ABSTRACT

A bi-regional fiber with a cellulosic core and a wax outer sheath is disclosed. The sheath can comprise high melting temperature wax. The fiber may be produced by processing the natural fiber at temperatures less than 70° C. The fiber can be processed in a standard manner, e.g., Keir process which may include bleach at approximately 100° C., and the wax subsequently added at a temperature sufficient to disperse the wax over the fibers. The fibers are ignition resistant as measured by industry standard tests, e.g., FAR 25.853(b) or 14 CFR 25.853(b). The wax may comprise less than 1 percent to 25 percent of the fiber by weight. The wax may be natural wax, synthetic or emulsified wax or blends thereof. The bi-regional fibers can be blended with other fibers including BRCF fibers subject of U.S. Pat. No. 5,700,573.
NOVEL IGNITION RESISTANT COTTON FIBER, ARTICLES MADE FROM IGNITION RESISTANT COTTON FIBERS, AND METHODS OF MANUFACTURE

FIELD OF THE INVENTION

[0001] The present disclosure relates to an ignition resistant (flame retardant) whole cotton fiber, said whole cotton fiber having a cellulose region at the core and an outer region of a wax sheath or surface. The disclosure also relates to methods for the manufacture of the ignition resistant whole cotton fiber, and to articles made from a multiplicity of said bi-regional carbonaceous fibers.

[0002] The untreated cellulose core fiber comprises at least 70% of the fiber by weight and the wax sheath comprises at least 5% of the cotton fiber by weight.

BACKGROUND OF THE INVENTION

[0003] Cotton is a natural fiber and is renewable. That is, a new crop can be grown each year. Most synthetic fibers are made from petroleum which is not a renewable resource. Cotton has been available for thousands of years; hence a great deal of knowledge about its physical and chemical properties are well known. Because of its unique chemical nature, it can be made to be fire retardant, have wash-wear (wrinkle free), among numerous other properties. It can be blended with other textile fibers to enhance the overall performance of the blended fabric.

[0004] Raw cotton, i.e., unprocessed, like all vegetable matter contains minerals, resins, gums, protein, tannins, oils and waxes, and carbohydrates, in addition to cellulose. It normally has to be purified in order to remove these products from the primary cellulose polymer substrate. Most of these are removed in a “Kier” boil process, a standard treatment process in which caustic soda (NaOH), and other processing aids are employed at temperatures of up to 100°C, to solubilize and remove these impurities. The oils and waxes are saponifiable; hence are removed by this “preparation” process. Continuous processes have been developed which utilize a steam treatment (100°C) to speed up the process and reduce the time required by the Kier (batch) method. A comparison of the composition of raw cotton versus a Kier like treatment is shown in Table 1.

<table>
<thead>
<tr>
<th>% Composition of Cotton: Raw vs. a Kier Treatment</th>
<th>RAW COTTON</th>
<th>KIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose</td>
<td>85-85</td>
<td>99.1-99.5</td>
</tr>
<tr>
<td>Wax</td>
<td>0.4-1.0</td>
<td>0.01-0.15</td>
</tr>
<tr>
<td>Ash</td>
<td>0.8-1.8</td>
<td>0.05-0.075</td>
</tr>
<tr>
<td>Pectin's</td>
<td>0.4-1.1</td>
<td>Nil</td>
</tr>
<tr>
<td>Protein (Nitrogen)</td>
<td>1.2-2.5</td>
<td>0.05-0.10</td>
</tr>
<tr>
<td>Pigment, Resin</td>
<td>3-5</td>
<td>Nil</td>
</tr>
<tr>
<td>Moisture</td>
<td>6-8</td>
<td>Nil</td>
</tr>
</tbody>
</table>

*From: Matthew’s Textile Fibers, 5th ed., Wiley & Sons, NY, 1947 p. 100

[0005] Note that virtually all impurities are removed by Kier boil “preparation” process treatment. Color is removed by a subsequent bleaching process normally employing either a Peroxide or a Hypochlorite process which removes the color to the desired degree of whiteness. The cotton fabric is now ready for numerous after-treatment processes such as dyeing by any of a variety of methods, conversion to a wash-wear, flame resistant or others, including combinations of all of the above. The patent literature is rife with further treatments to enhance the utility of the so treated cotton fabric (or cotton fabric blends).

