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(54) **A FIBER-BASED PAPER COMPRISING AT LEAST ONE TRANSPARENT AREA AND A METHOD OF PRODUCING THE SAME**

(57) The present invention relates to fiber-based transparent papers. More particularly, the invention relates to a fiber-based paper comprising at least one transparent area and to a method of producing said

fiber-based paper. The invention also relates to the use of the fiber-based paper comprising at least one transparent area in packaging applications.

1: Method of producing at least one transparent area  
3: Providing or producing a fiber-based substrate  
5: Applying a coating composition ->forming a coated fiber-based substrate  
7: At least partially drying the coated fiber-based substrate (optional)  
9: Calendaring  
11: Drying  
13: Rolling

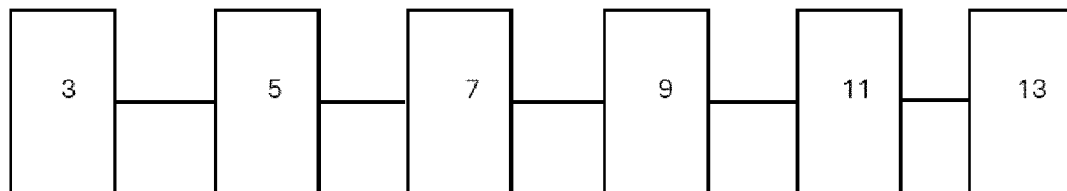


Fig. 1

**Description**

## FIELD

**[0001]** The present invention relates to fiber-based transparent papers. More particularly, the invention relates to a fiber-based paper comprising at least one transparent area and to a method of producing said fiber-based paper. The invention also relates to the use of the fiber-based paper comprising at least one transparent area in packaging applications.

## BACKGROUND

**[0002]** Previously, most transparent materials were formed from plastic-based materials. In an attempt to reduce the use of non-renewable, petroleum-based resources, renewable materials such as cellulose fibers were later combined with the petroleum-based chemicals or synthesized resins. Further, in order to improve transparent properties of papers comprising petroleum-based chemicals and cellulose fibers, usage of high levels of refining or high concentrations of chemical coatings were introduced, resulting in remarkable costs and environmental issues. Alternatively, or additionally, the obtained papers were supercalendered off-line, which is a highly energy consuming step and adds complexity to the manufacturing process of such papers.

**[0003]** Moreover, some of the existing transparent papers have a very low grammage (typically of less than 40 g/m<sup>2</sup>) and therefore exhibit weak mechanical properties. Such current transparent papers are encountering difficulties in achieving a balance between transparency and mechanical properties. Typically, the technologies that are currently accessible include a highly transparent paper with low mechanical properties or a paper with excellent mechanical properties but low transparency. The technology may also include the use of a high amount coating material compared to the weight of the fibers to attain the balance between the mechanical and transparency properties, but simultaneously utilizing high costs and energy.

**[0004]** Another option for producing transparent papers is the use of highly refined cellulosic fibers, such as for example of at least 70°SR, and optionally a supercalendering step. However, this refining step is also energy consuming and requires high drying energy of the transparent paper.

**[0005]** Moreover, most of the existing transparent papers are not based on fully renewable or bio-based materials, and thus do not offer recyclability or promote sustainability.

**[0006]** As apparent from above, it is challenging to balance between transparency and mechanical properties in order to create satisfying finished products. Highly transparent papers typically are not strong enough (because of their low grammages for example) for certain applications in terms of properties such as tensile strength, tear resistance and burst. On the other hand, the technical features may be in line with the requirements but the process is either too expensive or does not fulfill sustainability requirements. For example, highly refined transparent paper, such as tracing paper or Cristal paper, which are very transparent ones (at least 70% transparency roughly) consume a lot of energy for their productions because of the required very high refining levels (around 70-90°SR) and an off-line supercalendering step in order to achieve the level of transparencies of such kinds of papers. Moreover, the current transparent papers are typically not recyclable or repulpable.

**[0007]** Some attempts to find alternative transparent papers have been made. US 2024/0401280 A1 discloses a low opacity paper packaging material, made from a fibrous web containing highly refined cellulose fibers, the paper comprising a bio-based wax or oil and a heat-sealable composition in contact with the fibrous web. US 2024/0401276 A1 relates also to a low opacity paper, made from a fibrous web comprising highly refined cellulose fibers, and having an opacity of less than or equal to 40%. WO 2024024896 A1 relates to a base paper having a basis weight of 40-75 g/m<sup>2</sup>, impregnated with a transparent material such as acrylic resin, vegetable oil, or wax. EP 4471207 A1 discloses a low opacity and heat-sealable paper made from highly refined cellulose fibers, coated first with a wax and then with a coating composition providing heat-sealable properties, while EP 4471210 A1 discloses a similar paper without a heat-seal layer.

