FIBERGLASS FIRE BARRIER FOR MATTRESSES

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ABSTRACT

Provided is a mattress with a fire resistant layer. The layer is strategically placed in the mattress, preferably protecting its core materials, and comprises biosoluble glass microfibers having an average diameter ranging from 1.0 to 5.0 microns.
FIBERGLASS FIRE BARRIER FOR MATTRESSES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to open flame resistant mattresses and mattress foundations protected by a fire barrier comprised of microfiber fiberglass. More specifically, the microfiber is comprised of biodegradable glass having a diameter which ranges from 1.0 to 5.0 μm.

2. Description of the Related Art

The importance of preventing mattress fires in institutional settings has been recognized for many years, and a number of standards for flame retardance of these mattresses have been promulgated. A federal performance standard applicable to mattresses on a nationwide basis is codified in 16 CFR Part 1632 (Standard for Flammability of Mattresses and Mattress Pads), customarily referred to as the Cigarette Ignition Standard, the entire contents of which are incorporated herein by reference. However, even when mattresses meet the requirements of the Cigarette Ignition Standard, these can react with volatile and potentially deadly results when exposed to open-flame and smoldering ignition sources. The result can be a fire with sufficient energy to cause an average size room to reach a state of total instantaneous combustion or flashover. The California Bureau of Home Furnishings and Thermal Insulation has addressed the hazards associated with the ignition of mattresses in public institutions with California Technical Bulletin #279 (hereinafter ‘TB 129’), published as a draft standard in 1992. It has since been adopted as a voluntary consensus standard by the American Society of Testing and Materials as ASTM E-1590 and the National Fire Protection Association (NFPA) as NFPA 267. (ASTM E-1590 and NFPA 267 use essentially the same test protocol as TB 129 but contain no failure criteria.) The standard has also been embodied in NFPA's Life Safety Code 2000, section 10.3.4, and in Underwriter's Laboratories' 1895,

Although hazards in public institutions have been addressed with standards based on TB 129, the number of injuries and fatalities associated with residential fires in which a mattress was the first item ignited or the mattress exacerbated the fire event has led to efforts to reduce flammability of mattresses used in homes. One notable event is the passage of Assembly Bill 603 in the California Legislative Assembly. The bill calls for virtually all mattresses and sleep surfaces sold in the State of California, as of Jan. 1, 2005 to meet an open flame resistance standard. In addition, the Consumer Products Safety Commission is currently developing new regulations for further reducing mattress flammability beyond the level required by the Cigarette Ignition Standards. This was announced recently in the Federal Register (Advance Notice of Public Rule Making (ANPR) published Oct. 11, 2001).

New standards for flammability of residential mattresses will require new materials and methods of manufacturing these, as mattresses targeted for residential markets differ significantly from those typically used in institutions. Institutional bedding installations typically require only a mattress and no foundation; mattress may be simply a solid core of polyurethane foam, which may be combustion modified to some degree as well. Many of the components used in institutional mattresses and sleep support surfaces, including fill materials and covering fabrics are subject to performance testing according to test criteria such as NFPA 701 and California Technical Bulletin No. 117.

In contrast to institutional bedding, residential sleep surfaces are typically covered and filled with a number of potentially volatile components, including polyurethane foam, highly combustible ticking fabrics, insulator padding, and pockets or cavities of air that can serve to feed an ignition source such as a candle, match, lighter, faulty electric socket, tipped over lamp or smoldering cigarette. For instance, pillow-top constructions feature additional layers of filling materials contained in layers on the panel surfaces, and set off aesthetically from the basic mattress design by gussets or seam lines in the case of the box-top approach. Gussets create thin lines of highly volatile fill materials and add more gaps and crevasses that can trap and concentrate heat and flame. A crowned/convex shape for the sleep surface or mattress panel also creates crevasses or voids between a mattress and foundation, again providing areas that can trap heat and flames and concentrates these on small areas. Also, the presence of a foundation does not provide an easy escape path for dissipation of heat across and beyond the bottom of the mattress. Super heating in the air cavity within the mattress and/or foundation can lead to what has been referred to as a flashover event.

