A) and the fiber (B), and gives inadequate flame resistance.

[0034] In addition, an amount of the silicic acid containing cellulose fiber as the fiber (B) of less than 15 % by weight, impairs fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame. On the other hand, an amount exceeding 80 % by weight decreases a percentage of the fiber (A) to give inadequate flame resistance.

[0035] Reasons for the flame resistant fiber composite of the present invention to show excellent flame resistance is probably that combustion suppression effect of halogenated Sb compounds formed by the fiber (A), and formation effect of carbonized films of a composite by the silicic acid containing cellulose fiber as the fiber (B) are synergistically demonstrated during combustion, and that furthermore, the fiber (D) fuses in combustion and covers the flame resistant fiber composite to make more stable carbonized films formed from the flame resistant fiber composite, providing fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame. Thereby, flame resistance excellent greater than expectation may be demonstrated.

[0036] Although the silicic acid containing cellulose fiber as the fiber (B) is originally a fiber that cannot easily flame, it has poor ability for rendering other inflammable fiber flame resistant. Therefore, rendering the fiber (D) flame resistant by means of compounding of the fiber (B) and the fiber (D) will not be successful. Prominent effect may be obtained only by compounding fibers as in the present invention.

[0037] In the present invention, 100 % by weight of the flame resistant fiber composite of the present invention are produced from: 80 to 20 % by weight of the fiber (A); 5 to 40 % by weight of the fiber (B); 5 to 40 % by weight of the fiber (C); 5 to 40 % by weight of a polyester fiber as the fiber (D) in case of 4 component system according to claim 11. A blending ratio of the above-mentioned fibers may be determined according to quality, such as water absorptivity, touch, moisture absorptivity, feeling, sensuousness, product strength, washing resistance, and durability, as well as flame resistance necessary for final products produced from the flame resistant fiber composite obtained. The component fibers are compounded to give 100 % by weight of a sum total of: 80 to 20 % by weight of the fiber (A), and preferably 60 to 30 % by weight; 5 to 40 % by weight of the fiber (B), and preferably 10 to 35 % by weight; 5 to 40 % by weight of the fiber (C), and preferably 10 to 35 % by weight; and 5 to 40 % by weight of a polyester fiber as the fiber (D), and preferably 10 to 35 % by weight.

[0038] An amount of the fiber (A) less than 20 % by weight gives unsatisfactory flame resistance to the flame resistant fiber composite obtained. On the other hand, an amount exceeding 80 % by weight gives outstanding flame resistance, but decreases a percentage of the fiber (B) and the fiber (C), resulting in insufficient fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame.

[0039] In addition, an amount of the polyester fiber as the fiber (D) of less than 5 % by weight gives unsatisfactory processability, bulkiness, touch, feeling, etc., and an amount exceeding 40 % by weight relatively decreases amounts of the fiber (A), the fiber (B), and the fiber (C), and gives inadequate flame resistance.

[0040] An amount of the fiber (B) of less than 5 % by weight impairs fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame, demonstrating inadequate improvement in flame resistant effect. On the other hand, an amount exceeding 40 % by weight gives only flame resistant fiber composite having poor processability, touch, and sensuousness as a disadvantage of heat-resistant fibers.

[0041] Furthermore, an amount of a cellulosic fiber as the fiber (D) of less than 5 % by weight gives unsatisfactory water absorptivity, touch, dissatisfied moisture absorptivity, feeling, etc., and moreover cannot give sufficient improvement effect in flame resistance by means of carbonized film formation. On the other hand, an amount exceeding 40 % by weight relatively decreases an amount of the fiber (A) and the fiber (B), and impairs fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame, resulting in inadequate flame resistance.

[0042] Reasons for the flame resistant fiber composite of the present invention to show excellent flame resistance is probably that combustion suppression effect of halogenated Sb compounds formed by the fiber (A), carbonized film formation effect of the composite by the fiber (B), and carbonized film formation effect by carbonization in concurrent combustion of the fiber (C) and the fiber (A) are synergistically demonstrated during combustion, and that furthermore, a polyester fiber as the fiber (D) fuses in combustion and covers the flame resistant fiber composite to make more stable carbonized films formed from the flame resistant fiber composite, providing fire-resistant performance for preventing flaming to cotton and urethane foams to be used for beddings or furniture in prolonged exposure to intense flame. Thereby, flame resistance excellent greater than expectation may be demonstrated.

[0043] Although the fiber (B) is originally a fiber that cannot easily flame, it has poor ability for rendering other inflammable fiber flame resistant. Therefore, rendering the fiber (D), and the fiber (D) flame resistant by means of compounding only of the fiber (B) and fiber (D) or compounding only of the fiber (B) and the fiber (C) will not be successful. Prominent effect may be obtained only by compounding fibers as described in the present invention.

[0044] In the present invention, in case of 2 to 4 component system according to Claim 12, a flame resistant fiber composite of the present invention is produced to give 100 % by weight of a sum total of: 30 to 80 % by weight of the fiber (A) containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A) ; 10 to 50 % by weight of fiber (B); 5 to 40 % by weight of fiber (C) ; and 0 to 30 % by weight of fiber (D), and to satisfy relationships of contents of each fiber in the flame resistant fiber composite of (A) $\geq$ (C), and (A) + (C) to be 50 to 90 % by weight, and (B) + (C) to be 30 to 60 % by weight. A blending ratio of the above-mentioned fibers may be determined according to quality, such as sensuousness, water absorptivity, touch, moisture absorptivity, feeling, product strength, washing resistance, and durability, as well as flame resistance necessary for final products produced from the flame resistant fiber composite obtained.

