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(54) THERMALLY BONDED FIBRE PRODUCTS WITH BICOMPONENT FIBRES AS BONDING FIBRES

THERMISCH GEBUNDENE FASERERZEUGNISSE MIT BIKOMPONENTFASERN ALS HAFTFASERN

PRODUITS DE FIBRES LIES THERMIQUEMENT AVEC DES FIBRES A DEUX COMPOSANTS COMME FIBRES DE LIAISON

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Description

The present invention pertains to thermally bonded non-wet laid fiber products comprising dyeable thermoplastic bicomponent fibers and a method of preparation. The bicomponent fibers are characterized by contacting under thermally bonding conditions (a) a first component comprising at least one high performance thermoplastic polymer selected from polyesters and polyamides, and (b) a second component which is a polymer blend of a grafted linear ethylene polymer having pendant succinic acid or succinic anhydride groups and at least one ungrafted linear ethylene polymer. The bicomponent fibers can be prepared by coextruding (a) and (b) into fiber having a round, oval, trilobal, triangular, dog-boned, flat or hollow shape and a sheath/core or side-by-side configuration. The bicomponent fiber can be coextruded using melt blown, spunbond or staple fiber manufacturing process conditions. The present invention also pertains to a method of bonding high performance fibers using the dyeable thermoplastic bicomponent fibers as binder fibers.

Various olefin fibers, i.e., fibers in which the fiber-forming substance is any long chain, synthetic polymer of at least 85 weight percent ethylene, propylene, or other olefin units, are known from the prior art. The mechanical properties of such fibers are generally related in large part to the morphology of the polymer, especially molecular orientation and crystallinity. Thus, crystalline polypropylene fibers and filaments are items of commerce and have been used in making products such as ropes, non-woven fabrics, and woven fabrics. Polypropylene is known to exist as atactic (largely amorphous), syndiotactic (largely crystalline), and isotactic (also largely crystalline). The largely crystalline types of polypropylene (PP), including both isotactic and syndiotactic, have found wide acceptance in certain applications in the form of fibers.

Other types of polyolefins which have been suitably formed into fibers include linear ethylene polymers, such as linear high density polyethylene (HDPE) having a density in the range of 0.941-0.965 grams/cubic centimeter (g/cc) and linear low density polyethylene (LLDPE) having a density typically in the range of low density polyethylene (LOPE) and linear medium density polyethylene (LMDPE), or from 0.91 g/cc to 0.94 g/cc. The densities of the linear ethylene polymers are measured In accordance with ASTM D-792 and defined as in ASTM D-1248. These polymers are prepared using coordination catalysts and are generally known as linear polymers because of the substantial absence of branched chains of polymerized monomer pendant from the main polymer backbone. LLDPE is a linear low density ethylene polymer wherein ethylene has been polymerized along with minor amounts of α,β-ethylenically unsaturated alkenes having from three to twelve carbon (C_3-C_{12}) atoms per alkene molecule, and more typically four to eight (C_4-C_8). Although LLDPE contains short chain branching-due to the pendant side groups introduced by the alkene comonomer and exhibits characteristics of low density polyethylene such as toughness and low modulus, it generally retains much of the strength, crystallinity, and extensibility normally found in HDPE homopolymers. In contrast, polyethylene prepared with the use of a free radical initiator. Such as peroxide, gives rise to highly branched polyethylenes known as low density polyethylene (LDPE) and sometimes as high pressure polyethylene (HPPE) and ICI-type polyethylenes. Because of unsuitable morphology, notably long chain branching and concomitant high melt elasticity, LDPE is difficult to form into a fiber and has inferior properties as compared to LLDPE, HDPE and PP fibers.

One application of certain fibers such as. for example, polyvinyl chloride, low melting polyester and polyvinylacetate, has been the use of such fibers as binder fibers by blending the binder fiber with high performance natural and/or synthetic fibers such as polyesters (e.g., polyethylene terephthalate (PET) or polybutylene terephthalate (PBT)), polyamides, cellulosics (e.g., cotton), modified cellulosics (e.g., rayon), wool or the like, and heating the fibrous mixture to near the melting point of the binder fiber to thermally weld the binder fiber to the high performance fiber. This procedure has found particular application in non-woven fabrics prepared from performance fibers which would otherwise tend to separate easily in the fabric. However, because of the unavailability of reactive sites in the olefin fibers, the bonding of olefin fibers to the performance fibers is characterized by encapsulation of the performance fiber by the melted olefin fiber at the thermal bonding site by the formation of microglobules or beads of the olefin fiber. Moreover, it is difficult to achieve suitable thermal bonding in this fashion because of the poor wettability of a polar performance fiber by a nonpolar olefin fiber.

Another problem which has hampered the acceptance of olefin fibers is a lack of dyeability. Olefin fibers are inherently difficult to dye, because there are no sites for the specific attraction of dye molecules, i.e., there are no hydrogen bonding or ionic groups, and dyeing can only take place by virtue of weak van der Waals forces. Usually, such fibers are colored by adding pigments to the polyolefin melt before extrusion, and much effort has gone into pigmentation technology for dispersing a dye into the polyolefin fiber. This has largely been unsuccessful because of the poor lightfastness, poor fastness to dry cleaning, generally low color build-up, stiffness, a necessity for continuous production changes, poor color uniformity, possible loss of fiber strength and the involvement of large inventories.