One approach to reducing flammability of mattresses used in residential settings has been to treat fabrics used in their construction with chemical flame retardants. However, these chemical treatments may be objectionable because of distasteful odors which are noticeable when in close contact with the materials, off-gassing obnoxious elements, stiffness of the fabric caused by such treatments, which may compromise the comfort of the finished mattress or mattress foundation, and the potential temporary durability of such treatments, which may compromise the long term protection from open-flame, smoldering ignition and radiant/thermal heat flux sources.

The use of fiberglass as a fire barrier material has been suggested. For example, U.S. Pat. No. 4,504,991, to Klancnik, relates to a fire-resistant mattress that includes a flame-retardant composite. The composite is a two-layered material, made up of a flame-retardant material that forms a door when exposed to fire and a layer of high tensile strength material. The flameable materials of the mattress are enclosed by the composite. In the single embodiment disclosed, the composite is made up of a neoprene foam bonded to a fiberglass fabric.

U.S. Pat. No. 4,092,752, to Dougan, relates to a mattress enclosed with a flame-retardant polyurethane foam having an optional layer of polyimide foam. The foam core is enclosed in a flame retardant cloth or retardant ticking, e.g., fiberglass cloth.

U.S. Pat. No. 4,801,493 to Feiziger et al., describes coated fiberglass fabrics which are fire retardant. The chemically coated fabric comprises a woven or non-woven fiberglass fabric base to which one or more thin layers of a polymeric coating have been applied. The fiberglass fabric base is inherently fire retardant.

See also U.S. Pat. Nos. 4,866,799 and 6,823,548. Both of these patents relate to the use of a fire resistant barrier or shield in a mattress. The barrier or shield can comprise fiberglass.

U.S. Patent Publication No. 2006/0021148 A1 discloses glass fiber products used to reduce the flammability of mattresses and upholstery. In one disclosed embodiment, a
veil formed of glass fibers, comfort enhancing fibers, and optionally a combination of synthetic fibers is positioned on the bottom of a mattress to provide fire resistance or prevention. The binder composition used to form the veil may include a binder with a low glass transition temperature and a flame retardant additive. In a second embodiment, the glass veil is utilized in a fire retarding composite formed of an encapsulating layer, a fire retarding veil, and a backing layer. Preferably, all of the fibers in the veil are glass fibers. The glass fibers have a diameter which ranges from 6.5-25 microns. The fire retarding composite is positioned on the mattress with the encapsulating layer against the cushioning material, the backing layer facing externally, and the veil sandwiched between the encapsulating layer and the backing layer.

[0014] U.S. Pat. No. 6,718,583 discloses a fire retardant mattress which has a foam base covered by a fire barrier material. A ticking covers the fire barrier material, which can be fiberglass. Sheets of these combined materials are formed into a top, a bottom and sidewalls for the mattress. The intersecting planar surfaces are formed as a flange which is sandwiched between a fire-retardant treated edge binding tape. The flange is sewn with a fire retardant thread to encapsulate the mattress with the fire retardant components.

[0015] However, none of these solutions is capable of imparting sufficient and consistent flame-retardant characteristics to the full breadth of styles and constructions of bedding typically used in the home, that is, a comfortable mattress placed atop a foundation, both containing a significant amount of flammable material. As a result, there is a need for new materials to protect residential mattress sets from fire, and especially for material in use in manufacturing mattress that can meet the more stringent flammability standards expected to be imposed on the residential market, such as TB-603 (2004) and 16CFR1633 (2007). Also there is a need for providing comfortable bedding which is fire resistant. This is particularly true when using fiberglass, which can often result in itch. Providing protection without the need for flame retardant chemicals is also an important objective, as it would also avoid the irritation and problems that chemicals can cause.

