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(54) **Modified fibre, yarn and woven materials, methods of manufacture and uses thereof**

(57) A fiber material and/or yarn is described that includes: a) at least one staple fiber component; b) at least one base fiber component, wherein the at least one staple fiber component is at least about 50% shorter in length than the at least one base fiber component and wherein each of the at least one staple fiber component and the at least one base fiber component has at least one melting point. Methods are also provided herein that include: a) providing at least one staple fiber component having at least one melting point; b) providing at least one base fiber component having at least one melting

point, wherein at least one of the melting points of the staple fiber component is lower than at least one of the melting points of the base fiber component; c) mixing the at least one staple fiber component with the base fiber component to form a blend material; d) processing the blend material to form a fiber bundle or a yarn bundle; and e) applying a thermal energy source to the fiber bundle or yarn bundle to form the modified fiber bundle and/or yarn bundle.

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Description

[0001] This application claims priority to US Provisional Application Serial No.: 60/517531, which was filed on November 4, 2003 and which is incorporated herein in its entirety by reference.

FIELD OF THE SUBJECT MATTER

[0002] The field of the subject matter herein is modified fiber and yarn materials, fiber bundles, fiber products, yarn products, textile products and carpet products, methods of manufacture and uses thereof.

BACKGROUND

[0003] Fibers for consumer use, especially fibers that are incorporated into carpet products, fabrics/textiles, woven and upholstery products are constantly being evaluated for improvements with respect to the consumer's sensory perception. These improvements may relate to texture, quality, softness and luster.

[0004] Fibers and yarns, which are used in the production of carpet products, such as wall-to-wall carpet, rugs and mats, upholstery/textile products and woven products are modified and in some instances improved to provide a certain fiber texture, overall texture when the fibers are incorporated into a fiber product and to provide a desired "look" for the space or application where the fiber product is being used. Additional issues that arise in the design of fiber material and fiber products are short-term and long-term durability.

[0005] One method that is being used to modify the texture of fabrics is to incorporate fibers that have mixed deniers into the fabric product. Denier (or fiber denier) is a physical property of a particular fiber and can be defined as: "A direct yarn numbering measurement, it is the weight in grams of 9,000 meters of yarn. Therefore, the higher the denier, the larger the yarn. Typical nylon carpet fiber has 6-18 denier. This thickness of a fiber can be regulated by the size of the openings of the spinneret. (see www.fabrica.com: Glossary of Fabric and Rug Terms)

[0006] Slubs or nubs are small, short length staple fibers that can be incorporated into a fiber or yarn bundle to add another level of texture to the yarn and/or finished product despite the choices made with respect to denier and luster. Slubs or nubs previously inserted into a staple spun yarn cannot effectively be locked or bound into the parent yarn. Any insertion process relied on the twist of the yarn to hold the slub or nub in the yarn bundle. This reliance on the twist of the yarn results in a high probability that the slub or nub can be removed from the parent yarn bundle.

[0007] U.S. Patent Nos. 4144702, 4144703, 4160359, 4218868, 4305245, 4330988, 4351148, 4365145 and 4368612, which are assigned to Milliken Research Corporation, disclose open end spun slub

yarns, methods of producing the slub yarns and apparatus for forming the open end spun slub yarns or false twisted slub yarns. US 4144702, 4144703 and 4218868 disclose methods and apparatus used to produce an "open end spun slub yarn". Specifically, an open end spun yarn is directed through a spinning machine to a yarn take up roll. Periodically during this process, the velocity of the yarn is decreased in order to allow a "build-up of fibers" to form. This build-up of fibers forms a slub in the yarn. US 4160359 and 4365145 disclose random signal generators for the manufacture of slub open end spun yarns. The random signal generators use shift register sequences to provide control pulses to a slub yarn producing spinning system. US 4305245, 4330988, 4368612, 4343071 and 4351148 disclose methods and apparatus used to produce false twisted slub yarn. A core yarn and an effect yarn are combined in a "fluid tangling zone". By controlling the linear velocity of the apparatus, slubs are produced in the combined yarn.