Bicomponent fibers are typically fabricated commercially by melt spinning. In this procedure, each molten polymer is extruded through a die. e.g., a spinnerette, with subsequent drawing of the molten extrudate, solidification of the extrudate by heat transfer to a surrounding fluid medium, and taking up of the solid extrudate. Melt spinning may also include cold drawing, heat treating, texturizing and/or cutting. An important aspect of melt spinning is the orientation of the polymer molecules by drawing the polymer in the molten state as it leaves the spinnerette. In accordance with standard terminology of the fiber and filament industry, the following definitions apply to the terms used herein:

A "monofilament" (also known as "monofil") refers to an individual strand of denier (tex) greater than 15 (1.7), usually greater than 30 (3.3);

A "fine denier fiber or "filament" refers to a strand of denier (tex) less than 15 (1.7);

A "multi-filament" (or "multifil") refers to simultaneously formed fine denier (tex) filaments spun in a bundle of fibers, generally containing at least 3, preferably at least 15-100 fibers and can be several hundred or several thousand;

An "extruded strand" refers to an extrudate formed by passing polymer through a forming-orifice, such as a die;

A "bicomponent fiber" refers to a fiber comprising two polymer components, each in a continuous phase. e.g. side-by-side or sheath/core;

A "bicomponent staple fiber" refers to a fine denier (tex) strand which have been formed at, or cut to, staple lengths of generally one to eight inches (2.5 to 20 cm).

The shapes of these bicomponent fibers, extruded strands and bicomponent staple fibers can be any which is convenient to the producer for the intended end use, e.g., round, trilobal. triangular, dog-boned, flat or hollow. The configuration of these bicomponent fibers or bicomponent staple fibers can be symmetric (e.g.. sheath/core or side-by-side) or they can be asymmetric (e.g., a crescent/moon configuration within a fiber having an overall round shape).

Convenient references relating to fibers and filaments, including those of man made thermoplastics, and incorporated herein by reference, are, for example:

(a) Encyclopedia of Polymer Science and Technology, Interscience, New York, vol. 6 (1967), pp. 505-555 and vol. 9 (1968), pp. 403-440;

(b) Kirk-Othmer Encyclopedia of Chemical Technology, vol. 16 for "Olefin Fibers", John Wiley and Sons, New York, 1981. 3rd edition;

(c) Man Made and Fiber and Textile Dictionary, Celanese Corporation;

(d) Fundamentals of Fibre Formation--The Science of Fibre Spinning and Drawing, Adrezij Ziabicki, John Wiley and Sons, London/New York, 1976;

(e) Man Made Fibres, by R. W. Moncrieff, John Wiley and Sons, London/New York, 1975.

Other references relevant to this disclosure include US-A-4,644,045 which describes spun bonded non-woven webs of LLDPE having a critical combination of percent crystallinity, cone die melt flow, die swell, relation of die swell to melt index, and polymer uniformity; EP-A-0 248 598 which describes a non-woven fabric formed of heat bonded bicomponent filaments having a sheath of LLDPE and a core of polyethylene terephthalate.

In CA 91:22388p (1979) there is described a fiber comprising polypropylene and ethylene-maleic anhydride graft copolymer spun at a 50:50 ratio and drawn 300 percent at 100°C, and a blend of the drawn fibers and rayon at a 40:60 weight ratio carded and heated at 145°C to give a bulky non-woven fabric. However, polypropylene is disadvantageous in some applications because of its relatively high melting point (145°C), and because of the relatively poor hand or feel imparted to fabrics made thereof. Poor hand is manifested in a relatively rough and inflexible fabric, as opposed to a smooth and flexible fabric.

US-A-4,684,576 describes the use of blends of HDPE grafted with maleic acid or maleic anhydride to give rise to succinic acid or succinic anhydride groups along the polymer chain with other olefin polymers as an adhesive, for example, in extrusion coating of articles, as adhesive layers in films and packaging, as hot melt coatings, as wire and cable interlayers, and in other similar applications. Similar references describing adhesive blends containing HDPE grafted with unsaturated carboxylic acids, primarily for laminate structures, include US-A-4,460,632; 4,394,485; and 4,230,830 and GB-A-2,081,723 and 2,113,696.

WO-A-9005152 discloses the preparation of biconstituent fibers in which there is a continuous phase of either grafted linear polyethylene or LLDPE with the other component dispersed therein in a matrix/fibril orientation. However, it is stated that the grafted linear polyethylene and LLDPE can form a bicomponent fiber in which each constituent is in a continuous phase. There is no exemplification of bicomponent fibers and no reference to the possibility that they should be used instead of the biconstituent fibers.

US-A-4,500,384 relates to the preparation of a nonwoven fabric of hot melt-adhered composite fibers in which at least some of the fibers are sheath/core bicomponent fibers in which the sheath fiber is of lower melting point than the core fiber. In Example 2, the core fiber is PET and the sheath fiber is HDPE. There are no other references to any other polyester, polyamide or polyethylene.

The present invention provides a thermally bonded non-wet laid fiber product comprising

(i) high performance fibers selected from polyesters, polyamides, silk, cellulosics, modified cellulosics and wool thermally bonded with
(ii) dyeable thermoplastic bicomponent fibers comprising (a) a first component being at least one high performance thermoplastic polymer selected from polyesters and polyamides thermally bonded to (b) a second component which forms at least a portion of the fiber's surface and is a polymer blend of a grafted linear ethylene polymer having pendant succinic acid or succinic anhydride groups and at least one ungrafted linear ethylene polymer, said bicomponent fiber being present in an amount of 5 to 15 parts by weight per 100 parts by weight of the combined weight of said high performance and bicomponent fibers.

