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(54) **TEXTILE FIBER OR WEB, METHODS AND USE RELATED THERETO**

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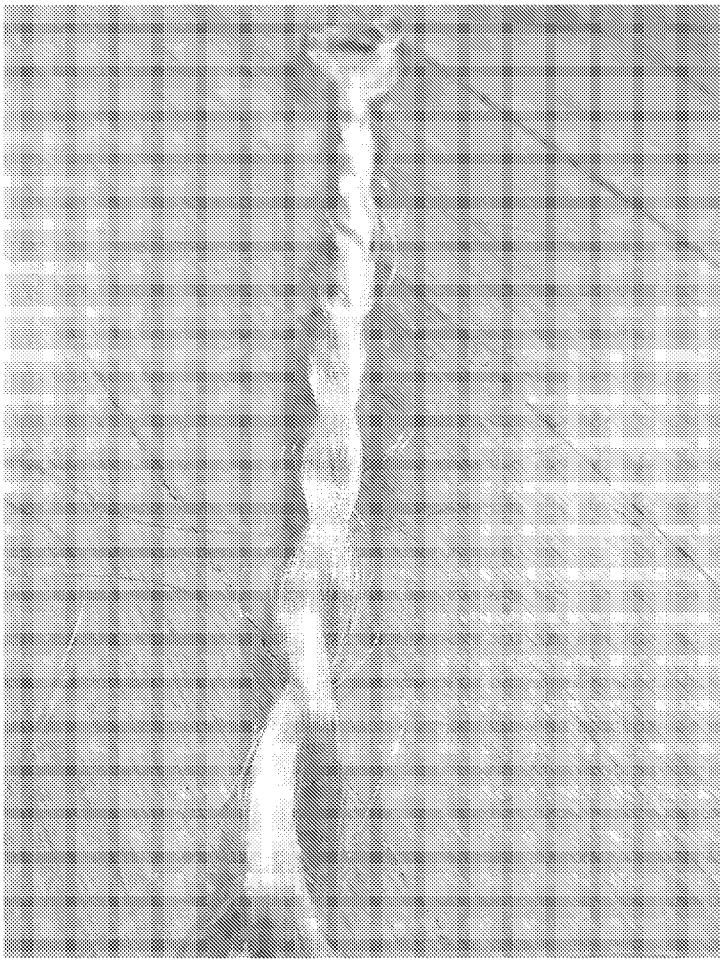
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(57) **ABSTRACT**

The invention concerns a textile fiber or textile web having a binary polymer composition, which binary polymer composition included a first polymer being cellulose acetate propionate and a second polymer selected from several polymers. Furthermore, a method and use related thereto are described.