[0006] The wax in the cotton fiber is not one having a single component but is thought to have a blend of complex esters and acids and alcohols. The waxes are thought to have a composition involving C24-C34 primary alcohols as well as other complex mixtures and a melting point of about 77°C, a density of 0.976, an acid value of 29, a saponification value of 57 (after acetylation, 137), an acetyl value of 84, an iodine number of 27, and 68% of un-saponifiable material (having an acetyl value of 123—indicating an absence of wax esters and a large proportion of free wax alcohols). It is probably the free wax alcohols that survive the treatment conditions outlined above (Kier process and the like). The purpose of the wax in the fiber is to protect the cotton seed from the harsh environments it may be subjected to prior to spring planting. Loose raw cotton will “float” on water for months; hence the cotton seed is protected against winter rains etc. Still, it is these wax components that survive the treatments outlined which result in the surprise benefits of ignition resistance cotton.

[0007] In order to reduce the inherent flammability of cotton fabrics, cotton fiber can be combined with inherently flame resistant fibers, such as synthetic fibers. For apparel use modacrylic fibers and matrix fibers of vinyl/vinylon, among others, have been used. The resulting fabrics frequently lack the performance properties and consumer appeal of pure cotton fabric. Fiber composed of 50% Vinal and 50% Vinyon, for example, is not strong enough to form its own fabric and is not easily dyed. Another disadvantage of this method of producing fire resistant fabric is that yarns containing two or more fibers with different flammability characteristics which tends to produce fabrics having non-uniform cross-sectional areas, and therefore, non-uniform fire resistant characteristics.

[0008] Alternatively, cotton fabric can be treated with flame retardant chemicals that change or interrupt the burning process known as pyrolysis. Cotton fabric treated with flame retardant chemicals, however, typically lack the performance properties and consumer appeal of pure cotton fabric. Most of these chemical treatments involve the use of harsh chemicals which are very unfriendly to the environment. Several have also been linked to health problems in infants and newborns. For this reason most of the newborn and infant bedding and sleepwear has been switched to 100% Polyester.

[0009] During pyrolysis most textile materials must first undergo decomposition to form volatile combustibles before they will burn. Decomposition occurs when the textile material is exposed to a sufficient source of heat. The decomposition temperature for textile materials is dependent upon the composition of the material and is different for different fibers. When the textile material decomposes, volatile materials are formed. The volatile materials ignite in the presence of oxygen to produce heat. The heat produced during pyrolysis may cause further decomposition of the textile material leading to its complete destruction.

[0010] The application of flame retardant chemicals may interrupt pyrolysis. For example, the flame retardant may be converted upon heating into acids and bases that catalyze decomposition of the textile at lower temperatures than are required for the formation of volatile combustibles. Compounds containing phosphorus are converted to acidic materials that catalyze the thermal decomposition of the polymer.
Alternatively, the flame retardant may decompose or sublime upon heating to release large amounts of nonflammable vapors which exclude oxygen from the flame.

A need exists for a cotton fiber that is inherently flame resistant such that fabric made from the fiber complies with flammability and safety regulations without application of flame retardant chemicals, or with application of reduced amounts of flame retardant chemical compared to fabric made from known untreated cotton fiber.

A need also exists for a cotton fiber that is made inherently flame resistant such that fabric made from the fiber complies with flammability safety regulations by having an ignition resistant wax sheath without application of flame retardant chemicals, or with application of reduced amounts of flame retardant chemical compared to fabric made from known untreated cotton fiber.

DEFINITIONS

The term “whole cotton” used herein generally refers to an ignitance resistant fiber that has a cellulose core and an outer region of a wax containing sheath or surface.

The term “ignitance resistant” as used herein refers to fibers or fiber assemblies that satisfactorily pass the (a) FAR 25.853(b) Flammability of Aircraft Seat Cushions, or (b) flammability test or the 45° angle flame impingement test (16 CFR 1610, Standard for the Flammability of Clothing Textiles).

The “fiber assembly” as used herein applies to a multiplicity of fibers that are in the form of a yarn, a wool like fluff, batt, mat, web or felt, and comprising a formed sheet, screen or panel, a braided, knitted or woven cloth or fabric, or the like.

The term “cohesion” or “cohesiveness” as used herein, applies to the force which holds fibers together, especially during yarn manufacture. It is a function of the type and amount of lubricant used, the fiber crimp and twist.

The term “Kier process” as used herein refers to the prior art standard processing of treating raw cotton by boiling the cotton in order to remove products from the primary cellulose polymer substrate. The oils and waxes are saponifiable; hence are removed by this “preparation” process.

The term “high temperature high alkalinity processed cotton” means cotton processed by the Kier process or similar processes conducted at temperatures of near 100° C.

All percentages given herein are in “percent by weight” unless otherwise specified.

