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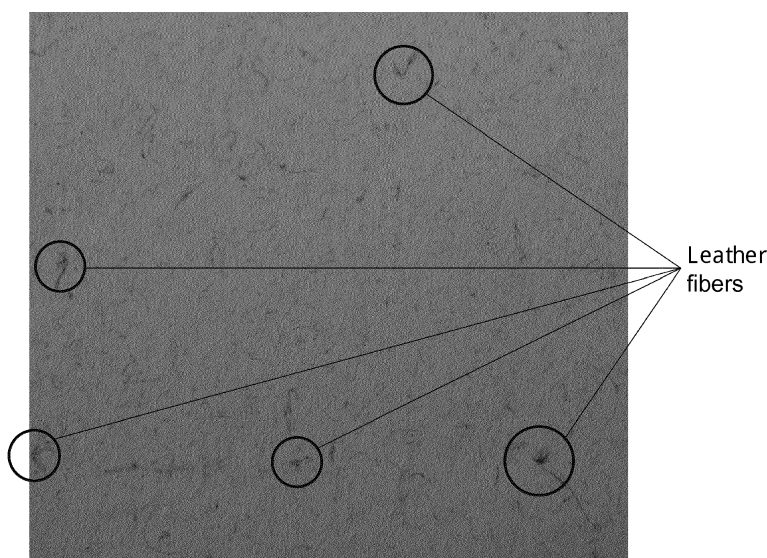
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(54) **PAPER MATERIAL COMPRISING CELLULOSE FIBERS AND LEATHER FIBERS AND PROCESS FOR THE PRODUCTION THEREOF**

(57) The present invention relates to a composite paper material comprising cellulose fibers and leather fibers. The invention also relates to a process for the production of the above-mentioned paper material.



**Fig. 1**

**Description**Field of application

- 5 **[0001]** The present invention relates to a paper material comprising cellulose fibers and leather fibers. The invention also relates to a process for the production of the above-mentioned paper material.

Known art

- 10 **[0002]** In the field of cellulose materials, in particular in the paper production industry, the problem of preserving the environment and reducing costs, is always relevant. For this reason considerable attention is paid to recycling techniques of paper materials, thus trying to limit the use of virgin cellulose material. The products obtained starting from recycled cellulose materials, however, have different physical properties from those obtained from virgin cellulose materials.
- 15 **[0003]** The Applicant has considered the problem of providing a paper material having a fibrous component comprising alternative fibrous materials to virgin cellulose, preferably deriving from recycled materials, without jeopardizing the mechanical properties of the final paper product, such as, for example, rigidity, thickness, burst strength, rupture length. A further objective of the present invention is to provide this type of paper material which also has a high electric conductivity and high volume or "bulk" values.
- 20 **[0004]** The above objectives have been achieved by the Applicant through a paper material, wherein the cellulose fibers of the fibrous component are partially substituted by leather fibers, in particular leather fibers obtained from waste of the tanning industry and leather transformation.

Summary of the invention

- 25 **[0005]** According to a first aspect, the present invention relates to a paper material wherein the fibrous component comprises leather fibers in a percentage within the range of 5-80% dry weight and cellulose fibers in a percentage within the range of 95-20% dry weight, wherein said dry weight percentages refer to the total dry weight of the fibrous component.
- [0006]** The fibrous component of the paper material according to the invention preferably consists of cellulose fibers and leather fibers.
- 30 **[0007]** The paper material according to the present invention advantageously has a high electric conductivity and a high "bulk".
- [0008]** Another advantage relates to the fact that the use of leather fibers in substitution of cellulose fibers allows a considerably reduced quantity of virgin cellulose material, up to 80% less, to be used in the production of the paper material according to the invention.
- 35 **[0009]** A further advantage provided by the present invention is the possibility of effectively recycling the tanning industry and leather transformation residues.
- [0010]** Another advantage lies in the fact that the paper material of the invention is biodegradable or compostable, reducible to pulp and can therefore be recycled in the paper production chain.
- 40 **[0011]** Yet another advantage is represented by the fact that the paper material according to the present invention can be coupled with non-paper materials, in particular biodegradable plastic films such as PHA (polyhydroxyalcanoate), Mater-Bi®, PLA (polylactic acid) to obtain compostable end-products, which can be used, for example, in the packaging industry.
- [0012]** For the purposes of the present invention, a material is considered "biodegradable" if it meets the biodegradability requirements established by the standard EN 13432.
- 45 **[0013]** For the purposes of the present invention, a material is considered "compostable" if it meets the compostability requirements established by the standard EN 13432.
- [0014]** For the purposes of the present description and enclosed claims, the verb "to comprise" and all terms deriving therefrom also include the meaning of the verb "to consist of" and all terms deriving therefrom.
- 50 **[0015]** The limits and numerical ranges expressed in the present description and enclosed claims also comprise the numerical value(s) mentioned. Furthermore, all the values and sub-ranges of a limit or numerical range should be considered as being specifically included as if explicitly mentioned.
- [0016]** Further features and advantages of the present invention will appear evident from the following detailed description.