[0008] U.S. Patent Nos. 4697317, 4736578 and 4809412, which are assigned to E. I. Du Pont de Nemours and Company, disclose twist free novelty nub yarns and processes for production thereof. All of the yarns produced by methods and fibers in the Du Pont patents are base or core yarns or fibers with slubs and/or nubs entangled around the yarn or fiber. The slubs and/or nubs are entangled using an aspirating entanglement jet process, whereby pressurized air is used to commingle the slubs and nubs with the base yarn.

[0009] U.S. Patent No. 4,010,523 (the '523 patent), which is assigned to Akzona Incorporated, discloses novelty yarns and processes for production thereof. The yarns produced by methods and fibers in the '523 patent are base or core yarns or fibers with fancy threads, which could be slubs and/or nubs, entangled around the yarn or fiber. The slubs and/or nubs are entangled using a combination of suction with a low jet pressure and a high jet pressure.

[0010] U.S. Patent No. 4,010,601 (the '601 patent), which is assigned to Toyo Boseki Kabushiki Kaisha, discloses "pre-slubbed" fancy yarns and processes for production thereof. The fancy fibers produced by methods in the '601 patent are wrapped around a core fiber, wherein some of the fancy fiber is wrapped as a slub, heated and then unwound - leaving the "slub" formed in the fancy fiber. When the fancy fiber is then combined with other fibers or yarns, the slub is already in place.

[0011] A common theme in the cited art is that slubs or nubs are included in "novelty" or "fancy" yarns, but none of these references teach or disclose that once the slubs or nubs are incorporated with the fibers or yarns those slubs or nubs should be locked into place by any method other than twisting the slub, nub or base fiber. As mentioned earlier, these conventional methods of "locking" or "holding" slubs and/or nubs into place is not sufficient when considering long-term durability of the fibers, fiber bundles and/or yarns.

[0012] Therefore, it would be desirable to produce a fiber bundle and/or yarn that comprises slubs and/or nubs that can be set into the fiber bundle and/or yarn, such that the nub and/or slubs are effectively locked or bound into the parent fiber bundle or yarn. It may also be desirable in some embodiments to pre-dye the slubs or nubs before they are set into the fiber bundle and/or yarn or post-dye the slubs or nubs after they are set into the fiber bundle and/or yarn.

SUMMARY OF THE SUBJECT MATTER

[0013] A fiber material and/or yarn is described that includes: a) at least one staple fiber component; b) at least one base fiber component, wherein the at least one staple fiber component is at least about 50% shorter in length than the at least one base fiber component and wherein each of the at least one staple fiber component and the at least one base fiber component has at least one melting point.

[0014] Methods are also provided herein that include: a) providing at least one staple fiber component having at least one melting point; b) providing at least one base fiber component having at least one melting point, wherein at least one of the melting points of the staple fiber component is lower than at least one of the melting points of the base fiber component; c) mixing the at least one staple fiber component with the base fiber component to form a blend material; d) processing the blend material to form a fiber bundle or a yarn bundle; and e) applying a thermal energy source to the fiber bundle or yarn bundle to form the modified fiber bundle and/or yarn bundle.

DETAILED DESCRIPTION

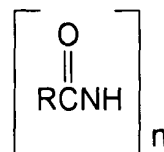
[0015] To this end, and in order to produce a fiber material and/or yarn that comprises slubs and/or nubs, which can be incorporated into the production of a new and unique fiber product, a modified fiber and/or yarn bundle has been developed that includes: a) at least one staple fiber component; b) at least one base fiber component, wherein the at least one staple fiber component is at least about 50% shorter in length than the at least one base fiber component and wherein each of the at least one staple fiber component and the at least one base fiber component has at least one melting point.

[0016] At this point it should be understood that, unless otherwise indicated, all numbers expressing quantities of ingredients, constituents, interaction conditions and so forth used in the specification and claims are to be understood as being modified in all instances by the term "about". Accordingly, unless indicated to the contrary, the numerical parameters set forth in the specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained by the subject matter presented herein. At the very least, and not as an attempt to limit the appli-

cation of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the subject matter presented herein are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contain certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