The dyeable thermoplastic bicomponent fibers have superior hand, a relatively low melting or bonding temperature, superior adhesive properties, superior dyeability and superior adhesion of the components within the bicomponent fiber. The bicomponent fiber can be prepared by coextruding (a) and (b) into a fiber having a symmetrical or asymmetrical sheath/core or side-by-side configuration and a round, oval, trilobal, triangular, dog-boned, flat or hollow shape. Component (a) is a polyester (such as polyethylene terephthalate or polybutylene terephthalate) or a polyamide (such as nylon). Component (b) is a polymer blend of a grafted linear ethylene polymer having pendant succinic acid or succinic anhydride groups and at least one ungrafted linear ethylene polymer. The bicomponent fiber can be formed under melt blown, spunbond or staple manufacturing process conditions.

Component (i) of the fiber product of the invention is a natural and/or synthetic fibers selected from polyester (e.g., PET or PBT), polyamides (e.g., nylon), silk, cellulosics (e.g., cotton), modified cellulosics (e.g., rayon), or wool.

The linear ethylene polymers used for grafting can be linear HDPE and/or LLDPE. The density of linear HDPE before grafting can be 0.94 to 0.97 g/cc, but is typically between 0.945 and 0.965 g/cc, while that of LLDPE before grafting can be 0.88 to 0.94 g/cc, but is typically between 0.91 and 0.94 g/cc. Typically, linear HDPE and LLDPE will have about the same density before and after grafting, but this can vary depending on, for example, the particular linear ethylene polymer properties, graft level, and grafting conditions. The linear ethylene polymer before grafting has a melt index (MI) measured at 190°C/2.16 kg from 0.1 to 1000 grams/10 minutes, but typically less after grafting. For example, linear HDPE with a 25 MI and a 0.955 g/cc density grafted to a level of about 1 weight percent maleic anhydride (MAH) has a MI after grafting of about 16-18 grams/10 minutes. Melt index herein is measured in accordance with ASTM D1238 condition 190°C/2.16 kg (also known as condition "E"). The MI of the ungrafted linear ethylene polymer used for grafting is selected depending on the specific melt spinning procedure employed and whether or not the grafted linear ethylene polymer is employed alone or in a blend with another linear ethylene polymer.

The grafting of succinic acid or succinic anhydride groups may be done by methods described in the art which generally involve reacting maleic acid or maleic anhydride in admixture with heated polymer. generally using a peroxide or free radical initiator to accelerate the grafting. The maleic acid and maleic anhydride compounds are known in these relevant arts as having their olefin unsaturation sites conjugated to the acid groups. Fumaric acid, an isomer of maleic acid which is also conjugated. gives off water and rearranges to form maleic anhydride when heated, and thus is operable in the present invention. Grafting may be effected in the presence of oxygen, air hydroperoxides, or other free radical initiators. or in the essential absence of these materials when the mixture of monomer and polymer is maintained under high shear and heat conditions. A convenient method for producing the graft polymer is extrusion machinery, although, for example, Brabender mixers or Banbury mixers, or roll mills may also be used for forming the graft polymer. It is preferred to employ a twin-screw devolatilizing extruder (such as a Werner-Pfleiderer twin-screw extruder) wherein maleic acid or maleic anhydride is mixed and reacted with the linear ethylene polymer(s) at molten temperatures to produce and extrude the grafted polymer.

The anhydride or acid groups of the grafted polymer generally comprise from 0.001 to 10 weight percent, preferably from 0.01 to 5 weight percent, and especially from 0.1 to 1 weight percent of the grafted polymer. The grafted polymer is characterized by the presence of pendant succinic acid or anhydride groups along the polymer chain, as opposed to the carboxylic acid groups obtained by the bulk copolymerization of ethylene with an α,β-ethylenically unsaturated carboxylic acid such as acrylic acid (as disclosed in EP-A-0 311 860). Grafted linear HDPE is the preferred grafted linear ethylene polymer.

The grafted linear ethylene polymer is employed as a component in a polymer blend with at least one ungrafted linear ethylene polymer. The polymer blend preferably contains from 0.5 to 99.5 weight percent of the grafted linear ethylene polymer, more preferably from 1 to 50 weight percent grafted linear ethylene polymer, and especially from 2 to 15 weight percent grafted linear ethylene polymer. The polymer blend may also include conventional additives, such as dyes, pigments, antioxidants, UV stabilizers, and spin finishes and/or relatively minor proportions of other fiber forming polymers which do not significantly alter the melting properties of the blend or the improved hand obtained in fabrics containing fibers employing LLDPE as a polymer blend component.

The LLDPE employed either as the grafted linear ethylene polymer component or as the ungrafted component in the dyeable thermoplastic bicomponent fiber, comprises at least a minor amount of a C_3-C_{12} olefinically unsaturated alkene, preferably a C_4-C_8 olefinically unsaturated alkene, and 1-octene is especially preferred. The alkene may constitute from 0.5 to 35 percent by weight of the LLDPE, preferably from 1 to 20 weight percent, and most preferably from 2 to 15 weight percent.

