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(54) Keksinnön nimitys - Uppfinningens benämning - Title of the invention
Tekstiilikuitu tai -raina, sekä näihin liittyviä menetelmiä ja käyttö
Textilfiber eller -nät, samt förfaranden och användning som hänför sig därtill
Textile fiber or web, methods and use related thereto

(56) Viitejulkaisut - Anförda publikationer - References cited
US 5939467 A, JP 2004204217 A, CN 107794593 A, JP 2000129035 A, US 2004030043 A1, LIANG, N.-Y. et al. Effect of a low-molecular-weight compatibilizer on the immiscible blends of cellulose acetate propionate and poly(butylene terephthalate). In: Journal of Polymer Research, 2018-03-06, Vol. 25, 88, JP 2007107142 A, US 2002132960 A1, WO 2019160906 A1

(57) Tiivistelmä - Sammandrag - Abstract
Keksintö koskee tekstiilikuitua tai tekstiilirainaa, joka käsittää binäärisen polymeerikoostumuksen, jossa binäärinen polymeerikoostumus käsittää ensimmäisen polymeerin, joka on selluloosaasetatipropionaatti ja toisen polymeerin, joka valitaan useista polymeereistä. Lisäksi kuvataan siihen liittyvää menetelmää ja käyttöä.
The invention concerns a textile fiber or textile web comprising a binary polymer composition, which binary polymer composition comprises a first polymer being cellulose acetate propionate and a second polymer selected from several polymers. Furthermore, a method and use related thereto are described.

TEXTILE FIBER OR WEB, METHODS AND USE RELATED THERETO**TECHNICAL FIELD**

5 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

10 There are various methods for producing textile fibers and textile webs.

 Fibers are typically manufactured by various spinning methods. Such methods include wet spinning, dry spinning, melt spinning, extrusion spinning, direct
15 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
20 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.

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

 Nonwovens are manufactured as sheets or webs of directionally or randomly oriented fibers, that have
30 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
35 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.

5 US 5939467A discloses biodegradable polymeric compositions that can be melt processed.

JP 2004204217A discloses polylactic resin compositions.

10 CN 107794593A discloses blends of thermoplastic cellulose and aliphatic aromatic copolyesters and fibers made therefrom.

JP 2000129035A discloses a moldable resin composition.

15 US 2004030043A1 discloses a cellulose derivative composition and fiber comprising the same.

JP 2007107142A discloses a spun yarn and a fabric comprising the same.

US 2002132960A1 discloses copolyesters and fibrous materials formed therefrom.

20 WO 2019160906A1 discloses cellulose ester and polymeric aliphatic polyester compositions and articles.

Publication Liang, N.-Y. et al., J. Polym. Rec. 2018, Vol. 25, 88 discusses the effect of a low-molecular-weight compatibilizer on the immiscible blends of cellulose acetate propionate and poly(butylene terephthalate).

SUMMARY

30 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
35 is it intended to be used to limit the scope of the claimed subject-matter.

The invention concerns a textile fiber or textile web comprising a binary polymer composition, which comprises a first polymer being cellulose acetate propionate (CAP), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS), in an amount of 25 to 45 weight-%, 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 composition.

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

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:

- obtaining a homogenous polymer blend of a binary polymer composition comprising at least a first polymer being cellulose acetate propionate (CAP), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS), in an amount of 25 to 45 weight-%, 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

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.

The invention also concerns use of a binary polymer composition comprising a first polymer being

cellulose acetate propionate (CAP), with a propionyl
content of 30 to 51 weight-%, and a number average molar
mass of between 85,000 and 95,000 Da, in an amount of
55 to 75 weight-%, and a second polymer being
5 polybutylene succinate (PBS), in an amount of 25 to 45
weight-%, 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
10 textile material.

BRIEF DESCRIPTION OF THE DRAWINGS

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

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 %.

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DETAILED DESCRIPTION

Cellulose derivatives are used in textile
fibers, but there are challenges regarding the used
processes. Wet spinning and dry spinning processes
25 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
30 fibers from cellulose derivatives.

The present invention provides a solution to
these problems.