**[0008]** However, the solutions proposed in the prior art still suffer from several shortcomings or do not fully solve the problem how to find a balance between transparency, mechanical properties, cost-effectiveness, and sustainability, including recyclability of the final paper.

**[0009]** The present invention provides a highly transparent paper with sufficient mechanical properties and with good to excellent recyclability. The transparent papers of the present invention may comprise higher grammages than the ones known from the prior art, without the need to use highly refined fibers. Further, the amount of transparentizing agent in the final paper can be kept at a low level, thus further increasing cost-effectiveness. Moreover, the fiber-based paper can be repulpable, recyclable and/or compostable, thus further reducing the environmental impact of the paper.

## SUMMARY OF THE INVENTION

**[0010]** The invention is defined by the features of the independent claims. Some specific embodiments are defined in the

dependent claims.

**[0011]** The present invention is based on the concept of using a transparentizing coating composition, which comprises at least one wax having a melting point of at least 60°C, on a fiber-based substrate, thus obtaining a fiber-based paper comprising at least one transparent area wherein the at least one transparent area has a transparency level of at least 60%, when measured according to DIN 53147:1993-01 standard. Preferably, the fiber-based paper has a recyclability score of at least 75/100, with reference to CEPI method of 2022.

**[0012]** According to a first aspect of the present invention, there is provided a fiber-based paper comprising at least one transparent area, wherein the fiber-based paper comprises

- a fiber-based substrate, the fiber-based substrate having a first side and a second side opposite to the first side;
- a transparentizing coating composition on at least one side of the fiber-based substrate;

wherein the at least one transparent area has a transparency level of at least 60%, when measured according to DIN 53147:1993-01 standard, and wherein the transparentizing coating composition comprises at least one wax having a melting point of at least 60°C.

**[0013]** According to a second aspect of the present invention, there is provided a method of producing the fiber-based paper according to the invention, wherein the method comprises the steps of:

- providing or producing a fiber-based substrate, said fiber-based substrate having a first side and a second side opposite to the first side;
- applying a transparentizing coating composition on at least one area of at least one side of the fiber-based substrate to form a fiber-based paper comprising at least one transparent area;

wherein the at least one transparent area on the fiber-based paper has a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard; and wherein the transparentizing coating composition comprises at least one wax having a melting point above 60°C.

**[0014]** Embodiments of the invention comprise use of the fiber-based paper of the invention in packaging applications.

**[0015]** Considerable advantages are obtained by the invention. The present fiber-based paper reaches a very high transparency with fiber-based substrates having heavier basis weights than the ones known in the art (up to 150 g/m<sup>2</sup>). By using a fiber-based substrate having a heavier basis weight, it is possible to have transparent fiber-based papers with higher mechanical properties or higher physical properties (tensile, tearing) than the low basis weight transparent papers known from the prior art. Furthermore, the present fiber-based paper may comprise a low amount of the transparentizing agent in the fiber-based paper but still reach high transparency levels. Furthermore, the present fiber-based paper comprises fibers with a lower refining level than the ones known in the art which enables to lower the energy input for preparing the fiber-based substrate.

**[0016]** More importantly, the fiber-based paper of the present invention is fully recyclable or has a recyclability score of at least 75/100, preferably of at least 80/100, more preferably of at least 90/100, according to CEPI method of 2022. The fiber-based paper according to the invention may also exhibit other advantageous properties, such as a good water repellency, oil or grease resistance, while also having an acceptable water vapour transmission rate, thus making the fiber-based paper of the present invention ideal for packaging applications.

**[0017]** Further features and advantages of the present technology will appear from the following description of some embodiments.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]**

FIGURE 1 is a flow graph showing the different steps of a method (1) for producing at least one transparent area on a fiber-based paper. Step 3 indicates a step of providing or producing a fiber-based substrate, while the other reference numbers indicate the following: Step 5: = applying a transparentizing coating composition → forming a coated fiber-based substrate; step 7 = at least partial drying the coated fiber-based substrate (optional step); step 9 = optional calendering; step 11 = drying; step 13 = rolling.

FIGURE 2 is a photograph of a fiber-based paper having transparent areas in the form of lines.

FIGURE 3 is a photograph of a fiber-based paper having transparent areas in the form of pyramids.

FIGURE 4a is a photograph of a handsheet made with repulped fibers obtained from a sample according to the

invention on a black screen.

FIGURE 4b is a photograph of a handsheet made with repulped fibers obtained from a sample according to the invention under natural light

FIGURE 5a is a photograph of a handsheet made with repulped fibers obtained from a comparative sample on a black screen.

FIGURE 5b is a photograph of a handsheet made with repulped fibers obtained from a comparative sample under natural light.