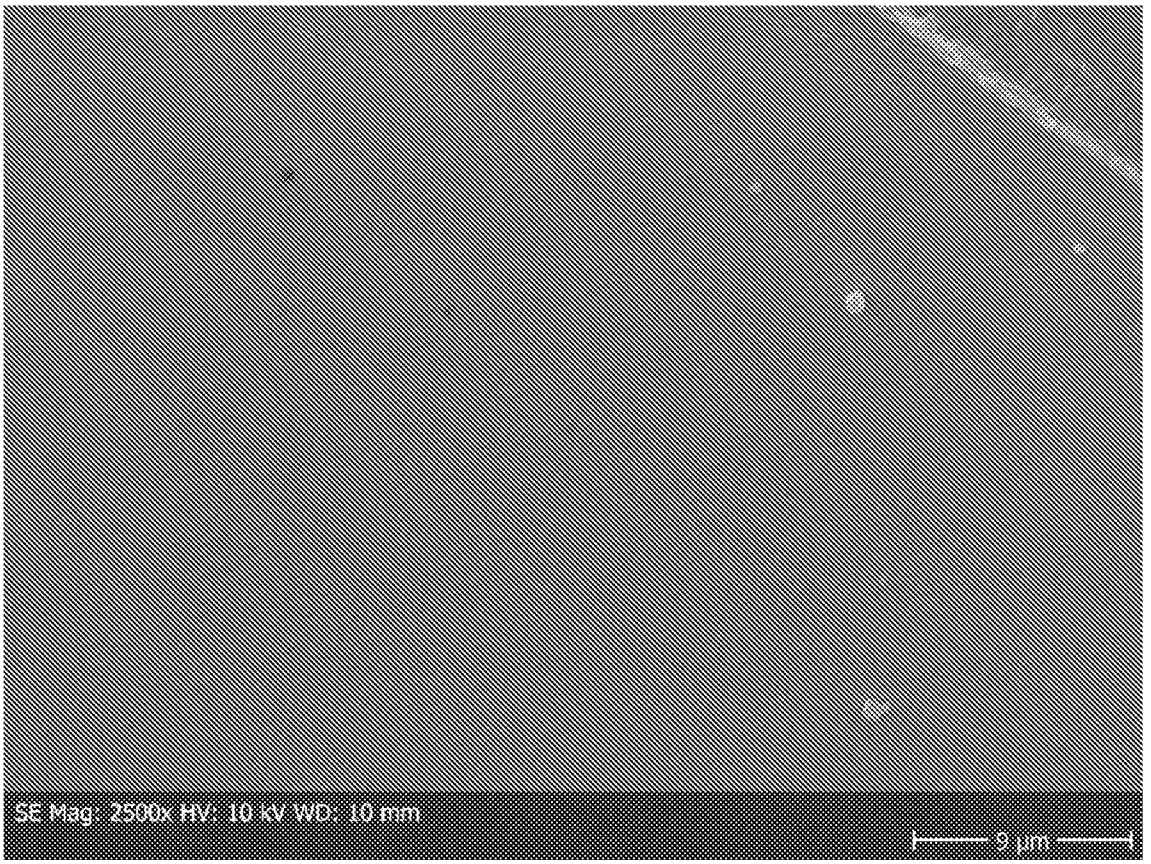


Figure 1



Figure 2

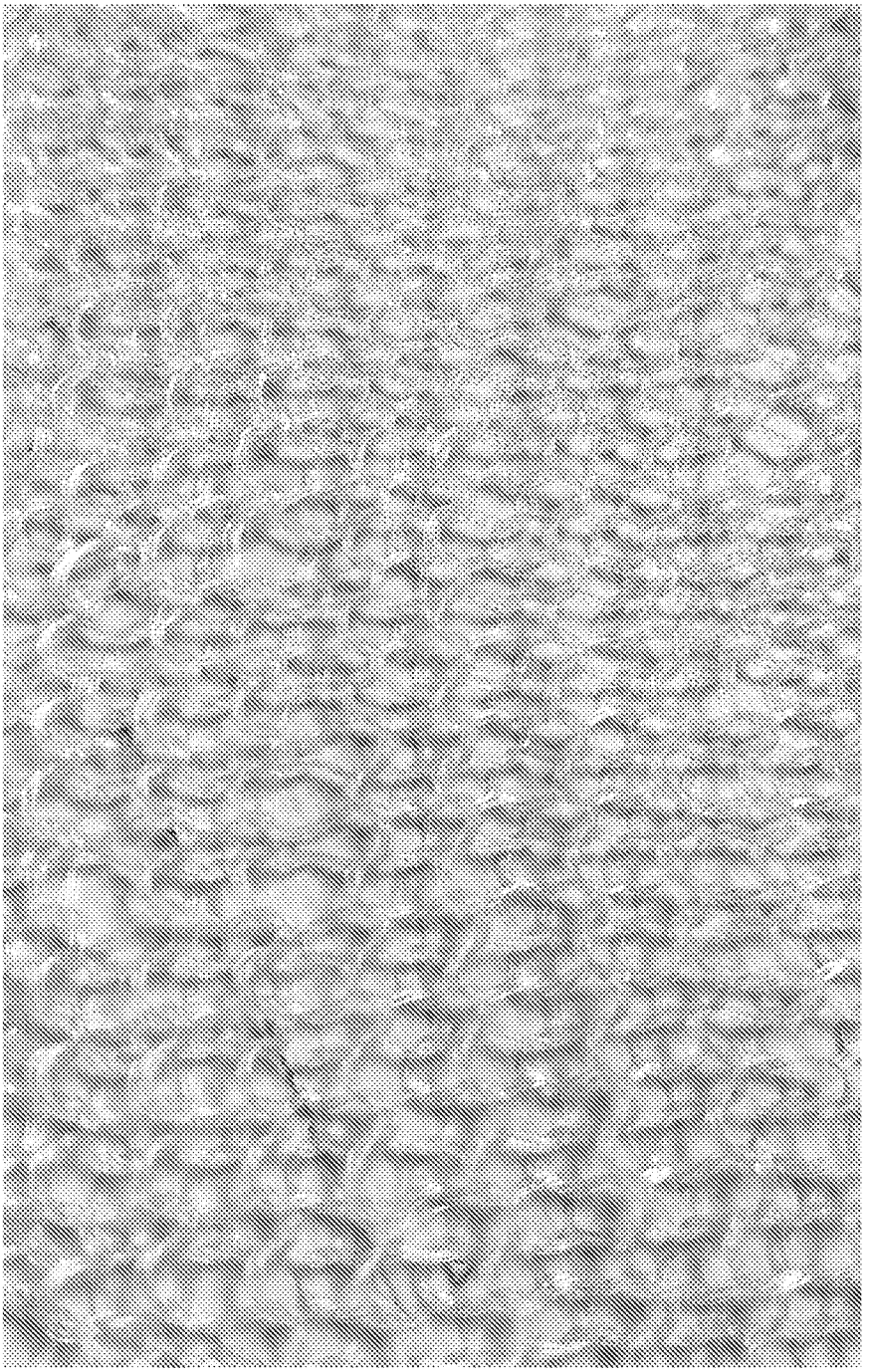


Figure 3

TEXTILE FIBER OR WEB, METHODS AND USE RELATED THERETO

TECHNICAL FIELD

[0001] The present disclosure relates to synthetic textile fibers and to their manufacturing. Especially, to a textile fiber or textile web comprising a binary polymer composition.

BACKGROUND

[0002] There are various methods for producing textile fibers and textile webs.

[0003] Fibers are typically manufactured by various spinning methods. Such methods include wet spinning, dry spinning, melt spinning, extrusion spinning, direct spinning, gel spinning and electrospinning. Of these spinning methods, particularly interesting are the ones where no solvents are needed. Solvents in wet spinning for instance are often highly toxic. Melt spinning is one method where no solvents are needed but the polymer is extruded through the spinneret in molten stage and cooled. The polymer can be in different forms before the spinning process: granulate, fluff, fiber, or raw materials ready to be extruded directly into the spinning process.

[0004] These fibers can be further converted into yarn and fabric. Textiles are produced for example by weaving and knitting yarn made of fibers.

[0005] Nonwovens are manufactured as sheets or webs of directionally of randomly oriented fibers, that have not been converted into yarns. These fibers can be bonded by for example adhesives, thermal methods, solvent treatments or stitching. The processes for producing nonwovens differ from those used for spun fibers. These methods include melt blowing, where the fibrous web or article is produced directly from the polymer of resin using high-velocity air. Spunbond nonwovens are made as continuous process where fibers are spun and then dispersed directly to a web. Nonwovens can also be produced from spun fibers, when the fibers are then cut and opened and laid into a web by a multistep process.