In general, the component fibers are compounded to give a sum total of 100 % by weight of: 30 to 80 % by weight of a fiber containing 0.5 to 5.5 parts by weight of Sb compound to a polymer containing chlorine of not less than 25% by weight as fiber (A), and preferably 35 to 55 % by weight; 10 to 50 % by weight of the fiber (B), and preferably 15 to 45 % by weight; 5 to 40 % by weight of the fiber (C), and preferably 10 to 35 % by weight; and 0 to 30 % by weight of fiber (D), and preferably 0 to 25 % by weight, more preferably 0 to 15 % by weight, and to satisfy relationships of contents of each fiber in the flame resistant fiber composite of (A) $\geq$ (C) and (A) + (C) to be 50 to 90 % by weight, and (B) + (C) to be 30 to 60 % by weight.

[0045] An amount of less than 30 % by weight of a fiber containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A) only gives inadequate ability for preventing combustion of the fiber (C) and the fiber (D), resulting in unsatisfactory flame resistance of the flame resistant fiber composite to be obtained. On the other hand, an amount exceeding 80 % by weight gives excellent flame resistance of the flame resistant fiber composite itself, but relatively decreases a component for forming a skeleton to maintain a shape in the flame resistant fiber composite in combustion. As a result, for example, performance for preventing flaming to flammable materials, such as urethane foams used for chairs or mattress, and touch, moisture absorptivity, etc. will be unsatisfactory.

[0046] In order to prevent combustion of the fiber (C) and the fiber (D), an amount of the fiber containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A) is preferably 40 to 80 % by weight.

[0047] In addition, an amount of the fiber (B) of less than 10 % by weight cannot give sufficient fire-resistant effect having durability to flame for a long time. On the other hand, an amount exceeding 50 % by weight gives the flame resistant fiber composite with only unsatisfactory touch and sensuousness as a disadvantage of usual heat-resistant fibers.

[0048] An amount of the fiber (C) of less than 5 % by weight gives inadequate amount of component for forming carbonized materials, while giving unsatisfactory touch, moisture absorptivity, etc., leading to insufficient fire-resistant effect having durability to flame for a long time. On the other hand, an amount exceeding 40 % by weight increases inflammable components in the flame resistant fiber composite, resulting in inadequate flame resistance. An amount of less than 55 % by weight of a total amount of a fiber containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A), and of the fiber (B) needs an amount of the fiber (C) of preferably 30 to 40 % by weight, in order to form a sufficient amount of carbonized materials in the flame resistant fiber composite in combustion.

[0049] Furthermore an amount of the fiber (D) exceeding 30 parts by weight also increases inflammable components in the flame resistant fiber composite, and impairs flame resistance.

[0050] In addition, an amount of the fiber containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A) is smaller than that of the fiber (C) in the flame resistant fiber composite, inadequate amount of formation of carbonized materials occurs, leading to decrease in fire-resistant effect with durability to flaming for a long time.

[0051] In addition, when a total amount of the fiber containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A), and an amount of fiber (C) is less than 50 % by weight in the flame resistant fiber composite, shortage of components forming carbonized materials does not allow sufficient demonstration of fire-resistant effect with durability to flaming for a long time, resulting in inadequate touch. On the other hand, the above-mentioned amount exceeding 90 % by weight gives inadequate amount of the fiber (B), leading to insufficient flame resistant effect. Furthermore, when a total amount of the fiber (B) and an amount of the fiber (C) is less than 30 % by weight, an amount of components for maintaining a structure in the flame resistant fiber composite in combustion is decreased, leading to inadequate fire-resistant effect. On the other hand, an amount exceeding 60 % by weight relatively decreases, to a total amount of the fiber (B) and amount of fiber (C), a percentage of the fiber

containing 0.5 to 5.5 parts by weight the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A), and does not allow sufficient formation of structures having durability to flaming for a long time.

[0052] Reasons for demonstration of excellent flame resistance in the flame resistant fiber composite of the present invention are considered as follows. When, during combustion, the flame resistant fiber composite is heated and reaches temperature conditions causing combustion, a fiber containing 0.5 to 5.5 parts by weight of the Sb compound to a polymer containing chlorine of not less than 25% by weight as the fiber (A) will discharge active chlorine radical and hydrogen chloride to catch the active radical that derives chain reactions of combustion of the flame resistant fiber composite. There will synergistically be demonstrated the above-described combustion suppression effect for cutting combustion chain reactions, subsequent acceleration of dehydration carbonization, forming carbonized materials with difficulty in decomposition even at elevated temperatures by the fiber (c) and also improved effects of heat-resistance in the composite by the fiber(B). Thereby, flame resistance excellent greater than expectation may be demonstrated.

[0053] Although the fiber (B) is a fiber that originally cannot easily flame, it has poor ability to give flame resistance to the other fiber (C), and therefore compounding of the fiber (B) with the fiber (C) may not give flame resistance to the fiber (C). And therefore, remarkable effect of rendering other fibers flame resistant will be obtained only by compounding of the fibers as described in the present invention.