The grafted linear ethylene polymer (e.g., grafted linear HDPE) and the ungrafted linear ethylene polymer (such as ungrafted LLDPE) are blended together prior to extrusion, either by melt blending or dry blending. Dry blending of pellets of the grafted linear ethylene polymer and the ungrafted linear ethylene polymer prior to extrusion is generally adequate where the melt indices of the blend components are similar, and there will generally be no advantage in melt blending such blend constituents prior to extrusion. However, where melt blending may be desired, as in the case of grafted linear HDPE and LLDPE or dissimilar melt indices, melt blending may be accomplished with conventional blending equipment, such as, for example, mixing extruders, Brabender mixers, Banbury mixers, or roll mills.

The high performance thermoplastic polymer useful as such as the second component of the dyeable thermoplastic bicomponent fiber is a polyester (e.g., PET or PBT) or a polyamide (e.g., nylon). The high performance thermoplastic polymer can be used as one component of the bicomponent fiber by contacting it with the grafted linear ethylene polymer(s) under thermally bonding conditions, such as that encountered when coextruding bicomponent fiber using a bicomponent staple fiber die. The high performance polymer can be either component of a sheath/core configuration or it can be either component of a side-by-side configuration. The high performance thermoplastic polymer can be chosen to provide stiffness in the bicomponent fiber, especially when the grafted linear ethylene polymer is a polymer blend of grafted linear HDPE blended with ungrafted LLDPE. Additionally, the high performance thermoplastic polymer used in making the bicomponent fiber in the present invention can be the same polymer as that used for making high performance fiber which is blended with the bicomponent fiber.

Extrusion of the polymer through a die to form a fiber is effected using conventional equipment such as, for example, extruders or gear pumps. It is preferred to employ separate extruders, which feed gear pumps to supply the separate molten polymer streams to the die. The grafted linear ethylene polymer or polymer blend is preferably mixed in a mixing zone of the extruder and/or in a static mixer, for example, upstream of the gear pump in order to obtain a more uniform dispersion of the polymer components.

Following extrusion through the die, the fiber is taken up in solid form on a godet or another take-up surface. In a bicomponent staple fiber forming process, the fibers are taken up on a godet which draws down the fibers in proportion to the speed of the take-up godet. In the spunbond process, the fibers are collected in a jet, such as, for example, an air gun, and blown onto a take-up surface such as a roller or moving belt. In the melt blown process, air is ejected at the surface of the spinnerette which serves to simultaneously draw down and cool the fibers as they are deposited on a take-up surface in the path of the cooling air. Regardless of the type of melt spinning procedure which is used, it is important that the fibers be partially melt drawn in a molten state, i.e. before solidification occurs. At least some drawdown is necessary in order to orient the polymer molecules for good tenacity. It is not generally sufficient to solidify the fibers without significant extension before take-up, as the fine strands which are formed thereby can hardly be cold drawn, i.e. in a solid state below the melting temperature of the polymer. because of their low tenacity. On the other hand, when the fibers are drawn down in the molten state, the resulting strands can more readily be cold drawn because of the improved tenacity imparted by the melt drawing.

Melt drawdowns of up to 1:1000 may be employed depending upon spinnerette die diameter and spinning velocity, preferably from 1:10 to 1:200, and especially 1:20 to 1:100.

Where the bicomponent staple-forming process is employed, it may be desirable to cold draw the strands with conventional drawing equipment, such as, for example, sequential godets operating at differential speeds. The strands may also be heat treated or annealed by employing a heated godet. The strands may further be texturized, such as, for example, by crimping and cutting the strand or strands to form staple. In the spun bonded or air jet processes, cold drawing of the solidified strands and texturizing is effected in the air jet and by impact on the take-up surface, respectively. Similar texturizing is effected in the melt blown process by the cooling fluid which is in shear with the molten polymer strands, and which may also randomly delinearize the fibers prior to their solidification.

The bicomponent fibers are generally fine denier filaments of 15 denier (1.7 tex) or less down to fractional deniers (below 0.1 tex), preferably in the range of from 1 to 10 denier (0.1-1.1 tex), although this will depend on the desired properties of the fibers and the specific application in which they are to be used.

The bicomponent fibers have a wide variety of potential applications. For example, the bicomponent fibers may be formed into a batt and heat treated by calendaring on a heated, embossed roller to form a fabric. The batts may also be heat bonded, for example, by infrared light or ultrasound, to obtain a high loft fabric. The fibers may also be employed in conventional textile processing such as carding, sizing or weaving. Woven fabrics made from the bicomponent fibers of the present invention may also be heat treated to alter the properties of the resulting fabric.

In accordance with the invention, the bicomponent fibers (ii) are used in binder fiber applications with high performance natural and/or synthetic fibers selected from polyamides, polyesters, silk, cellulosics (e.g. cotton), wool, or modified cellulosics such as rayon and rayon acetate. The bicomponent fibers (ii) find particular advantage as binder fibers owing to their adhesion to performance fibers and dyeability thereof which is enhanced by the presence of the acid groups in the grafted linear ethylene polymer component and the relatively lower melting temperature or range of the grafted linear ethylene polymer component relative to the performance fiber. The relative proportions of the binder fiber employed in admixture with performance fibers in a fiber blend will depend on the desired application and capabilities of the resulting fiber mixture and/or fabric obtained thereby. 5 to 15 parts by weight of the binder fiber are employed per 100 parts by weight of the binder fiber/performance fiber mixture.