SUMMARY

[0006] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject-matter.

[0007] The invention concerns a textile fiber or textile web comprising a binary polymer composition, which comprises a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), and in which the total amount of the first and the second polymer is at least 80 weight-% of the binary polymer composition based on the total weight of the binary polymer compostions.

[0008] The invention also concerns a textile material comprising the textile fiber or textile web.

[0009] Further, the invention concerns a method for manufacturing a textile fiber or a textile web from a binary polymer composition, which method comprises the following steps:

[0010] obtaining a homogenous polymer blend of a binary polymer composition comprising at least a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), wherein the total amount of the first and the second polymer is at least 80 weight-% based on the total weight of the binary polymer composition, and

[0011] a) forming said homogenous polymer blend into a textile fiber by a spinning method, or

[0012] b) forming said homogenous polymer blend into a textile web by a method of producing nonwoven materials.

[0013] The invention also concerns use of a binary polymer composition comprising a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), and wherein the total amount of the first and the second polymer is at least 80 weight-% based on the total weight of the binary polymer composition, in the manufacture of a textile fiber, a textile web, and/or a textile material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The accompanying drawings, which are included to provide a further understanding of the embodiments and constitute a part of this specification, illustrate embodiments. In the drawings:

[0015] FIG. **1** illustrates Example 1, Scanning electron microscopy of a binary polymer composition suitable for the invention, made of CAP 72.5% and PBS 27.5%.

[0016] FIG. **2** illustrates Example 4, fibers produced from a binary polymer composition according to this disclosure.

[0017] FIG. **3** illustrates Example 4, knitted fabric produced from the fibers of FIG. **2**.

DETAILED DESCRIPTION

[0018] Cellulose derivatives are used in textile fibers, but there are challenges regarding the used processes. Wet spinning and dry spinning processes require the use of toxic solvents. A melt spinning process requires the use of a large amounts of plasticizers and problems arise with the process temperatures. It is of high importance that the breaking elongation is good, and this is hard to obtain with fibers from cellulose derivatives.

[0019] The present invention provides a solution to these problems.

[0020] The present invention is based on the finding that new environmentally friendly good quality synthetic textile fibers and webs can be achieved by a binary polymer composition comprising cellulose acetate propionate (CAP) and a second polymer being polybutylene succinate (PBS).

[0021] According to one embodiment, the binary polymer composition comprises a further polymer selected from the group consisting of, polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these.

[0022] Especially, in connection with the present invention it was noticed that CAP and the second polymer, PBS,

form a homogeneous polymer mixture, i.e. there is no phase separation between the two polymers when the mixture is prepared with the method disclosed herein. This is illustrated by FIG. **1** showing a SEM (Scanning Electron Microscopy) picture of an embodiment of the invention (Example 1). The binary polymer composition may provide a high quality raw-material for textile fiber and web production, with high tensile strength. Long textile fibers can be formed from strong fibers, and length of the fiber is important to provide good spinning results. The textile fiber according to the invention is expected to have a diameter/bredth ratio of more than 100:1. Furthermore, it is expected that the strength, uniformity, spinnability and durability of the textile fibers according to the invention are good.

[0023] Mechanical properties of the binary polymer composition materials are close to commercial plastics used for fiber and nonwoven production. Properties can also be modified with additives. Processing temperatures of over 200° C. can be used. All fiber and nonwoven applications can be used where thermoplastic properties are required. The melt flow index (MFI) of the binary polymer blend is also applicable to fiber and nonwoven processes.

[0024] The material properties of the binary polymer compositions are similar to those of PET. Also, higher break elongation can be achieved. High break elongation is required for fiber applications and weaving processes.

[0025] The binary polymer composition used in textile fiber or web applications can also be a recycled feedstock.

[0026] The molecular weight and the length of molecular chains can be chosen to best meet the requirements of each fiber or nonwoven application. The mechanical properties and processability can be modified by choosing longer or shorter polymer chains.

[0027] To achieve the desired effect, it is essential that the textile fibers and webs comprise at least two polymers, a first polymer and a second polymer (a binary polymer composition). According to one embodiment of the present invention, the binary polymer composition comprises only two polymers, and optionally additives.

[0028] The textile fibers and webs according to this invention can be particulary suitable for replacing textile material made of PET (polyethylene terephthalate).

[0029] Syntetic PET fiber is widely used as the material in various fiber products. The applications include industrial and consumer textiles. The fibers and webs according to this invention, may have high mechanical properties that are needed for high strength demanding application like ropes, nets and car textiles. These are typically made of polyester, and the fibers and webs according to the invention would be suitable for these application as an environmentally friendly high-quality alternative. Many types of clothing are produced from polyesters as well as household and furnishing textiles including sheets, carpets and rugs, covers and curtains. Nonwovens, filters and sanitary products are also produced from polyesters. The fibers and webs according to the invention could be suitable for all of the above applications.

[0030] PET has relatively high carbon footprint and these types of fibers, webs and textiles are not environmentally friendly. Typically, PET is mostly made from fossil resources. It is very difficult to make PET products more sustainable.

[0031] Thus, the present invention describes a new kind of textile fiber and web which may replace for example PET and PP in different types of fibers, yarns, textile and nonwoven application. PET materials were used as reference examples in tests performed in connection with the present invention (described in more detail in the Examples).

[0032] The fibers and webs made of binary polymer compositions presented herein have advantageous properties in tests performed in connection with the present invention.

[0033] Especially, the binary polymer composition provides good elongation properties. These are measured with tensile strain tests. In the tests they were compared to PET. Similar PET grades are used in the fiber production as plastic grade PET, this is one of the major recycled PET applications for plastic bottles and the like. It base been shown in tests performed in connection with the present invention that the binary polymer compositions for textile fiber or textile web applications may withstand recycling well.