SUMMARY OF THE INVENTION

[0016] The present invention provides a fire resistant layer for use in mattresses, and other furniture such as upholstered furniture, which layer is comprised of glass microfibers. The glass microfibers are biodegradable and have a diameter ranging from 1.0 to 5.0 microns, more preferably from 1.0 to 3.0 microns, and are generally employed in a fire resistant layer strategically placed within the mattress or other item. In mattresses, the layer will generally be placed as a shield against an open flame reaching the core contents of the mattress, which are generally comprised of highly flammable materials.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The fire resistant layer can be a single layer of primarily microfiber fiberglass, or a single layer of primarily microfiber fiberglass with a nonwoven or woven facer on one side, or a “sandwich” of woven or nonwoven fabric, e.g. such as a needlepunched or spunbond nonwoven, around a core of primarily microfiber fiberglass.

[0018] The fiberglass fire barrier layer of the invention will be comprised primarily of microfibers of fiberglass having an average fiber diameter ranging from 1.0 microns to 5.0 microns, and preferably from 1.0 to 3.0 microns, and more preferably from 1.0 to 1.5 microns when used together with ticking, and preferably from 2.0 to 2.5 microns when used in a mattress border in combination with a synthetic fiber, such as a spunbond polyester mat. The smaller microfibers are preferred for reasons of comfort. The glass microfiber is also biodegradable, which is important for health considerations, particularly in light of the microfiber size employed. Use of the microfibers of the present invention also offers better thermal insulation in resistance to flame penetration.

[0019] The microfiber fiberglass nonwoven layer can be formed using a variety of conventional nonwoven processes. These include, but are not limited to air-laid, dry-laid or wet-laid processes. These processes form a fire-resistant nonwoven fabric. This fire-resistant fabric can also contain between 0% and 60% by weight, and most preferably from 0 to 40% by weight, of polymer, natural and/or glass fibers that are longer than 8 microns in diameter. It is preferred, however, that the fabric be an all glass product, but not necessarily an all micro-fiberglass product.

[0020] Any type of glass fibers, such as A-type glass fibers, C-type glass fibers, E-type glass fibers, S-type glass fibers, FAC-type glass fibers or modifications thereof can be used to form the fire retardant barrier. In addition to glass fibers, synthetic fibers such as, but not limited to, polyester, polyamide, aramid, polycarbonate chloride and polystyrene acetate, melamine (e.g., Basofil.RTM.), modacrylic, Vysil.RTM. (a silic acid modified rayon), nylon, rayon, acetate, and mixtures thereof may be used in combination with the glass fibers.

[0021] The fire-resistant nonwoven can be either bonded or unbonded. For bonding, an organic binder, such as, but not limited to, urea formaldehyde, melamine or acrylic binder can be used. Also, an inorganic binder, such as, but not limited to, the bonding action of acid drying on glass fibers is an option. Unbonded fibers that are held together by the tangling of the fibers either with or without one or two facers for added strength or handleability can also be employed in another embodiment.

[0022] In a preferred embodiment, the binder is a formaldehyde free binder, such as an acrylic binder, a styrene acrylonitrile binder, or a styrene butadiene rubber binder. Most preferably, the binder is a standard thermosetting acrylic binder formed by reacting polyacrylic acid and a polyol such as triethanolamine. The binder is also preferably cross-linked. Such binders are commercially available and are well known to the industry.

[0023] The binder is supplied to the fibers at a rate such that the glass microfiber barrier contains up to about 25% by weight binder and more preferably from 5 to 25 weight %. The combined weight of the glass microfiber and the binder is generally in the range of from 0.1 to 1.0 oz/sq ft, and more preferably in the range of from 0.15 to 0.50 oz/sq ft. When the glass microfiber fire barrier layer is to be used in a mattress border the combined weight of the glass microfiber and binder is preferably in the range of from 0.20 to 0.50 oz/sq ft, whereas the preferred range is from 0.16 to 0.40 oz/sq ft when the fire barrier is used integrally with ticking. Overall, the minimum preferred product weight should be 0.25 oz/sq ft for low fuel load mattress sets, and 0.50 oz/sq ft for high fuel load mattress sets.
If desired, the binder composition can also optionally include a flame retardant. Non-limiting examples of suitable flame retardants that may be used in the binder composition include phosphorus-based flame retardants such as nitrogen phosphorus and phosphate; aluminum trihydrate; magnesium hydroxide; calcium hydroxide; calcium carbonate; antimony trioxide; boron salts; halogenated flame retardants; melamine-based flame retardants; and mixtures thereof. The flame retardant may be present in the binder composition in an amount up to 20% by weight of the binder composition. Preferably, use of fire retardant chemicals like antimony trioxide, boron salts, and halogenated compounds are avoided.