[0054] Furthermore, use of at least one kind of fusible fibers, such as polyester fibers and nylon fibers as the fiber (D) will make fused materials formed in combustion process permeate into the flame resistant fiber composite, and fill space between fibers to form a firm structure. Thereby flame resistance of the flame resistant fiber composite will be improved. In addition, use of antimony oxide in the fiber containing 0.5 to 5.5 parts by weight of the Sb compound to the polymer containing chlorine of not less than 25% by weight as the fiber (A) will make chlorine compounds react with antimony oxide at high temperatures to form volatile antimony chloride, and the volatile antimony chloride will stay in the reaction system for a long time, and will work as an effective active radical scavenger because of heavier property than of air.

[0055] A flame resistant fiber composite of the present invention may be obtained by compounding of the above-described fiber (A), (B), (C), and (D), and may be in forms of fabrics, such as textiles, knittings, and nonwoven fabrics; assembled items of fibers, such as slivers and webs; yarn-like materials, such as spun yarns, ply yarns, twisted yarns; and string-like materials, such as knit strings and plaited cords.

[0056] The above-described "compounding" means a process for obtaining fabrics etc. including each fiber at predetermined ratios, by mixing of fiber (A), (B), (C), and (D) using various methods, and also means combining each fiber and yarn in stages of blending, spinning, twisting, weaving and knitting.

[0057] A flame resistant fiber composite of the present invention may include antistatic agents, agents for prevention of coloring by heat, light resistance improvers, whiteness improver, matting inhibitors, etc. if necessary.

[0058] Thus obtained flame resistant fiber composite of the present invention has desired flame resistance, and has characteristics excellent in touch, feeling, moisture absorptivity, sensuousness, etc.

[0059] When the above-mentioned fibers (A), (B), (C), and (D) are in a shape of staple fibers, a flame resistant fiber composite of the present invention may be manufactured in following methods by: spinning after blending of the fibers; manufacturing yarns and sliver and subsequent twisting thereof; wrapping of two kinds of spun yarns around one kind of the sliver; and wrapping of one kind of the spun yarn around a sliver obtained by blending two kinds. The composite may be manufactured by combination of the methods.

[0060] And when the above-mentioned fibers (A), (B), (C), and (D) are in a form of filament, a flame resistant fiber composite of the present invention may be manufactured in following methods by: twisting of each filament; twisting of two kinds of filaments around one kind of filament, respectively; twisting of one kind of filament to a filament obtained by twisting of two kinds of filaments; and twisting of a filament obtained by twisting of two kinds of filaments to one kind of filament. The composite may be manufactured by combination of the methods.

[0061] Furthermore, when a part in the above-mentioned fibers (A), (B), (C), and (D) is in a form of a staple fiber, and remainder is in a form of a filament, the composite may be manufactured in a method that a component of a staple fiber is blended with other component fiber(s) to obtain a spun yarn, and the spun yarn may be twisted with other component filament(s).

[0062] When a fabric is manufactured using the flame resistant fiber composite of the present invention, the fabrics has characteristics, such as outstanding flame resistance, touch, feeling, moisture absorptivity, sensuousness, etc. originated in the flame resistant fiber composite of the present invention.

[0063] The above-described "fabric" comprises textiles, knittings, nonwoven fabrics, and strings, and the "fabric" may be advantageously used not only in garments, such as fire-resistant work uniforms, but in interior designed products, such as curtains and carpets, beddings, such as sheets, blankets, bed mats, and bed pads etc. and moreover in applications that need general fiber characteristics and advanced flame resistance and also that need excellent touch, moisture absorptivity, feeling, and sensuousness.

[0064] Special methods are not necessary for manufacturing these fabrics, and conventional processes generally used may be used without any special techniques.

BEST MODE FOR CARRYING-OUT OF THE INVENTION

[0065] The present invention will, hereinafter, be described in more detail, with reference to Examples, but the present invention is not limited only to the Examples. The fibers were measured for flame resistance in Examples as follows in a form of a nonwoven fabric.

(Preparation of a nonwoven fabric for combustion test)

(1) Sample nonwoven fabric

[0066] Sample nonwoven fabric with a weight of 200 g/m² and a dimension of 30 cm length and 45 cm width was prepared by needle punch method using a fiber mixed at a predetermined percentage.

(2) Nonwoven fabric for coverings

[0067] Sample polyester nonwoven fabric for coverings with a weight of 200 g/m² and a dimension of 30 cm length and 45 cm width was prepared by needle punch method using a fiber mixed at a predetermined percentage in a same manner.

(Preparation of a sample for combustion test)

[0068] A simple mattress was made and was used as a sample for combustion test. The sample nonwoven fabric (1) was layered on the polyester nonwoven fabric for covering (2), and a textile fabric made of a polyester (weight 120 g/m²) as a surface fabric was further layered on the above-described layered fabrics to obtain a three-layered structure. The three-layered structure obtained was quilted using a cotton thread, and furthermore was fixed onto a polyurethane foam (Type 360S by Toyo Tire & Rubber CO. LTD.) having a dimension with 30 cm of a length, 45 cm of a width, and 7.5 cm of a thickness, and a density of 22 kg/m³, using staplers.

(Combustion test method)

(1) Burner shape

[0069] The burner head has a shape of character of T, and the burner head was made by a stainless steel having an outside diameter of 1.27 cm, and a thickness of 0.0889 cm. A portion of a bar of a character of T has a length of 30.48 cm, an uppermost surface for the bar part of character of T has 34 openings (perforation out of which gas comes) of 1.2 mm in a diameter at equal intervals.