55 Detailed description

- [0017]** According to a preferred aspect of the present invention, the leather fibers have a length comprised within the range of 0.1-30 mm, preferably within the range of 1 - 20 mm, more preferably 4 - 15 mm.

**[0018]** Preferably, the leather fibers are obtained by the defibration of leather, more preferably leather obtained from wastes of the tanning industry and leather transformation industry, such as, for example, residues of shaving and splitting phases of tanning processes or trimming scraps of the leather transformation industry.

**[0019]** For the purposes of the present invention, the above-mentioned waste products are reduced to the state of fibers using processes and techniques known in the field of leather scrap recovery, in particular in the field of so-called "bonded leather" production.

**[0020]** In particular, the defibration can be obtained mechanically, by grinding the scraps in synchronized hammer and/or knife mills and/or defibration mills, preferably Pallmann defibration mills.

**[0021]** Preferably, the defibration process in mills is continued for a period of time that avoids the complete separation of the single fibers, but for a duration that is such as to obtain leather fibers in bundles, which is preferably a maximum of 30 minutes. It has in fact been observed that defibration times longer than those indicated above, damage the collagen fibers forming the leather, in addition to causing excessive energy consumptions.

**[0022]** The leather fibers are preferably partially defibrated.

**[0023]** The leather fibers are preferably in the form of bundles of fibers, more preferably similar to a tangle.

**[0024]** The fibers obtained from the defibration processes described above, have a morphology and dimensions similar to those of cellulose fibers. This makes the above leather fibers compatible with cellulose fibers, and they can therefore be used as part of the fibrous component of a paper material.

**[0025]** The use of leather fibers according to the present invention gives the paper material a characteristic aspect, as these fibers are at least partially visible also to the naked eye in the end-product, as pointed out in the enclosed figure 1 which shows a paper material according to the invention.

**[0026]** The presence of leather fibers in bundles can also be noticed in the enclosed figures 2 and 3 which show electron microscope images of a sample of leather fibers according to the invention. The presence of bundles of leather fibers offers the advantage of increasing the bulk value of the paper material obtainable, without substantially deteriorating the other properties.

**[0027]** The leather fibers are preferably obtained from leather tanned through tanning processes of the type that do not use chromium, more preferably vegetable tanning (for example, using tannin as tanning agent) or "wet white" tanning (e.g. using aldehydes as tanning agent). Vegetable and "wet white" tanning, in fact, do not use chromium. The use of fibers deriving from these tanned leathers in the production of paper material according to the present invention, therefore avoids all problems of an environmental nature relating to the use of this heavy metal.

**[0028]** The paper material of the present invention is preferably one or more selected from printing paper or cardboard; paper for the lining of boxes; paper for packaging; corrugated paper and cardboard; paper for shoppers and bags; paper for labels; and security paper.

**[0029]** The paper material is preferably coated, embossed, die-cut and/or laminated.

**[0030]** The paper material according to the present invention can be in various forms, for example in the form of a sheet having variable dimensions, in the form of a reel, etc.

**[0031]** According another preferred aspect, the paper material of the present invention has an electric conductivity within the range of  $1 \times 10^{-7}$  -  $1 \times 10^{-10}$  S/m, more preferably  $1 \times 10^{-8}$  -  $1 \times 10^{-9}$ . This conductivity value makes the paper material according to the present invention particularly suitable for use as a support for digital printing, photostat printing and similar. For this kind of application, the fibrous component of the paper material preferably comprises leather fibers in a percentage within the range of 5 - 20%, more preferably 5 - 10% dry weight and cellulose fibers in a percentage within the range of 95 - 80%, more preferably 95 - 90% dry weight, wherein said dry weight percentages refer to the total dry weight of the fibrous component.

**[0032]** For comparative purposes, the typical electric conductivity of the paper produced with cellulose fibers alone is normally comprised within the range of  $1 \times 10^{-12}$  -  $1 \times 10^{-14}$  S/m.

**[0033]** The paper material preferably has an absolute humidity within the range of 4-12%, more preferably 5-10%. The paper material preferably has a *bulk* value (thickness ( $\mu\text{m}$ ) / grammage ( $\text{g/m}^2$ ) ratio) within the range of 1.2-1.8, more preferably within the range of 1.4-1.7. These values are on an average about 25% higher than the bulk values obtainable for conventional paper materials, without leather fibers.

**[0034]** High bulk values are desirable for blotting paper, for example. Low bulk values are desirable for printing paper, for example. With the present invention a paper material can be obtained, having a desired bulk value, using a lower amount of cellulose fibers with respect to a conventional paper not containing leather fibers.

**[0035]** The paper material preferably has an organic nitrogen content within the range of 1-12%, more preferably 3-6% (Kjendahl method). This nitrogen content makes the paper material easily compostable.

**[0036]** The paper material preferably has a grammage within the range of 80-1,100  $\text{g/m}^2$ , more preferably 100-600  $\text{g/m}^2$ .