SUMMARY OF THE INVENTION

The present invention comprises a major departure from the present state of the art by discovering that be cotton fiber which has a wax sheath unexpectedly has ignition resistance properties, even after being dyed under low temperature and alkaline conditions.

Bi-regional cotton of the invention is made from regular, ECRU or unbleached cotton either in the yarn or in fabric form. The resultant bi-regional cotton is 10% to 20% stronger than regular process cotton using high temperature and high alkalinity and has superior moisture handling capability and wrinkle resistance compared to traditional cotton. Superior moisture handling capability means that the fiber or fiber assembly is less absorbent of water.

Most importantly, we have recently discovered that the bi-regional cotton is inherently flame retardant and passes the 45° angle flame impingement test as prescribed for children's sleepwear in the United States. The bi-regional cotton has no harsh chemicals in contact with the infant skin and requires no additional flame retardant treatment such as that required by traditional cotton to pass the 45° angle flame impingement test. The flame retardant treatments normally used in traditional cotton have been linked to sudden infant death syndrome and low IQs. The cost of making the bi-regional cotton is competitive with polyester and should restore this material as the material of choice for newborn, infant and children’s clothing.

The preferred embodiment of bi-regional cotton retains the natural waxes and oils of raw cotton and requires no additional finishes or lubricants and has superior handling compared with traditional cotton fabrics. The bi-regional cotton dyes in a more uniform manner than traditional processed cotton, such as the Kier process, and has far superior comfort properties.

The intended consequence of the Kier process, i.e., normal or standard processing of cotton, is that it removes all of the wax from the cotton fibers. A novel treatment has been developed which employs a low alkaline and low temperature process that does not remove the waxes. We have found that an unexpected result of such a treatment, allows the wax to either migrate to the surface of the cotton fiber or does not remove the surface wax thereby markedly increasing the ignition resistance of the final cotton fabric. Also the method (mild heating) migrates the wax to the surface forming the bi-regional fiber. Other properties, such as an enhanced hand (feel) smoothness of the fiber assemblies is also obtained. The cotton feels smoother than standard processed cotton. The process requires that all treatments must be done at a low temperature and alkalinity in order not to result in any unintended saponification which will solubilize, and result in removal of the wax.

Dye-ability is an important asset for any textile fiber. Cotton is fortunate that it can be colored by numerous different dyeing classes. Unfortunately, many of these (such as vat, Sulfur & Naphthol) are done employing high alkaline conditions. The choice of dye class will vary in the fastness properties they are able to impart to the finished dyed cotton such as light fastness, wash fastness, fastness to perspiration and the like. In order to achieve uniformity of dyeing, it is necessary to first prepare the cotton so that a uniform uptake and leveling of the applied dye stuff is achieved. The normal preparation step involves a Kier type treatment followed by bleaching to remove natural colored impurities. The most desirable dyeing conditions which insure survivability of the residual wax is a low temperature/low alkali reactive dyeing process.

The normally employed Kier/bleach process can be replaced with either a low temperature—peroxide/catalyst or low alkalinity hypochlorite process. These bleaching steps employ an “oxidative” rather than a high “heat/alkalinity” process to remove all the cotton impurities. The result is a process which retains essentially all of the waxy composition of the cotton fiber. In addition, the wax appears un-expectantly, to either migrate to the surface of the fiber or remain on the surface and is not removed by these oxidative processes. This process creates a wax layer on the outer surface of the cotton, thereby causing it to be bi-regional. This surface wax contributes to improving the ignition resistance of the fabric.

When using peroxide bleaching as taught by the instant disclosure, the bleach temperature does not exceed 60° C. Normal peroxide processes are done at the boil or
employ a steaming step, i.e., saturated steam at 100° C. or greater for continuous operations. Instead of employing a high alkalinity to stabilize the peroxide bath, only a 2 g/l Caustic solution is employed along with a complex blend of low foaming surfactants, a stabilizer (such as Crospre HES), and a catalyst that is active at the lower temperature (such as Crospre CAT) is employed. Any remaining peroxide is neutralized employing a non alkaline agent (such as Croszyme PEK). (The Crospre and Croszyme are obtained from Euro- dye-CTC S.A., Jodoigne, Belgium.)