The present invention is based on the finding
that new environmentally friendly good quality synthetic
35 textile fibers and webs can be achieved by a binary
polymer composition comprising cellulose acetate

propionate (CAP) and a second polymer. The second polymer is polybutylene succinate (PBS), and the binary polymer composition may comprise a polymer selected from the group consisting of polypropylene succinate (PPS),
5 polybutylene succinate adipate (PBSA), polybutylene adipate terephthalate (PBAT), polylactic acid (PLA), polycaprolactone (PCL), polybutylene adipate (PBA), polyhydroxyalkanoate (PHA), polyhydroxybutyrate (PHB), polyethylene furanoate (PEF), polybutylene
10 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).
15 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
20 illustrated by Figure 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
25 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/breadth ratio of more than 100:1. Furthermore, it is expected that the strength,
30 uniformity, spinnability and durability of the textile fibers according to the invention are good.

Mechanical properties of the binary polymer composition materials are close to commercial plastics used for fiber and nonwoven production. Properties can
35 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.

5 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.

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

15 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.

20 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.

25 The textile fibers and webs according to this invention can be particularly suitable for replacing textile material made of PET (polyethylene terephthalate).

30 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

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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.

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.

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 non-woven application. PET materials were used as reference examples in tests performed in connection with the present invention (described in more detail in the Examples).

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

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 has 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.

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.

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.

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

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.

The invention concerns a textile fiber or textile web comprising a binary polymer composition, which comprises a first polymer being cellulose acetate propionate (CAP), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS) in an amount of 25 to 45 weight-%, 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. The binary polymer composition may further comprise a polymer selected from the group consisting of 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. 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 composition.

According to an embodiment of the invention, the total amount of the first polymer and said second polymer is at least 80 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.

According to an embodiment of the invention, the binary polymer composition comprises the first polymer in an amount of 60 to 75 weight-%, or 65 to 75 weight-%, and the second polymer in an amount of 25 to 40 weight-%, or 25 to 35 weight-%.

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).

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

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.

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

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:

- 5 - obtaining a homogenous polymer blend of a binary polymer composition comprising at least a first polymer being cellulose acetate propionate (CAP), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in
10 an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS) in an amount of 25 to 45 weight-%, 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
15 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
20 materials.

 According to one embodiment the binary polymer composition comprises a polymer selected from the group consisting of polybutylene succinate (PBS), polypropylene succinate (PPS), polybutylene succinate
25 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
30 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).

35 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.

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.

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

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.

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

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.

The invention also concerns use of a binary polymer composition comprising a first polymer being cellulose acetate propionate (CAP), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS) in an amount of 25 to 45 weight-%, 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 composition, in the manufacture of a textile fiber, a textile web, and/or a textile material.

According to one embodiment, the binary polymer composition comprises a polymer selected from the group consisting of 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).

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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.

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According to one very specific embodiment, the binary polymer composition comprises CAP in an amount of 60 to 75 weight-%, or 65 to 75 weight-%. The composition then comprises the second polymer in an amount of 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.

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According to one very specific embodiment, the binary polymer composition consists of CAP in an amount of 60 to 75 weight-%, or 65 to 75 weight-%, and PBS in an amount of 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.

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

According to one specific embodiment, CAP has
5 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.%.

Suitably, if CAP is used, the number average
10 molar mass of the CAP polymer is above 20,000 Da. According to one embodiment, the number average molar mass is 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
15 ranges may provide a resilient material with mechanical properties that withstand processing and form durable textile fibers.

All number average molar mass measurements performed in connection with the invention were measured
20 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
25 detected using Waters 2414 Refractive index detector. The molar mass distributions (MMD) were calculated against 10 x PS (580 - 3040000 g/mol) standards, using Waters Empower 3 software.

Different grades of cellulose esters, such as
30 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
35 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.

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.

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.

According to one embodiment, the binary polymer composition suitable for the solution according to the invention comprises CAP and the second polymer, 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.

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, the 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.

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

- Providing an environmentally friendly synthetic textile material, manufactured from biopolymers, and which is a high-quality material suitable for replacing conventional textile materials.
- 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.
- In addition, the material can be made out of food-grade materials, which means that they can be used for food/medical products.

EXAMPLES

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

5 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
10 will be obvious for the person skilled in the art based on this specification.

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

15 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 %.