[0034] Also, the materials according to the invention based on binary polymer compositions presented herein can be processed with the same fiber and web production equipments as used with known material, such as PET fibers. This is beneficial, since no large investments in new equipment is needed.

[0035] Furthermore, the fibers and webs made from binary polymer compositions presented herein may have a low environmental impact. This has been shown in tests. Their global warming potential is much lower, and the renewable content is much higher than those of e.g. PET.

[0036] One aim of the invention is to achieve an environmentally friendly textile solution, which could replace traditional synthetic textile materilas based on fossil raw-materials. Thus, biopolymers are preferred in the binary polymer composition.

[0037] Biopolymers are polymers which are made, either partially or completely, from renewable resources. Another definition of biopolymers are polymers which are biodegradable. It is enough for a biopolymer to fulfil one of these definitions.

[0038] The invention concerns a textile fiber or textile web comprising a binary polymer composition, which comprises a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS). The total amount of the first and the second polymer is at least 80 weight-% of the binary polymer composition based on the total weight of the binary polymer compostions.

[0039] According to one embodiment, the binary polymer composition comprises a further polymer selected from the group consisting of polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these.

[0040] According to an embodiment of the invention, the binary polymer composition comprises the first polymer in an amount of 5 to 95 weight-%, and the second polymer in an amount of 95 to 5 weight-%, based on the total weight of the binary polymer composition.

[0041] According to an embodiment of the invention, the total amount of the first polymer and said second polymer it at least 80 wt. %, or at least 85 wt. %. Typically, the amount

is at least 90 wt. %, or at least 95 wt. %, based on the total weight of the binary polymer composition the rest being other polymers and/or additives such as softeners, pigments, stabilizers or other additives for use in plastic compositions.

[0042] According to an embodiment of the invention, the binary polymer composition comprises the first polymer in an amount of 55 to 80 weight-%, or 60 to 75 weight-%, or 65 to 75 weight-%, and the second polymer in an amount of 20 to 45 weigh-%, or 25 to 40 weight-%, or 25 to 35 weight-%.

[0043] According to an embodiment of the invention, the binary polymer composition comprises recycled binary polymer composition comprising cellulose acetate propionate (CAP) and polybutylene succinate (PBS).

[0044] The invention also concerns a textile material comprising the textile fiber or textile web according to any embodiment described herein.

[0045] According to an embodiment of the invention, the textile material is selected from the group consisting of a fiber, a yarn, textiles, fabrics, nonwovens, textile products for one of the following applications; apparel, household, industrial, technical, ropes, nets and car textiles, household and furnishing textiles including sheets, carpets and rugs, covers and curtains, and nonwovens, such as filters and sanitary products.

[0046] According to an embodiment of the invention, the textile material is recyclable.

[0047] Further, the invention relates to a method for manufacturing a textile fiber or a textile web from a binary polymer composition. The method of the invention comprises the following steps:

[0048] obtaining a homogenous polymer blend of a binary polymer composition comprising at least a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), and wherein the total amount of said first and said second polymer is at least 80 weight-% based on the total weight of said binary polymer compostions, and

[0049] a) forming said homogenous polymer blend into a textile fiber by a spinning method, or

[0050] b) forming said homogenous polymer blend into a textile web by a method of producing nonwoven materials.

[0051] According to one embodiment of the method, the binary polymer composition comprises a further polymer selected from the group consisting of polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these.

[0052] According to one embodiment, obtaining a homogenous polymer blend is not performed in a separate step, but rather in the same step as forming the blend into a textile fiber or textile web.

[0053] According to an embodiment of the invention, the method of forming the homogenous polymer blend into a textile fiber is done by a spinning method selected from the group consisting of wet spinning, dry spinning, melt spinning, extrusion spinning, direct spinning, gel spinning and electrospinning. Preferably, melt spinning and/or direct spinning are used.

[0054] According to one very specific embodiment, forming the homogenous polymer blend into a textile fiber is done by a melt spinning method, where the melt spinning temperature is between 180 and 270° C. The temperature may also be between 200 and 250° C., or between 210 and 230° C., or between 215 and 225° C.

[0055] According to one very specific embodiment, forming the homogenous polymer blend into a textile fiber is done by a melt spinning method using a melt spinneret with at least one hole with a hole diameter of 0.1 to 2 mm, or 0.5 to 1.5 mm, or 0.8 to 1.2 mm. The diameter may also be about 1 mm. The suitable diameter of the spinneret depends on the desired quality of the fiber. In the industrial melt spinning processes, the spinneret can typically have any number of holes between 1 and 1000, such as 2 to 500 holes, or 5 to 50 holes.

[0056] According to an embodiment of the invention, forming said homogenous polymer blend into a textile web is done by melt blow and/or spunbond.

[0057] According to an embodiment of the invention, obtaining the homogenous polymer blend is performed by melt-mixing. The melt-mixing is performed at a temperature between 200° C. and 300° C. Preferably the temperature is between 200° C. and 270° C., or between 210° C. and 250° C., or between 210° C. and 230° C.

[0058] According to an embodiment of the invention, obtaining a homogenous polymer blend is done by a recycling process.

[0059] The method may be used to obtain a textile fiber or a textile web based on a binary polymer composition according to any one of the embodiments described herein.

[0060] The invention also concerns use of a binary polymer composition comprising a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), and wherein the total amount of said first and said second polymer is at least 80 weight-% based on the total weight of said binary polymer compostions, in the manufacture of a textile fiber, a textile web, and/or a textile material.