[0028] If chlorine bleach is used only 1 g/l Cl₂ is employed in the bleach bath to prevent over bleaching. The pH is maintained at 7.5 to 8.0. Sodium carbonate is better at buffering the bleach bath than caustic soda. This also reduces the potential saponification of the wax. At lower pH, the bleaching reaction increases. For cotton fabrics with high natural color content, the temperature can also be increased but should never exceed 40° C. In such cases it is best to employ the weaker (1 g/l Cl₂) bleach solution at a higher temperature than to use stronger bleach solutions at lower temperatures. This is because the activity of the OCI⁻ ion responsible for the bleaching is temperature dependent. (See R. H. Peters, Textile Chemistry Vol. II, Elsevier, N.Y. 1967) Normal Chlorine bleaching processes, pads the bleach solution onto wet goods such as fabric directly from the kier process. In the revised process subject of this disclosure, the bleach is applied directly to the dry cloth and the problems with bleach uniformity in the fabric is reduced. The bleach solution can be applied by any of the application processes such as spraying, foaming or padding or the like.

[0029] Acidic products are produced as the oxidation process proceeds which reduces the normal alkalinity present. Ordinary bleaching with chlorine requires additional alkali to insure neutralization of the HCl which is formed during bleaching. This results in excessive alkali being present after bleaching which must be removed usually by a post treatment with acetic acid. Another advantage of this bi-regional cotton process is that an acetic acid wash step (to remove residual alkali) can usually be omitted since very little residual base should be present after the bleaching process. This saves processing time and expenses. The pH of the fabric will be sufficiently low after rinsing so as not to interfere with subsequent dyeing processes.

[0030] In a continuous process, J boxes can be employed to store the padded cloth but the dwell time should not exceed 20 minutes. As with any chlorine bleach methods any residual chlorine should be neutralized with either sodium thiosulfate or sodium bisulfite antioxidant.

[0031] Bleaching with bromine is faster than with chlorine but generally the method is not as cost effective as with chlorine. We have found that Small amounts (1-2% of bromine on weight of chlorine content) added to the chloride bleach solutions also measurably improves bleaching efficiency. Ref: R. H. Peters, Textile Chemistry Vol II, Elsevier, N.Y., 1967

[0032] Other cellulose fibers which may not have an inherent natural wax content similar to our so treated cotton, (bi-regional cotton) can be treated with a topical wax and receive the same ignition resistance. These other cellulose fibers include the Rayon’s, Linen (although non prepared Linen has a natural wax content of 0.5-2.0% (having a melting point of about 62° C.) as well as their blends. In these cases it is possible to subsequently treat the cellulose containing fabrics with a number of natural wax emulsions. The temperatures of drying will allow the emulsified wax to evenly distribute itself and become affixed on the fiber surface to achieve the bi-regional structure and the same ignition resistance as the so treated cotton.

[0033] This technique can also be employed to treat cotton fabrics that have been processed in the classical fashion i.e. Kier process, that removed virtually all of its natural wax. Applying any of a number of different natural waxes that include, but not limited to carnauba, bees wax, palm, soy, candelilla, jojoba, & wool waxes and the like. A number of high melting petroleum based waxes are also known and are available that will also have utility as substitutes for the natural waxes. These are also known and those skilled in the art have knowledge of methods necessary to emulsify and apply these waxes, that will well work to achieve the desired ignition resistant properties of the natural waxes. Blends of natural waxes and petroleum based waxes will also have utility for these applications. Cotton having different processing histories can be treated with these types of wax blends and are included within the scope of the invention.

<table>
<thead>
<tr>
<th>Melting Points of Some Natural Waxes (° C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bees Wax</td>
</tr>
<tr>
<td>Palm</td>
</tr>
<tr>
<td>Carnauba</td>
</tr>
<tr>
<td>Candelilla</td>
</tr>
<tr>
<td>Soy (high melting type)</td>
</tr>
<tr>
<td>Jojoba (high melting type)</td>
</tr>
<tr>
<td>Cotton</td>
</tr>
</tbody>
</table>

[0034] From the foregoing discussion, it should be obvious to those of ordinary skill in the art that blends of cellulose fibers will well benefit from a post application of an emulsified wax or combination of waxes. In addition the application of the saponified acid derivatives such as Lauric, Myristic, Palmitic, Stearic, Oleic among others will provide some ignition resistance to the so treated fabrics. These products will be removable in the laundry cycle but might be useful for fabrics that are not intended to be laundered.

[0035] Once the fabric has been bleached it may be dyed. The dyeing method of choice is with reactive dyes that can be dyed at temperatures not exceeding 60° C. and at low alkalinity. The dyes forms a covalent dye with an active hydrogen on the cotton fiber. The dye must be salted on with high concentrations of sodium chloride. The amount employed depends upon the dye level required to produce the required shade. Table 3 provides the suggested level of salt to employ and concentration of alkali (The preferred alkali is soda ash) that needs to be employed to achieve the fixation of the dye. Once the dye reaches the desired equilibrium (i.e., the proper shade), 2 gpl soda ash is added to fix the dye within the fibers. This level of alkalinity does not result in saponification of the surface wax. Dyeing is continued at the 60° C. until fixation is assured.

