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(54) **FLAME-RETARDANT SYNTHETIC FIBER, FLAME-RETARDANT FIBER COMPOSITE, AND UPHOLSTERED FURNITURE PRODUCT MADE WITH THE SAME**

(57) A flame resistant synthetic fiber having advanced flame resistance is provided. Furthermore, the flame resistant synthetic fiber may preferably be used in textiles used for furniture, such as beddings and chairs, such as mattress, and sofa, etc. that need extremely high carbonizability rendered highly flame resistant by flame resistant agents and advanced flame resistance. The present invention also aims at obtaining upholstered furniture products using the flame resistant fiber composite having advanced flame resistance. That is, the present invention relates to a flame resistant fiber composite consisting of a flame resistant synthetic fiber (A) not less

than 10 parts by weight, and at least one fiber (B) selected from a natural fiber and/or a chemical fiber (B) not more than 90 parts by weight, the flame resistant synthetic fiber (A) comprising 100 parts by weight of a polymer containing halogen atom of not less than 17% by weight, 3 to 50 parts by weight of a zinc compound, 0 to 30 parts by weight of an antimony compound, and 3 to 30 parts by weight of an other inorganic compound, a total amount of these compounds being not less than 15 parts by weight, and also relates to upholstered furniture products using the flame resistant fiber composite.

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Description**Field of the Invention**

5 **[0001]** The present invention relates to a flame resistant synthetic fiber having advanced flame resistance preferably usable for textiles, to a flame resistant fiber composite, and a nonwoven fabric comprising the flame resistant fiber composite, usable for furniture that needs advanced flame resistance, such as bedding as bed mattress, chairs, and sofa, the fiber being rendered highly flame resistant with flame resistant agents, also having extremely high carbonizability. Furthermore, the present invention relates to upholstered furniture products using them.

Background Art

15 **[0002]** In recent years, demands for safety reservation of living circumstances such as clothing, food and housing, are growing, and necessity for flame resisting material is increasing from a viewpoint of fire defense. Under such circumstances, in order to prevent a fire during sleep hours that possibly induces serious human damage especially, now increasing is necessity for flame resistance given to material used for beddings, furniture, etc.

20 **[0003]** In order to realize comfort and sensuousness (highly designing) for products of the above-mentioned beddings and furniture in use, flammable materials, such as cotton, polyesters, urethane foams, have been used inside and outside in many cases. For reservation of flame retardation of those materials, it is important to give those materials advanced flame resistance wherein use of suitable flame resisting materials in those products prevents flaming to the flammable materials over a long period of time. In addition, the flame resisting materials must not impair comforts or sensuousness of the products of these beddings and furniture.

25 **[0004]** Since flammable materials, such as cotton, urethane foams, polyesters, are used in these textiles for comfort during use, important is flame retardation covering over a long period of time for preventing flaming to the flammable materials. In addition, the flame retardant material must not impair comforts or sensuousness of furniture, such as beddings or chairs, and of mattresses, and sofas.

30 **[0005]** Various flame resistant synthetic fibers and flame retardants have so far been examined for textiles used for the flame resisting material, but materials having requirements of advanced flame resistance, and comfort and sensuousness necessary for the products, such as beddings and furniture have not yet been realized.

35 **[0006]** For example, some techniques of additional processing flame retardation with application of flame retardants onto cotton cloths have problems in evenness of application of flame retardants, hardening of cloths caused by application, drop-off by washing, product safety, etc.

40 **[0007]** Since polyesters cannot exhibit functions as a carbonizable component, they induce melting and perforation by power burner combustion. Use of inexpensive polyester materials induces flaming to cottons and urethane foams used for the above-mentioned beddings, furniture, etc., and disables maintenance of structure of the materials, resulting in completely inadequate performance.

45 **[0008]** Although cloths from organic heat-resistant fibers are excellent in flame resistance, they are extremely expensive, and have further problems of workability in filament opening, poor moisture absorptivity or touch, and difficulty in highly designed colored patterns resulting from poor dyestuff affinity.

50 **[0009]** In order to improve disadvantages of the flame resistant fiber materials described above used for these furniture and beddings, there have been proposed a flame resistant fiber composite (Referential Patent 1) having combination of a halogen containing fiber being rendered highly flame resistant, having a flame resistant agent added in large quantities, and an other fiber not rendered flame resistant as material having outstanding feeling, moisture absorptivity, touch, and stable flame resistance necessary as general characteristics.

55 **[0010]** In addition there is given a description that an advanced flame resistant fiber composite obtained by mixing a small amount of an organic heat-resisting fiber for work uniform usage has excellent touch and moisture absorptivity and also has advanced flame resistance (Referential Patent 2).

[0011] However, organic heat-resistant fibers are generally colored resulting in inadequate whiteness of fabrics. Further organic heat-resistant fibers have problems in coloring during dyeing process. Therefore the composite has problems in sensuousness.

[0012] Furthermore, proposed is a flame resistant nonwoven fabric having bulkiness obtained from essentially flame resistant fibers, and halogen containing fiber (Referential Patent 3). However, in these methods, advanced flame resistance may be obtained, only when plurality of fibers are used in a composite form. In addition, these methods have problems that they need complicated manufacturing process for production, and those organic heat-resistant fibers and essentially flame resistant fibers have disadvantageously expensive price and high-cost.

Referential Patent 1: Japanese Patent Laid-Open No. 61-89339 gazette

Referential Patent 2: Japanese Patent Laid-Open No. 08-218259 gazette

Referential Patent 3: W003/023108 gazette

Description of the Invention

Problems to be solved by the Invention

[0013] The present invention aims at solving problems that have been difficult to be solved by conventional flame resistant materials. That is, the present invention aims at obtaining a flame resistant synthetic fiber with satisfactory workability, touch, and feeling, and furthermore satisfactory sensuousness, being suitably used for upholstered furniture products, a flame resistant fiber composite, and nonwoven fabric comprising the flame resistant fiber composite, and furthermore upholstered furniture products using the composite.

Means for Solving the Problems

[0014] As a result of wholeheartedly repeated investigation in order to solve the problems, the present inventors found out that simultaneous inclusion of zinc compounds, antimony compounds, and other inorganic compounds in a flame resistant synthetic fiber having a content of halogen of not less than 17% by weight might enable acquisition of advanced flame resistance. In addition, the present inventors also found out that a flame resistant synthetic fiber for providing textiles, usable for furniture, bedding, etc., having flame resistance with prolonged durability to flame, and self-extinguishing property without impairing sensuousness might be obtained at low costs. Furthermore, the present inventors also found out that problems of workability in use in independent use of a heat-resistant fiber, and of price might be improved, leading to completion of the present invention.

[0015] In more detail, it was found out that simultaneous inclusion a zinc compound, an antimony compound and an other inorganic compound in a fiber having a halogen content of not less than 17% by weight might develop extremely high carbonizability and self-extinguishing property at the time of combustion, without impairing satisfactory workability, touch, and feeling, and moreover sensuousness, and might give advanced flame resistance enabling maintenance of fiber form after combustion. As a result, it was found out that a flame resistant fiber composite having a combination of a flame resistant synthetic fiber (A) and at least one kind of fiber (B) of natural fibers and/or chemical fibers might be obtained, enabling realization of textiles used for furniture, beddings, etc. that need advanced flame resistance. Furthermore, it was also found out that problems of workability and price as problems of independent use of the heat-resistant fiber might also be improvable, leading to completion of the present invention.

[0016] That is, the present invention is a flame resistant fiber composite consisting of:

a flame resistant synthetic fiber (A) not less than 10 parts by weight; and
 a natural fiber and/or a chemical fiber (B) not more than 90 parts by weight;
 the flame resistant synthetic fiber (A) comprising:
 100 parts by weight of a polymer containing halogen atom of not less than 17 by weight;
 3 to 50 parts by weight of a zinc compound;
 0 to 30 parts by weight an antimony compound; and
 3 to 30 parts by weight of an other inorganic compound, and
 a total amount of these compounds being not less than 15 parts by weight.

[0017] The polymer containing halogen atom of not less than 17% by weight is preferably a flame resistant synthetic fiber (A) consisting of:

acrylonitrile 30 to 70% by weight;
 halogen containing vinyl and/or halogen containing vinylidene monomer 70 to 30% by weight; and
 a vinyl monomer copolymerizable with the monomers 0 to 10% by weight.

[0018] The zinc compound contained in the flame resistant synthetic fiber (A) is a compound selected from a group consisting of zinc, zinc oxide, zinc borate, zinc stannate, and zinc carbonate.

[0019] The inorganic compound is a compound selected from a group consisting of natural or synthetic mineral based compounds, such as kaolin, zeolite, montmorillonite, talc, perlite, bentonite, vermiculite, diatomaceous earth, and graphite;

aluminum based compounds, such as aluminum hydroxide, aluminum sulfate, and aluminum silicate;
 magnesium compounds, such as magnesium hydroxide and magnesium oxide; and silicon compounds, such as silicate and glasses.