In preparing non-woven fabrics from the bicomponent binder fiber/performance fiber blend, there are several important considerations. Where the binder fibers are in staple form, there should be no fusing of the fibers when they are cut into staple, and the crimp imparted to the binder fibers should be sufficient for blending with the performance fibers to obtain good distribution of the fibers.

The ability of the component comprising at least one grafted linear ethylene polymer having pendant succinic acid or anhydride groups to adhere to the other component of at least one high performance thermoplastic polymer is an important consideration in cutting of bicomponent staple fiber. When bicomponent staple fiber is cut and one of the components (e.g., the core of a bicomponent fiber) protrudes from the cut edge, the fiber will create an irritation when worn next to the skin. The irritation is especially pronounced when the core component is a PET. When ungrafted linear ethylene polymer and PET are made, respectively, into a sheath/core bicomponent fiber and cut into short staple fiber, the core of PET protrudes beyond the cut edge. The enhanced adhesion of the grafted linear ethylene polymer component to the PET component used in making the dyeable thermoplastic bicomponent fiber reduces PET protrusion beyond the fiber after cutting and thus enables fabrics and fiber blends to be made which can be more comfortably worn next to the skin.

The ability of the bicomponent binder fibers to adhere to the performance fibers is another important consideration. Adhesion and dyeability can generally be controlled by varying the acid content of the binder fiber, either by the level of graft of maleic acid or anhydride in the grafted linear ethylene polymer, or by the proportion of the grafted linear ethylene polymer blended with the ungrafted linear ethylene polymer in the bicomponent binder fibers. In typical non-woven fabrics obtained by thermally bonding the performance fibers with a bicomponent binder fiber, the ability of the binder fibers to bond together the performance fibers depends largely on the thermal bonding of the performance fibers together by the binder fibers. In typical prior art non-woven fabrics employing binder fibers, the binder fiber thermally bonds performance fibers together by at least partially melting to form globules or beads which encapsulate the performance fibers. The binder fibers enhance the non-woven fabric by providing great adhesion of the binder fiber to the performance fiber. Employing the binder fibers, it is also possible to obtain thermal bonding of the binder fiber to a performance fiber by partial melting and contact adhesion in which the bicomponent binder fibers largely retain their fibrous form, and the resulting non-woven fabric is characterized by a reduced number of globules or beads formed by the melting of the lower melting component of the bicomponent binder fibers.

It is also important for one component of the bicomponent binder fiber to have a relatively broad melting point range or thermal bonding window, particularly where hot calendaring is employed to obtain a thermal bonding of a non-woven or woven fabric. A good indication of melting point range or thermal bonding window is the difference between the Vicat softening point and the peak melting point determined by differential scanning calorimetry (DSC). Narrow melting point ranges present a difficult target for process bonding equipment such as a calendar roll, and even slight variations in the temperature of bonding equipment can result in an insufficient bond to be formed between the bicomponent binder fibers and the performance fibers. If too low a temperature is employed, the bicomponent binder fibers will not sufficiently fuse, whereas when too high a temperature is employed, one component of the bicomponent binder fiber may completely melt and run right out of the performance fiber batt. Thus, a broad melting point range is desired in order that partial fusion of one component of the bicomponent binder fiber material can be achieved without a complete melting. A melting point range of at least 7.5°C is desired for proper thermal bonding, and preferably a sufficiently broad melting point range that a minimum 10°C bonding window is obtained.

Another important characteristic of bicomponent binder fibers is that when they are melted in equipment such as a calendar roll, one of the components will have a sufficient melt viscosity to be retained in the fiber matrix and not readily flow therefrom. An important advantage of the bicomponent binder fibers is that one component has generally higher melt viscosity than fibers consisting of ungrafted LLDPE and/or ungrafted linear HDPE. In addition to using a calendar roll, bonding of the present binder fibers can also be obtained using other bonding techniques, e.g. with hot air or infrared heaters.

The thermoplastic bicomponent fibers can be dyed by contacting them with a water soluble ionic dye, preferably a water soluble cationic dye, in a suitable aqueous medium. The aqueous medium can contain surfactants, if desired, to promote contact.

The invention is illustrated by way of, but not limited to, the examples which follow.

Example 1

Ten percent of a grafted linear HDPE (ethylene/ propylene copolymer, MI of 25 grams/10 minutes before grafting, density of 0.955 g/cc before grafting) having about 1% by weight succinic acid groups is blended with about 90% by weight of an ungrafted LLDPE (ethylene/ octene copolymer, MI of 18 grams/10 minutes, 0.930 g/ cc density) to form a polymer blend having about 0.1% by weight succinic acid groups. The polymer blend is then used as a sheath component in a bicomponent staple fiber spinning operation, with the core component being PET. The sheath/core bicomponent fibers are blended with other performance fibers such as PET or cellulosics, formed into batts and oven bonded, The batts are found to be well-bonded and have good physical integrity.

Example 2

Linear HDPE (ethylene-propylene copolymer, MI of 25 grams/10 minutes, 0.955 g/cc density) is grafted with maleic acid to provide succinic acid groups along the polymer chain. Portions of the grafted linear HDPE are then blended with amounts of ungrafted LLDPE (ethylene-octene copolymer, MI of 18 grams/10 minutes, 0.930 g/cc density) to produce polymer blends containing 0.05%, 0.1%, 0.15%, 0.2%, and 0.4% by weight of the succinic acid. The grafted linear HDPE/LLDPE polymer blend samples are coextruded with PET to produce side-by-side bicomponent fibrous material. The adhesion between fibers in a heat-bonded batt of the fibrous material is appreciably better than that obtained in comparison by using the same linear HDPE and LLDPE without any grafted acid groups. The maximum heat-bonded batt strength occurs when using bicomponent fiber having a succinic acid level of about 0.1% by weight.