<table>
<thead>
<tr>
<th>Salt and Alkali Concentrations at Specific Dye Add-ons</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Dye on Fabric</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>&lt;0.50</td>
</tr>
<tr>
<td>0.50-1.0</td>
</tr>
</tbody>
</table>
One disadvantage of cotton fabric, however, is that it ignites easily and burns rapidly. The flammability of a fabric is dependent upon its composition. Mehta, R. D., Textile Research Journal 44(10): 825-826 (1974), incorporated herein by reference, for example, found that the extent of flame and glow resistance of a fabric increased as the carboxyl and metal contents of the fabric increased. In view of the danger posed by flammable textiles in general, the government has promulgated consumer safety regulations for textiles including safety standards for carpets and rugs, mattresses and children’s sleepwear. The flammability characteristics of textiles used to manufacture upholstery found in motor vehicles and airplanes are also regulated by the government.

DETAILED DESCRIPTION OF THE INVENTION

This disclosure teaches a novel bi-regional cotton fiber or fabric (fiber assembly) made from such fibers. The cotton or cellulose (cellulosic) core comprises the fiber core at least 70% of the fiber by weight and have a wax sheath or coating (outer core) comprising at least 30% of the whole cotton fiber by weight. The wax coating may be high temperature (high melting point) wax, i.e., melting point at or above 70°C. The wax coating may be of lower temperature melting wax. High temperature wax is deemed to be wax with a melting point in excess of 70°C. This bi-regional fiber contains a unique blend of cellulose with wax. The wax may be a naturally occurring wax from the processed cotton ball or it may be an emulsified wax added to the fiber surface. This wax can be added to the fiber after a low temperature processing (less than 70°C). In another embodiment, the wax may be coated on the fibers after standard process, e.g., Kier processing.

In one embodiment the wax may constitute 10% to 25% by weight of the cotton fiber. In another embodiment, the wax may comprise 14% to 16% of the cotton fiber by weight.

The fibers or woven fabric made from such fibers become an ignition resistant fiber. This is attributed to the high wax content of the fibers coating the exterior. See Example 4 below. The fibers or fabric also exhibit a smooth silky texture. The fibers are also exhibit enhanced moisture (water wetting) resistance as a result of the wax coating. The fiber is also stronger than standard cotton fibers because of the milder processing conditions employed, e.g., lower processing temperature. The cotton taught by this disclosure possesses inherent flame resistance to meet flammability safety regulation without application chemical additives or with application of reduced amounts of flame retardant chemicals.

It was also found that novel blends of the cotton fiber of the invention can be made with flexible biregional fibers (BRCF) as described in U.S. Pat. No. 5,700,573 which is herein incorporated by reference with the blend comprising from 10 to 90% of the cotton fibers of the invention with the balance of the lands containing the flexible biregional fibers. These blends made into knitted fabrics having densities ranging from 3 to 15 ounces per square yard are ignition resistant and have superior cooling properties due to the micro evaporative cooling nature of both the cotton fibers of the invention and the BRCF. The ignition resistance of the fabric blends, utilizing the BRCF and the cotton fibers of the invention, are determined following the test procedure set forth in 14 CFR 25.853(b) which is herein incorporated by reference. All samples pass this FR test. The samples also exhibit superior thermal resistance values with clo Thermal resistance value values ranging from 2.6 to 3.6.

It is to be understood that the forms of the disclosure herein shown and described are to be taken as the presently preferred embodiments. As already stated, various changes may be made in the shape, size and arrangement of components or adjustments made in the steps of the method without departing from the scope of this invention. For example, equivalent elements may be substituted for those illustrated and described herein and certain features of the invention may be utilized independently of the use of other features, all as would be apparent to one skilled in the art after having the benefit of this description of the invention.

While specific embodiments have been illustrated and described, numerous modifications are possible without departing from the spirit of the invention, and the scope of protection is only limited by the scope of the accompanying claims.