**[0037]** The paper material according to the present invention advantageously does not cause skin irritation. This evaluation can be effected by carrying out, for example, a patch test of the occlusive type.

**[0038]** The paper material according to the invention preferably has, on the surface, occlusions deriving from partially defibrated leather fibers. These occlusions give the material a characteristic or immediately recognizable appearance.

**[0039]** A second aspect of the present invention relates to a process for the production of a paper material as defined above and comprises the following steps:

- a) preparing a water-based mixture comprising cellulose fibers and leather fibers, wherein the leather fibers are in a percentage comprised within the range of 5 - 80% dry weight and the cellulose fibers in a percentage within the range of 95 - 20% dry weight, wherein said dry weight percentages are based on the total dry weight of the sum of the cellulose fibers and the leather fibers;
- b) forming a layer of said mixture on a draining screen and draining the water contained in said mixture; and
- c) drying said drained mixture so as to obtain said paper material.

**[0040]** Preferably, a tanning agent is added to the water-based mixture of step a).

**[0041]** In the present description and enclosed claims, the term tanning agent refers to a compound of the type generally used in the tanning processes of animal hides, that stabilizes the collagen.

**[0042]** For the purposes of the present invention, the addition of the tanning agent in step a) favours the formation of a homogeneous mixture of the leather fibers and cellulose fibers.

**[0043]** Preferably, the tanning agent is within the group which is selected from: mineral tanning agents (e.g. zirconium or aluminium salts), tannins, more preferably vegetable tannins, aldehydes (e.g. glutaraldehyde), tanning oils, or combinations thereof.

**[0044]** Preferably, the tanning agent is added in step a) in a dry weight percentage within the range of 0.1-2.0%, more preferably 0.2-0.8%, wherein said percentage refers to the total dry weight of the leather fiber.

**[0045]** One or more additives of the type commonly used in the paper industry, such as optical brightener agents, dyes, sizing agents, fillers (e.g. calcium carbonate and kaolin) silica, cationic starch, wet-strength agents, etc., are preferably added to the water-based mixture of step a), according to the characteristics desired for the final paper material.

**[0046]** Preferably, the dyes are present in a quantity within the range of 0.05 - 10.00% dry weight, wherein said percentage refers to the total dry weight of the mixture.

**[0047]** Preferably, step b) is preceded by a refining step of the mixture of step a), more preferably with the use of conical or disc refiners.

**[0048]** The process according to the present invention can be carried out with equipment known to skilled person in the paper industry field. Steps b) and c), in particular, can be effected with a continuous machine for the production of paper.

**[0049]** The paper material obtained at the end of step c) is preferably subjected to one or more finishing steps selected from the group comprising calendering, embossing, corrugation, coupling and coating.

**[0050]** In particular, the coating can be effected using techniques and equipment known to skilled person in the field, such as air knife coating, curtain coating, stiff blade, bent blade, metering and film press.

**[0051]** According to a third aspect, the present invention relates to the paper material obtained according to the above-mentioned production process.

**[0052]** According to a fourth aspect, the present invention relates to the use of the above-mentioned paper material for producing a biodegradable multilayer composite material together with one or more non-paper materials, in particular biodegradable plastic films, i.e. films comprising biodegradable polymers, such as cellulose acetate, PBS (polybutylenesuccinate), PHA (polyhydroxyalkanoate), Mater-Bi®, PLA (polylactic acid), etc.

**[0053]** According to a fifth aspect, the present invention relates to a biodegradable multilayer composite material comprising at least one layer of the paper material described above, laminated with at least one biodegradable film.

**[0054]** Such composite material can be advantageously used for preparing biodegradable or compostable end-products, which can be used, for example, in the packaging and agricultural fields.

**[0055]** The biodegradable films that can be used for the purposes of the present invention are known to skilled persons in the field and can be found on the market. These films comprise biodegradable polymers such as, for example, polymers and copolymers of hydroxy acids (so-called poly(hydroxy acids)) - in particular polymers and copolymers of lactic acid and glycolic acid -, cellulose polymers, hydroxyalkanoate polymers (e.g. polyhydroxybutyrate-co-valerate (PHBV), biodegradable copolyesters (e.g. polybutylenesuccinate adipate (PBSA), polybutylene adipate-co-terephthalate), polycaprolactones (PCLs) and starch-based polymers.

**[0056]** The multilayer composite materials according to the present invention can be prepared by means of processes known to skilled persons in the field.

#### Short description of the figures

**[0057]**

Figure 1 shows a sample of paper material according to the invention;

Figure 2 is an electronic microscope image of a leather fiber sample according to the present invention;

Figure 3 is another electronic microscope image of a leather fiber sample according to the present invention;

#### Examples

5 **[0058]** The present invention will now be further illustrated by means of some embodiment examples as described hereunder.

Example 1: Paper material with 60% of leather fibers and 40% of cellulose fibers (cellulose soft wood NBSK).