(2) Combustion test method

[0070] A sample for combustion test was disposed so as to show an upper surface side of a three-layered structure. The burner head was disposed in a center of the sample, and in parallel to a longitudinal direction of the sample, when observed in an upper surface of the sample, so that a face of perforation to blow out flame might give a height of 42 mm in an upper part of the sample, and that a horizontal bar of character of T might horizontally extend, and a vertical bar might extend in a vertical and upper direction. As combustion gas, propane (99% or more of purity) was used, and conditions for gas pressure of 0.11 MPa, a gas mass flow of 12.9 L/min, and a flaming period 70 seconds were adopted. Existence of firing to urethane foam at this time, a state of the sample nonwoven fabric, and combustion of surface fabric were evaluated. A case where the urethane foam did not have firing at this time was evaluated as A, and a case having firing as C. In a state of carbonized films of a sample nonwoven fabric, a case where the carbonized films of the sample nonwoven fabric did not have penetrated perforations, and a case where it did not have cracks were evaluated as A, and a case where it had perforations and cracks was evaluated as C after termination of the combustion test. In combustion of a surface fabric, a case where self-extinguishing occurred promptly within 30 seconds was evaluated as A after termination of flaming by a burner, and a case where combustion continued as C. In flame resistant evaluation, a case where A was given for all of the three items was evaluated as A, and a case where one or more items of C were given was evaluated as C.

(Sensual evaluation result)

(Bulkiness of sample nonwoven fabric)

[0071] In order to evaluate processability of the flame resistant fiber composite nonwoven fabric, sensual evaluation was performed about voluminous touch of fabrics in quilting process.

[0072] Evaluation was performed by visual method, and a level where a front fabric in quilting process had voluminous touch preferable as a nonwoven fabric for beddings was evaluated as A (for example, a nonwoven fabric using polyester fibers), a level suitable for use as B, a level inferior to B was evaluated as C (for example, a nonwoven fabric using rayon fibers.)

(Evaluation method of characteristic of a cellulose fiber)

[0073] Examined was by sensual evaluation whether a flame resistant fiber composite had characteristic (visual appreciation, feeling) as a cellulosic fiber. Evaluation A shows that the flame resistant fiber composite has characteristics (visual appreciation, feeling) of cellulosic fiber, and evaluation C shows that the flame resistant fiber composite does not have them.

(Evaluation method of whiteness of a sample nonwoven fabric)

[0074] In order to evaluate sensuousness of nonwoven fabric of a flame resistant fiber composite, whiteness of the sample nonwoven fabric was evaluated by sensual method. Sensuous evaluation was performed based on visual viewpoint, and a level suitable for use in usage of upholstered furniture surface fabrics, where gloss and coloring property were required, was evaluated as A, and an unsuitable level as C.

(Evaluation method of touch)

[0075] Sensual evaluation was performed about touch and feeling, especially feeling of dry touch, of a flame resistant fiber composite nonwoven fabric. Evaluation was performed in a manner that a preferable level or usable level in usage of a front side of upholstered furniture was evaluated as A (for example, nonwoven fabric using polyester fiber), and a level inferior to the above-mentioned level was evaluated as C (for example, nonwoven fabric using melamine fiber.)

(Evaluation method of sensuousness (feeling of gloss, coloring property))

[0076] In order to evaluate sensuousness of a flame resistant fiber composite nonwoven fabric, sensual evaluation was performed, respectively about feeling of gloss, and coloring property after dyeing of the sample nonwoven fabric. Sensuous evaluation was carried out from visual viewpoint. In gloss, a level suitable for use in front fabric usage of upholstered furniture was evaluated as A, and an unsuitable level was evaluated as C. In coloring property, a level suitable for use to coloring property needed in front fabric usage of upholstered furniture was evaluated as A, and an unsuitable level was evaluated as C. Dyeing was performed under following conditions: cationic dyestuffs (Maxilon Yellow 2RL 0.55% omf, Maxilon Red GRL 0.25% omf, Maxilon Blue GRL 0.30% omf: all manufactured by Ciba-Geigy), acetic acid, sodium acetate, and anionic dispersant 2%omf (LevenolWX: manufactured by Kao Corp.) as an auxiliary agent, an accelerating agent 0.4% omf (sodium lauryl sulfate), liquor ratio 1 : 2.5, and boiled at normal pressure for 1-hour. After dyeing, the sample was dehydrated by a centrifugal dehydrator, and dried at ordinary temperature to obtain a nonwoven fabric having dark brown hue.

(Manufacturing Example 1)

[0077] A copolymer comprising 51% by weight of acrylonitrile, 48% by weight of vinylidene chloride, and 1% by weight of p-sodium styrene sulfonate was dissolved so that a resin concentration might give 30% by weight into dimethylformamide. Antimony trioxide 15 parts was added to 100 parts of a resin weight of the obtained resin solution to obtain a spinning solution.

[0078] The antimony trioxide had a particle diameter uniformly adjusted to not more than 2 micrometers, and was beforehand adjusted so that it might disperse uniformly in a diluting resin solution.

[0079] A spinning solution including antimony trioxide was extruded into an dimethylformamide aqueous solution with a concentration of 50% by weight, using a nozzle having a diameter of nozzle hole of 0.08 mm, and a number of holes of 300 holes. The obtained fiber was dried at 120 degrees C after washing with water, subsequently, after drawing at 3 times, heat treatment was given at 145 degrees C for 5 minutes to obtain a fiber (A).

[0080] A chlorine content of the obtained fiber gave 35.1% by weight to a weight of a chlorine containing copolymer. A staple fiber having a size of a fiber of 2.2 dtex, a strength of 2.5 cN/dtex, an elongation ratio of 40%, and a cut length of 51 mm was obtained.