[0061] According to one embodiment of the use, the binary polymer composition comprises a further polymer selected from the group consisting of polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these.

[0062] According to one specific embodiment, the binary polymer composition comprises CAP in an amount of 5 to 95 weight-%, preferably 10 to 90 weight-%, more preferably 20 to 80 weight-%, and the second polymer in an amount of 5 to 95 weight-%, preferably 10 to 90 weight-%, more preferably 20 to 80 weight-%, based on the total weight of the polymer composition.

[0063] According to one embodiment, PBS is used, and the PBS has a number average molar mass in the range of

30,000 to 100,000 Da. Typically, 50,000 to 80,000 Da, or for example 60,000 to 70,000 Da.

[0064] According to one very specific embodiment, the binary polymer composition comprises CAP in an amount of 55 to 80 weight-%. Typically, in an amount of 60 to 75 weight-%, or 65 to 75 weight-%. The composition then comprises the second polymer in an amount of 20 to 40 weight-%. Typically, 25 to 40 weight-%, or 25 to 35 weight-%. Weight-%:s are based on the total weight of the composition. Optionally, the mixture comprises at least one additive such as softeners, pigments, stabilizers and/or other additives for use in plastic compositions.

[0065] According to one very specific embodiment, the binary polymer composition consists of CAP in an amount of 60 to 80 weight-%, typically 60 to 75 weight-%, or 65 to 75 weight-%, and PBS in an amount of 20 to 40 weight-%, typically 25 to 40 weight-% or 25 to 35 weight %, based on the total weight of the composition, and optionally at least one additive, such as softeners, pigments, dyes, stabilizers and/or other additives for use in plastic compositions, and/or other thermoplastic polymers compatible with CAP and PBS.

[0066] According to one embodiment, the binary polymer composition comprises at least one softener. For example, triethyl citrate (TEC).

[0067] According to one specific embodiment, the CAP has a number average molar mass of 15,000 to 120,000 Da, or 30,000 to 110,000 Da. Typically, 50,000 to 100,000 Da; or for example 65,000 to 95,000 Da.

[0068] According to one specific embodiment, CAP has an acetyl content of 0.8 to 2.0 wt. %, or 1.0 to 1.5 wt. %, and/or a propionyl content of 30 to 51 wt. %, or 40 to 50 wt. %, and/or a hydroxyl content of 1.0 to 2.5 wt. %, or 1.5 to 2.0 wt. %.

[0069] Suitably, if CAP is used, the number average molar mass of the CAP polymer is above 20,000 Da. According to one embodiment, the number average molar mass is between 30,000 to 110,000 Da, typically between 50,000 to 100,000 Da, or 65,000 to 95,000 Da. The number average molar mass may be between 85,000 and 95,000 Da, or between 85,000 and 91,000 Da, for example 90,000 Da, 91,000 Da or 92,000 Da. A number average molar mass within the above defined ranges may provide a resilient material with mechanical properties that withstand processing and form durable textile fibers.

[0070] All number average molar mass measurements performed in connection with the invention were measured with size exclusion chromatography (SEC) using chloroform eluent for the number average molar mass measurements. The SEC measurements were performed in chloroform eluent (0.6 ml/min, T=30° C.) using Styragel HR 4 and 3 columns with a pre-column. The elution curves were detected using Waters 2414 Refractive index detector. The molar mass distributions (MMD) were calculated against 10×PS (580-3040000 g/mol) standards, using Waters Empower 3 software.

[0071] Different grades of cellulose esters, such as cellulose acetate propionate, are commercially available from several suppliers. In the disclosed binary polymer composition, the polymer raw materials affect the properties of the formed mixture. In other words, the combined properties of the polymers need to be evaluated when forming the composition according to the invention. For example, if one of the polymers has a high number average molar mass, such as 90,000 Da or 70,000 Da, it could be suitable to combine this polymer with another polymer having a lower number average molar mass. Alternatively, or additionally, a higher amount of softener may be used together with polymers with a high molar mass. The suitable number average molar mass depends on the end use of the composition, i.e. the most suitable cellulose ester grade may be different depending on the intended end use. Cellulose esters may have different grades of substitution. The CAP suitable for the composition of the present invention suitably has an acetyl content of 0.8 to 2.0 wt. %. Typically, 1.0 to 1.5 wt. %, for example 1.3 wt. %. The CAP suitable for the composition of the present invention suitably has a propionyl content of 30 to 51 wt. %. Typically, it may be 40 to 50 wt. %. A very specific example is 48 wt. %. The CAP suitable for the composition of the present invention suitably has hydroxyl content of 1.0 to 2.5 wt. %. Typically, 1.5 to 2.0 wt. %, for example 1.7 wt. %. In addition, the glass transition temperature is suitably 140 to 155° C. Typically, 142 to 152° C., for example 147° C.

[0072] According to one embodiment, if PBS is used, the PBS suitable for the composition of the present invention has a number average molar mass in the range of 30,000 to 100,000 Da. Typically, 50,000 to 80,000 Da; or 60,000 to 70,000 Da. The number average molar mass of the PBS may be for example 65,000 to 70,000 Da, such as for example 68,000 Da, 69,000 Da or 70,000 Da.

[0073] Melt flow index (or melt flow rate) is a measure to describe ease of flow of the melt of a thermoplastic polymer or plastic. The melt flow index can be used to characterize a polymer or a polymer mixture. For polyolefins, i.e. polyethylene (PE, at 190° C.) and polypropylene (PP, at 230° C.) the MFI is commonly used to indicate order of magnitude for its melt viscosity. In standardized MFI measuring instrument a constant pressure generates shear stress which pushes melt plastic through a die. Typically, MFI is inversely proportional to molecular weight. For an embodiment of the binary polymer composition tested in connection with the invention the MFI was measured at two temperatures 215 and 240° C. According to one very specific embodiment, the binary polymer composition has a melt flow index of 6 to 8 g/10 min. Suitably, about 7 g/10 min, or 6.9 g/10 min. Measured at: load 2.16 kg, at 215° C., and/or about 26 to 28 g/10 min, 27 g/10 min, or 27.1 g/10 min, load 2.16 kg, at 240° C.