Example 3

Linear HDPE (ethylene-propylene copolymer, MI of 25 grams/10 minutes, 0.955 g/cc density) is grafted with maleic anhydride to provide about 1% by weight succinic anhydride groups along the polymer chain. Portions of the grafted linear HDPE are blended with amounts of ungrafted LLDPE (ethylene-octene copolymer, MI of 18 grams/10 minutes, 0.930 g/cc density) to produce polymer blends containing 0.05%, 0.1%, 0.15%, 0.2%, and 0.5% by weight of the succinic acid groups. Polymer blends of the grafted linear HDPE with the ungrafted LLDPE can be coextruded as the sheath layer in a bicomponent spunbond system using a PET as the core layer. The resultant thermally bonded fabric has a bonded fabric strength higher than that obtained using ungrafted linear ethylene polymer alone as the sheath resin.

Example 4 (Outside the scope of the claims)

LLDPE (ethylene-octene copolymer, MI of 18 grams/10 minutes, 0.930 g/cc density) does not accept dye when treated with Basic Violet III (a basic dye also known as Crystal Violet) at 80°C for 15 minutes in the presence of a drop of didecyl dimethyl ammonium chloride used as a wetting agent. When blended with enough LLDPE grafted with maleic anhydride to provide a polymer blend having about 0.15% by weight succinic acid groups, the resulting polymer blend, when treated in the same manner as immediately above, became dyed to a blue/purple color. The dye does not readily leach out, even when placed in boiling water for 10-15 minutes. Other water soluble cationic dyes (i.e., dyes which are typically referred to as "basic dyes" in the industry) can be similarly used to dye the bicomponent fibers.

Claims

1. A thermally bonded non-wet laid fiber product comprising

(i) high performance fibers selected from polyesters, polyamides, silk, cellulosics, modified cellulosics and wool thermally bonded with
(ii) dyeable thermoplastic bicomponent fibers comprising (a) a first component being at least one high performance thermoplastic polymer selected from polyesters and polyamides thermally bonded to (b) a second component which forms at least a portion of the fiber's surface and is a polymer blend of a grafted linear ethylene polymer having pendant succinic acid or succinic anhydride groups and at least one ungrafted linear ethylene polymer, said bicomponent fiber being present in an amount of 5 to 15 parts by weight per 100 parts by weight of the combined weight of said high performance and bicomponent fibers.

2. A product defined by Claim 1, wherein said bicomponent fiber is prepared by coextruding (a) and (b) into a fiber having a round, oval, trilobal, triangular, dog-boned, flat or hollow shape and a symmetrical or asymmetrical sheath/ core or side-by-side configuration.

3. A product defined by Claim 2, wherein said bicomponent fiber has a round shape and a sheath/core configuration.

4. A product defined by any one of the preceding claims, wherein (i) is selected from polyethylene terephthalate, polybutylene terephthalate, nylon, cotton, silk, rayon, rayon acetate and wool.

5. A product defined by any one of the preceding claims, wherein (a) is polyethylene terephthalate or polybutylene terephthalate.

6. A product as defined by any one of Claims 1 to 4, wherein (a) is nylon.

7. A product defined by any one of the preceding claims, wherein said grafted polymer is a grafted linear high density polyethylene having pendant succinic acid or succinic anhydride groups.

8. A product defined by any one of Claims 1 to 6, wherein said grafted polymer is a grafted linear low density polyethylene having pendant succinic acid or succinic anhydride groups.

9. A product defined by any one of the preceding claims, wherein the succinic acid or succinic anhydride groups comprise 0.01 to 5 weight percent of the grafted polymer.

10. A product defined by Claim 9, wherein the succinic acid or succinic anhydride groups comprise 0.1 to 1 weight percent of the grafted polymer.

11. A product defined by any one of the preceding claims, wherein said polymer blend comprises a grafted linear high density ethylene polymer and an ungrafted linear low density ethylene polymer.

12. A product defined by any one of the preceding claims, wherein said polymer blend contains 1 to 50 weight percent of the grafted linear ethylene polymer.

13. A product defined by any one of the preceding claims, wherein said polymer blend contains 2 to 15 weight percent of the grafted linear ethylene polymer.

14. A product defined by any one of the preceding claims, wherein said fiber is formed by coextrusion under melt blown, spunbond or staple fiber manufacturing process conditions.

15. A method of bonding high performance fibers selected from polyesters, polyamides, silk, cellulosics, modified cellulosics and wool by non-wet laid blending the high performance fibers with binder fibers and heating the non-wet laid fibrous mixture to near the melting point of the binder fibers to thermally bond the binder fibers to the high performance fibers, wherein the binder fibers are dyeable thermoplastic bicomponent fibers comprising (a) a first component being at least one high performance thermoplastic polymer selected from polyesters and polyamides thermally bonded to (b) a second component which forms at least a portion of the fiber's surface and which is a polymer blend of a grafted linear ethylene polymer having pendant succinic acid or succinic anhydride groups and at least one ungrafted linear ethylene polymer, said bicomponent fiber being present in an amount of 5 to 15 parts by weight per 100 parts by weight of the combined weight of said high performance and bicomponent fibers.