[0017] Contemplated modified fiber and/or yarn bundles comprise at least one staple fiber component and at least one base fiber component. The staple fiber component and/or the base fiber component may comprise any suitable fiber material, as long as the staple fiber component comprises at least one melting point that is lower than the at least one melting point of the base fiber component. In other contemplated embodiments, the staple fiber component and/or the base fiber component comprise materials previously disclosed in European Patent No. 324,773 and US Patent No. 5,478,624, which are both commonly-owned and incorporated herein by reference in their entirety. As mentioned in those patents, the staple fiber component and/or the base fiber component may comprise natural or synthetic materials, including a polyamide-based compound, including nylon-6 and nylon-6,6, a polyester-based compound or copolymer, wool, cotton, PET, PTT, polyolefins, such as polyethylene or polypropylene, or combinations thereof. As described herein, at least one staple fiber component is contemplated and may comprise any suitable fiber material depending on the needs of the product, customer and/or the vendor.

[0018] Amides are an important group of nitrogenous compounds and monomers that are used as intermediates and/or building blocks in the production of polymers, textiles, plastics and adhesives. Amide monomers are generally represented by the following formula:



wherein R is an alkyl group, an aryl group, a cyclic alkyl group, an alkenyl group, an arylalkylene group, or any other appropriate group that can be utilized to be a part of an amide compound.

[0019] As used herein, the term "monomer" generally refers to any chemical compound that is capable of forming a covalent bond with itself or a chemically different compound in a repetitive manner. The repetitive

bond formation between monomers may lead to a linear, branched, super-branched, or three-dimensional product. Furthermore, monomers may themselves comprise repetitive building blocks, and when polymerized the polymers formed from such monomers are then termed "blockpolymers". The weight-average molecular weight of monomers may vary greatly between about 40 Dalton and 20000 Dalton. However, especially when monomers comprise repetitive building blocks, monomers may have even higher molecular weights. Monomers may also include additional groups, such as groups used for crosslinking, radiolabeling, and/or chemical or environmental protecting.

[0020] The term "alkyl" is used herein to mean a branched or a straight-chain saturated hydrocarbon group or substituent of 1 to 24 carbon atoms, such as methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, t-butyl, octyl, decyl, tetradecyl, hexadecyl, eicosyl, tetracosyl and the like. In some embodiments, contemplated alkyl groups contain 1 to 12 carbon atoms. The term "cyclic alkyl" means an alkyl compound whose structure is characterized by one or more closed rings. The cyclic alkyl may be mono-, bi-, tri- or polycyclic depending on the number of rings present in the compound. The term "aryl" is used herein to mean a monocyclic aromatic species of 5 to 7 carbon atoms or a compound that is built with monocyclic aromatic species of 5 to 7 carbon atoms and is typically phenyl, naphthalyl, phenanthryl, anthracyl etc. Optionally, these groups are substituted with one to four, more preferably one to two alkyl, alkoxy, hydroxy, and/or nitro substituents.

[0021] The term "alkenyl" is used herein to mean a branched or a straight-chain hydrocarbon chain containing from 2 to 24 carbon atoms and at least one double bond. Preferred alkenyl groups herein contain 1 to 12 carbon atoms. The term "alkoxy" is used herein to mean an alkyl group bound through a single, terminal ether linkage; that is, an alkoxy group may be defined as -OR wherein R is an alkyl group, as defined above. The term "arylalkylene" is used herein to mean moieties containing both alkylene and monocyclic aryl species, typically containing less than about 12 carbon atoms in the alkylene portion, and wherein the aryl substituent is bonded to the structure of interest through an alkylene linking group. Exemplary arylalkylene groups have the structure $-(CH_2)_j-Ar$ wherein "j" is an integer in the range of 1 to 6 and wherein "Ar" is an aryl species. The term "olefin" is used herein to describe a class of unsaturated aliphatic hydrocarbons having one or more double bonds.

[0022] ϵ -Caprolactam, also known as aminocaproic lactam and 2-oxohexamethyleneimine, is a compound that is produced in flake and molten forms and is used primarily in the manufacture of nylon-6, nylon-6,6 and nylon-12 products such as those products contemplated herein or other synthetic fibers, plastics, bristles, films, coatings, synthetic leathers, plasticizers and paint vehicles. Caprolactam can also be used as a cross-linking

agent for polyurethanes and in the synthesis of the amino acid lysine.