The following raw materials have been used in the
20 Examples; properites 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	Chloro- form

25 Cellulose acetate propionate had degree of substitution of:

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

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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	Chloro- form

- The number average molar mass measurements (M_n) 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 μ m) 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 x 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

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Example 1: Production and properties of binary polymer mixtures

- 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.

- 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 (Figure 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 upto 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

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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

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.

5 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

10 Example 2: Production of fibers from binary polymer mixtures

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.

15 According to one alternative, a melt-spun fiber could be manufactures.

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.

25 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.

30 Example 3: Production of nonwoves from binary polymer mixtures

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.

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

The products and finished articles from a melt blown process and a spunbond process are nonwoven textiles.
10

It is obvious to a person skilled in the art that with the advancement of technology, the basic idea
15 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.

The embodiments described hereinbefore may be used in any combination with each other. Several of the
20 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
25 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
30 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.

35

CLAIMS

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), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS) in an amount of 25 to 45 weight-%, 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, **characterized** in that the binary polymer composition comprises a 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 any one of the preceding claims, **characterized** in that 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.

4. The textile fiber or textile web according to any one of the preceding claims, **characterized** in

that said binary polymer composition comprises the first polymer in an amount of 60 to 75 weight-%, or 65 to 75 weight-%, and said second polymer in an amount of 25 to 40 weight-%, or 25 to 35 weight-%.

5 5. The textile fiber or textile web according to any one of the preceding claims, **characterized** in that the second polymer is PBS.

6. The textile fiber or textile web according to any one of the preceding claims, **characterized** in
10 that it comprises recycled binary polymer composition comprising cellulose acetate propionate (CAP) and polybutylene succinate (PBS).

7. A textile material comprising the textile fiber or textile web according to any one of the claims
15 1 to 6.

8. The textile material according to claim 7, **characterized** in that it is selected from the group consisting of a fiber, a yarn, textiles, fabrics, nonwovens, textile products for one of the following
20 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.

25 9. The textile material according to claim 7 or 8, **characterized** in that it is recyclable.

10. A method for manufacturing a textile fiber or a textile web from a binary polymer composition, **characterized** in that the method comprises the following
30 steps:

- obtaining a homogenous polymer blend of a binary polymer composition comprising at least a first polymer being cellulose acetate propionate (CAP), with a propionyl
35 content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-

%, and a second polymer being polybutylene succinate (PBS) in an amount of 25 to 45 weight-%, 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

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

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

11. The method according to claim 10, **characterized** in that 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

20 melt spinning and/or direct spinning.

12. The method according to claim 10 or 11, **characterized** in that the binary polymer composition comprises a 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.

13. The method according to claim 10, 11 or 12, **characterized** in that forming said homogenous polymer

blend into a textile web is done by melt blow and/or spunbond.

14. The method according to any of the claims 10 to 13, **characterized** in that 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.

15. The method according to claim any one of the claims 10 to 14, **characterized** in that obtaining a homogenous polymer blend is done by a recycling process.

16. Use of a binary polymer composition comprising a first polymer being cellulose acetate propionate (CAP), with a propionyl content of 30 to 51 weight-%, and a number average molar mass of between 85,000 and 95,000 Da, in an amount of 55 to 75 weight-%, and a second polymer being polybutylene succinate (PBS) in an amount of 25 to 45 weight-%, 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 composition, in the manufacture of a textile fiber, a textile web, and/or a textile material, or any combination of these.

17. The use according to claim 16, wherein the binary polymer composition comprises a 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.

PATENTTIVAATIMUKSET

1. Tekstiilikuitu tai tekstiiliraina, joka käsittää binäärisen polymeerikoostumuksen, **tunnettu** siitä, että binäärinen polymeerikoostumus käsittää ensimmäisen polymeerin, joka on selluloosa-asetaattipropionaatti (CAP), jonka propionyyllisisältö on 30 - 51 paino-%, ja lukukeskimääräinen moolimassa 85 000 ja 95 000 Da:n välillä, ja jonka määrä on 55 - 75 paino-%, ja toisen polymeerin, joka on polybuteenisukkinaatti (PBS), jonka määrä on 25 - 45 paino-%, ja mainitun ensimmäisen ja mainitun toisen polymeerin kokonaismäärä on vähintään 80 paino-% mainitun binäärisen polymeerikoostumuksen kokonaispainon perusteella.