16. A method defined by Claim 15, wherein said high performance fiber is a polyester, polyamide, cellulosic, modified cellulosic or wool, or a mixture thereof.

17. A method defined by Claim 15 or Claim 16 wherein the bicomponent fibers are as defined for the bicomponent fibers of the fiber product as claimed in any one of Claims 2 to 14.

Patentansprüche

1. Thermisch gebundenes, nicht feucht ausgelegtes Faserprodukt, umfassend

(i) Hochleistungsfasern, ausgewählt aus Polyestern, Polyamiden, Seide, Cellulosen, modifizierten Cellulosen und Wolle, die thermisch gebunden sind mit
(ii) färbbaren thermoplastischen Zweikomponentenfasern, umfassend (a) eine erste Komponente, die mindestens ein thermoplastisches Hochleistungspolymer ist, ausgewählt aus Polyestern und Polyamiden, die thermisch gebunden sind an (b) eine zweite Komponente, die mindestens einen Teil der Faseroberfläche bildet und ein Polymergemisch aus einem gepfropften linearen Ethylenpolymer ist, mit Succinsäure- oder Succinsäureanhydridseitengruppen und mindestens einem ungepfropften linearen Ethylenpolymer, wobei die Zweikomponentenfaser in einer Menge von 5 bis 15 Gewichtsteile pro 100 Gewichtsteile des kombinierten Gewichts der Hochleistungs- und Zweikomponentenfasern vorliegt.

2. Produkt nach Anspruch 1, worin die Zweikomponentenfaser hergestellt ist durch Coextrudieren von (a) und (b) in eine Faser mit einer runden, ovalen, trilobalen, dreieckigen, hundeknochenförmigen, flachen oder hohlen Form und einer symmetrischen oder asymmetrischen Hülle/Kern- oder Seite-an-

Seite-Konfiguration.

3. Produkt nach Anspruch 2, worin die Zweikomponentenfaser eine runde Form und eine Hülle/Kern-Konfiguration aufweist.

4. Produkt nach einem der vorhergehenden Ansprüche, worin (i) ausgewählt ist aus Polyethylenterephthalat, Polybutylenterephthalat, Nylon, Baumwolle, Seide, Rayon, Rayonacetat und Wolle.

5. Produkt nach einem der vorhergehenden Ansprüche, worin (a) Polyethylenterephthalat oder Polybutylenterephthalat ist.

6. Produkt nach einem der Ansprüche 1 bis 4, worin (a) Nylon ist.

7. Produkt nach einem der vorhergehenden Ansprüche, worin das gepfropfte Polymer ein gepfropftes lineares hochdichtes Polyethylen mit Succinsäure- oder Succinsäureanhydridseitengruppen ist.

8. Produkt nach einem der Ansprüche 1 bis 6, worin das gepfropfte Polymer ein gepfropftes lineares Polyethylen mit niederer Dichte mit Succinsäure- oder Succinsäureanhydridseitengruppen ist.

9. Produkt nach einem der vorhergehenden Ansprüche, worin die Succinsäure- oder Succinsäureanhydridgruppen 0,01 bis 5 Gew.-% des gepfropften Polymers umfassen.

10. Produkt nach Anspruch 9, worin die Succinsäure- oder Succinsäureanhydridgruppen 0,1 bis 1 Gew.-% des gepfropften Polymers umfassen.

11. Produkt nach einem der vorhergehenden Ansprüche, worin das Polymergemisch ein gepfropftes lineares Ethylenpolymer mit hoher Dichte und ein ungepfropftes lineares Ethylenpolymer mit niederer Dichte umfaßt.

12. Produkt nach einem der vorhergehenden Ansprüche, worin das Polymergemisch 1 bis 50 Gew.-% des gepfropften linearen Ethylenpolymers enthält.

13. Produkt nach einem der vorhergehenden Ansprüche, worin das Polymergemisch 2 bis 15 Gew.-% des gepfropften linearen Ethylenpolymers enthält.

14. Produkt nach einem der vorhergehenden Ansprüche, worin die Faser durch Coextrusion unter Schmelzblas-, Spinnbindungs- oder Stapelfaserherstellungsverfahrensbedingungen gebildet ist.

15. Verfahren zum Binden von Hochleistungsfasern, ausgewählt aus Polyestern, Polyamiden, Seide, Cellulosen, modifizierten Cellulosen und Wolle durch nicht feucht ausgelegtes Mischen der Hochleistungsfasern mit Bindefasern und Erhitzen des nicht feucht ausgelegten faserförmigen Gemisches bis nahe dem Schmelzpunkt der Bindefasern, um thermisch die Bindefasern an die Hochleistungsfasern zu binden, worin die Bindefasern färbbare thermoplastische Zweikomponentenfasern sind, umfassend (a) eine erste Komponente, die mindestens ein thermoplastisches Hochleistungspolymer ist, ausgewählt aus Polyestern und Polyamiden, die thermisch gebunden sind an (b) eine zweite Komponente, die mindestens einen Teil der Faseroberfläche bildet und welche ein Polymergemisch aus einem gepfropften linearen Ethylenpolymer mit Succinsäure- oder Succinsäureanhydridseitengruppen und mindestens einem ungepfropften linearen Ethylenpolymer ist, wobei die Zweikomponentenfaser in einer Menge von 5 bis 15 Gewichtsteile pro 100 Gewichtsteile des kombinierten Gewichts der Hochleistungs- und Zweikomponentenfasern vorliegt.