(Manufacturing Example 2)

[0081] A copolymer comprising 56% by weight of acrylonitrile, 41% by weight of vinylidene chloride, and 3% by weight of sodium 2-acrylamide-2-methylpropanesulfonate was dissolved into dimethylformamide so that a resin concentration might give 20% by weight. Antimony trioxide was added into the obtained resin solution to give a spinning solution. Table 1 shows amounts of addition of antimony trioxide.

[0082] The antimony trioxide had a particle diameter uniformly adjusted to not more than 2 micrometers, and was beforehand adjusted so that it might disperse uniformly in a diluting resin solution.

[0083] A spinning solution including antimony trioxide was extruded into an dimethylformamide aqueous solution with a concentration of 50% by weight using a nozzle having a diameter of nozzle hole of 0.08 mm, and a number of holes of 300 holes. The obtained fiber was dried at 120 degrees C after washing with water, and subsequently, after drawing at 3 times, heat treatment was given at 145 degrees C for 5 minutes to obtain a fiber (A).

[0084] A chlorine content of the obtained fiber gave 30.0% by weight to a weight of a chlorine containing copolymer. A staple fiber having a size of a fiber of 2.2 dtex, strength of 2.9 cN/dtex, an elongation ratio of 38%, and a cut length of 51 mm was obtained.

(Examples 1 to 7 and Comparative Examples 1 to 14)

[0085] Blended at percentages shown in Table 1 were the Fiber (A) obtained by Manufacturing Example 1; Basofil of a melamine fiber (having a distribution of a size of a fiber of approximately 1 to 3.5 dtex, and distribution of 20 to 200 mm of cut length, manufactured by Basofil Fibers), Visil as a silicon containing cellulosic fiber (1.7 dtex, 40 mm of a cut length, manufactured by SATERI INTERNATIONAL), and Technora (1.7 dtex, 38 mm of a cut length, manufactured by Teijin Ltd.) of a para-aromatic polyamide fiber as the fiber (B); a rayon (1.5 dtex, 38 mm of a cut length) as the cellulosic fiber (C); and a polyester fiber (6.6 dtex, 51 mm of a cut length) as the fiber (D), and sample nonwoven fabrics were manufactured. These samples were used for combustion test. Table 2 shows evaluation results.

Table1

Example number	Blending ratio in a flame resistant fiber composite (% by weight)					
	Fiber (A)	Fiber (B)			Fiber (C)	Fiber (D)
		Melamine fiber	Silicic acid containing cellulose fiber	Aromatic polyamide fiber		
1	55	15	0	0	15	15
2	45	15	0	0	15	25
3	35	35	0	0	15	15
4	35	15	0	0	35	15
5	35	15	0	0	15	35
6	35	0	15	0	15	35
7	35	0	0	15	15	35
Comparative Example 1	100	0	0	0	0	0
" 2	0	0	0	0	0	100
" 3	0	100	0	0	0	0
" 4	0	0	0	0	100	0
" 5	50	0	0	0	0	50
" 6	50	0	0	0	50	0
" 7	0	50	0	0	0	50
" 8	0	0	0	0	50	50
" 9	0	50	0	0	50	0
" 10	50	0	5	0	45	0

Table continued

Example number	Blending ratio in a flame resistant fiber composite (% by weight)					
	Fiber (A)	Fiber (B)			Fiber (C)	Fiber (D)
		Melamine fiber	Silicic acid containing cellulose fiber	Aromatic polyamide fiber		
" 11	45	0	10	0	45	0
" 12	35	0	20	0	45	0

Table2

Example number	Combustion test result				Sensual evaluation result	
	Existence of urethane combustion	Perforation of sample nonwoven fabric	Surface fabric combustion	Flame resistant result	Sample nonwoven fabric bulkiness	Characteristic of cellulosic fiber
1	A	A	A	A	B	A
2	A	A	A	A	A	A
3	A	A	A	A	B	A
4	A	A	A	A	B	A
5	A	A	A	A	A	A
6	A	A	A	A	A	A
7	A	A	A	A	A	A
Comparative Example 1	C	C	A	C	C	C
" 2	C	C	C	C	A	C
" 3	A	A	C	C	C	C
" 4	C	C	C	C	C	A
" 5	C	C	A	C	A	C
" 6	C	C	A	C	C	A
" 7	A	A	C	C	A	C
" 8	C	C	C	C	A	A
" 9	A	A	C	C	C	C
" 10	C	C	A	C	C	A
" 11	A	A	A	A	C	A
" 12	A	A	A	A	C	A

[0086] Examples 1 to 7 gave all satisfactory results in combustion test, bulkiness of sample nonwoven fabric, and characteristics (feeling etc.) as cellulosic fibers. Any kind of fiber (B) did not give difference to the results.

[0087] In Comparative Examples 1, 5, 6, and 10, although the fiber (A) demonstrated effect and promptly extinguished flame of the surface fabric, small percentages of the fiber (B) exhibited unsatisfactory formation ability of carbonized films, leading to combustion of the urethane foams by direct exposure to flame of a burner.

[0088] In Comparative Examples 2, 4, and 8, small percentages of the fiber (A) and fiber (B) made flame resistance be unsatisfactory, and both of urethane foam and surface fabric were burned.

[0089] In Comparative Examples 3, 7, and 9, although the fiber (B) formed carbonized films and urethane foams did not burn, small percentages of the fiber (A) continued combustion of the surface fabrics.