[0020] The present invention relates to a flame resistant fiber composite using the flame resistant synthetic fiber (A) and a polyester fiber especially a binder fiber having a low melting point 0 to 40 parts by weight, as the natural fiber and/or the chemical fiber (B).

[0021] The present invention further relates to a nonwoven fabric comprising the flame resistant fiber composites, and especially to a nonwoven fabric for flame shielding barriers, and furthermore to upholstered furniture products using these flame resistant fiber composites, nonwoven fabrics, and nonwoven fabric for flame shielding barriers.

[0022] Hereinafter, a fiber (A) as used herein for a flame resistant fiber composite means the above described flame resistant synthetic fiber.

Effect of the Invention

[0023] The flame resistant synthetic fiber composite of the present invention and interior designed textile product thereof have outstanding sensuousness, such as touch, feeling, and visual appreciation, and also workability, and it enables demonstration of advanced flame resistance by maintaining a fiber form thereof against touch to a flame for a long period of time.

Best Mode for Carrying-out of the Invention

[0024] A preferable minimum amount of halogen content in the polymer containing halogen atom of not less than 17% of the present invention is 20%, and more preferably it is 26%. A preferable maximum amount is 86%, more preferably it is 73%, and still more preferably 48%. When the halogen content is less than 17%, rendering of the fiber flame resisting undesirably becomes difficult. Since a halogen content of vinylidene bromide homopolymers has a value of 86%, this value makes a maximum value of halogen content. In order to obtain halogen content not less than this value, it is necessary to further increase halogen atoms in a monomer, therefore becoming technically less realistic.

[0025] The polymer containing halogen atom of not less than 17% includes, but not limited to, for example, polymers of a monomer containing halogen atom, copolymers of the monomer containing halogen atom and monomers without halogen atom, mixtures of a polymer containing halogen atom, and a polymer without halogen atom, and halogen atom containing polymers having halogen atom introduced during or after polymerization of monomers without halogen atom or polymer etc.

[0026] Examples of such polymers containing halogen atom of not less than 17% by weight include, but not limited to, for example, homopolymers of halogen containing vinyl based or vinylidene based monomers or copolymers obtained from two or more kinds the monomers such as vinyl chloride, vinylidene chloride, vinyl bromide, vinylidene bromide, vinyl fluoride, and vinylidene fluoride; copolymers of halogen containing vinyl based or vinylidene based monomers, and acrylonitrile, such as acrylonitrile-vinyl chloride, acrylonitrile- vinylidene chloride, acrylonitrile-vinyl bromide, acrylonitrile-vinyl fluoride, acrylonitrile-vinyl chloride-vinylidene chloride, acrylonitrile-vinyl chloride-vinyl bromide, acrylonitrile-vinylidene chloride-vinyl bromide and acrylonitrile-vinylidene chloride-vinylidene fluoride; copolymers of one or more kinds of halogen containing vinyl based or vinylidene based monomers, such as vinyl chloride, vinylidene chloride, vinyl bromide, vinylidene bromide, vinyl fluoride, and vinylidene fluoride, acrylonitrile, and vinyl monomers copolymerizable with the monomers; polymers obtained by adding or polymerizing a halogen containing compound with an acrylonitrile homopolymer; halogen containing polyester; copolymers of vinyl alcohol and vinyl chloride; polymers obtained by chlorination of polyethylenes, and polyvinyl chlorides, etc. In addition, the above-mentioned homopolymers and copolymers may be used in an appropriate combination.

[0027] A fiber obtained especially preferably has touch of acrylic fiber, while having desired performances (strength, flame resistance, dyestuff affinity, etc.), when the polymer containing halogen atom of not less than 17% by weight is a polymer consisting of acrylonitrile 30 to 70 parts by weight, a halogen containing vinyl and/or halogen containing vinylidene monomer 70 to 30 parts by weight, and a vinyl monomer copolymerizable with the monomer 0 to 10 parts by weight, preferably of acrylonitrile 40 to 60 parts by weight, a halogen containing vinyl and/or halogen containing vinylidene monomer 60 to 40 parts by weight and a vinyl monomer copolymerizable with the monomer 0 to 10 parts by weight.

[0028] The vinyl monomers copolymerizable with the monomers, for example, include acrylic acid, esters thereof, methacrylic acid, esters thereof, acrylamide, methacryl amide, vinyl acetate, vinyl sulfonic acid, salts thereof, methallyl sulfonic acid, salts thereof, styrene sulfonic acid, salts thereof, 2-acrylamide-2-methylpropanesulfonic acid, salts thereof etc., and they may be used independently or two or more kinds may be used in combination. When at least one kind of them is a sulfonic group containing vinyl monomer, dyestuff affinity preferably will improve.

[0029] The vinyl monomers copolymerizable with the monomers, for example, include acrylic acid, esters thereof, methacrylic acid, esters thereof, acrylamide, methacryl amide, vinyl acetate, vinyl sulfonic acid, salts thereof, methallyl sulfonic acid, salts thereof, styrene sulfonic acid, salts thereof, 2-acrylamide-2-methylpropanesulfonic acid, salts thereof etc., and they may be used independently or two or more kinds may be used in combination. When at least one kind is a sulfonic group containing vinyl monomer among them, dyestuff affinity preferably will improve.

[0030] Examples of copolymer including the halogen containing vinyl based monomer and/or halogen containing vinylidene monomer and a unit from acrylonitrile include, for example, a copolymer consisting of vinyl chloride 50 parts, acrylonitrile 49 parts, and sodium styrene sulfonate 1 part; a copolymer consisting of vinylidene chloride 47 parts, acrylonitrile 51.5 parts, and sodium styrene sulfonate 1.5 parts; and a copolymer consisting of vinylidene chloride 41 parts, acrylonitrile 56 parts, and 3 part of sodium 2-acrylamide-2-methylsulfonate etc. These copolymers can be obtained by conventionally known polymerization methods.

[0031] Zinc compounds used for the present invention include, but not limited to, zinc, zinc oxide, zinc borate, zinc stannate, zinc carbonate, etc. They may be used independently and combination of them may also be used. An amount to be used is 3 to 50 parts by weight to the polymer containing halogen atom of not less than 17% 100 parts by weight, preferably it is 4 to 40 parts by weight, and more preferably 5 to 30 parts by weight. An amount of less than 3 parts by weight to be used tends to reduce effect (carbonizing effect) of carbonizing the polymer containing halogen atom of not less than 17% at the time of combustion, and cannot provide necessary carbonizing effect for providing requested advanced flame resistance. An amount used exceeding 50 parts by weight may provide sufficient carbonizing effect and form maintenance effect, but undesirably generates yarn breakage etc. in manufacturing process at the time of fiber production. In order to avoid troubles, such as clogging of nozzles on manufacturing process of a fiber obtained by adding zinc compound component to a halogen containing polymer, to improve strength of the fiber, and to disperse the zinc compound component particles in the fiber, an average particle diameter of the zinc compounds is preferably not more than 3 micrometers. The zinc compound component may further have chemical modification onto particle surface thereof for improvement in blocking property.

[0032] Examples of the antimony compounds include inorganic antimony compounds as follows, but not limited to, antimony oxide compounds, such as antimony trioxide, antimony tetroxide, and antimony pentoxide; antimonious acid and salts thereof; antimony oxychloride etc. They may be used independently and combination of them may also be used. An amount to be used is 0 to 30 parts by weight to the polymer containing halogen atom of not less than 17% 100 parts by weight, preferably it is 0 to 25 parts by weight, and more preferably 0 to 20 parts by weight. An amount to be used exceeding 30 parts by weight saturates the effect, and undesirably causes increase in costs. Although desired flame resisting performance may be attained even if the amount to be used is 0 parts by weight, only little self-extinguishing effects will be demonstrated. Therefore, when still more advanced, self-extinguishing effect is needed; an amount of not less than 3 parts by weight is preferable.

[0033] Examples of the inorganic compounds include, but not limited to, natural or synthetic mineral product based compounds, such as kaolin, zeolite, montmorillonite, talc, perlite, bentonite, vermiculite, diatomaceous earth, and graphite; aluminum based compounds, such as aluminum hydroxide, aluminum sulfate, and aluminum silicate; magnesium compounds, such as magnesium hydroxide and magnesium oxide; and silicon compounds, such as silicates and glasses etc. They may be used independently and combination of them may also be used. An amount is 3 to 30 parts by weight to polymers containing halogen atom of not less than 17% 100 parts by weight, it is preferably 5 to 25 parts by weight, and more preferably 7 to 20 parts by weight. An amount of less than 3 parts by weight gives only a small amount of residual carbide at the time of combustion, and thereby fails to demonstrate sufficient form maintenance effect. An amount exceeding 30 parts by weight saturates desired effect, gives factor of increase in costs, and disadvantageously causes trouble occurrence, such as nozzle clogging on manufacturing process of the fiber.