[0023] Amides, such as caprolactam, are generally produced by reacting a ketone with hydroxylamine to make an oxime, and then using an acid catalyzed rearrangement of the oxime(s), conventionally called the Beckmann rearrangement, to form the amide. Merchant quality caprolactam can be produced by methods described in US Patent Application Serial No.: 10/251335 filed on September 21, 2002, which is commonly owned and herein incorporated in its entirety.

[0024] As mentioned, the staple fiber component is at least about 50% shorter than the base fiber component. In contemplated embodiments, the staple fiber component comprises slubs or nubs that are intended to provide a level of texture to the fiber and/or yarn bundle. In other contemplated embodiments, the staple fiber component is at least 70% shorter than the base fiber component. In yet other contemplated embodiments, the staple fiber component is at least 90% shorter than the base fiber component. As used herein, the term "component" means the collective plurality of staple fibers and/or base fibers. Furthermore, when referring to the length of the staple fiber component or the base fiber component, this length is considered to be the average and/or mean length of the plurality of staple fibers and/or base fibers, which can be calculated using methods known by one of ordinary skill in the art of fiber production.

[0025] The staple fiber component also comprises at least one melting point that is less than the melting point of the base fiber component. As used herein, the term "melting point" means the temperature at which a substance changes from a solid to a liquid. For a polymeric material, it is the temperature when the solid polymer changes to a liquid melt flow. Melting points can be determined by any available and conventional method, including but not limited to differential scanning calorimetry (DSC) or a Fisher-Johns melting point apparatus consisting of a compact hot plate, a magnifying glass, and a thermometer from which the hot plate temperature can be read when the solid substance being observed begins a melt flow. (A.M. James and M.P. Lord in *Macmillan's Chemical and Physical Data*, Macmillan, London, UK, 1992; and G.W.C. Kaye and T.H. Laby in *Tables of Physical and Chemical Constants*, Longman, London, UK, 15th edition, 1993.) It should be understood that the ratio of melting points depends on the heat source. A pressurized energy source produces a lower melting point for melting the staple fibers than an atmospheric forced air energy source. In some embodiments, the other energy sources may or may not produce different melting point ratios between base and other staple fibers.

[0026] In some embodiments, at least part of the staple fiber component is referred to as a "low melt" component or fiber. It should be understood that the lower melting point of the staple fiber component contributes

to the physical stability of the modified fiber bundle and/or yarn bundle by enabling the staple fiber component to bond to or couple with at least part of the base fiber component. In other words, the staple fibers can be thermally activated to a point where they at least begin to melt, thus physically locking the staple fibers in place in relation to the binder fiber through a chemical, physical or attractive bond. In some embodiments, at least part of the staple fibers and the base fibers may be heated to the point where both begin to melt. In some embodiments, activating the fiber components comprises forming chemical, such as covalent, ionic or hydrogen and/or physical, such as adhesion, bonds between at least some of the plurality of staple fibers and at least one of the base fiber component.

[0027] There are several embodiments of staple fiber components and base fiber components having at least one melting point that are contemplated herein. In one embodiment, the at least one staple fiber component has one melting point and the at least one base fiber component has one melting point. In this embodiment, the melting point of the at least one staple fiber component is lower than the melting point of the at least one base fiber component. In another embodiment, one of the at least one staple fiber component or the at least one base fiber component comprises a composite fiber material where there are at least two constituents forming the composite fiber material. In this embodiment, the fiber component that comprises a composite fiber material will also comprise at least two melting points - one melting point for each constituent. In yet another embodiment, both of the at least one staple fiber component and the at least one base fiber component comprises a composite fiber material where there are at least two constituents forming each of the composite fiber materials. In this embodiment, each of the fiber components comprising composite fiber materials also comprise at least two melting points - one melting point for each composite constituent. A couple of provisions should be understood at this point with respect to the melting points and composition of each of the fiber components and/or the composite constituents. First, the at least one staple fiber component should comprise at least one low melting point material as compared to the melting point(s) of the at least one base fiber components. Second, the at least one low melting point material should be adherably compatible with at least part of the at least one base fiber component - meaning that the at least one low melting point material should be able to adhere with at least part of the at least one base fiber component when the melting point of the at least one low melting point material is approached or reached. Specifically, in one contemplated embodiment, at least one of the base fiber components or staple fiber components may comprise a core material sheath surrounded or coated by another material. In another embodiment, at least one of the base fiber components or staple fiber components may comprise two materials that are

"blended".