EXAMPLE 1

Bleaching with Peroxide

To the cotton fabric is added a solution containing 3-4 gpl, peroxyde (50%), 2 gpl Caustic Soda (NaOH), and 1 gpl of a low foaming surfactant/stabilizer (such as Crosprep HES) at a 10:1 fabric to liquor ratio. The fabric and solution is heated to 60°C over 15 minutes. 1 gpl of a catalyst suitable for low temperature peroxyde bleaching (such as Crosprep CAT) is added and the fabric heated in this mixture at the 60°C temperature for 45 minutes followed by draining and refilling. Acetic acid is added over 5 minutes until the pH stabilizes to 6.5-7.0. The fabric is then treated for 10 minutes with a stabilized liquid catalase (such as Crozyme PEK) to neutralize any residual peroxyde. The fabric is rinsed, drained and dried.

Cotton yarns can be bleached effectively in a pressure dyeing machine. The pH of the bleach liquor can be easily adjusted to control the pH with soda ash. The bleach solution is automatically programmed to give alternate inside out and outside in of the yarn package to insure bleach uniformity. The acetic acid rinse can be controlled to keep the cloth near neutral. This is followed by treatment with the catalase to remove residual peroxyde and a final rinse.

Bleaching with Chlorine

The fabric is padded to 100% wet pick up in a solution containing 0.2 g/l wetting agent and 1 gpl Chlorine bleach at a pH of 7.5-8.0 and stored in a J Box for 20 minutes at room temperature. For highly discolored fabrics the temperature may be increased but may not exceed 40°C. For pH adjustments, soda ash is preferred because of its buffering effect and so the cloth will not need an acetic acid rinse to obtain a final pH of 6.8-7.2. An antichlor treatment with sodium bisulfite or sodium thiosulfate to remove any unreacted chlorine completes the bleaching process.
[0047] The disclosure also teaches a process of making an ignition resistant cotton fiber where said fiber is derived from an ECRA or raw cotton fiber by bleaching fiber at less than 70°C with a bleaching solution comprising an OX− system, where X is a halogen and where the pH is 6.5 to 8.

[0048] Dyeing

[0049] The dyebath is set with the proper concentration of dye on the fabric, 1 gpl of an amphoteric such as Crescol SR New, 1 gpl of Crescours HP-3S and the salt concentration from Table 3. The temperature is raised to 60°C and dye for 20 minutes. Soda Ash from Table 3 is added and dyeing continued for 40 additional minutes. The bath is dropped and the fabric is ginned a hot (60°C) rinse containing 1 gpl acetic acid. The bath is dropped and the fabric is soaked 10 minutes at 60°C. With a 1 gpl Crescol BCSR followed by a hot (60°C) rinse for 10 minutes and a cold rinse (20°C) for 10 minutes.

[0050] Treatment of Cellulose Containing Fabrics after a Standard Preparation Treatment

EXAMPLE 2

[0051] A desired and bleached cotton print cloth (Testfabrics style 460 weighing 3.03 oz (oz/yd²) was treated at 100% wet pickup with a solution of a 0.75% owf (on weight of fabric) emulsified candelilla wax, and 0.1% nonionic wetting agent. After drying, the fabric passed the 45° flammability test. (16 CFR 1610, Standard for the Flammability of Clothing Textiles which is incorporated herein by reference in its entirety) and did not ignite even after a 4 second flame impingement.

EXAMPLE 3

[0052] An Army carded cotton sateen which had been desized and bleached (Testfabrics style 428 weighing 6.93 oz, and a bleached, mercerized, and carded cotton broad cloth (Testfabrics style 453, weighing 3.53 oz) and a cotton sheeting (Testfabrics style 493, weighing 4.45 oz) gave the same results (passed the 45° flammability test) after treating in the fabrics in the manner described above, (treated at 100% wet pickup with a solution of a 0.75% owf (on weight of fabric) emulsified candelilla wax, and 0.1% nonionic wetting agent).

EXAMPLE 4

[0053] A spun Viscose challis (ISO-105/F02, Testfabrics style 266, weighing 4.07 oz) treated as above, did not ignite even after a 4 second flame impingement.

EXAMPLE 5

[0054] A Cotton/Linen 56/44 blended fabric (Testfabrics style L040, weighing 6.4 oz) treated as above did not ignite even after a 4 second flame impingement.

[0055] The same results were obtained when bees wax was substituted for the candelilla wax.

[0056] The same results were obtained when a 50/50 emulsified blend of Jojoba and Carnuba wax was employed.

[0057] The desired and bleach print cloth (Testfabrics style 400) cited above was treated with 1.0% blend (50/50 w/w) mixture of Oleic and Stearic acid at 75% wet pickup. After drying, fabric did not ignite even after a 4 second flame impingement. The ignition resistance protection did not occur after the fabric was laundered to remove the acid blend.