[0074] According to one embodiment, the binary polymer composition suitable for the solution according to the invention comprises CAP and the second polymer, for example PBS, in combination with another component, which is selected from the list consisting of a cellulose ester, such as cellulose acetate or cellulose acetate butyrate (CAB), and polybutylene succinate (PBS), polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these. According to one embodiment, the binary polymer composition comprises also other similar polymers, which are compatible with CAP and the second polymer, such as PBS.

[0075] The elongation and other mechanical properties of the binary polymer compositions can also be modified with small amounts of additives to reach the elongation and other properties required. Thus, thee binary polymer composition may also comprise other components, such as additives typically used in textile fibers or textile webs. These additives are for example softeners or plasticizers, fillers, aids, pigments, stabilizers or other agents. Typically, the amounts of these additives vary between 0.01 to 10 weight-% based on the weight of the binary polymer composition used in the invention. The amount of one additive may for example be 0.1 to 5 weight-% based on the total weight of the composition.

[0076] The solution according to the present invention has several advantages. The most important are:

[0077] Providing an environmentally friendly synthetic textile material, manufactured from biopolymers, and which is a high-quality material suitable for replacing conventional textile materials.

[0078] Providing a solution where the manufacturing processes of cellulose based textile fibers or textile webs do not require the use of large amounts of toxic solvents, or a large amount of plasticizers.

[0079] In addition, the material can be made out of food-grade materials, which means that they can be used for food/medical products.

[0080] In addition, the described solution may provide an environmentally friendly textile fiber or web that can be recycled with chemical and/or mechanical recycling methods and may contain recycled content or can be produced from recycled film.

EXAMPLES

[0081] Reference will now be made in detail to various embodiments, an example of which is illustrated in the accompanying drawing.

[0082] The description below discloses some embodiments in such a detail that a person skilled in the art is able to utilize the embodiments based on the disclosure. Not all steps or features of the embodiments are discussed in detail, as many of the steps or features will be obvious for the person skilled in the art based on this specification.

[0083] For reasons of simplicity, item numbers will be maintained in the following exemplary embodiments in the case of repeating components.

[0084] FIG. **1** illustrates Example 1, Scanning electron microscopy of a binary polymer composition suitable for the invention, made of CAP 72.5% and PBS 27.5%.

[0085] FIG. **2** illustrates fibers produced from the binary polymer composition.

[0086] FIG. **3** illustrates knitted fabric produced from the fibers of FIG. **2**.

[0087] The following raw materials have been used in the Examples; properties are indentified in Table 1 to Table 3.

TABLE 1

Cellulose acetate propionate (CAP)

Entry	Compound	Mn g/mol	Mw g/mol	PD	Eluent/ HPSEC system
1	CAP	90,000	221,000	2.5	Chloroform

Cellulose acetate propionate had degree of substitution of:

acetyl content	1.2 wt %
propionyl content	48 wt %
hydroxyl content	1.7 wt %

TABLE 2

Polybutylene succinate (PBS)

Entry	Compound	Mn g/mol	Mw g/mol	PD	Eluent/ HPSEC system
1	PBS	76,000	215,000	2.8	Chloroform

The number average molar mass measurements (Mn) were performed with size exclusion chromatography (SEC) using chloroform eluent for the number average molar mass measurements, the samples (Entries 1 to 4), were dissolved overnight using chloroform (concentration of 1 mg/ml). Samples were filtered (0.45 μm) before the measurement.

The SEC measurements were performed in chloroform eluent (0.6 ml/min, T=30° C.) using Styragel HR 4 and 3 columns with a pre-column. The elution curves were detected using Waters 2414 Refractive index detector. The molar mass distributions (MMD) were calculated against 10×PS (580-3,040,000 g/mol) standards, using Waters Empower 3 software.

TABLE 3

Tg values of used raw materials.

Entry	Polymer	Tg
1	PBS	−32° C.
2	CAP	140° C.

Further descriptions of the materials:

CAP is Cellulose acetate propionate from Eastman, grades CAP-482-20, Treva Engineering Bioplastic GC6011 clear, Treva Engineering Bioplastic TR6012FPNAT Natural

FZ91 is BioPBS FZ91PM from PTT MCC Biochem

ES01G is Origo-Bi ES01G from Novamont

4060D is Ingeo Biopolymer 4060D from NatureWorks

Example 1: Production and Properties of Binary Polymer Mixtures

[0088] Homogeneous mixtures of a binary polymer composition were formed into granulate and films. Homogeneous polymer mixtures were obtained by melt mixing. The mixing was conducted at temperatures between 210-230° C. for a time period of 30 sec to 4 min.

[0089] The binary polymer blend consisting of 72.5% CAP and 27.5% of PBS was made into a film. The film was treated with liquid nitrogen. The samples were broken under liquid nitrogen to give perfect cross-section view into the film. The SEM cross-section views did not show any fine

structure and is homogeneous showing excellent miscibility of the polymer blend (FIG. **1**).

Particularly important is the breaking elongation of the material. The elongation is also called tensile strain. This can be measured for yield and for break. The elongation at break for the binary polymer blend is measured to be up to 97%.