[0028] The staple fiber component and the base fiber component may comprise any suitable denier. As mentioned earlier, denier (or fiber denier) is a physical property of a particular fiber and can be defined as: "A direct yarn numbering measurement, it is the weight in grams of 9,000 meters of yarn. Therefore, the higher the denier, the larger the yarn. For example, typical nylon carpet fiber has 6-18 denier. This thickness of a fiber can be regulated by the size of the openings of the spinneret." (see www.fabrica.com: Glossary of Fabric and Rug Terms)

[0029] In addition, methods are provided herein that teach that a modified fiber bundle and/or yarn product may be produced that includes: a) providing at least one staple fiber component having at least one melting point; b) providing at least one base fiber component having at least one melting point, wherein at least one of the melting points of the staple fiber component is lower than at least one of the melting points of the base fiber component; c) mixing the at least one staple fiber component with the base fiber component to form a blend material; d) processing the blend material to form a fiber bundle or a yarn bundle; and e) applying a thermal energy source to the fiber bundle or yarn bundle to form the modified fiber bundle and/or yarn bundle.

[0030] In some contemplated embodiments, at least one of the staple fiber component or the base fiber component may be dyed - alone or in combination - using any conventional dyeing methods (such as solution dyed) and/or colorants, such as those that are currently being used in the carpet and textile industries. It should also be understood that the at least one of the staple fiber component, the base fiber component, the fiber material, the yarn product or the carpet/textile product may be produced in a "non-dyed" form in order to send to customers for dyeing treatments. The fiber components may be pre-dyed or dyed by using any suitable dyeing material or pigment. As used herein, the term "pigment" means any substance, usually in the form of a dry powder, that imparts color to another substance or mixture or that has a positive colorant value. Pigments may comprise any suitable inorganic or organic material, such as metal oxides, metal powder suspensions, earth colors, lead chromates, carbon black, animal pigments and vegetable pigments. The staple fiber component may be dyed one color or a plurality of colors. Additionally, the staple fiber component may be dyed the same color as the base fiber component or may be a different color than one another in order to impart a color texture to the finished product or bundle. In some embodiments, the dyeing process for the fibers comprises "stock dyeing". In one example, the at least one staple component may be dyed and then combined with the at least one base component. The resulting fiber material may then be thermally activated and the entire fiber material dyed.

[0031] The staple fiber component and/or the base fiber component may be provided by any suitable meth-

od, including a) buying the staple fiber component and/or the base fiber component from a supplier or textile mill; b) preparing or producing the staple fiber component and/or the base fiber component in house using chemicals provided by another source and/or c) preparing or producing staple fiber component and/or the base fiber component in house using chemicals also produced or provided in house or at the location. It is contemplated that the staple fiber component and/or the base fiber component are made of any suitable material, such as those materials already described herein.

[0032] The staple fiber component and/or the base fiber component can be mixed once both the components are provided. Mixing the staple fiber component and/or the base fiber component to form a blend material can be done using any suitable, conventional and/or readily available mixing method. It is contemplated that the staple fiber component and/or the base fiber component can be mixed together at the same time or can be mixed together sequentially - meaning that, in some contemplated embodiments, the staple fiber component can be mixed first (if there are a plurality of different staple fiber components) before the at least one base fiber components and vice versa.

[0033] During or after the formation of contemplated fiber materials, yarn products and/or carpet products, a thermal energy may be applied to the materials and/or products, wherein the thermal energy comprises a temperature that is at or above the melting point of the base fiber and/or other heat-active components. The thermal energy is applied to reach the melting point(s) of at least part of the at least one staple fiber component and/or at least part of the at least one base fiber component. In some embodiments, at least part of the staple fibers and the base fibers may be heated to the point where both begin to melt. In some embodiments, activating the fiber components comprises forming chemical, such as covalent, ionic or hydrogen and/or physical, such as adhesion, bonds between at least some of the plurality of staple fibers and at least one of the base fiber component.