[0034] A total amount of the previously described zinc compounds, antimony compounds, and other inorganic compounds is not less than 15 parts by weight and not more than 110 parts by weight to the polymer containing halogen atom of not less than 17% 100 parts by weight, preferably it is not less than 17 parts by weight and is not more than 70 parts by weight, and more preferably not less than 20 parts by weight and not more than 50 parts by weight. It is disadvantageously difficult for an amount of the additives of less than 15 parts by weight to give previously described advanced flame resisting effect.

[0035] A flame resistant synthetic fiber of the present invention may include other additives, such as antistatic agents, agents for prevention of coloring by heat, light resistance improvers, whiteness improvers, matting inhibitors, colorants, and flame resistant agents, if necessary.

[0036] A flame resistant synthetic fiber of the present invention may be manufactured using polymers containing halogen atom of not less than 17% by weight, using publicly known manufacturing methods, such as a wet spinning method, a dry spinning method, and a half-dry half-wet method. For example, in wet spinning methods, after dissolving the polymer in solvents, such as N,N-dimethylformamide, N,N-dimethylacetamide, acetone, and rhodan salt aqueous solution, an obtained solution is extruded and coagulated in a coagulation bath through nozzles, subsequently, obtained fibers are washed, dried, stretched and heat-treated, and then the fibers will be crimped and cut if necessary, obtaining a desired product.

A form of the flame resistant synthetic fiber of the present invention may be of staple fiber or may be of filament, and may be appropriately selected based on application for use. For example, a similar form as of a partner fiber is preferable in processing by means of compounding with other natural fibers and chemical fibers. According to other natural fibers and chemical fibers used for textiles usage, a staple fiber having approximately 1.7 to 12 dtex and approximately a cut

length of 38 to 128 mm is preferable.

[0037] The reason for a flame resistant synthetic fiber of the present invention to exhibit excellent flame resistance is considered as follows. When a fiber (A) containing a zinc compound 3 to 50 parts by weight, an antimony compound 0 to 30 parts by weight, and an other inorganic compound 3 to 30 parts by weight to a polymer containing halogen atom of not less than 17% 100 part by weight is made to burn by other sources of flame, halogen atoms in a polymer decomposed by combustion of the polymer first easily react with a zinc compound and an antimony compound contained in a fiber (A) to form zinc chloride and antimony chloride compounds, and, when an antimony compound is not included, to form hydrogen chloride.

[0038] Since the zinc chloride works as a catalyst of chain cross-link reaction in the polymer, chains in the polymer are mutually cross-linked during combustion, resulting in formation of solid carbides (carbonizing effect). In addition, since the antimony chloride compound or hydrogen chloride is a low boiling compound and a gas thereof is incombustible, oxygen of a combustion area is blocked out, and thereby combustion is suppressed, resulting in demonstration of fire extinguishing action (self-extinguishing effect). Furthermore, since the other inorganic compound is not completely reduced to ashes at the time of combustion, the inorganic compound remains within the carbides, when above described solid carbide is formed, thereby increasing strength of the carbides (form maintenance effect). As a result of these effects, the fiber (A) may have combination of the carbonizing effect, the self-extinguishing effect, and the form maintenance effect, and may maintain a form in a state of carbides, without fiber form collapse even after combustion. Moreover, since the fiber (A) has the self-extinguishing effect, a flame is blocked out and spread of a fire may be suppressed, therefore demonstrating excellent flame resistance.

[0039] Natural fibers and/or chemical fibers (B) used for the present invention are components for giving a flame resistant fabric of the present invention outstanding touch, feeling, sensuousness, product strength, washing resistance, and durability in use, and they are also components for satisfactorily improving workability at time of using a flame resistant nonwoven fabric for beddings or furniture.

[0040] Examples of the natural fiber include, but not limited to, vegetable fibers, such as cotton and hemp; animal fibers, such as wool, camel hair, goat hair, and silk etc., and examples of chemical fiber include, regenerated fibers, such as viscose rayon fibers and cuprammonium rayon fibers; regenerated fiber, such as acetate fibers; and synthetic fibers, such as nylon fibers, polyester fibers, polyester based low melting point binder fibers, and acrylic fibers. These natural fibers and chemical fibers may be independently used with the flame resistant synthetic fiber (A), and two or more kinds may be used in combination with the flame resistant synthetic fiber (A).

[0041] In the present invention, it is preferable that polyesters of 15 to 25 parts by weight as B in a whole of (A + B) 100 parts by weight may be included, because the polyester fiber generates fused materials at the time of combustion to cover a flame resistant nonwoven fabric and thereby to strengthen a carbonized layer formed of the flame resistant nonwoven fabric, and also the polyester fiber can give flame shielding barrier performance for preventing flaming to cotton materials and urethane foam materials used for beddings or furniture, in prolonged exposure to intense flame; because the polyester fiber easily give bulkiness in processing into a nonwoven fabric; and because the polyester fiber may suppress a problem of damaging fibers due to a weak strength of a halogen containing synthetic fiber in a hopper feeder (carding device).

[0042] Use of the above described polyester based low melting point binder fibers enables adoption of a simpler thermo-fusible adhesion method in the case of manufacturing of nonwoven fabric. Examples of the polyester based low melting point binder fiber may also include a low melting point polyester single type fiber, and may include conjugate fibers of parallel connected type or core-in-sheath type consisting of (polyester) / (low melting point polypropylene, low melting point polyethylene, and low melting point polyester).

[0043] Generally low melting point polyesters have a melting point of almost 110 to 200 degree C, low melting point polypropylenes have a melting point of almost 140 to 160 degree C, low melting point polyethylene have a melting point of almost 95 to 130 degree C, and the materials are not especially limited, if they demonstrate fusible adhesion capability at temperatures about 110 to 200 degree C. In addition, use of polyester fibers without low melting points allows adoption of simpler needle punch methods in manufacture of the nonwoven fabric.

[0044] In the present invention, a flame resistant fabric 100 parts by weight of the present invention may be manufactured from a flame resistant synthetic fiber (A) not less than 10 parts by weight, and a natural fiber and/or a chemical fiber (B) not more than 90 parts by weight. Blending ratios of the material fibers here are determined according to quality, such as flame resistance needed for final products manufactured from a flame resistant nonwoven fabric obtained, and moreover absorptivity, touch, moisture absorptivity, feeling, sensuousness, product strength, washing resistance, and durability in use.

[0045] In general, the synthetic fiber (A) 95 to 10 parts by weight, and preferably 60 to 20 parts by weight, the natural fiber and/or chemical fiber (B) 5 to 90 parts by weight, preferably 80 to 40 parts by weight are used to be compounded so that this total amount may give 100 parts by weight. In selection of the thermo-fusible adhesion method in the case of the nonwoven fabric manufacturing process, inclusion of the polyester based low melting point binder fiber of at least 10 parts by weight is preferable as the natural fiber and/or chemical fiber (B).

[0046] An amount of less than 10 parts by weight of the flame resistant synthetic fiber (A) fails to realize enough formation of carbonized layer for preventing flaming to cotton and urethane foams used for beddings or furniture on the occasion of prolonged exposure to intense flame, and may only demonstrate poor self-extinguishing property, making it difficult to realize requested advanced flame resistance.

[0047] In a flame resistant fiber composite of the present invention, the previously described fibers (A) and (B) are compounded, and the flame resistant fiber composite has a form of: fabrics, such as woven or knitted fabrics and nonwoven fabrics; collection of fibers, such as slivers and webs; fibrous materials, such as spun yarns, multiple wound yarns, twisted yarns; and corded materials, such as knitted strings and plaited cords.

[0048] The above-described "compound" as used herein means that the fibers (A) and (B) are mixed by various methods to obtain a fabric including the fibers (A) and (B) at a predetermined ratio, and also that each fibers and yarns are combined in stages of blending, spinning, twisting, weaving and knitting.

[0049] A flame resistant fiber composite of the present invention may suitably be used as a nonwoven fabric for flame shielding barriers. "Flame shielding barrier" as used herein means that when a flame resistant nonwoven fabric is exposed to flame, it shields against the flame by carbonizing itself, while maintaining a form of the fiber in an inflammable nonwoven fabric, to prevent the flame moving to an opposite side of the woven fabric.

[0050] Concretely, interposition of the flame resistant nonwoven fabric of the present invention between a fabric disposed outside of mattress and upholstered furniture etc., and urethane foam or packing as an internal structure etc., can prevent catching of a flame to internal structure in case of contacting flame, thereby giving least damage.