10 **[0059]** Composition 1:

- 300 kg of shaved leather tanned by means of the "wet white" technique (leather previously defibrated using a blade mill and for 10 minutes with a Pallmann defibrator mill);
- 300 kg of leather residues tanned by means of the "wet white" technique (residues previously chopped with a blade mill and defibrated for 20 minutes with a Pallmann defibrator mill);
- 400 kg of bleached chemical cellulose ASPA (NBSK);
- 20 kg of cold-soluble cationic starch;
- 50 kg of calcium carbonate;
- 20 kg of natural tanning agent, 50% of dry product (Chimotan OPS of Chimotan Group).

20 **[0060]** The materials of composition 1 were introduced into a vat and refined for 10 minutes, by means of conical refiners, in order to obtain the homogenization of the fibrous component. The mixture obtained, equal to 1,090 kg was added to a Fourdrinier continuous machine for the production of paper, with a production of 1,000 kg/h and a rate of 22 m/min, obtaining a reel of paper material. The final grammage of the paper material obtained was about 700 g/m<sup>2</sup>, whereas the thickness was 1,100 microns. The final absolute humidity of the paper material was equal to 12%.

25 **[0061]** The paper material is biodegradable, recyclable and reducible to pulp. This latter feature makes the material suitable for further transformations of the paper process. Table 1 hereunder, item A, shows the characteristics of the paper material obtained.

30 Example 2: paper material with 15% of leather fibers and optical bleacher for printing.

**[0062]** Composition 2:

- 750 kg of paper material of example 1 cut into sheets;
- 2,000 kg of bleached chemical cellulose, of which: 500 kg of soft wood cellulose (NBSK) and 1,500 kg of hardwood cellulose (eucalyptus, beech, poplar, aspen);
- 200 kg of calcium carbonate;
- 25 kg of optical bleacher (Leucophor® ACK of Archroma);
- 5 kg of natural tanning agent, 50% of dry product (Chimotan OPS of Chimotan Group).

40 **[0063]** The materials of composition 2 were dosed and the following products were added: cationic starch 15 kg dry, aluminium polychloride 30 kg as such, colloidal silica 4.5 kg dry and 30 kg of sizing agent based on AKD for the sizing of the paper. The latter materials are useful for retention.

45 **[0064]** The mixture was homogenized with a pulper, stored in a vat and dosed on a Fourdrinier continuous paper machine. The rate of the machine was 120 m/min, with an hourly production of 1,200 kg/h. A final smoothing was effected to make the paper suitable for printing. The final absolute humidity of the paper material was 7.0%. The production yield was equal to 2,700 kg as reels which were subsequently cut into sheets. The grammage of the paper was 120 g/m<sup>2</sup>. During production, a solution of starch was applied to the surface by means of a size-press machine, in order to improve the surface characteristics of the paper and make it suitable for printing.

50 **[0065]** As resulting product, a paper material was obtained, that is recyclable, reducible to pulp, biodegradable, compostable and sized. The presence of the optical brightener agents makes the paper whiter, favouring its use as printing and writing paper. The presence of bundles of leather fibers gives the paper a characteristic appearance. Table 1 hereunder, item B, shows the characteristics of the paper material obtained.

55 Example 3: paper material in reel of printing paper with 30% of leather fibers having a natural colour.

**[0066]** Composition 3:

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- 2,200 kg of the material obtained according to example 1 cut into sheets;
- 2,000 kg of bleached chemical cellulose, of which: 500 kg of soft wood cellulose (NBSK) and 1,500 kg of hardwood cellulose (eucalyptus, beech, poplar, aspen);
- 200 kg of calcium carbonate;
- 10 kg of natural tanning agent, 50% of dry product (Chimotan OPS of Chimotan Group).

**[0067]** The following products were added to the materials of composition 3: cationic starch 15 kg dry, aluminium polychloride 30 kg as such, colloidal silica 4.5 kg dry, and 30 kg of size agent based on AKD for sizing the paper. These latter materials are useful for retention.

**[0068]** The mixture was homogenized with a pulper, stored in a vat and subsequently dosed on a Fourdrinier continuous paper machine. The rate of the machine was equal to 70 m/min, with an hourly production of 1,400 kg/h. The absolute humidity of the final paper material was equal to 7.5%. The production yield was equal to 4,200 kg. The paper grammage was 250 g/m<sup>2</sup>. During the production, a starch solution was applied to the surface with a film-press machine in order to improve the surface characteristics of the paper, thus making the same suitable for printing. As resulting product, a paper material was obtained, which is recyclable, reducible to pulp, biodegradable, compostable and sized. The presence of bundles of leather fibers gives the paper a characteristic appearance.

**[0069]** Table 1 hereunder, item C, indicates the characteristics of the paper material obtained. Due to the presence of animal fibers, a test was carried out for assessing skin irritability (patch test of the occlusive type) which gave a negative result.

Example 4: black paper material, with 30% of leather fibers, coloured with direct dyes.