EXAMPLE 6

[0058] The nonflammability and ignition resistance of the bi-regional cotton fibers of the disclosure is determined following the test procedure set forth in 14 CFR 25.853(b), which is incorporated herewith by reference. The test is performed as follows:

[0059] A minimum of three 1" x 6" x 6" (2.54 cm x 15.24 cm x 15.24 cm) specimens (derived from a batting of the bi-regional Whole Cotton fibers of Example 5 are prepared. The specimens are conditioned by maintaining them in a conditioning room maintained at a temperature of 70°C ±3° and 5% relative humidity for 24 hours preceding the test.

[0060] Each specimen is supported vertically and exposed to a Bunsen or Turriell burner with a nominal I.D. tube of 1.5 inches (3.8 cm) in height. The minimum flame temperature is measured by a calibrated thermocouple pyrometer in the center of the flame and is 1500°F. The lower edge of the specimen is 0.75 inch (1.91 cm) above the top edge of the burner. The flame is applied to the cluster line of the lower edge of the specimens for 12 seconds and then removed.

[0061] Pursuant to the test, the material is self-extinguishing. The average burn length does not exceed 5 in. (20.32 cm), the average after flame does not exceed 15 seconds and flaming drippings did not continue to burn for more than 5 seconds after falling to the burn test cabinet floor.

What is claimed is:

1. An ignition resistant fiber or assembly of fibers comprising a fiber having a cellulosic center and an outer region or surface of a wax wherein the wax comprises 0.4 to 1.0 or greater portion by weight of fiber.

2. The fiber or assembly of fibers of claim 1 further comprising an outer region of a high temperature melting wax.

3. The fiber or assembly of fiber of claim 2 further comprising an outer region of wax having a melting point of 70°C or higher.

4. The fiber or assembly of fibers of claim 1 further comprising a cellulosic center of cotton fiber.

5. The fiber or assembly of fibers of claim 1, wherein said wax is a natural wax.

6. The fiber of claim 1 or assembly of fibers, wherein the said wax is an emulsified wax or mixtures of emulsified waxes.

7. The fiber or assembly of fibers of claim 1, wherein said wax is a mixture of natural and emulsified waxes.

8. The fiber or assembly of fibers of claim 1, wherein said wax is cotton wax.

9. The fiber or assembly of fibers of claim 1 wherein said wax is jojoba wax.

10. The fiber or assembly of fibers of claim 1 wherein said wax is high melting soy wax.

11. The fiber or assembly of fibers of claim 1 wherein said wax is cannauba wax.

12. The fiber or assembly of fibers of claim 2 wherein the wax is selected from a group consisting of natural wax, emulsified wax, a mixture of emulsified waxes, a mixture of emulsified waxes and natural wax, cotton wax, jojoba wax, high melting soy wax, cannauba wax or combinations thereof.

13. The fiber or assembly of fibers comprising bi-regional cotton of claim 4 is 10% to 20% stronger than standard high temperature high alkalinity processed cotton.

14. The fiber or assembly of fibers of claim 1 wherein the fibers have reduced absorption of water than high temperature high alkalinity processed cotton.
15. The fiber or assembly of fibers of claim 1 wherein the fibers have improved wrinkle resistance to high temperature high alkalinity process cotton.

16. The fiber or assembly of fibers of claim 1 further comprising applying a saponified acid derivative selected from a group consisting of Lauric, Myristic, Palmitic, Stearic, Oleic or combinations thereof.

17. Bi-regional cotton fibers comprising a cellulosic center and an outer region of high temperature wax wherein the fibers pass a standard vertical burn tests conducted according to FAR 25.853(b).

18. Bi-regional cotton fibers comprising a cellulosic center and an outer region of a cotton wax, a natural wax, or a blend of natural and synthetic waxes melting in the range of 58 to 87°C wherein the fiber passes an ignition resistance test comprising: a minimum of three battings having a dimension of 2.5 cm x 15 cm x 30 cm and comprised of 80% the bi-regional carbonaceous fibers and 20% polyester fibers sprayed with a solution of a hydrolyzed partial condensation of trimethoxy methyl silane wherein the battings are compressed at 25 lb/in² (1.75 Kg/cm²) at a temperature of 260°F (127°C) into panels and wherein the coating is comprised of 10% by weight wherein standard vertical burn tests according to FAR 25.853(b) are conducted, wherein the panels are conditioned by maintaining the panels in a conditioning room maintained at a temperature of 21°C ± 5°C and 50% ± 5% relative humidity for 24 hours preceding the test, wherein each panel is supported vertically and exposed to a Bunsen or Turill burner with a nominal I.D. tube adjusted to give a flame of 3.8 cm in height with a minimum flame temperature is 843°C wherein the lower edge of the panel is 1.9 cm above the top edge of the burner, wherein the flame is applied to the center line of the lower edge of the specimen for 12 seconds and then removed and wherein the panel self extinguishes and average burn length does not exceed 20 cm, the average after flame does not exceed 15 seconds and there are no flame drippings.