[0090] In Comparative Example 11, although a high percentage of the fiber (A) and the fiber (B) demonstrated formation ability of carbonized films and gave satisfactory combustion test result, absence of the fiber (D) gave inadequate bulkiness.

[0091] In Comparative Examples 4, 5, and 6, smaller percentages of the fiber (A) weakened ability of extinguishing flame of the sample, and unsatisfactory ability of extinguishing combustion of the surface fabric was demonstrated.

[0092] In Comparative Examples 5 and 7, larger percentages of the fiber (D) spread flame of the polyester fiber, and inferior flame resistance was demonstrated.

[0093] Existence of the fiber (D) made bulkiness of sample nonwoven fabrics increase in both of Examples and Comparative Examples.

[0094] In characteristics (feeling) as a cellulosic fiber, in Comparative Examples 1 to 3, 4, 5, and 6, absence of the fiber (C) did not allow touch as a cellulosic fiber, and in Comparative Example 9, despite existence of the fiber (C), high ratios of the fiber (B) demonstrated inferior touch.

(Examples 8 to 12 and Comparative Examples 13 to 20)

[0095] Blended at percentages shown in Table 3 were the fiber (A) obtained in Manufacturing Example 1; Visil (1.7 dtex, 40 mm of cut length, manufactured by SATERI INTERNATIONAL) of a silicic acid containing cellulose fiber as the fiber (B); and a polyester fiber (6.6 dtex, 51 mm of cut length) as the fiber (D), and sample nonwoven fabrics were manufactured. These samples were used for combustion test. Table 3 shows evaluation results.

Table 3

Example number	Blending ratio in flame resistant fiber composite (%)			Combustion test result					Sensual evaluation result	
	Fiber (A)	Fiber (B)	Fiber (D)	Urethane combustion suppression	Sample nonwoven fabric perforation suppression	Surface fabric combustion suppression	Flame resistant result	Sample nonwoven fabric whiteness evaluation result	Touch evaluation result	
8	70	10	20	A	A	A	A	A	A	
9	55	25	20	A	A	A	A	A	A	
10	45	35	20	A	A	A	A	A	A	
11	35	30	35	A	A	A	A	A	A	
12	50	0	50	A	A	A	A	A	A	
Comp. Example 13	100	0	0	C	C	C	C	A	C	
" 14	50	50	0	C	C	C	C	A	C	
" 15	90	0	10	C	C	A	C	A	A	
" 16	10	0	90	A	A	C	C	A	A	
" 17	0	100	0	C	C	C	C	A	C	
" 18	0	0	100	A	A	C	C	A	A	
" 19	0	50	50	A	A	C	C	A	A	
" 20	35	45	20	C	C	C	C	A	A	

[0096] Although flame resistant fiber composites of Examples 8 to 12 gave satisfactory combustion result, smaller percentages of the fiber (B) exhibited unsatisfactory formation ability of carbonized films, leading to combustion of the urethane foams by direct exposure to flame of a burner in composites of Comparative Examples 13, 14, and 17.

[0097] In Comparative Examples 16, 17, 18, and 19, smaller percentages of the fiber (A) weakened ability of extinguishing flame of the sample, and unsatisfactory ability of extinguishing combustion of the surface fabric was demonstrated.

[0098] In composites of Comparative Examples 17 and 20, larger percentages of the fiber (D) as compared with other fibers spread flame of the polyester fiber, and inferior flame resistance was demonstrated.

[0099] In addition, in results of sensual evaluation, evaluation of whiteness of sample nonwoven fabrics gave satisfactory results, and yellowish hue of the sample nonwoven fabrics was not observed in Examples and Comparative Examples. Although Examples gave satisfactory results in touch evaluation results, Comparative Examples 13, 14, and 17 gave inferior touch due to shortage of amounts of polyester fiber.

(Examples 13 to 21 and comparative examples 21 to 33)

[0100] Blended at percentages shown in Table 4 were the fiber (A) obtained in Manufacturing Example 2; Basofil of a melamine fiber (having a distribution of a size of a fiber of approximately 1 to 3.5 dtex, and distribution of 20 to 200 mm of cut length, manufactured by Basofil Fibers), Visil as a silicon containing cellulosic fiber (1.7 dtex, 40 mm of a cut length, manufactured by SATERI INTERNATIONAL), and Technora (1.7 dtex, 38 mm of a cut length, manufactured by Teijin, Ltd.) as a para-aromatic polyamide fiber as fiber (B), ; a rayon (1.5 dtex, 38 mm of a cut length) as the cellulosic fiber (C); and a polyester fiber (6.6 dtex, 51 mm of a cut length) as the fiber (D), and sample nonwoven fabrics were manufactured. These samples were used for combustion test. Table 5 shows evaluation results.