[0051] As manufacturing methods of the flame resistant nonwoven fabric, in general, nonwoven fabric preparation methods, such as a general thermofusible adhesion method, a chemical bonding method, a water jet method, a needle punch method, and a stitch bonding method, may be used. After blending a plurality of kinds of fibers, filament opening and webbing are performed with a carding device, and then this obtained web is treated by a nonwoven fabric manufacturing installation to produce the nonwoven fabric. Manufacturing by a needle punching system is preferable from a viewpoint of simplicity of apparatus, and manufacturing by a thermofusible adhesion system is preferable when low melting point polyester based binder fiber. These manufacturing methods are conventionally utilized and have high productivity, but the present invention is not limited to these methods.

[0052] If necessary, the flame resistant fiber composite of the present invention may include antistatic agents, agents for prevention of coloring by heat, light resistance improvers, whiteness improvers, matting inhibitors, etc., and moreover coloring and dyeing by means of dyestuffs, pigments, etc. may be given without any trouble.

[0053] Thus obtained flame resistant fiber composite of the present invention has desired flame resistance, and demonstrates characteristics excellent in touch, feeling, moisture absorptivity, sensuousness, etc.

[0054] Upholstered furniture of the present invention are beddings, such as bed mattress, chairs, sofas, and seats for vehicles etc. covered by the previously described flame resistant fiber composite.

[0055] As bed mattress, for example, a pocket coil mattress, a box coil mattress using metal coils inside, or mattresses using insulators, such as styrene and urethane resins of a foamed state inside may be mentioned. Since demonstration of flame retardation by means of the flame resistant composite used for the present invention enables prevention of spread of a fire to a structure inside the mattress, mattresses having excellent flame resistance and simultaneously outstanding touch, or feeling may be obtained in any structures.

[0056] On the other hand, as chairs, there may be mentioned chairs used indoors, such as stools, bench, side chairs, armchairs, lounge chair sofas, seat unit (sectional chairs, separated chairs), locking chairs, folding chairs, stacking chairs, swivel chairs, or seats used outdoors for seating for vehicles etc., such as, automobile seat, seat for vessels, seat for airplanes, seat for trains etc. Also in these chairs, upholstered products having functions to prevent internal spread of a fire, and simultaneously having visual appearance and feeling needed for usual furniture may be obtained.

[0057] In addition, mattresses and chairs using low repulsion urethane foams represented by Tempur material (manufactured by Tempur World, Inc.) and having pressure dispersion function is extremely flammable as compared to mattresses and chairs using foamed material of usual styrene and urethane resins. However, demonstration of flame retardation by means of the flame resistant fiber composite used for the present invention can prevent spread of a fire to the low repulsion urethane foam as an internal structure of the mattresses or chairs.

[0058] Examples of usage of the flame resistant fiber composite of the present invention to upholstered furniture products include use in a form of textile fabrics or knittings on a surface cloth, and interposition in a form of textile fabrics, or knittings and nonwoven fabrics between a surface cloth and internal structure, for example, urethane foams and packing. In use to a surface cloth, a conventional cloth may only be replaced with a cloth comprising the flame resistant fiber composite of the present invention.

[0059] In addition, when textile fabrics and knitted fabrics are sandwiched between a surface fabric and an internal structure, there may be used a method of sandwiching the fabrics like layered surface fabric of two sheets, and a method of covering an internal structure using textile fabrics and knitted fabrics comprising the flame resistant fiber composite of the present invention.

[0060] When a cloth comprising the flame resistant fiber composite of the present invention is sandwiched as a cloth

textile fabrics for flame shielding barriers between a surface fabric and an internal structure, a nonwoven fabric comprising the flame resistant fiber composite of the present invention covers the whole internal structure, or at least in a portion contacting a surface cloth a nonwoven fabric comprising the flame resistant fiber composite of the present invention is certainly disposed on an outside surface of the internal structure, and subsequently a surface cloth is disposed outside thereon.

[0061] When upholstered furniture is manufactured using the flame resistant fiber composite of the present invention, there may be obtained upholstered furniture products having highly excellent flame resistance as outstanding characteristics of the flame resistant fiber composite of the present invention, and having characteristics excellent also in touch, feeling, moisture absorptivity, sensuousness, etc.

Examples

[0062] 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. Measurement of flame resistance of a fiber in Examples and judgment were made as follows.

Comprehensive judgment of passed as "Passed", failure as "Failed" was given by collectively judging results of these four methods: flame resistance evaluation test (LOI value, flame resistance of a nonwoven fabric, twisted fiber bundle fire extinguishing period), and residual ratio at the time of heating.

(Flame resistance evaluation test 1)

(Flame resistance evaluation by means of LOI value)

[0063] A fiber prepared according to the following Manufacturing Examples 2 g was sampled, and the fiber was equally divided into 8 samples to obtain 8 twisted fiber bundles with a length of approximately 6 cm. The samples were vertically fixed to a holder of an oxygen index measuring instrument made by SUGA TEST INSTRUMENT Co., LTD. (ON-1 type). Lowest oxygen concentration necessary for the 5 cm of samples to continue burning was measured to obtain an LOI value. Larger LOI value means that it is difficult for the sample to burn with higher flame resistance.

(Flame resistance evaluation by means of nonwoven fabric)

1) Preparing of nonwoven fabric for flame resistance evaluation examination

[0064] Fibers prepared according to following Manufacturing Examples were opened with a roller carding device, and subsequently, nonwoven fabrics having weight of 300 g/m² and measuring 20 cm x 20 cm were prepared by a needle punch method.

2) Flame resistance evaluation test method

[0065] A perlite board with sides of 200 mm by 200 mm, and a thickness of 10 mm having a hole with a diameter of 15cm in a center thereof was prepared. A nonwoven fabric for flame resistance evaluation examination was disposed on the board, and four sides of the nonwoven fabric were fixed with clips so that the nonwoven fabric for flame resistance evaluation examination might not shrink at the time of heating.

[0066] The sample was set so that a center of the sample might meet a center of a burner and that a surface of the nonwoven fabric for flame resistance evaluation examination might show upwards, in a position separated from the burner face by 40 mm to a gas stove (made by Paloma LTD, PA-10H-2). As a fuel gas, propane having a purity of not less than 99% was used, and a contact period to flame was set as 180 seconds, and a height of the flame as 25 mm.

[0067] In this examination, evaluated as B was a case where a carbonized layer of the nonwoven fabric for flame resistance evaluation examination had no perforated holes and no cracks, and a case where it had both of holes and cracks was evaluated as C. Evaluation B was determined as passed.

(Flame resistance evaluation by means of twisted fiber bundle-fire extinguishing period test)

[0068] A fiber prepared according to the following Manufacturing Examples 2 g was sampled, the fiber was equally divided into 8 samples to obtain 8 twisted fiber bundles with a length of approximately 6 cm.

[0069] A mending tape (Sumitomo 3M Limited, Scotch mending tape) was attached twice around an end of the twisted fiber bundle so that a width of 13 mm might be given, and subsequently, while maintained horizontally, an end of the twisted fiber bundle was contacted with a flame for 2 seconds. The sample was kept standing to maintain the state, and

a period (fire extinguishing period) until the fire was extinguished was measured.

[0070] A shorter fire extinguishing period means a higher flame resistance that is a higher self-extinguishing effect.

(Measuring method of residual ratio at the time of heating (carbide weight))

[0071] Approximately 5 mg of fiber prepared according to the following Manufacturing Examples was sampled. Measurement was carried out using an apparatus for thermo-gravimetry (made by Seiko Instruments, TG/DTA220, gas used: air, amount of gas flow: 200 ml/min, heating rate: 3 degrees C/min).

[0072] An initial weight was set as 100% and a weight of a residual matter (carbide) at 500 degrees C was represented with a ratio. A larger number preferably represents a larger amount of residual matter (carbide).

(Measuring method of halogen content in a fiber)

[0073] Using an elemental analysis measuring instrument (made by Yanaco, CHN coder MT-5), elemental analysis about C element, H element, and N element of the obtained copolymer was conducted, it was determined that N atom is of acrylonitrile origin, and an acrylonitrile component content in the polymer was determined using the N atom content.

[0074] Based on an assumption that all of p-sodium styrene sulfonate was copolymerized, remaining amount was determined as component of halogen monomer origin, and thus a halogen content in the halogen containing copolymer obtained by calculation was determined.

(Manufacturing Example 1)

[0075] A copolymer comprising acrylonitrile 51 %, vinylidene chloride 48%, and p-sodium styrene sulfonate 1% (halogen atom ratio: 35%) was dissolved in dimethylformamide to obtain a resin solution having a resin concentration of 30%.