### **[0070]** Composition 4:

- 2,200 kg of the paper material obtained according to example 1 cut into sheets;
- 2,000 kg of bleached chemical cellulose, of which: 500 kg of softwood cellulose (NBSK) and 1,500 kg of hardwood cellulose (eucalyptus, beech, poplar, aspen);
- 200 kg of calcium carbonate;
- 40 kg of Cartacrom 2T Black in powder form (CI: Direct Black 80);
- 40 kg of Cartacrom N Black in powder form (CI: Direct Black 168);
- 10 kg Cartacrom GTN Red 150% in powder form (CI: Direct Red 239).

**[0071]** The following products were added to the materials of composition 4: cationic starch 20 kg dry, aluminium polychloride 40 kg as such, colloidal silica 5.5 kg dry, and 30 kg of sizing agent on AKD for sizing the paper. These latter materials are useful for retention.

**[0072]** The mixture was homogenized with a pulper, stored in a vat for dyeing and then dosed on a Fourdrinier continuous paper machine. The rate of the machine was 120 m/min, with an hourly production of 1,200 kg/h in a reel. A final smoothing was effected to make the paper suitable for main paper transformations, in particular lamination. The final absolute humidity of the paper material was 7.0%. The production yield was equal to 4,250 kg. The paper grammage was 250 g/m<sup>2</sup>. During production, a solution of starch and direct black dye was applied to the surface with a size-press machine, in order to improve the surface characteristics of the paper and increase the colour intensity of the paper.

**[0073]** As resulting product, a paper material was obtained, that is recyclable, reducible to pulp, biodegradable, compostable and sized, black in colour (L=26.5; a=0.7 b=-1.4) and characterized by whitish inclusions due to the presence of leather fibers that do not absorb direct dyes.

**[0074]** Table 1, item D, indicates the characteristics of the material obtained.

Example 5: Coated paper with 30% of leather fibers.

**[0075]** A paper reel produced according to example 3, of 250 g/m<sup>2</sup> was coated with an air knife coating machine applying a coating equal to 10 g/m<sup>2</sup>. The dry product of the coating was 35% and the pH was adjusted to a value of 8.5 with NaOH.

**[0076]** Composition of the dry coating:

polymethyl urea	100 kg
precipitated calcium carbonate	200 kg
kaolin	100 kg

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(continued)

styrene-butadiene latex	300 kg
Insolubilizing agents	15 kg
Dispersing and wetting agents	5 kg
Thickening agents	6 kg
NaOH	1 kg
Optical bleacher	4 kg.

**[0077]** As resulting product a paper material was obtained, which is recyclable, reducible to pulp, biodegradable, compostable, sized and coated, characterized by whitish inclusions due to the presence of collagen which absorbed the coating in a different way.

**[0078]** Table 1, item E, indicates the characteristics of the material obtained.

### Example 6: Embossing of the paper material according to the present invention

**[0079]** A paper reel produced according to example 2 (15% of leather fibers and optical brightener agents) of 120 g/m<sup>2</sup> was embossed with a UNIMATEC embosser at a rate of 100 m/min, a temperature of 75°C and a pressure of 80 bar. The steel marking cylinder was characterized by a width of 150 cm and a diameter of 25.34 cm. The absolute humidity of the final marked paper was 7.0%.

**[0080]** As resulting product, a paper material was obtained with a surface marking similar to canvas. The paper material thus obtained can be used for example in the coating of boxes.

### Example 7: biodegradable multilayer composite material

**[0081]** A paper reel produced according to example 3 (30% of leather fibers and a natural colour) of 250 g/m<sup>2</sup> was cut by means of a Jagemberg SYNCHRO cutter into a format of 72x102 cm and was coupled on a PAPERPLAST WD coupling machine with a cellulose acetate film ACE BLUE of CLARIFOIL of 32 g/m<sup>2</sup> using 4 g/m<sup>2</sup> of a biodegradable adhesive (aqueous dispersion based on polyester-polyurethane elastomers - EPOTAL P100 Eco of BASF). The absolute humidity of the final laminated paper was 7.0%, whereas the final grammage was 286 g/m<sup>2</sup>.

**[0082]** As resulting product, a biodegradable multilayer composite material was obtained, which can be used for example in the production of compostable flower pots.

TABLE 1: physico-mechanical characteristics of the paper materials obtained

			A	B	C	D	E
Type of paper			Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5
leather fibers	%		60	15	30	30	30
grammage	g/m <sup>2</sup>	ISO 536	700	120	250	250	260
Thickness	micron	ISO 534	1100	192	430	430	430
bulk			1.57	1.60	1.72	1.72	1.63
L*			77.8	88.9	80.2	26.5	82.0
a*			2.5	3.8	4.0	0.7	3.0
b*			16.5	1.8	18.7	-1.4	12.0
Bendtsen smoothness	ml/min	ISO 8791	>2000 >2000	1000 900	1500 1400	1300 1000	800 1000
Cobb 60s Felt side	g/m <sup>2</sup>	ISO 535	50	25	35	40	35
Cobb 60s Wire side	g/m <sup>2</sup>	ISO 535	40	25	35	40	40
Dennison waxes	N.		10/10	16/18	16/18	16-18	18-18
Absolute humidity	%		12.0	7.0	7.5	7.0	7.0
Occlusive Patch Test					Not irritating		