[0034] The thermal energy may come from any suitable source, including extended/non-point sources, such as a UV-VIS source, an infra-red source, a heat source, both radiative and convective, or a microwave source; or electron sources, such as electron guns or plasma sources. Other suitable energy sources include electron beams, and radiative devices at non-IR wavelengths including x-ray, and gamma ray. Still other suitable energy sources include vibrational sources such as microwave transmitters. In preferred embodiments, the energy source is an extended source. In more preferred embodiments, the energy source is a heat source, such as an atmospheric pressure forced air machine, which can be followed by a steam purge, or a pressurized twist-setting machine. An example of an atmospheric pressure forced air machine is the Suessen® Twist-Setting Machine, which can reach temperatures ranging from about 195°C to about 200°C. Examples of pressu-

rized twist-setting machines are those of the autoclave-type and those manufactured by Superba®, which can reach temperatures ranging from about 105°C to about 138°C.

[0035] It should be understood that the thermal energy may be applied consistently or in short bursts. It is also contemplated that the thermal energy may be gradually and continuously applied over a temperature range until the thermal energy is at or above the melting point of the heat-active and/or low melt components. For example, the fiber material and/or yarn may be heated by an atmospheric pressure forced air machine at a temperature of about 195°C for a residence time of about 60 seconds, before the treated fiber material and/or yarn product is tufted. The thermal energy may also be immediately applied at or above the melting point of the binder fiber and/or other heat-active components without any ramp time.

[0036] The fiber materials contemplated and described herein may be used alone or in combination with other materials and/or products to form any suitable product, including yarn products, upholstery products and carpet products.

[0037] Thus, specific embodiments and applications of modified fiber, yarn and woven compositions and materials, their manufacture and uses thereof have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the disclosure. Moreover, in interpreting the disclosure, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

Claims

1. A fiber material comprising:

at least one staple fiber component; and

at least one base fiber component, wherein the at least one staple fiber component is at least about 50% shorter in length than the at least one base fiber component and wherein each of the at least one staple fiber component and the at least one base fiber component comprise at least one melting point.

2. The fiber material of claim 1, wherein at least part of the staple fiber component is physically bound to

at least part of the at least one base fiber component.

3. The fiber material of claim 1, wherein at least part of the staple fiber component is chemically bound to at least part of the at least one base fiber component. 5
4. The fiber material of any preceding claim, wherein the at least one staple fiber comprises natural or synthetic materials. 10
5. The fiber material of claim 4, wherein the at least one staple fiber comprises a polyamide-based compound, a polyester-based compound or copolymer, wool, cotton, PET, PTT, polyolefins, or a combination thereof. 15
6. The fiber material of claim 5, wherein the polyamide-based compound comprises nylon-6 or nylon-6,6. 20
7. The fiber material of claim 5, wherein the polyolefin comprises polyethylene or polypropylene. 25
8. The fiber material of any preceding claim, wherein the at least one staple fiber component is at least about 70% shorter in length than the at least one base fiber component. 30
9. The fiber material of claim 8, wherein the at least one staple fiber component is at least about 90% shorter in length than the at least one base fiber component. 35
10. The fiber material of any preceding claim, wherein the melting point of at least part of the at least one staple fiber is lower than the melting point of at least part of the at least one base fiber. 40
11. A fiber bundle comprising the fiber material of any preceding claim. 45
12. A yarn comprising the fiber material of any of claims 1 to 10. 45
13. A method of forming a modified fiber material, comprising:

providing at least one staple fiber component having at least one melting point; 50
 providing at least one base fiber component having at least one melting point, wherein at least one of the melting points of the staple fiber component is lower than at least one of the melting points of the base fiber component; 55
 mixing the at least one staple fiber component with the base fiber component to form a blend

material;
 processing the blend material to form a fiber bundle or a yarn bundle; and
 applying a thermal energy source to the fiber bundle or yarn bundle to form the modified fiber bundle and/or yarn bundle.

14. The method of claim 13, wherein the staple fiber component is as defined in any of claims 2 to 10.
15. A fiber bundle obtainable by the method defined in claim 13 or claim 14.
16. A yarn obtainable by the method defined in claim 13 or claim 14.