[0076] To a resin weight of the obtained resin solution zinc oxide (three kinds of zinc oxides manufactured by Sakai Chemical Ind. Co. Ltd.) as zinc compounds; antimony trioxide as an antimony compound; and kaolin (kaolin ASP 170 manufactured by Engelhard Corporation) as an other inorganic compound or aluminum hydroxide were added as shown in Tables 1 and 2 to obtain a spinning solution.

[0077] This spinning solution was extruded into a 50% dimethylformamide aqueous solution using a nozzle having 0.10 mm of a nozzle hole diameter and a number of holes of 1000 holes, and the fiber obtained was dried at 120 degrees C after washing. Subsequently, after stretching by 3 times, the fiber was heat-treated for 5 minutes at 150 degrees C, and furthermore the fiber was cut to obtain a halogen containing fiber. Obtained fiber was a staple fiber having a size of a fiber of 5.6 dtex, and a 51 mm cut length.

(Manufacturing Example 2)

[0078] A copolymer consisting of acrylonitrile 49%, vinyl chloride 50.5%, and p-sodium styrene sulfonate 0.5% (halogen atom ratio: 34%) was dissolved in dimethylformamide to obtain a resin solution having a resin concentration of 30%. To a resin weight of the obtained resin solution zinc oxide (three kinds of zinc oxides manufactured by Sakai Chemical Ind. Co. Ltd.) as zinc compounds; antimony trioxide as an antimony compound; and kaolin (kaolin ASP 170 manufactured by Engelhard Corporation) as an other inorganic compound or aluminum hydroxide were added as shown in Tables 3 and 4 to obtain spinning solutions.

[0079] The spinning solutions were extruded into a 50% dimethylformamide aqueous solution using a nozzle having 0.10 mm of a nozzle hole diameter and a number of holes of 1000 holes, the fibers obtained were dried at 120 degrees C after washing. Subsequently, after stretching by 3 times, the fibers were heat-treated for 5 minutes at 130 degrees C, and furthermore the fiber was cut to obtain halogen containing fibers. Obtained fibers were staple fibers having a size of a fiber of 5.6 dtex, and a 51 mm cut length.

(Examples 1 to 4, Comparative Examples 1 to 3)

[0080] According to the Manufacturing Example 1, halogen containing fibers including zinc oxide as a zinc compound, antimony trioxide as an antimony compound, and kaolin as an inorganic compound in amounts in Table 1 were produced. LOI values, flame resistance as in nonwoven fabric, and residual ratio at the time of combustion by means of thermo-gravimetric measurement were evaluated for. Table 1 shows results.

[0081] Combustion tests of Examples 1 to 4 gave satisfactory results. They give high LOI values, in nonwoven fabric examination, they formed satisfactory carbonized layer and did not give occurrence of perforations or cracks to give passing levels after heating by means of gas stove.

[0082] They gave high residual ratios at the time of heating and comprehensive judgment of passing based on judg-

ments of advanced flame resistance. Example 4 also had advanced flame resistance, and Example 3 included equivalent amount of zinc oxide and of kaolin as in Example 4 and, Example 3 included antimony trioxide, and therefore had a shorter twisted fiber bundle fire extinguishing period, exhibiting more advanced flame resistance.

[0083] On the other hand, although Comparative Example 1 had an equivalent amount of antimony trioxide and a total amount of additives as in Example 1, it did not include kaolin, and therefore Comparative Example 1 failed to form satisfactory carbonized layer but makes nonwoven fabric cause perforation, and furthermore demonstrated a low LOI value and low residual ratio at the time of heating, and gave comprehensive judgment of failure.

[0084] Comparative Example 2 had an equivalent amount of antimony trioxide and a total amount of additives as in Example 1, it did not include zinc oxide, and therefore Comparative Example 2 failed to form satisfactory carbonized layer but made nonwoven fabric cause perforation, and furthermore demonstrated a low LOI value and gave comprehensive judgment of failure.

[0085] Since Comparative Example 3 had a small total amount of zinc oxide and kaolin, made nonwoven fabric cause perforation, without forming satisfactory carbonized layer, Comparative Example 3 was not judged to have advanced flame resistance, but comprehensive judgment gave failure. Table 1 shows flame resistance evaluation test results of Examples 1 to 4 and Comparative Examples 1 to 3.

		Amount of additives (parts by weight)				Flame resistance evaluation result			Residual ratio at the time of heating (%)	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Kaolin	Additives total amount	LOI value	Nonwoven fabric	Twisted fiber bundle fire extinguishing period(sec)		
Ex.	1	20	10	20	50	36	B	17	65	Passed
	2	5	10	20	35	37	B	17	50	Passed
	3	10	5	20	35	42	B	17	61	Passed
	4	10	0	20	30	40	B	21	62	Passed
Com. Ex.	1	40	10	0	50	35	C	17	78	Failed
	2	0	10	40	50	35	C	18	45	Failed
	3	5	0	5	10	31	C	25	75	Failed

(Examples 5 to 9, Comparative Examples 4 and 5)

5 [0086] According to Manufacturing Example 1, prepared were halogen containing fibers comprising zinc oxide as zinc compound, antimony trioxide as antimony compound, and aluminum hydroxide as other inorganic compound as shown in Table 2. LOI values, flame resistance evaluation in nonwoven fabric, and residual ratio measurement at the time of combustion by means of thermogravimetric measurement were measured for the obtained fibers. Table 2 shows results.

10 [0087] Examples 5 to 9 gave satisfactory combustion test results. They gave high LOI values, in nonwoven fabric examination, they sufficiently formed satisfactory carbonized layer and generated neither perforations nor cracks after heating by means of gas stove. Furthermore, they demonstrated high residual ratios at the time of heating and therefore they were judged to have advanced flame resistance, giving satisfactory comprehensive judgment.

[0088] Example 8 also had advanced flame resistance, and since Example 7 had equivalent amount of zinc oxide and aluminum hydroxide as in Example 8, and included antimony trioxide, it showed a shorter twisted fiber bundle fire extinguishing period, and had more advanced flame resistance.

15 [0089] Comparative Example 4 had an equivalent amount of antimony trioxide, and total amount of additives as in Example 5, but did not have zinc oxide, and it made a nonwoven fabric cause perforation, without formation of satisfactory carbonized layer. Comparative Example 4 had low residual ratio at the time of combustion. It gave comprehensive judgment of failure.

20 [0090] Since Comparative Example 5 had a small amount of total of zinc oxide and aluminum hydroxide, it made nonwoven fabric to cause perforation, without forming satisfactory carbonized layer. It was not judged to have advanced flame resistance, giving comprehensive judgment of failure. Table 2 shows flame resistance evaluation test results of Examples 5 to 9 and Comparative Examples 4 and 5.

		Amount of additives (parts by weight)				Flame resistance evaluation result			Residual ratio at the	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Alumi num hydro xide	Additives total amount	LOI value	Nonwo ven fabric	Twisted fiber bundle fire extinguishing period(sec)	time of heating (%)	
Ex.	5	20	10	20	50	39	B	9	68	Passed
	6	5	10	20	35	45	B	8	50	Passed
	7	10	5	20	35	47	B	15	62	Passed
	8	10	0	20	30	46	B	19	64	Passed
	9	15	10	10	35	43	B	10	65	Passed
Com. Ex.	4	0	10	40	50	47	C	10	45	Failed
	5	5	0	5	10	34	C	23	77	Failed

(Examples 10 and 11, Comparative Example 6)

[0091] According to Manufacturing Example 2, prepared were halogen containing fibers comprising zinc oxide as zinc compound, antimony trioxide as antimony compound, and kaolin as other inorganic compound as shown in Table 3. LOI values, flame resistance evaluation in nonwoven fabric, and residual ratio measurement at the time of combustion by means of thermogravimetric measurement were measured for the obtained fibers. Table 3 shows results.

[0092] Examples 10 and 11 gave satisfactory combustion test results. They gave high LOI values, in nonwoven fabric examination, they formed satisfactory carbonized layer and generated neither perforations nor cracks after heating by means of gas stove. Furthermore, they demonstrated high residual ratios at the time of heating and therefore they were judged to have advanced flame resistance, giving satisfactory comprehensive judgment.

[0093] On the other hand, Comparative Example 6 had an equivalent amount of antimony trioxide and kaolin as in Examples 10 and 11, it did not have zinc oxide, and therefore, it formed perforation in a nonwoven fabric without forming satisfactory carbonized layer. And furthermore, since it had a low residual ratio at the time of heating, it gave comprehensive judgment of failure. Table 3 shows flame resistance evaluation test results of Examples 10 and 11 and Comparative Example 6.