Table4

Example number	Amount of addition of antimony trioxide to fiber (A)	Blending ratio in flame resistant fiber composite (% by weight)					
		Fiber (A)	Fiber (B)			Fiber (C)	Fiber (D)
			Melamine fiber	Silicic acid containing cellulose fiber	Aromatic polyamide fiber		
13	0.5	55	10	0	20	0	15
14	3	35	15	15	0	0	35
15	3	35	25	0	0	15	25
16	3	35	15	0	0	35	15
17	3	45	15	15	0	0	25
18	3	45	25	0	0	15	15
19	3	45	25	0	15	0	15
20	3	45	0	45	0	0	10
21	3	55	15	15	0	0	15
21	3	25	0	25	0	0	50
22	3	100	0	0	0	0	0
23	-	0	100	0	0	0	0
24	-	0	0	100	0	0	0
25	-	0	0	0	0	0	100
26	3	50	50	0	0	0	0
27	3	50	0	0	0	0	50
28	-	0	50	50	0	0	0
29	-	0	50	0	0	0	50
30	-	0	0	50	0	0	50
31	15	50	0	0	0	5	45
32	15	45	0	0	0	10	45
33	15	35	0	0	0	20	45

Table5

Example number	Combustion test result			Sensuousness evaluation result		Touch evaluation result
	Urethane combustion	Perforation of sample nonwoven fabric	Surface fabric combustion	Feeling of gloss	Coloring property	
13	A	A	A	A	A	A
14	A	A	A	A	A	A
15	A	A	A	A	A	A
16	A	A	A	A	A	A
17	A	A	A	A	A	A
18	A	A	A	A	A	A
19	A	A	A	A	A	A
20	A	A	A	A	A	A
21	A	A	A	A	A	A
22	C	C	C	A	A	A
23	C	C	C	A	A	C
24	A	A	C	A	C	C
25	C	C	C	A	A	A
26	C	C	A	A	A	C
27	C	C	A	A	A	A
28	A	A	C	A	C	C
29	C	C	C	A	A	A
30	A	A	C	A	A	A
31	C	C	A	C	A	A
32	A	A	A	C	A	A
33	A	A	A	C	A	A

[0101] All Examples 13 to 21 gave satisfactory combustion test results, and demonstrated levels being usable as surface fabrics for upholstered furniture in sensuousness and touch.

[0102] Since comparative Examples 21, 22, 23, 25, 26, 27, 29, and 31 had inadequate amounts of components for forming carbonized films, and/or since they had inadequate amounts of components for maintaining structures in the flame resistant fiber composite in combustion, they formed perforated holes and cracks in sample nonwoven fabrics during combustion test, leading to combustion of the urethane foams by direct exposure to flame of a burner.

[0103] Since Comparative Examples 24, 28, and 30, including a large amount of the fiber (B), had sufficient amounts of components for maintaining structures in the flame resistant fiber composite in combustion, neither perforations nor cracks was formed. However, smaller percentages of the fiber (A) weakened ability of extinguishing flame of the sample, and demonstrated unsatisfactory ability of extinguishing combustion of the surface fabric.

[0104] Although Comparative Examples 32 and 33 showed satisfactory combustion test results and levels with usable touch as a surface fabric of upholstered furniture, and exhibited poor gloss due to inclusion of a large amount of antimony trioxide in the fiber (A), resulting in properties inadequate for use as a surface fabric of upholstered furniture.

INDUSTRIAL APPLICABILITY

[0105] Use of the flame resistant fiber composite of the present invention may provide fabrics having outstanding characteristics of the flame resistant fiber composite of the present invention, namely, characteristics, such as outstanding flame resistance, sensuousness, touch, feeling, moisture absorptivity. The fabrics comprise textiles, knittings, nonwoven fabrics, and strings, and may preferably be used in usage requiring advanced flame resistance and general fiber characteristics, such as outstanding sensuousness, touch, moisture absorptivity, feeling, etc. The usage includes furniture, such as chair coverings, beddings, pillow cases, sheets, bedcovers and mattress coverings, and furthermore surface fabrics for beddings, blankets, materials for barriers inserted between non-flame resistance fabrics and urethane foams,

clothes, such as fire-resistant work uniforms, interior designed products, such as curtains and carpets etc.

Claims

1. A flame resistant fiber composite obtained by compounding:

20 to 85% by weight of a fiber (A) containing 0.5 to 50 parts by weight of an Sb compound to 100 parts by weight of a polymer containing halogen atom of not less than 17% by weight;
5 to 80% by weight of a heat-resistant fiber (B);
0 to 40% by weight of a cellulosic fiber (C); and
0 to 40% by weight of an inflammable fiber (D), such as chemical fiber.

2. The flame resistant fiber composite according to Claim 1 obtained by compounding:

20 to 85% by weight of a fiber (A) containing 6 to 50 parts by weight of an Sb compound to 100 parts by weight of the polymer containing halogen atom of not less than 17% by weight;
15 to 80% by weight of the heat-resistant fiber (B) ; and
0 to 40% by weight of the inflammable fiber (D), such as chemical fiber.

3. The flame resistant fiber composite according to Claim 1 obtained by compounding:

20 to 85% by weight of a fiber (A) containing 0.5 to 50 parts by weight of an Sb compound to 100 parts by weight of a polymer containing halogen atom of not less than 17% by weight;
5 to 40% by weight of the heat-resistant fiber (B);
5 to 40% by weight of the cellulosic fiber (C); and
5 to 40% by weight of the inflammable fiber (D), such as chemical fiber.

4. The flame resistant fiber composite according to any one of Claims 1 to 3, wherein the polymer containing halogen atom is a copolymer comprising:

30 to 70% by weight of acrylonitrile;
70 to 30% by weight of a halogen containing vinyl based monomer; and
0 to 10 % by weight of a vinyl monomer copolymerizable therewith.

5. The flame resistant fiber composite according to any one of Claims 1 to 3, wherein the heat-resistant fiber (B) is selected from silicic acid containing cellulosic fibers, aramid fibers, and melamine fibers.