(continued)

			A	B	C	D	E
Electric conductivity	S/m			$2 \times 10^{-9}$	$5 \times 10^{-8}$	$1 \times 10^{-8}$	

**Claims**

1. Paper material wherein the fibrous component comprises leather fibers in a percentage comprised within the range 5 - 80% dry weight and cellulose fibers in a percentage comprised in the range 95 - 20% in dry weight, wherein said percentages in dry weight are based on the total dry weight of the fibrous component.
2. Paper material according to claim 1, wherein said leather fibers have a length comprised within the range 0.1 - 30 mm, preferably 1 - 20 mm, more preferably 4 - 15 mm.
3. Paper material according to claim 1 or 2, wherein the leather fibers are obtained through leather defibration, preferably leather obtained from scraps of the leather tanning and transformation industry.
4. Paper material according to any one of the preceding claims, wherein the leather fibers are obtained from leather tanned through tanning processes of the type that do not use chrome, preferably vegetal tanning or wet white tanning.
5. Paper material according to any one of the preceding claims, wherein said paper material has an electric conductivity in the range  $1 \times 10^{-7}$  -  $1 \times 10^{-10}$  S/m, more preferably  $1 \times 10^{-8}$  -  $1 \times 10^{-9}$  S/m.
6. Paper material according to any one of the preceding claims, wherein said material has an absolute humidity within the range 4 - 12%, preferably 5 - 10%.
7. Paper material according to any one of the preceding claims, wherein said material has a *bulk* value in the range 1.2 - 1.8, preferably in the range 1.4 - 1.7.
8. Paper material according to any one of the preceding claims having an organic nitrogen content comprised within the range 1 - 12%, preferably 3 - 6%.
9. Paper material according to any one of the preceding claims, having occlusions on the surface deriving from partially defibrated fibers.
10. Process for the manufacture of a paper material as defined in the preceding claims 1-9, comprising the steps of:
  - a) preparing a water-based mixture comprising cellulose fibers and leather fibers, wherein the leather fibers are present in a percentage comprised within the range 5 - 80% dry weight and the cellulose fibers in a percentage comprised within the range 95 - 20% dry weight, wherein said dry weight percentages are based on the total dry weight of the sum of the cellulose fibers and the leather fibers;
  - b) forming a layer of said mixture on a draining screen and draining the water contained in said mixture; and
  - c) drying said drained mixture so as to form said paper material.
11. Process according to claim 10, wherein a tanning agent is further added to the water-based mixture of step a), preferably in a dry weight percentage within the range 0.1 - 2.0%, preferably 0.2 - 0.8%, wherein said percentage is based on the total dry weight of the leather fibers.
12. Process according to any one of claims 10 or 11 wherein said step b) is preceded by a refining step of the mixture of step a), more preferably by using conical or disc refiners.
13. Process according to any one of claims 10 - 12 wherein, at the end of step c), said paper material is subjected to one or more refining steps selected from the group comprising calendering, embossing, corrugation, coupling and coating.
14. Use of the paper material according to any one of claims 1 - 9 for manufacturing a biodegradable multilayer composite



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material together with one or more non-paper materials, particularly biodegradable plastic films, such as PHA (polihydroxyalcanoates), materBi<sup>®</sup>, PLA (polylactic acid).

- 5      **15.** A biodegradable multilayer composite material comprising at least one layer of a paper material according to claim 1 laminated with at least one biodegradable film.