19. Bi-regional cotton fibers comprising a cellulosic center and an outer region of a cotton wax, a natural wax, or blend of natural and synthetic waxes melting in the range of below 58°C wherein the fiber passes an ignition resistance test comprising: a minimum of three battings having a dimension of 2.5 cm x 15 cm x 30 cm and comprised of 80% the bi-regional carbonaceous fibers and 20% polyester fibers sprayed with a solution of a hydrolyzed partial condensation of trimethoxy methyl silane wherein the battings are compressed at 25 lb/in² (1.75 Kg/cm²) at a temperature of 260°F (127°C) into panels and wherein the coating is comprised of 10% by weight wherein standard vertical burn tests according to FAR 25.853(b) are conducted, wherein the panels are conditioned by maintaining the panels in a conditioning room maintained at a temperature of 21°C ± 5°C and 50% ± 5% relative humidity for 24 hours preceding the test, wherein each panel is supported vertically and exposed to a Bunsen or Turill burner with a nominal I.D. tube adjusted to give a flame of 3.8 cm in height with a minimum flame temperature is 843°C wherein the lower edge of the panel is 1.9 cm above the top edge of the burner, wherein the flame is applied to the center line of the lower edge of the specimen for 12 seconds and then removed and wherein the panel self extinguishes and average burn length does not exceed 20 cm, the average after flame does not exceed 15 seconds and there are no flame drippings.

20. A fabric or fiber assembly comprising bi-regional cotton fibers comprising a cellulosic center and an outer region of a wax wherein the fibers passes Testing Flammability of Clothing Textiles, 16 CFR 1610, comprising fabric specimens of 2 inches by 6 inches are dried and cooled, the specimens are placed at a 45° angle impinged with a flame of 3½ inch length for a second wherein a plain surface fabric burn time is 3.5 seconds or more and a raised surface fabric average burn time is 7 seconds or more.

21. An ignition resistant fiber or assembly of fibers comprising a fiber having a cellulosic center and an outer region of a wax wherein the wax comprises 0.4 to 25 percent of the fibers by weight.

22. The fibers or assembly of fibers of claim 16 wherein the wax comprises 1.0 to 15 percent of the fibers by weight.

23. The fibers or assembly of fibers of claim 16 wherein the wax comprises 10 to 25 percent of the fibers by weight.

24. The fibers or assembly of fibers of claim 16 wherein the wax comprises 14 to 16 percent of the fibers by weight.

25. Bi-regional cotton fiber comprising a cellulosic center and an outer region comprising a wax coating wherein the wax comprises 0.4 percent to 1.5 percent by weight of the fiber.

26. A bi-regional fiber having a cellulosic center and an outer wax coating bleached in a low temperature—peroxide/catalyst or low alkalinity hypochlorite process employing an oxidative process to remove impurities.

27. A process of making an ignition resistant cotton fiber where said fiber is derived from an ECRU or raw cotton fiber by bleaching fiber at less than 70°C with a bleaching solution comprising a peroxide, peroxide catalyst, and a wetting agent.

28. A process of bleaching cotton fiber comprising a bleach solution of 1 g/l Cl₂ at a temperature not exceeding 40°C.

29. A treatment process for raw cotton comprising treating the raw cotton at a temperature below 75°C and a peroxide/catalyst or low alkalinity hypochlorite process.

30. A process of treating a cotton of claim 22 further comprising omitting a post treatment acid wash step.

31. A process of making an ignition resistant cotton fiber where said fiber is derived from an ECRU or raw cotton fiber by bleaching fiber at less than 70°C with a bleaching solution comprising an OX⁻ system, where X is a halogen and where the pH is 6.5 to 8.

32. A process of making an ignition resistant cotton fiber where said fiber is derived from a standard bleaching process wherein an outer region comprises a natural, emulsified or blend of wax that is added subsequent to the bleaching process.

33. The process of claim 25 further comprising wax comprising a high temperature melting wax.

34. A blended fire retardant fiber assembly comprising from 10 to 90% of bi-regional cotton fibers with BRCF fibers wherein the blended fibers comprises fire retardant properties.

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