6. The flame resistant fiber composite according to Claim 1 or 3, wherein the cellulosic fiber (C) is a fiber without flame resisting treatment selected from cotton, hemp, acetate based fibers, and rayon based fibers.

7. The flame resistant fiber composite according to any one of Claims 1 to 3, wherein the inflammable fiber (D), such as a chemical fiber, comprises at least one kind of polyester fibers and nylon fibers.

8. The flame resistant fiber composite according to Claim 2 obtained by compounding:

85 to 20 % by weight of a fiber containing 6 to 50 parts by weight of an Sb compound to 100 parts by weight of a polymer containing chlorine atom of not less than 17% by weight as the polymer containing halogen atom;
15 to 80% by weight of a silicic acid containing cellulosic fiber as the heat-resistant fiber (B); and
0 to 40 % by weight of one or more kinds of the inflammable fiber (D), such as chemical fibers,
the flame resistant fiber composite being compounded so as to give contents of each fiber of (A) $\geq$ (D) or (B) $\geq$ (D).

9. The flame resistant fiber composite according to Claim 2, 3, 7, or 8 comprising 5 to 35% by weight of polyester fibers and/or nylon fibers as the inflammable fiber (D), such as a chemical fiber, in the flame resistant fiber composite.

10. The flame resistant fiber composite according to Claim 2, 4, 5, 7, 8, or 9, wherein a silicic acid containing cellulosic fiber as the heat-resistant fiber (B) comprises 20 to 50% by weight of silicic acid therein.

11. The flame resistant fiber composite according to Claim 3, 4, 5, 6, or 7 obtained by compounding:

80 to 20 % by weight of a fiber (A) containing 6 to 50 parts by weight of an Sb compound to 100 parts by weight of a polymer containing chlorine atom of not less than 17% by weight, as the polymer containing halogen atom;
5 to 40% by weight of the heat-resistant fiber (B) ;
5 to 40% by weight of the cellulosic fiber (C); and
5 to 40 % by weight of a polyester fiber as the inflammable fiber (D), such as a chemical fiber.

12. The flame resistant fiber composite according to Claim 1, 4, 5, 6, or 7 comprising:

30 to 70 % by weight of a fiber, containing 0.5 to 5.5 parts by weight of Sb to 100 parts by weight of a polymer containing chlorine atom of not less than 25% by weight as a polymer containing halogen atom, as the fiber (A);
10 to 50 % by weight of the heat-resistant fiber (B);
5 to 40 % by weight the cellulosic fiber (C); and
0 to 30 % by weight of the inflammable fiber (D), such as a chemical fiber, wherein contents of the fibers (A) to (D) satisfy relationships of

- (1) (A) $\geq$ (D) ;
- (2) (A) + (D) is 50 to 90% by weight; and
- (3) (C) + (D) is 30 to 60 % by weight.

13. The flame resistant fiber composite according to Claim 1, 4, or 12, wherein a chlorine containing polymer as the polymer containing halogen atom is a copolymer comprising:

40 to 60% by weight of acrylonitrile;
60 to 40 % by weight of a chlorine containing vinyl monomer; and
0 to 10 % by weight of a vinyl monomer copolymerizable therewith.

14. The flame resistant fiber composite according to Claim 1, 7, 12, or 13, wherein the inflammable fiber (D), such as a chemical fiber, comprises 16 to 100% by weight of at least one kind of fibers of polyester fibers and nylon fibers.

15. The flame resistant fiber composite according to Claim 1, 7, 12, 13, or 14, wherein the inflammable fiber (D), such as a chemical fiber, is an inflammable fiber comprising 16 to 100% by weight of a polyester fiber.

16. The flame resistant fiber composite according to Claim 1, 12, 13, 14, or 15, wherein a fiber containing an Sb compound in a polymer as the polymer containing halogen atom containing chlorine atom is in an amount of 40 to 70% by weight.

17. The flame resistant fiber composite according to Claim 1, 6, 12, 13, 14, 15, or 16, wherein the cellulosic fiber (C) is in an amount of 30 to 40% by weight.

18. The flame resistant fiber composite according to Claim 1, 12, 13, 14, 15, 16, or 17, wherein a content of the Sb compound is 0.5 to 3.5 parts by weight to 100% by weight of the polymers containing chlorine atom as the polymer containing halogen atom.

19. A fabric manufactured using the flame resistant fiber composite according to Claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, or 18.

20. A nonwoven fabric manufactured using the flame resistant fiber composite according to Claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, or 18.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/005583

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl⁷ D02G3/04, D04H1/42

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl⁷ D02G, D02J, D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2004
Kokai Jitsuyo Shinan Koho 1971-2004 Jitsuyo Shinan Toroku Koho 1996-2004

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 8-218259 A (Kaneka Corp.). 27 August, 1996 (27.08.96), Claims; Par. Nos. [0025], [0028] (Family: none)	1-20
A	WO 97/43474 A (Kaneka Corp.), 20 November, 1997 (20.11.97), Full text & EP 908545 A & US 6162747 A	1-20
A	JP 2002-161461 A (Kaneka Corp.), 04 June, 2002 (04.06.02), Full text (Family: none)	1-20

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search
10 June, 2004 (10.06.04)

Date of mailing of the international search report
29 June, 2004 (29.06.04)

Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/005583

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 61-89339 A (Kaneka Corp.), 07 May, 1986 (07.05.86), & EP 183014 A & US 4863797 A	1-20

Form PCT/ISA/210 (continuation of second sheet) (January 2004)