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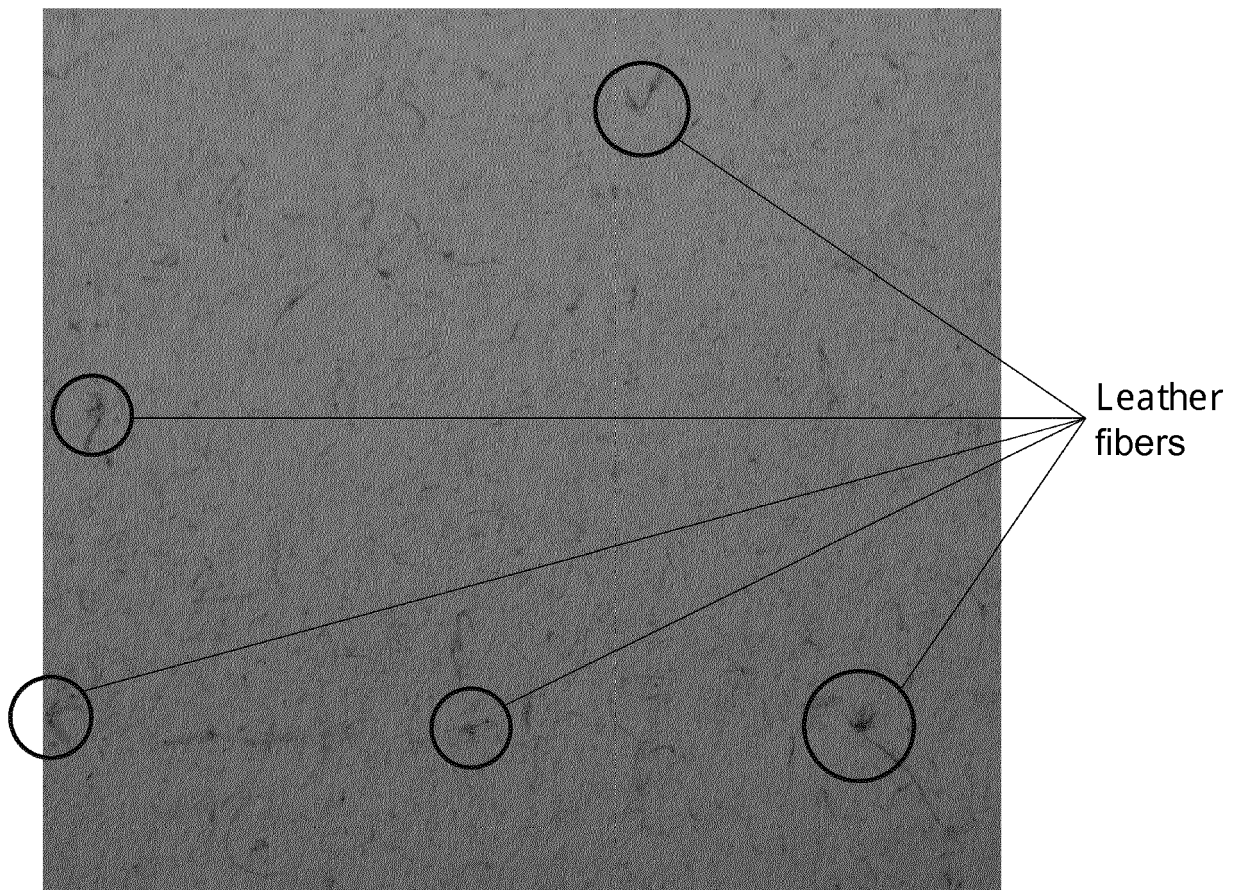