Furthermore, the binder composition may optionally contain conventional additives such as dyes, oils, fillers, thermal stabilizers, emulsifiers, anti-foaming agents, antioxidants, organosilanes, colorants, UV stabilizers, and/or other conventional additives. Other additives may be added to the binder composition for the improvement of process and product performance. Such additives include coupling agents (e.g., silane, aminosilane, and the like), dust suppression agents, lubricants, wetting agents, surfactants, antistatic agents, and/or water repellent agents.

The fire resistant layer comprising the glass microfibers can further comprise a woven or non-woven substrate. The substrate can be a needlepunched, hydroentangled, or spunbond nonwoven fabric bonded on one or both sides of the fire resistant layer. These substrates can add comfort, tensile and tear strength to the fire resistant layer. The substrate can be of any suitable polymeric fiber, e.g., polyester, polypropylene or nylon.

In one embodiment, the product is comprised of a glass microfiber which is biosoluble, and has an average diameter in the range of from 1.0 to 5.0 microns, more preferably from 2.0 to 2.5 microns. The product is bound with a binder free of formaldehyde, and the combined weight of glass microfiber and binder ranges from 0.16 to 0.80 oz/sq ft, and more preferably from 0.20 to 0.50 oz/sq ft. The glass microfiber is collected on polymeric backing, such as a lightweight, thermally bonded polyester spunbond backing. The use of such a backing, and in particular a polyester spunbond backing, has multiple benefits. Losses in the manufacturing process are reduced, the backing provides tensile strength to allow the product to be pulled through the manufacturing process, and the backing can serve as a stitch-holding layer in the mattress binder quilting process, thereby acting as a mattress component and reducing the number of components that must be fed into the quilting machine, reducing product waste during roll transaction.

In another embodiment, the backing discussed above is removed, or absent. The absence of the spunbond backing allows the glass microfiber fire barrier to be used in the top layer of the mattress. The backing can often create noise as it is deformed and frequently causes wrinkles during the mattress panel quilting process.

The functionality of the fire-resistant nonwoven is to act as a barrier to inhibit fire and heat from an open flame such as a candle, match, cigarette lighter or the same from reaching the inside of the mattress. Typically the inside of a mattress is made of highly flammable material such as foam that will burn quickly and at high temperatures if exposed to an open flame and may spontaneously combust if enough heat is added. As noted above, the functionality of the outside woven or nonwoven substrates is to provide tensile and tear strength to allow the fire resistant layer fabric to be more easily stitched into a mattress in a standard construction and as a comfort layer.

A typical design approach for residential mattresses is to localize comfort elements, such as polyurethane foams and battings, in the sleep surface areas (panels), with a minimum of fabric in the borders or sides. Accordingly, the fire barrier fabric comprising the glass microfibers according to the present invention at least partially encloses the core of the mattress, and the core may be fully enclosed, if desired. In addition, the weight of the fire barrier layer and the composition of any outside substrate may be varied in order to address the burning and combustion challenges presented by a variety of mattress and mattress foundation designs. The fire barrier fabric having different compositions and weight may be used to cover different areas of the mattress or mattress foundation. In general, design and financial resources for raw materials and assembly costs may be targeted to areas of the mattress and foundation that require a greater investment for fire protection. Also, the fire barrier fabric for the panel and/or border may be joined at the tape edge of the mattress with sewing thread specifically designed to withstand ignition, typically para-aramid or fiberglass sewing thread.