## EMBODIMENTS

### DEFINITIONS

**[0019]** In the present context, the term "transparent" in connection with a material or an area of a material, such as a fiber-based paper, means that said material or an area thereof has a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard using a test equipment model BCMTS M Type 40605, with Touchscreen M software of the company Frank PTI. This equipment uses a Konica Minolta CM-3630 Spectrophotometer. In order to measure the transparency of the transparent area, said transparent area should cover at least an area comprising a circle of 9 mm of diameter to allow testing.

**[0020]** A "fiber-based paper" includes in particular a paper based on cellulosic fibers or regenerated cellulosic fibers. Cellulosic fibers or cellulose fibers refer to fibers composed of or derived from cellulose. The cellulosic fibers may be selected from the group consisting of kraft pulp fibers, sulfite pulp fibers, chemically treated fibers, mechanically treated pulp fibers, chemi-thermo mechanically treated pulp fibers, regenerated cellulosic fibers and combinations thereof. Advantageously, the use of cellulosic fibers or regenerated cellulosic fibers together with a transparentizing coating composition, which comprises at least one wax having a melting point of at least 70°C, enables the repulpability, recyclability, and/or compostability of the fiber-based paper.

**[0021]** Within the present disclosure, "bio-based" or "biosourced" means that the substance referred to is wholly or partly derived from materials of biological origin. Thus "bio-based products" are products made entirely or in significant part from renewable materials or natural products.

**[0022]** Within the present disclosure, "recyclability score" means that the substance referred to can be repulped and the obtained repulped fibers can be reused in order to form a new paper sheet of a good quality with reference to CEPI method of 2022. More particularly, this recyclability score takes into consideration the amount of fibers recovered, the visual aspect of the paper produced and also the presence or not of stickies. According to this method, the score can vary between -100/100 and 100/100, the higher the score, the better the repulpability and recyclability.

**[0023]** Within the present disclosure, "melting point" is measured by DSC and corresponds to the temperature of the peak maximum.

**[0024]** In the present invention it has been found that by providing a fiber-based substrate comprising a transparentizing coating composition on at least one area of at least one side of the fiber-based substrate, wherein the transparentizing coating composition comprises at least one wax having a melting point of at least 60°C, the fiber-based paper comprising the fiber-based substrate and the transparentizing coating composition achieves a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard. Preferably, the fiber-based paper is recyclable or has a recyclability score of at least 75/100, with reference to CEPI method of 2022.

**[0025]** The fiber-based substrate can be a calendered or an uncalendered fiber-based substrate. Preferably, the fiber-based substrate is an uncalendered fiber-based substrate to facilitate the penetration of the coating composition inside it and also to decrease the energy consumptions of the overall method. However, in some embodiments the fiber-based substrate may be calendered.

**[0026]** According to another embodiment the transparentizing coating composition can be applied on at least one side of the fiber-based substrate during the manufacturing of the same. Furthermore, the fiber-based substrate may have a basis weight of at least 40 g/m<sup>2</sup>, and less than 150 g/m<sup>2</sup>, preferably less than 120 g/m<sup>2</sup>, preferably less than 90 g/m<sup>2</sup>, more preferably less than 80 g/m<sup>2</sup>, still more preferably less than 70 g/m<sup>2</sup>. Any combinations of these end points are also possible (e.g. greater than or equal to 40 g/m<sup>2</sup> and less than or equal to 150 g/m<sup>2</sup>, greater than or equal to 40 g/m<sup>2</sup> and less than or equal to 120 g/m<sup>2</sup>, greater than or equal to 40 g/m<sup>2</sup> and less than or equal to 90 g/m<sup>2</sup>, or also greater than or equal to 40 g/m<sup>2</sup> and less than or equal to 80 g/m<sup>2</sup>). Other ranges are also possible.

**[0027]** The fiber-based substrate comprises at least 60 wt%, preferably at least 70 wt%, more preferably at least 80 wt%, still more preferably at least 95 wt% cellulosic fibers and/or regenerated cellulose fibers, based on the total weight of the fibers forming the fiber-based substrate. According to a preferred embodiment, the cellulosic fibers and/or the regenerated

cellulose fibers have a freeness of at least 30°SR, preferably at least 35°SR, and below 95°SR, preferably below 80°SR, more preferably below 70°SR, using the Schopper-Riegler method. Any combinations of these end points are also possible. Advantageously, the present method works also on fibers with lower refining such as between 40 and 75°SR, other ranges are also possible.