Fig. 1

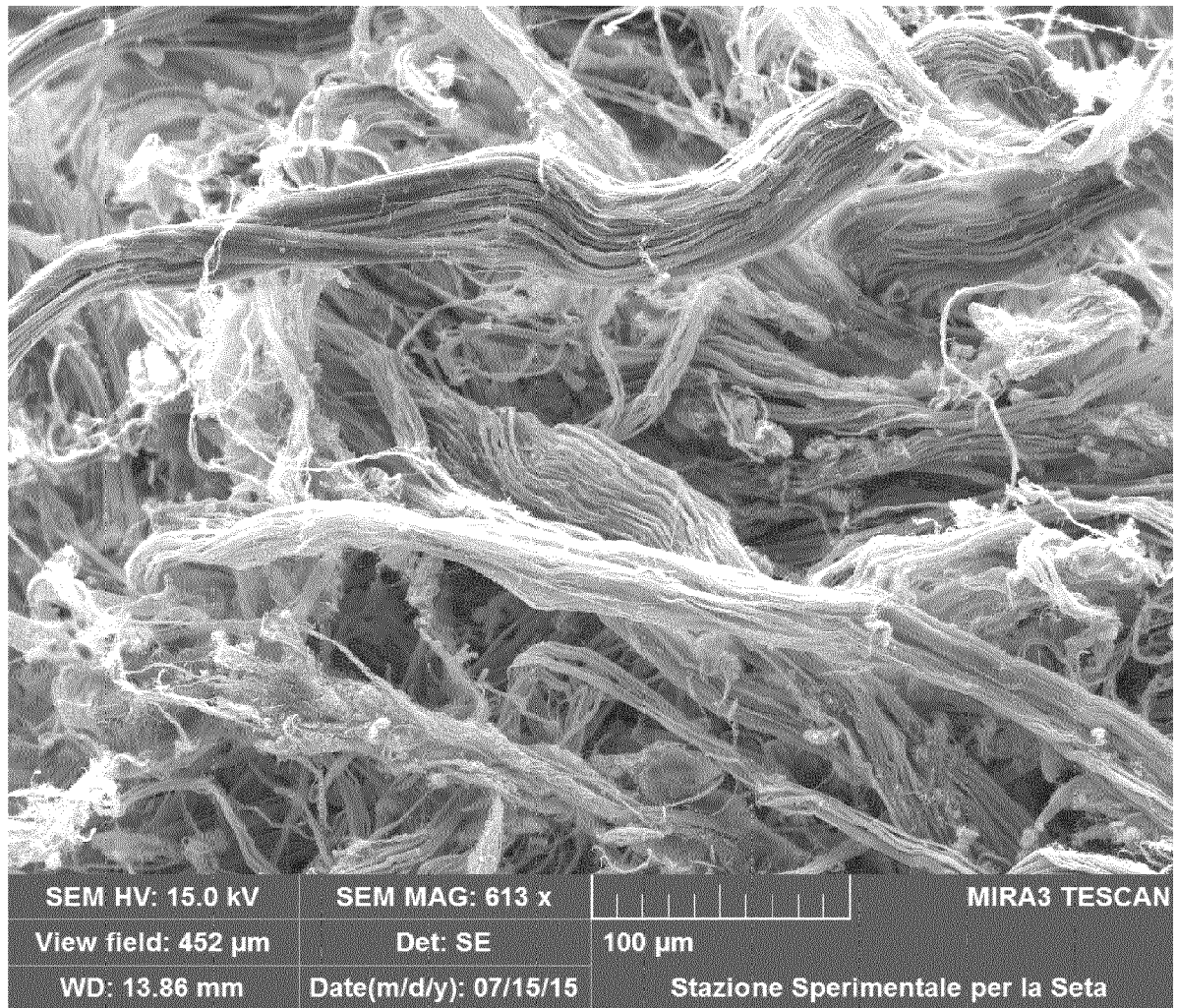


Fig. 2

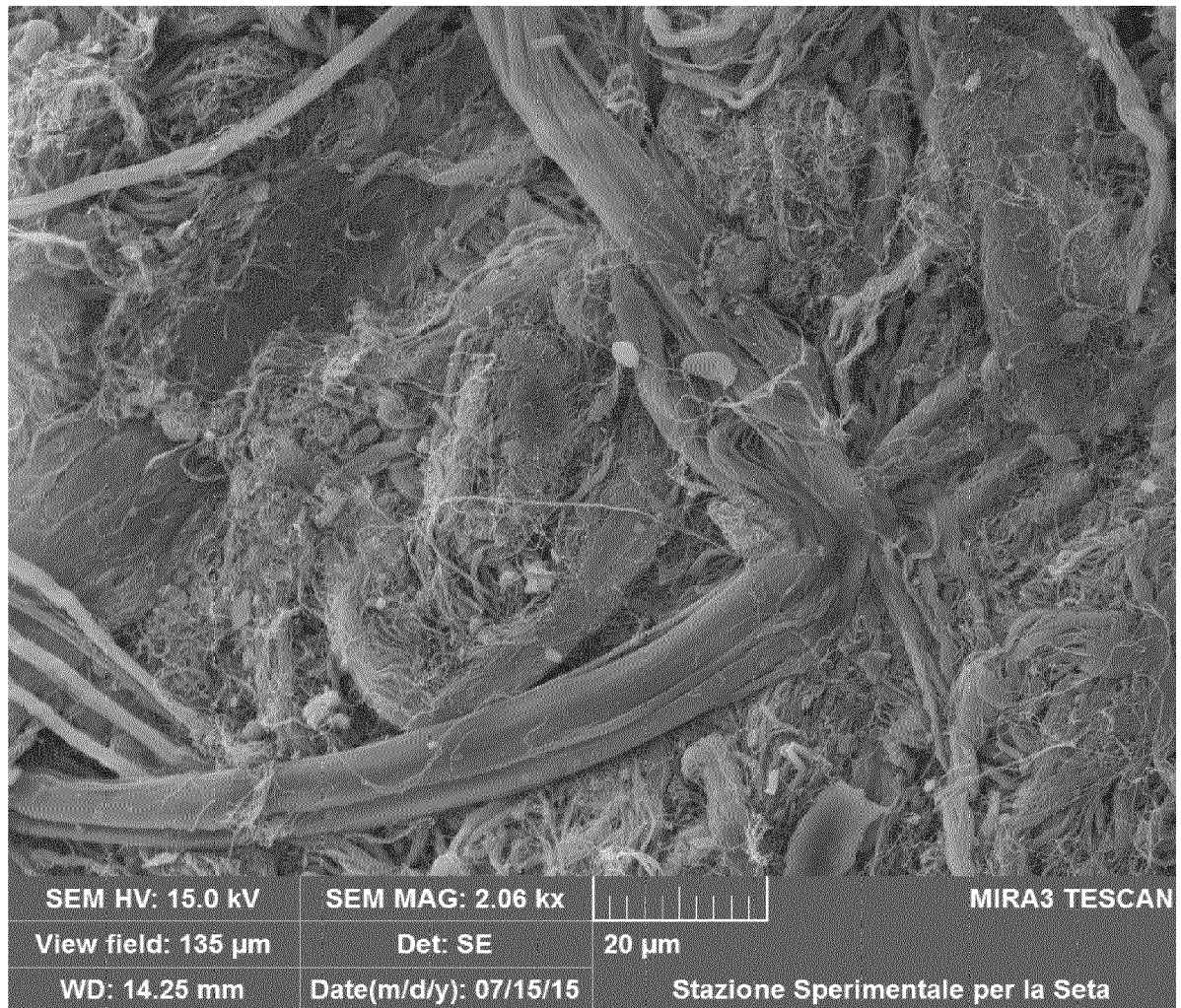


Fig. 3



## EUROPEAN SEARCH REPORT

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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