16. Verfahren nach Anspruch 15, worin die Hochleistungsfaser ein Polyester, Polyamid, Cellulose, modifizierte Cellulose oder Wolle oder ein Gemisch davon ist.

17. Verfahren nach Anspruch 15 oder Anspruch 16, worin die Zweikomponentenfasern wie die Zweikomponentenfasern des Faserproduktes nach einem der Ansprüche 2 bis 14 definiert sind.

Revendications

1. Produit constitué de fibres liées thermiquement déposées par voie non humide, ledit produit constitué de fibres comprenant:

   (i) des fibres à performance élevée choisies parmi les polyesters, les polyamides, la soie, les matières cellulosiques, les matières cellulosiques modifiées et la laine, liées thermiquement avec
   (ii) des fibres thermoplastiques à deux composants pouvant être teintes, comprenant (a) un premier composant qui est au moins un polymère thermoplastique à performance élevée choisi parmi les polyesters et les polyamides, lié thermiquement à (b) un second composant qui forme au moins une portion de la surface de la fibre et qui est un mélange polymère d'un polymère d'éthylène linéaire greffé ayant des groupes acide succinique ou anhydride succinique pendants et d'au moins un polymère d'éthylène linéaire non greffé, ladite fibre à deux composants étant présente à raison de 5

à 15 parties en poids pour 100 parties du poids combiné desdites fibres à performance élevée et à deux composants.

2. Produit selon la revendication 1, dans lequel ladite fibre à deux composants est préparée en coextrudant (a) et (b) sous forme d'une fibre ayant une configuration ronde, ovale, trilobée, triangulaire, en forme d'haltère, de forme plate ou creuse et une configuration symétrique ou asymétrique coque/noyau ou côte à côte.

3. Produit selon la revendication 2, dans lequel ladite fibre à deux composants possède une forme ronde et une configuration coque/noyau.

4. Produit selon l'une des revendications précédentes, dans lequel (i) est choisi parmi le poly(téréphtalate d'éthylène), le poly(téréphtalate de butylène), le nylon, le coton, la soie, la rayonne, l'acétate de rayonne et la laine.

5. Produit selon l'une des revendications précédentes, dans lequel (a) est le poly(téréphtalate d'éthylène) ou le poly(téréphtalate de butylène).

6. Produit selon l'une des revendications 1 à 4, dans lequel (a) est le nylon.

7. Produit selon l'une des revendications précédentes, dans lequel ledit polymère greffé est un polyéthylène haute densité linéaire greffé ayant des groupes acide succinique ou anhydride succinique pendants.

8. Produit selon l'une des revendications 1 à 6, dans lequel ledit polymère greffé est un polyéthylène basse densité linéaire greffé ayant des groupes acide succinique ou anhydride succinique pendants.

9. Produit selon l'une des revendications précédentes, dans lequel les groupes acide succinique ou anhydride succinique représentent 0,01 à 5 pourcent en poids du polymère greffé.

10. Produit selon la revendication 9, dans lequel les groupes acide succinique ou anhydride succinique représentent 0,1 à 1 pour-cent en poids du polymère greffé.

11. Produit selon l'une des revendications précédentes, dans lequel ledit mélange polymère comprend un polymère d'éthylène haute densité linéaire greffé et un polymère d'éthylène basse densité linéaire non greffé.

12. Produit selon l'une des revendications précédentes, dans lequel ledit mélange polymère contient 1 à 50 pour-cent en poids du polymère d'éthylène linéaire greffé.

13. Produit selon l'une des revendications précédentes, dans lequel ledit mélange polymère contient 2 à 15 pour-cent en poids du polymère d'éthylène linéaire greffé.

14. Produit selon l'une des revendications précédentes, dans lequel ladite fibre est formée par coextrusion par soufflage à l'état fondu, un procédé de liaison par filature ou de fibres en brins coupés.

15. Procédé de liaison de fibres à performance élevée choisies parmi les polyesters, les polyamides, la soie, les matières cellulosiques, les matières cellulosiques modifiées et la laine en mélangeant par dépôt non humide des fibres à performance élevée avec des fibres liantes et en chauffant le mélange fibreux non humide à une température proche du point de fusion des fibres liantes pour lier thermiquement les fibres liantes aux fibres à performance élevée, dans lequel les fibres liantes sont des fibres thermoplastiques à deux composants pouvant être teintes, comprenant (a) un premier composant qui est au moins un polymère thermoplastique à performance élevée choisi parmi les polyesters et les polyamides, lié thermiquement à (b) un second composant qui forme au moins une portion de la surface de la fibre et qui est un mélange polymère d'un polymère d'éthylène linéaire greffé ayant des groupes acide succinique ou anhydride succinique pendants et d'au moins un polymère d'éthylène linéaire non greffé, ladite fibre à deux composants étant présente à raison de 5 à 15 parties en poids pour 100 parties en poids du poids combiné desdites fibres à performance élevée et à deux composants.

16. Procédé selon la revendication 15, dans lequel ladite fibre à performance élevée est un polyester, un polyamide, une matière cellulosique, une matière cellulosique modifiée ou de la laine, ou un mélange de ceux-ci.

17. Procédé selon la revendication 15 ou la revendication 16, dans lequel les fibres à deux composants sont telles que définies pour les fibres à deux composants du produit constitué de fibres selon l'une des revendications 2 à 14.