Table 3

		Amount of additives (parts by weight)				Flame resistance evaluation result			Residual ratio at the time of heating (%)	Comprehensive evaluation
		Zinc Antimony oxide trioxide		Kaolin	Additives total amount	value	Nonwoven fabric	Twisted fiber bundle fire extinguishing period(sec)		
Ex.	10	10	10	20	45	39	B	18	67	Passed
	11	5	10	20	35	40	B	19	63	Passed
Com. Ex.	6	0	10	20	30	41	C	18	50	Failed

(Examples 12 and 13, Comparative Example 7)

[0094] According to Manufacturing Example 2, prepared were halogen containing fibers comprising zinc oxide as zinc compound, antimony trioxide as antimony compound, and aluminum hydroxide as other inorganic compound as shown in Table 4. LOI values, flame resistance evaluation in nonwoven fabric, and residual ratio measurement at the time of combustion by means of thermogravimetric measurement were measured for the obtained fibers. Table 4 shows results.

[0095] Examples 12 and 13 gave satisfactory combustion test results. They gave high LOI values, in nonwoven fabric examination, they formed satisfactory carbonized layer and generate neither perforations nor cracks after heating by means of gas stove. Furthermore, they demonstrated high residual ratios at the time of heating and therefore they were judged to have advanced flame resistance, giving satisfactory comprehensive judgment.

[0096] On the other hand, Comparative Example 7 had an equivalent amount of antimony trioxide and aluminum hydroxide as in Examples 12 and 13, it did not have zinc oxide, and therefore it formed perforation in a nonwoven fabric without forming satisfactory carbonized layer. And furthermore, since it had a low residual ratio at the time of heating, it gave comprehensive judgment of failure. Table 4 shows flame resistance evaluation test results of Examples 12 and 13 and Comparative Example 7.

		Amount of additives (parts by weight)				Flame resistance evaluation result			Residual ratio at the time of heating (%)	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Alumi num hydro xide	Additives total	LOI value	Nonw oven fabric	Twisted fiber bundle fire extinguishing period(sec)		
Ex.	12	15	10	20	45	45	B	10	70	Passed
	13	5	10	20	35	47	B	9	66	Passed
Com. Ex.	7	0	10	20	30	48	C	11	52	Failed

[0097] Flame resistance of fibers in Examples was measured as follows using nonwoven fabrics. Evaluation was performed using:

- a flame resistance evaluation test 1 for a flame resistant synthetic fiber;
- a flame resistance evaluation test 2 for a flame resistant fiber composite; and
- a flame resistance evaluation test 3 for an upholstered product furniture products.

[0098] These evaluation methods are simple evaluation methods for a case wherein firing of flame to the internal structure in the case where fire is prevented by inserting a flame resistant nonwoven fabric of the present invention between a surface fabrics for upholstered furniture, such as bed mattresses, chairs, or sofas, and an internal structure such as urethane foam or packing etc.

[0099] In the case of the flame resistance evaluation test 2, comprehensive evaluation was performed in consideration of both of flame resistance evaluation and workability evaluation. Evaluation "Passed" was determined as passed, and "Failed" as failure.

(Flame resistance evaluation test 2)

1) Preparation of nonwoven fabric for flame resistance evaluation examination

[0100] A fiber mixed at a predetermined ratio was opened with a carding device, subsequently, using a needle punch method obtained was a nonwoven fabric with a weight of 200 g/m², and a width of 20 cm and a length of 20 cm for flame resistance evaluation examination.

2) Flame resistance evaluation test method

[0101] A perlite board with sides of 200 mm by 200 mm, and a thickness of 10 mm having a hole with a diameter of 15 cm in a center thereof was prepared. A nonwoven fabric for flame resistance evaluation examination was disposed on the board, and four sides of the nonwoven fabric were fixed with clips so that the nonwoven fabric for flame resistance evaluation examination might not shrink at the time of heating.

[0102] The sample nonwoven fabric was set so that a center of the sample might meet a center of a burner and that a surface of the nonwoven fabric for flame resistance evaluation examination might show upwards, in a position separated from the burner face by 40 mm to a gas stove (made by Paloma LTD, PA-10H-2). As a fuel gas, propane having a purity of not less than 99% was used, and a contact period to flame was set as 180 seconds, and a height of the flame as 25 mm.

[0103] In this evaluation, evaluated as A was a case where a carbonized film of the nonwoven fabric for flame resistance evaluation examination had no difference of thickness, no perforated holes nor cracks, B as a case where a carbonized film had no penetrated perforations and no crack, and C as a case where a carbonized film had perforations and cracks. A and B were evaluated as passed.

(Flame resistance evaluation test 3)

1) Preparation of a sample for flame resistance evaluation examination

[0104] A fiber mixed at a predetermined ratio was opened with a carding device, and subsequently, using a needle punch method obtained was a nonwoven fabric with a weight of 200 g/m², and a width of 30 cm and a length of 45 cm. Beneath the nonwoven fabric, a urethane foam (length of 45 cm, width of 30 cm and thickness of 53 mm) was disposed in layers, a polyester nonwoven fabric (weight 300 g/m²) having a same size, and furthermore a fabric made of polyester (unit weight 120 g/m²) were disposed on the nonwoven fabric in layers. These four layers were fixed with stapler so that they might not shift, to give a sample for flame resistance evaluation examination.

2) Flame resistance evaluation test method

[0105] Evaluation was carried out according to "Bed Surface Test Method" in combustion test method of bed "Technical Bulletin 603" (hereinafter, referred to as TB603) of U.S. California. That is, a burner having a form of a character T was disposed horizontally in a position 39 mm above a surfaces of a sample, and a flame was contacted to the sample for 70 seconds using LPG as combustion gas, on conditions of gas pressure of 101 KPa and quantity of gas flow 12.9 L/minute.

[0106] In this evaluation, evaluated as A was a case where a carbonized film of the nonwoven fabric had no difference of thickness, no perforated holes nor cracks, B as a case where a carbonized film had no penetrated perforations and no crack, and C as a case where a carbonized film had perforations and cracks. A and B were evaluated as passed.

(Processability evaluation)

[0107] Evaluated as A was a case where card processability at the time of carding of nonwoven fabric (easiness of processing) was satisfactory, B a case where card processing was possible, and C a case where card processing was difficult due to occurrence of waste fibers. A and B were evaluated as passed.

(Manufacturing Example 3)

[0108] A copolymer consisting of acrylonitrile 51%, vinylidene chloride 48%, and p-sodium styrene sulfonate 1% (halogen atom ratio: 35%) was dissolved in dimethylformamide to obtain a resin solution having a resin concentration of 30%. To a resin weight of the obtained resin solution, added were zinc oxide (three kinds of zinc oxides manufactured by Sakai Chemical Ind., Co., Ltd.) as zinc compounds; antimony trioxide as an antimony compound; and kaolin (kaolin ASP170 manufactured by Engelhard Corporation) as an other inorganic compound or aluminum hydroxide, as shown in Tables 1, 2, 5, and 6 to obtain spinning solutions.

[0109] This spinning solutions were extruded into a 50% dimethylformamide aqueous solution using a nozzle having 0.10 mm of a nozzle hole diameter and a number of holes of 1000 holes to be coagulated, and the fibers obtained were dried at 120 degrees C after washing. Subsequently, after stretching by 3 times, the fibers were heat-treated for 5 minutes at 150 degrees C, and furthermore the fibers were cut to obtain a halogen containing fibers. Obtained fibers were staple fibers having a size of a fiber of 5.6 dtex, and a 51 mm cut length.

(Manufacturing Example 4)

[0110] A copolymer consisting of acrylonitrile 49%, vinyl chloride 50.5%, and p-sodium styrene sulfonate 0.5% (Halogen atom ratio: 34%) was dissolved in dimethylformamide to obtain a resin solution having a resin concentration of 30%. To a resin weight of the obtained resin solution added were zinc oxide (three kinds of zinc oxides manufactured by Sakai Chemical Ind., Co., Ltd.) as zinc compounds; antimony trioxide as an antimony compound; and kaolin (kaolin ASP] 70 manufactured by Engelhard Corporation) as an other inorganic compound or aluminum hydroxide, as shown in Tables 3 and 4 to obtain spinning solutions.

[0111] The spinning solutions were extruded into a 50% dimethylformamide aqueous solution using a nozzle having 0.10 mm of a nozzle hole diameter and a number of holes of 1000 holes, and the fibers obtained were dried at 120 degrees C after washing. Subsequently, after stretching by 3 times, the fibers were heat-treated for 5 minutes at 130 degrees C, and furthermore the fibers were cut to obtain halogen containing fibers. Obtained fibers were staple fibers having a size of a fiber of 5.6 dtex, and a 51 mm cut length.

(Examples 14 to 19, Comparative Examples 8 to 11)

[0112] According to the Manufacturing Example 3, halogen containing fibers including zinc oxide as a zinc compound, antimony trioxide as an antimony compound, and kaolin as an inorganic compound in amounts in Table 5 were produced. Then nonwoven fabrics consisting of predetermined ratios of the obtained halogen containing fibers, a polyester fiber (6.6 dtex, 51 mm of cut length), and a rayon fiber (1.5 dtex, 38 mm of cut length) were prepared for flame resistance evaluation test 1. Table 5 shows results.