TABLE 4

mechanical properties of binary polymer mixture film of 40 μm (SFS-EN ISO 527-3/2/100)

Entry	CAP	PBS	Tensile stress at yield (MPa)	Tensile strain at yield (%)	Tensile stress at break (MPa)	Tensile strain at break (%)
1	70%	30%	36.5	4.4	52.7	97

TABLE 5

mechanical properties of PET film of thickness 300 μm (EN ISO 527-3)

Entry	Polymer	Tensile stress maximum load (MPa)	Tensile strain at maximum load (%)	Tensile strain at break (%)
1	PET	56.6	3.0	3.0

TABLE 6

mechanical properties of binary polymer mixture film of thickness 300 μm (EN ISO 527-3)

Entry	CAP	PBS	Additive	Tensile stress at yield (MPa)	Tensile strain at yield (%)	Tensile strain at break (%)
1	72.5%	27.5%		35.8	4.3	44.0
2	72.5%	25.5%	2%	39.0	4.3	38.7
3	72.5%	23.5%	4%	41.1	4.3	62.9

[0090] In film applications, the elongation properties are much higher with the binary polymer mixtures than with the PET films. Similar PET grades are used in the fiber production than plastic grade PET, this is one of the major recycled PET applications for plastic bottles and the like.

The MFI (melt flow index) of the binary polymer blends is suitable for fiber production at different temperatures.

TABLE 7

MFI of binary polymer mixtures

Entry	CAP	PBS	MFI
1	70%	30%	6.9 g/10 min at 215° C. and 2.16 Kg
2	70%	30%	27.1 g/10 min at 240° C. and 2.16 Kg
3	72.5%	27.5%	6.0 g/10 min at 215° C. and 2.16 Kg

Example 2: Production of Fibers from Binary Polymer Mixtures

[0091] Based on test done to evaluate the properties of the raw material (Example 1), it is expected that a binary polymer composition comprising CAP and PBS can be processed into fibers with various methods.

[0092] According to one alternative, a melt-spund fiber could be manufactured.

[0093] For the production of melt-spun filaments of fibers with binary polymer compositions comprising CAP and PBS, a ready compounded binary polymer could be used and fed to the spinning process. Alternatively, feeding the CAP and PBS polymers separately directly into the spinning process could be done.

[0094] The products based on a melt-spun process are fibres, from which different fiber and yarn products can be made. The yarn can also be woven or knitted into textiles and fabrics for various applications.

Example 3: Production of Nonwoves from Binary Polymer Mixtures

[0095] Based on test done to evaluate the properties of the raw material (Example 1), it is expected that a binary polymer composition comprising CAP and PBS can be processed into nonwovens with the at least the following methods; melt blown process and a spunbond process.

[0096] A ready compounded binary polymer could be used and fed to the web forming process. Alternatively, feeding the CAP and PBS polymers separately directly into the process.

[0097] The products and finished articles from a melt blown process and a spunbond process are nonwoven textiles.

Example 4: Melt Spinning

[0098] Melt spinning was carried out with a Fourne melt spinning machine (Fourne Polymertechnik GmbH, Germany). The melt spinning line consisted of a 10 mm single screw extruder, metering pump, and melt spinneret with 8 holes (diameter 1 mm). The spinning temperature was set to 215° C.

[0099] After the spinneret, the as-spun fibers were guided through a quench duct with ambient temperature. The melt spun fibers were collected on skein as spun. No orientation forces were applied in the fibers.

[0100] Production of the fibers are presented in Table and the properties of the produced fibers are presented in Table 9.

TABLE 8

Producing the fibers by melt spinning

Blend	Polymer 1 (wt %)	Polymer 2 (wt %)	Polymer 3 (wt %)	T (° C.)	P (bar)	Extruder (rpm)	Melt pump (rpm)
1	CAP (70%)	FZ91 (30%)		215	80	36.5	10.5
2	CAP (80%)	FZ91 (20%)		215	80	36.5	10.5
3	CAP (56%)	FZ91 (24%)	ES01G(20%)	215	60	44	10.5
4	CAP (56%)	FZ91 (24%)	4060D(20%)	215		46	10.5

TABLE 9

Mechanical properties of the fibers

Blend	Diameter (mm)	Modulus (Automatic) (MPa)	Tensile strength (MPa)	Strain at Break (%)	Stress at Yield (MPa)	Strain at Yield (%)
1	0.20	667.4	16.08	63.9	14.95	3.06
2	0.25	747.6	15.68	26.1	16.61	3.14
3	0.50	516.5	15.13	59.3	9.74	2.81
4	0.28	1049	21.04	59.5	22.28	2.94

The fibers produced were transcluent or white in colour, except Blend 3 which had a beige and opaque coloring. The fibers had a soft and pleasant feeling to touch.

The fibers of blend 1 (FIG. **2**) were used for the production of knitted fabric (FIG. **3**).

Example 5: Producing Fibers from Recycled Blend

[0101] Mixed film waste containing blends 1 and 2 (table 8) with additives was fed into a shredder, then melted and further extruded into a strand and pelletized. The granulate obtained was clear and transparent.

[0102] This recycled granulate was made into a fiber product with a melt spinning machine.

[0103] Melt spinning was carried out with a Fourne melt spinning machine (Fourne Polymertechnik GmbH, Germany). The melt spinning line consisted of a 10 mm single screw extruder, metering pump, and melt spinneret with 8 holes (diameter 1 mm). The spinning temperature was set to 215° C.

[0104] After the spinneret, the as-spun fibers were guided through a quench duct with ambient temperature. The melt spun fibers were collected on skein as spun. No orientation forces were applied in the fibers.

[0105] The recycled blend was easy to process with the spinning machine and the fibers were easily collected with no breakages indicating good recyclability for the blends.