2. Patenttivaatimuksen 1 mukainen tekstiilikuitu tai tekstiiliraina, **tunnettu** siitä, että binäärinen polymeerikoostumus käsittää polymeerin, joka valitaan ryhmästä, joka koostuu seuraavista: polypropeenisisukkinaatti (PPS), polybuteenisukkinaatti-adipaatti (PBSA), polybuteeni-adipaatti-tereftalaatti (PBAT), polymaitohappo (PLA), polykaprolaktone (PCL), polybuteeni-adipaatti (PBA), polyhydroksialkanaatti (PHA), polyhydroksibutyräatti (PHB), polyeteenifuranaatti (PEF), polybuteeni-tereftalaatti (PBT), polybuteenisukkinaatti-tereftalaatti (PBST) ja mikä tahansa polyesteri, joka sisältää sebaasiini- ja/tai atselaiinihappoa ja/tai dodekaanidihappoa dikarboksyylisäminä yksinään tai yhdistelmänä terftaalihapon kanssa, ja näiden mistä tahansa yhdistelmästä.

3. Jonkin edellisistä patenttivaatimuksista mukainen tekstiilikuitu tai tekstiiliraina, **tunnettu** siitä, että mainitun ensimmäisen polymeerin ja mainitun toisen polymeerin kokonaismäärä on vähintään 80 p-% tai vähintään 90 p-% tai vähintään 95 p-%, binäärisen polymeerikoostumuksen kokonaispainon perusteella, loppuosan ollessa muita polymeerejä ja/tai lisäaineita

kuten pehmittimiä, pigmenttejä, stabilisaattoreita tai muita muovikoostumuksissa käytettäviä lisäaineita.

4. Jonkin edellisistä patenttivaatimuksista mukainen tekstiilikuitu tai tekstiiliraina, **tunnettu** siitä, että mainittu binäärinen polymeerikoostumus käsittää ensimmäistä polymeeriä määrän, joka on 60 - 75 paino-% tai 65 - 75 paino-%, ja mainittua toista polymeeriä määrän, joka on 25 - 40 paino-% tai 25 - 35 paino-%.

5. Jonkin edellisistä patenttivaatimuksista mukainen tekstiilikuitu tai tekstiiliraina, **tunnettu** siitä, että toinen polymeeri on PBS.

6. Jonkin edellisistä patenttivaatimuksista mukainen tekstiilikuitu tai tekstiiliraina, **tunnettu** siitä, että se käsittää kierrätettyä binääristä polymeerikoostumusta, joka käsittää selluloosa-asetaattipropionaattia (CAP) ja polybuteenisukkinaattia (PBS).

7. Tekstiilimateriaali, joka käsittää jonkin patenttivaatimuksista 1 - 6 mukaisen tekstiilikuidun tai tekstiilirainan.

8. Patenttivaatimuksen 7 mukainen tekstiilimateriaali, **tunnettu** siitä, että se valitaan ryhmästä, joka koostuu kuidusta, langasta, tekstiileistä, kankaista, kuitukankaista, tekstiilituotteista johonkin seuraavista sovelluksista: vaatetus, kotitalous, teollisuus, tekniikka, köydet, verkot ja autotekstiilit, kotitalous- ja sisustustekstiilit mukaan lukien lakanat, kokolattiamatot ja matot, päälliset ja verhot sekä kuitukankaat kuten suodattimet ja saniteettituotteet.

9. Patenttivaatimuksen 7 tai 8 mukainen tekstiilimateriaali, **tunnettu** siitä, että se on kierrätettävä.

10. Menetelmä tekstiilikuidun tai tekstiilirainan valmistamiseksi binäärisestä

polymeerikoostumuksesta, **tunnettu** siitä, että menetelmä käsittää seuraavat vaiheet:

- saadaan binäärisen polymeerikoostumuksen, joka käsittää vähintään ensimmäisen polymeerin, joka on selluloosa-asetaattipropionaatti (CAP), jonka propionyyლისäältö on 30 - 51 paino-%, ja lukukeskimääräinen moolimassa 85 000 ja 95 000 Da:n välillä, ja jonka määrä on 55 - 75 paino-%, ja toisen polymeerin, joka on polybuteenisukkinaatti (PBS), jonka määrä on 25 - 45 paino-%, ja mainitun ensimmäisen ja mainitun toisen polymeerin kokonaismäärä on vähintään 80 paino-% mainitun binäärisen polymeerikoostumuksen kokonaispainon perusteella, homogeeninen polymeeriseos, ja
 - a) muodostetaan mainitusta homogeenisesta polymeeriseoksesta tekstiilikuitu kehräysmenetelmällä, tai
 - b) muodostetaan mainitusta homogeenisesta polymeeriseoksesta tekstiiliraina kuitukangasmateriaalien valmistamismenetelmällä.

11. Patenttivaatimuksen 10 mukainen menetelmä, **tunnettu** siitä, että tekstiilikuidun muodostaminen mainitusta homogeenisesta polymeeriseoksesta tehdään kehräysmenetelmällä, joka valitaan ryhmästä, joka koostuu seuraavista: märkäkehräys, kuivakehräys, sulakekehräys, ekstruusiokkehräys, suorakehräys, geelikehräys ja sähkökehräys, edullisesti sulakekehräyksellä ja/tai suorakehräyksellä.

12. Patenttivaatimuksen 10 tai 11 mukainen menetelmä, **tunnettu** siitä, että binäärinen polymeerikoostumus käsittää polymeerin, joka valitaan ryhmästä, joka koostuu seuraavista: polypropeenisisukkinaatti (PPS), polybuteenisukkinaatti-

adipaatti (PBSA), polybuteeni-adipaatti-tereftalaatti (PBAT), polymaitohappo (PLA), polykaprolaktoni (PCL), polybuteeni-adipaatti (PBA), polyhydroksialkanoaatti (PHA), polyhydroksibutyraatti (PHB),
 5 polyeteenifuranoaatti (PEF), polybuteeni-tereftalaatti (PBT), polybuteenisukkinaatti-tereftalaatti (PBST) ja mikä tahansa polyesteri, joka sisältää sebasiini- ja/tai atselaiinihappoa ja/tai dodekaanidihappoa dikarboksyylihappona yksinään tai yhdistelmänä
 10 tereftaalihapon kanssa, ja näiden mistä tahansa yhdistelmästä.

13. Patenttivaatimuksen 10, 11 tai 12 mukainen menetelmä, **tunnettu** siitä, että tekstiilirainan muodostaminen mainitusta homogeenisesta
 15 polymeeriseoksesta tehdään sulapuhalluksella ja/tai kehräyssidonnalla (spunbond).

14. Jonkin patenttivaatimuksista 10 - 13 mukainen menetelmä, **tunnettu** siitä, että homogeenisen polymeeriseoksen saaminen suoritetaan sulasekoituksella
 20 ja sulasekoitus suoritetaan lämpötilassa, joka on 200 °C - 300 °C tai 200 °C - 270 °C tai 210 °C - 250 °C tai 210 °C - 230 °C.

15. Jonkin patenttivaatimuksista 10 - 14 mukainen menetelmä, **tunnettu** siitä, että homogeenisen
 25 polymeeriseoksen saaminen tapahtuu kierrätysprosessilla.

16. Binäärisen polymeerikoostumuksen käyttö, jossa binäärinen polymeerikoostumus käsittää ensimmäisen polymeerin, joka on selluloosa-
 30 asetaattipropionaatti (CAP), jonka propionyyllisisältö on 30 - 51 paino-%, ja lukukeskimääräinen moolimassa 85 000 ja 95 000 Da:n välillä, ja jonka määrä on 55 - 75 paino-%, ja toisen polymeerin, joka on polybuteenisukkinaatti (PBS), jonka määrä on 25 - 45
 35 paino-%, ja jossa mainitun ensimmäisen ja mainitun toisen polymeerin kokonaismäärä on vähintään 80 paino-%
 % mainitun binäärisen polymeerikoostumuksen

kokonaispainon perusteella, tekstiilikuidun, tekstiilirainan ja/tai tekstiilimateriaalin tai näiden minkä tahansa yhdistelmän valmistuksessa.