In still another embodiment, there is provided a product that targets the mattress manufacturer who desires a fire barrier capable of delivering superior loft without having to introduce another roll good into the quilting machine. In this embodiment, the glass microfiber barrier layer is formed on a high-loft polymeric, e.g., polyester, fiberfill fabric. Such fabrics are often used by mattress manufacturers to deliver loft in non-fire resistant mattresses. The primary benefit to the mattress manufacturer would be the amount and quality of loft that could be imparted to quilted borders and panels. Additional benefits would be realized through reduced waste during roll transition on the quilting machine. The fiberfill will provide sufficient tensile strength to allow the fire barrier to be pulled through the manufacturing process without requiring modifications to the machine. As a forming surface, the fiberfill will also drastically reduce and prevent the process losses often realized when the air-laid fire barrier product is formed without a form.

The fire barrier fabric may be placed under or disposed beneath a mattress ticking, but is generally never placed as the outermost layer. The fire barrier fabric may be simply placed adjacent to or in contact with the ticking using flame-retardant thread, or it may be bonded or attached to it. In particular, the fire barrier fabric may be conveniently quilted to the ticking, as mattresses for the residential market typically have decorative patterns stitched in the cover fabric or filling materials. This can be of benefit to mattress manufacturers, and only one feed position on quilting equipment may be required to add the fire barrier fabric during the quilting operation. Fire-retardant thread composed of the resistant fibers such as fiberglass or para-aramid may be used in the quilting operation. Thus, this embodiment would offer the mattress manufacturer an integrated ticking/fire barrier product that could be used virtually anywhere on the mattress. The ticking would also serve in place of the backing desired above, as a forming surface and a tensile reinforcement.

Having thus described the invention in detail, it will be understood that such detail need not be strictly adhered to, but that additional changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.
1. A mattress comprising a fire resistant layer of at least 15% by weight biosoluble glass microfiber having an average diameter in the range of from 1.0 to 5.0 microns.

2. The mattress of claim 1, wherein the glass microfiber has an average diameter of from 1.0 to 3.0 microns.

3. The mattress of claim 2, wherein the glass microfiber has an average diameter of from 2.0 to 2.5 microns.

4. The mattress of claim 2, wherein the glass microfiber has an average diameter of from 1.0 to 2.0 microns.

5. The mattress of claim 1, wherein the glass microfiber has an average diameter of from 4.0 to 5.0 microns.

6. The mattress of claim 1, wherein the fire resistant layer further comprises a woven or non-woven fabric on one or both sides of the layer.

7. The mattress of claim 6, wherein the fire resistant layer comprises a polymeric fabric on at least one side.

8. The mattress of claim 6, wherein the fire resistant layer comprises a sandwich of woven or nonwoven fabric around a core comprised of glass microfiber.

9. The mattress of claim 7, wherein the polymer fabric is comprised of a polyester or polypropylene material.

10. The mattress of claim 7, wherein the polymer fabric is comprised of a spunbond polyester material.

11. Furniture comprising a fire resistant layer of at least 15% by weight glass microfiber having an average diameter in the range of from 1.0 to 5.0 microns.

12. The furniture of claim 11, wherein the glass microfiber has an average diameter of from 1.0 to 3.0 microns.

13. The furniture of claim 12, wherein the glass microfiber has an average diameter in the range of from 2.0 to 2.5 microns.

14. The furniture of claim 12, wherein the glass microfiber has an average diameter in the range of from 1.0 to 2.0 microns.

15. The furniture of claim 11, wherein the glass microfiber has an average diameter in the range of from 4.0 to 5.0 microns.

16. The furniture of claim 11, wherein the furniture comprises a fire resistant layer of at least 75% by weight glass microfiber having an average diameter in the range of from 1.0 to 5.0 microns.

17. The mattress of claim 1, wherein the mattress comprises a fire resistant layer of at least 75% by weight biosoluble glass microfiber having an average diameter in the range of from 1.0 to 5.0 microns.

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