[0113] Examples 14 to 19 gave satisfactory combustion test results, nonwoven fabrics for flame resistance evaluation examination gave occurrence of neither cracks nor perforations after heating by means of a gas stove, but formed satisfactory carbonized film.

[0114] On the contrary, Comparative Examples 8 to 9 had an equivalent amount of flame resistant agent as in Example 14, but since Comparative Example 8 did not include kaolin as an other inorganic compound, and Comparative Example 9 did not include zinc oxide as zinc compound, they could not form satisfactory carbonized film but gave occurrence of perforations therein.

[0115] Comparative Example 11 included a small quantity of halogen containing fiber, and failed to form satisfactory carbonized film.

[0116] Although Comparative Example 11 demonstrated satisfactory flame resistance based on 100% of content of the halogen containing fiber, but since it did not include any natural fibers and/or chemical fibers, it gave a problem in processability at the time of nonwoven fabric preparation. Table 5 shows flame resistance evaluation test results of Examples 14 to 19 and Comparative Examples 8 to 11.

Table 5

		Amount of addition in halogen containing fiber (parts by weight)				Ratio of fibers constituting nonwoven fabric (parts by weight)			Flame resistance evaluation result	Processability evaluatio	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Kaolin	Additive total amount	Halogen containing	Rayon fiber	Poly ester fiber	State of nonwoven fabric		
Ex.	14	20	10	20	50	80	0	20	B	B	Passed
	15	20	10	20	50	40	40	20	A	A	Passed
	16	20	10	20	50	20	60	20	B	A	Passed
	17	20	10	20	50	20	40	40	A	A	Passed
	18	5	10	20	35	40	40	20	B	A	Passed
	19	10	5	20	35	40	40	20	B	A	Passed
Com. Ex.	8	40	10	0	50	80	0	20	C	B	Failed
	9	0	10	40	50	80	0	20	C	B	Failed
	10	20	10	20	50	5	75	20	C	A	Failed
	11	20	10	20	50	100	0	0	B	C	Failed

(Examples 20 to 27, Comparative Examples 12 to 14)

5 [0117] According to Manufacturing Example 3, prepared were halogen containing fibers comprising zinc oxide as zinc compound, antimony trioxide as antimony compound, and aluminum hydroxide as other inorganic compound as shown in Table 6. Then nonwoven fabrics consisting of predetermined ratios of the obtained halogen containing fibers, a polyester fiber (6.6 dtex, 51 mm of cut length), and a rayon fiber (1.5 dtex, 38 mm of cut length), and cotton were prepared for flame resistance evaluation test 2. Table 6 shows evaluation results.

[0118] Examples 20 to 27 gave satisfactory combustion test results. The nonwoven fabrics for flame resistance evaluation examination did not give occurrence of any cracks or perforations, but formed satisfactory carbonized films.

10 [0119] On the contrary, although Comparative Examples 12 to 14 included equivalent amounts of flame resistant agents as in Example 14, Comparative Example 12 could not form satisfactory carbonized films, and gave perforations in the nonwoven fabrics due to absence of zinc oxide as zinc compound therein.

[0120] Comparative Example 13 had a small amount of content of the halogen containing fiber, and could not form satisfactory carbonized film.

15 [0121] Although Comparative Example 14 demonstrated satisfactory flame resistance based on 100% of content of the halogen containing fiber, but since it did not include any natural fibers and/or chemical fibers, it gave a problem in processability at the time of nonwoven fabric preparation. Table 6 shows flame resistance evaluation test results of Examples 20 to 27 and Comparative Examples 12 to 14.

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Table 6

		Amount of addition in halogen containing fiber (parts by weight)				Ratio of fibers constituting nonwoven fabric (parts by weight)				Flame resistance evaluation result	Processability evaluation	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Aluminum hydroxide	Additive total amount	Halogen containing fiber	Rayon fiber	Cotton fiber	Polyester fiber	State of nonwoven fabric		
Ex.	20	20	10	20	50	80	0	0	20	B	B	Passed
	21	20	10	20	50	40	40	0	20	A	A	Passed
	22	20	10	20	50	20	60	0	20	B	A	Passed
	23	20	10	20	50	20	40	0	40	A	A	Passed
	24	5	10	20	35	40	40	0	20	A	A	Passed
	25	10	5	20	35	40	40	0	20	A	A	Passed
	26	15	10	10	35	40	40	0	20	A	A	Passed
	27	15	10	10	35	40	0	40	20	A	A	Passed
Com. Ex.	12	0	10	40	50	80	0	0	20	C	B	Failed
	13	20	10	20	50	5	75	0	20	C	A	Failed
	14	20	10	20	50	100	0	0	0	B	C	Failed

(Examples 28 to 30, Comparative Example 15)

[0122] According to the Manufacturing Example 4, halogen containing fibers including zinc oxide as a zinc compound, antimony trioxide as an antimony compound, and kaolin as an inorganic compound in amounts in Table 7 were produced. Then nonwoven fabrics consisting of predetermined ratios of the obtained halogen containing fibers, a polyester fiber (6.6 dtex, 51 mm of cut length), and a rayon fiber (1.5 dtex, 38 mm of cut length) were prepared for flame resistance evaluation test 2. Table 7 shows evaluation results.

[0123] Examples 28 to 30 gave satisfactory combustion test results. The nonwoven fabrics for flame resistance evaluation examination did not give occurrence of any cracks or perforations, but formed satisfactory carbonized films after heating by means of gas stove.

[0124] Although Comparative Example 15 included equivalent amounts of antimony compounds, and kaolin as in Examples 28 to 30, but it could not form a satisfactory carbonized film but gave perforations caused in the nonwoven fabric due to the absence of zinc oxide as zinc compound. Table 7 shows flame resistance evaluation test results of Examples 28 to 30 and Comparative Example 15.

		Amount of addition in halogen containing fiber (parts by weight)				Ratio of fibers constituting nonwoven fabric (parts by weight)			Flame resistance evaluation result	Processability evaluation	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Kaolin	Additive total amount	Halogen containing fiber	Rayon fiber	Polyester fiber	State of nonwoven fabric		
Ex.	28	15	10	20	45	40	40	20	A	A	Passed
	29	15	10	20	45	20	60	20	B	A	Passed
	30	15	10	20	45	20	40	40	B	A	Passed
Com. Ex.	15	0	10	20	30	40	40	20	C	B	Failed

Table 7

(Examples 31 to 33, Comparative Example 16)

[0125] According to Manufacturing Example 4, prepared were halogen containing fibers comprising zinc oxide as zinc compound, antimony trioxide as antimony compound, and aluminum hydroxide as other inorganic compound as shown in Table 8. Then nonwoven fabrics consisting of predetermined ratios of the obtained halogen containing fibers, a polyester fiber (6.6 dtex, 51 mm of cut length), and a rayon fiber (1.5 dtex, 38 mm of cut length) were prepared for flame resistance evaluation test 2. Table 8 shows results.

[0126] Examples 31 to 33 gave satisfactory combustion test results, nonwoven fabrics for flame resistance evaluation examination gave occurrence of neither cracks nor perforations after heating by means of a gas stove, but formed satisfactory carbonized film.

[0127] Although Comparative Example 16 included equivalent amounts of antimony trioxide and aluminum hydroxide as in Examples 31 to 33, but it could not form a satisfactory carbonized film but gave perforations caused in the nonwoven fabric due to the absence of zinc oxide as zinc compound. Table 8 shows flame resistance evaluation test results of Examples 31 to 33 and Comparative Example 16.

		Amount of addition in halogen containing fiber (parts by weight)				Ratio of fibers constituting nonwoven fabric (parts by weight)			Flame resistance evaluation result	Process ability evaluation	Comprehensive evaluation
		Zinc oxide	Antimony trioxide	Aluminum hydroxide	Additive total amount	Halogen containing fiber	Rayon	Polyester fiber	State of nonwoven fabric		
Ex.	31	15	10	20	45	40	40	20	A	A	Passed
	32	15	10	20	45	20	60	20	A	A	Passed
	33	15	10	20	45	20	40	40	A	A	Passed
Com. Ex.	16	0	10	20	30	40	40	20	C	B	Failed

Table 8

(Examples 34 to 36, Comparative Example 17)

[0128] According to the Manufacturing Example 3, halogen containing fibers including zinc oxide as a zinc compound, antimony trioxide as an antimony compound, and kaolin as an inorganic compound in amounts in Table 9 were produced. Then nonwoven fabrics consisting of predetermined ratios of the obtained halogen containing fibers, a polyester fiber (6.6 dtex, 51 mm of cut length), and a rayon fiber (1.5 dtex, 38 mm of cut length) were prepared for flame resistance evaluation test 3. Table 9 shows results.