17. Patenttivaatimuksen 16 mukainen käyttö,
- 5 jossa binäärinen polymeerikoostumus käsittää polymeerin, joka valitaan ryhmästä, joka koostuu seuraavista: polypropeenisukkinaatti (PPS), polybuteenisukkinaatti-adipaatti (PBSA), polybuteeni-adipaatti-tereftalaatti (PBAT), polymaitohappo (PLA),
- 10 polykaprolaktoni (PCL), polybuteeni-adipaatti (PBA), polyhydroksialkanoaatti (PHA), polyhydroksibutyraatti (PHB), polyeteenifuranoaatti (PEF), polybuteeni-tereftalaatti (PBT), polybuteenisukkinaatti-tereftalaatti (PBST) ja mikä tahansa polyesteri, joka
- 15 sisältää sebiini- ja/tai atselaiinihappoa ja/tai dodekaanidihappoa dikarboksyylihappona yksinään tai yhdistelmänä tereftaalihapon kanssa, ja näiden mistä tahansa yhdistelmästä.

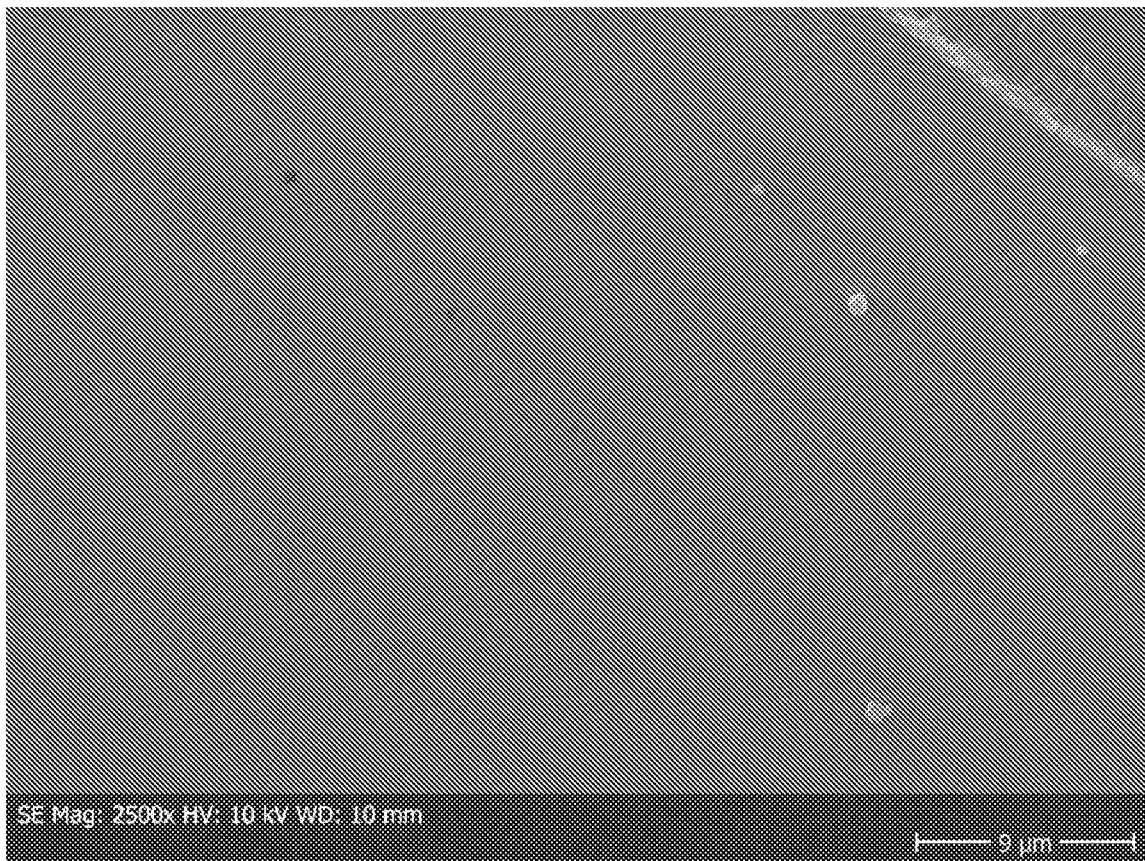


Figure 1