[0106] Production of the fibers are presented in Table and the properties of the produced fibers are presented in Table 11.

TABLE 10

Producing the fibers by melt spinning

Blend	T (° C.)	P (bar)	Extruder (rpm)	Melt pump (rpm)
Recycled blend	205-215		44	10.5-11.5

TABLE 11

Mechanical properties of the fibers

Blend	Diameter (mm)	Modulus (Automatic) (MPa)	Tensile strength (MPa)	Strain at Break (%)	Stress at Yield (MPa)	Strain at Yield (%)
Recycled blend	0.14	448	9.96	30.9	10.67	2.35

The fibers produced were transcluent or white in colour. The fibers had a soft and pleasant feeling to touch.

[0107] It is obvious to a person skilled in the art that with the advancement of technology, the basic idea may be implemented in various ways. The embodiments are thus not limited to the examples described above; instead they may vary within the scope of the claims.

[0108] The embodiments described hereinbefore may be used in any combination with each other. Several of the embodiments may be combined together to form a further embodiment. A product, a system, a method, or a use, disclosed herein, may comprise at least one of the embodiments described hereinbefore. It will be understood that the benefits and advantages described above may relate to one

embodiment or may relate to several embodiments. The embodiments are not limited to those that solve any or all of the stated problems or those that have any or all of the stated benefits and advantages. It will further be understood that reference to 'an' item refers to one or more of those items. The term "comprising" is used in this specification to mean including the feature(s) or act(s) followed thereafter, without excluding the presence of one or more additional features or acts.

1. A textile fiber or textile web comprising a binary polymer composition, characterized in that the binary polymer composition comprises a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), and the total amount of said first and said second polymer is at least 80 weight % based on the total weight of said binary polymer composition.

2. The textile fiber or textile web according to claim **1**, wherein the binary polymer composition comprises a further polymer selected from the group consisting of polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these.

3. The textile fiber or textile web according to claim **1**, wherein said binary polymer composition comprises

said first polymer in an amount of 5 to 95 weight-%, and said second polymer in an amount of 95 to 5 weight-% based on the total weight of said binary polymer composition.

4. The textile fiber or textile web according to claim **1**, wherein the total amount of said first polymer and said second polymer is at least 80 wt. %, or at least 90 wt. %, or at least 95 wt. %, based on the total weight of the binary polymer composition, the rest being other polymers and/or additives such as softeners, pigments, stabilizers or other additives for use in plastic compositions.

5. The textile fiber or textile web according to claim **1**, wherein said binary polymer composition comprises the first polymer in an amount of 55 to 80 weight-%, or 60 to 75 weight-%, or 65 to 75 weight-%, and said second polymer in an amount of 20 to 45 weigh-%, or 25 to 40 weight-%, or 25 to 35 weight-%.

6. The textile fiber or textile web according to claim **1**, wherein the second polymer is PBS.

7. The textile fiber or textile web according to claim **1**, wherein it comprises recycled binary polymer composition comprising cellulose acetate propionate (CAP) and polybutylene succinate (PBS).

8. A textile material comprising the textile fiber or textile web according to claim **1**.

9. The textile material according to claim **7**, wherein it is selected from the group consisting of a fiber, a yarn, textiles, fabrics, nonwovens, textile products for one of the following applications; apparel, household, industrial, technical, ropes, nets and car textiles, household and furnishing textiles including sheets, carpets and rugs, covers and curtains, and nonwovens, such as filters and sanitary products.

10. The textile material according to claim **7**, wherein it is recyclable.

11. A method for manufacturing a textile fiber or a textile web from a binary polymer composition, wherein the method comprises the following steps:

obtaining a homogenous polymer blend of a binary polymer composition comprising at least a first polymer being cellulose acetate propionate (CAP), and a second polymer being polybutylene succinate (PBS), and the total amount of said first and said second polymer is at least 80 weight-% based on the total weight of said binary polymer composition, and

a) forming said homogenous polymer blend into a textile fiber by a spinning method, or

b) forming said homogenous polymer blend into a textile web by a method of producing nonwoven materials.

12. The method according to claim **11**, wherein forming said homogenous polymer blend into a textile fiber is done by a spinning method selected from the group consisting of wet spinning, dry spinning, melt spinning, extrusion spinning, direct spinning, gel spinning and electrospinning, preferably melt spinning and/or direct spinning.

13. The method according to claim **12**, wherein forming said homogenous polymer blend into a textile fiber is done by a melt spinning method, where the melt spinning temperature is between 180 and 270° C., or between 200 and 250° C., or between 210 and 230° C.

14. The method according to claim **13**, wherein forming said homogenous polymer blend into a textile fiber is done by a melt spinning method using a melt spinneret with at least one hole with a hole diameter of 0.1 to 2 mm, or 0.5 to 1.5 mm, or 0.8 to 1.2 mm.

15. The method according to characterized in that claim **12**, wherein the binary polymer composition comprises a further polymer selected from the group consisting of polypropylene succinate (PPS), polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene terephthalate (PBT), polybutylene succinate terephthalate (PBST), and any polyester containing sebacic and/or azelaic acid and/or dodecanedioic acid as dicarboxylic acid alone or in combination with terephthalic acid, and any combination of these.

16. The method according to claim **12**, wherein forming said homogenous polymer blend into a textile web is done by melt blow and/or spunbond.

17. The method according to claim **12**, wherein obtaining the homogenous polymer blend is performed by melt-mixing and the melt-mixing is performed at a temperature between 200° C. and 300° C., or between 200° C. and 270° C., or between 210° C. and 250° C., or between 210° C. and 230° C.

18. The method according to claim **12**, wherein obtaining a homogenous polymer blend is done by a recycling process.

19-20. (canceled)

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