[0129] Examples 34 to 36 gave satisfactory combustion test results, and formed satisfactory carbonized films, and flaming to urethane foam was not observed.

[0130] Although Comparative Example 17 included an equivalent amount of an antimony compound and kaolin as in Examples 34 to 36, but since it did not include zinc oxide as a zinc compound, it could not form satisfactory carbonized film but gave flaming to urethane foam. Table 9 shows flame resistance evaluation test results of Examples 34 to 36 and Comparative Example 17.

Table 9

		Amount of addition in halogen containing fiber (parts by weight)				Ratio of fibers constituting nonwoven fabric (parts by weight)			Flame resistance evaluation result
		Zinc oxide	Antimony trioxide	Kaolin	Additive total amount	Halogen containing fiber	Rayon fiber	Polyester fiber	
Ex.	34	15	10	20	45	40	40	20	A
	35	5	10	20	35	40	40	20	B
	36	10	5	20	35	40	40	20	A
Com. Ex.	17	0	10	20	30	40	40	20	C

(Examples 37 to 39, Comparative Example 18)

[0131] According to the Manufacturing Example 3, halogen containing fibers including zinc oxide as a zinc compound, antimony trioxide as an antimony compound, and kaolin as an inorganic compound in amounts in Table 9 were produced. Then nonwoven fabrics consisting of predetermined ratios of the obtained halogen containing fibers, a polyester fiber (6.6 dtex, 51 mm of cut length), and a rayon fiber (1.5 dtex, 38 mm of cut length) were prepared for flame resistance evaluation test 3. Table 10 shows results.

[0132] Examples 37 to 39 gave satisfactory combustion test results, and formed satisfactory carbonized films, and flaming to urethane foam was not observed.

[0133] Although Comparative Example 18 included an equivalent amount of an antimony compound and kaolin as in Examples 37 to 38, but since it did not include zinc oxide as a zinc compound, it could not form satisfactory carbonized film but gave flaming to urethane foam. Table 10 shows flame resistance evaluation test results of Examples 37 to 39 and Comparative Example 18.

Table 10

		Amount of addition in halogen containing fiber (parts by weight)				Ratio of fibers constituting nonwoven fabric (parts by weight)			Flame resistance evaluation result
		Zinc oxide	Antimony trioxide	Aluminum hydroxide	Additive total amount	Halogen containing fiber	Rayon fiber	Polyester fiber	
Ex.	37	15	10	20	45	40	40	20	A
	38	5	10	20	35	40	40	20	A
	39	10	5	20	35	40	40	20	B
Com. Ex.	18	0	10	20	30	40	40	20	C

Claims

1. A flame resistant synthetic fiber comprising:

100 parts by weight of a polymer containing halogen atom of not less than 17% by weight;
 3 to 50 parts by weight of a zinc compound;
 0 to 30 parts by weight of an antimony compound; and
 3 to 30 parts by weight of an other inorganic compound, and
 total amount of the zinc compound, the antimony compound and the other inorganic compound being not less than 15 parts by weight.

2. The flame resistant synthetic fiber according to Claim 1, wherein the polymer containing halogen atom of not less than 17% by weight consists of:

acrylonitrile 30 to 70 parts by weight;
 a halogen containing vinyl and/or halogen containing vinylidene monomer 70 to 30 parts by weight; and
 a vinyl monomer copolymerizable with the monomers 0 to 10 parts by weight.

3. The flame resistant synthetic fiber according to any one of Claim 1 and 2, wherein the zinc compound is a compound selected from zinc, zinc oxide, zinc borate, zinc stannate, and zinc carbonate.

4. The flame resistant synthetic fiber according to Claim 3, wherein the other inorganic compound is a compound selected from a group consisting of natural or synthetic mineral based compounds, such as kaolin, zeolite, montmorillonite, talc, perlite, bentonite, vermiculite, diatomaceous earth, and graphite;

aluminum based compounds, such as aluminum hydroxide, aluminum sulfate, and aluminum silicate;
 magnesium compounds, such as magnesium hydroxide and magnesium oxide; and
 silicon compounds, such as silicate and glasses.

5. The flame resistant synthetic fiber according to Claim 3 comprising:

100 parts by weight of the polymer containing halogen atom of not less than 17% by weight
 3 to 30 parts by weight of the zinc compound;
 0 to 30 parts by weight of the antimony compound; and
 3 to 30 parts by weight of kaolin or aluminum hydroxide as the other inorganic compound, total amount of the zinc compound, the antimony compound and the other inorganic compound being 20 to 50 parts by weight.

6. A flame resistant fiber composite consisting of:

a fiber (A) not less than 10 parts by weight, and
 a natural fiber and/or a chemical fiber (B) not more than 90 parts by weight,
 the fiber (A) comprising:
 100 parts by weight of a polymer containing halogen atom of not less than 17% by weight;
 3 to 50 parts by weight of a zinc compound;
 0 to 30 parts by weight of an antimony compound; and
 3 to 30 parts by weight of an other inorganic compound, and
 total amount of the zinc compound, the antimony compound, and the other inorganic compound being not less than 15 parts by weight.

7. The flame resistant fiber composite according to claim 6, wherein the polymer containing halogen atom of not less than 17% by weight is a copolymer comprising:

acrylonitrile 30 to 70% by weight;
 a halogen containing vinyl and/or halogen containing vinylidene monomer 70 to 30% by weight; and
 a vinyl monomer copolymerizable therewith 0 to 10% by weight.

8. The flame resistant fiber composite according to Claim 7, wherein the zinc compound is a compound selected from a group consisting of zinc, zinc oxide, zinc borate, zinc stannate, and zinc carbonate.

9. The flame resistant fiber composite according to any one of Claims 6 to 8, wherein the other inorganic compound is a compound selected from a group consisting of:

5 natural or synthetic mineral based compounds, such as kaolin, zeolite, montmorillonite, talc, perlite, bentonite, vermiculite, diatomaceous earth, and graphite;
 aluminum based compounds, such as aluminum hydroxide, aluminum sulfate, and aluminum silicate;
 magnesium compounds, such as magnesium hydroxide and magnesium oxide; and
 silicon compounds, such as silicate and glasses.

- 10 **10.** The flame resistant fiber composite according to Claim 9, wherein the chemical fiber of at least one kind of fiber in the natural fiber and/or chemical fiber (B) is a polyester fiber and the amount of the polyester fiber being not more than 40 parts by weight.

- 15 **11.** The flame resistant fiber composite according to Claim 10, wherein the polyester fiber is a low melting point binder fiber.

- 12.** A nonwoven fabric comprising the flame resistant fiber composite according to any one of Claims 6 to 8.

- 20 **13.** A nonwoven fabric for flame shielding barriers according to Claim 12.

- 14.** An upholstered furniture products using the flame resistant fiber composite according to any one of Claims 6 to 8.

- 15.** An upholstered furniture products using the nonwoven fabric according to Claim 12.

- 25 **16.** An upholstered furniture products using the nonwoven fabric for flame shielding barriers according to Claim 13.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/014692

A. CLASSIFICATION OF SUBJECT MATTER

D01F6/48 (2006.01), **D01F6/54** (2006.01), **C08K3/00** (2006.01),
C08K3/20 (2006.01), **C08L101/04** (2006.01), **D01F1/07** (2006.01)

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)

D01F1/00-6/96 (2006.01), **C08K3/00** (2006.01), **C08K3/20** (2006.01),
C08L101/04 (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-96619 A (Kanebo, Ltd.), 03 April, 2003 (03.04.03), Claims 1, 2; Par. Nos. [0025], [0036] (Family: none)	1-16
X	JP 53-28728 A (KANEKA Corp.), 17 March, 1978 (17.03.78), Claim 1; page 2, upper right column, lines 11 to 16; example 3 (Family: none)	1-3, 5-8, 10-16
A	JP 10-1821 A (KANEKA Corp.), 06 January, 1998 (06.01.98), Claims 1 to 3; page 2, upper right column, lines 11 to 16; example 3 (Family: none)	1-16

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
05 October, 2005 (05.10.05)Date of mailing of the international search report
25 October, 2005 (25.10.05)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/014692

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), Claims 1, 2; page 3, lower left column, lines 1 to 12 & US 4863797 A1 & EP 183014 A2	1-16
A	JP 50-24531 A (Kohjin Co., Ltd.), 15 March, 1975 (15.03.75), Claims 1, 2 (Family: none)	1-16
A	JP 49-62731 A (KANEKA Corp.), 18 June, 1974 (18.06.74), Claim 1; example 4 & US 3862070 A & DE 2352572 A	1-16

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 61089339 A [0012]
- JP 8218259 A [0012]
- WO 03023108 A [0012]