**[0028]** In some embodiments, the at least one transparent area on the fiber-based paper may have a transparency level of at least 70%, preferably of at least 78%, more preferably of at least 82%, more preferably of at least 85%, when measured according to DIN 53147:1993-01 standard. Typically, the at least one transparent area extends on a surface of the fiber-based paper from at least 1%; preferably from at least 5%, more preferably from at least 10%, of the surface of the fiber-based paper to the entire area of the fiber-based paper. According to some specific embodiments, the at least one transparent area has a transparency of at least 70%, preferably at least 80%, more preferably at least 85% when measured according to DIN 53147:1993-01 standard

**[0029]** The transparentizing coating composition comprises at least one wax having a melting point of at least 60°C. In some embodiments, the at least one wax has a melting point in the range of above 60°C, preferably above 65°C, more preferably above 70°C and below 120°C, preferably below 100°C. Any combinations of these end points are also possible, for example the at least one wax may have a melting point comprised between 60°C and 120°C, or between 65°C and 100°C, also between 70°C and 120°C, other ranges are also possible. Waxes having a melting point of at least 60°C enable the transparentizing agent to remain hard at room temperature and also prevent some dusting of the paper machine or roll pollution on machine parts. Preferably, the at least one wax is selected from fully bio-based waxes and/or partially bio-based waxes, more preferably from fully bio-based waxes. Such waxes are renewable and the fiber-based paper comprising said waxes may be recyclable, repulpable and/or compostable. However, in some embodiments also other waxes, such as partially biosourced polyester wax, may be employed.

**[0030]** Examples of waxes having a melting point of at least 60°C include but are not limited to a soy-based wax, rice-based wax, carnauba wax, or a mixture thereof. An example of a suitable mixture of waxes of the above kind is a mixture of soybean wax and rice-based wax, such as rice bran wax. In some embodiments, the wax comprises or consists of a mixture of a soybean wax and rice bran wax, wherein the mixture has a melting point above 60°C. In some embodiment the wax may comprise or consist of carnauba wax having a melting point above 60°C.

**[0031]** The waxes employed in the present fiber-based paper are typically provided in the form of a wax emulsion or a wax dispersion. In some embodiments, the wax is a wax dispersion, typically having a particle size below 15 µm, when measured according to ISO 13320:2020 standard. In some embodiments, the wax is a wax emulsion, typically having a particle size of below 10 µm, preferably below 5 µm, measured according to ISO 13320:2020 standard.

**[0032]** In some embodiments, the transparentizing coating composition comprises a wax having a refractive index between 1.40 and 1.55, when measured at 589 nm. The indicated refractive index values provide a range wherein the reflection of light on and inside the material is minimized. Indeed, the wax should have a refractive index close to the one of the material forming the fiber-based substrate in order to limit the distortion of the light when passing through the fiber-based paper and therefore preventing the loss of light passing through the at least one transparent area on the fiber-based paper.

**[0033]** In embodiments, the transparentizing coating composition is applied on the fiber-based substrate in a dry coat weight of at least 0.05 g/m<sup>2</sup>, preferably at least 0.30 g/m<sup>2</sup>, preferably at least 0.50 g/m<sup>2</sup>, preferably at least 0.70 g/m<sup>2</sup>, preferably at least 1 g/m<sup>2</sup>, preferably at least 1.30 g/m<sup>2</sup>, more preferably at least 1.50 g/m<sup>2</sup> and in a dry coat weight of less than 10 g/m<sup>2</sup>, preferably less than 7 g/m<sup>2</sup>, more preferably less than 5 g/m<sup>2</sup>, still more preferably less than 4 g/m<sup>2</sup>. Any combinations of these end points are also possible, for example in some embodiments, the transparentizing coating composition is applied on the fiber-based substrate in a dry coat weight of between 0.05 and 10 g/m<sup>2</sup>; of between 0.05 and 7 g/m<sup>2</sup>, typically between 0.50 and 5 g/m<sup>2</sup>, preferably between 1 and 4 g/m<sup>2</sup>. Other ranges for the transparentizing coating composition applied on the fiber-based substrate are also possible. The amount of the transparentizing coating composition may thus be reduced compared to the prior art processes, wherein depending on the basis weight and structure of the fiber-based substrate, dry coat weight of over 2 g/m<sup>2</sup> and up to 15 g/m<sup>2</sup> or even more can be recommended.

**[0034]** The transparentizing coating composition may comprise the wax and optionally additives. These additives if present, are present in an amount of less than 20%, preferably less than 10%, preferably less than 5%, more preferably less than 3% based on the total dry weight of the transparentizing coating composition. These additives may comprise rheology modifiers, anti-foam additives, wetting agents, coloring agents such as pigments dyes or oxides, binders, dispersants, lubricants, optical brightening agents, preservatives, or UV stabilizers, in addition to the wax having a melting point of at least 60°C. According to an embodiment, the transparentizing coating composition comprises a coloring agent in addition to the wax in order to produce a colored transparentized area on the fiber-based substrate.

**[0035]** In some embodiments, the transparentizing coating composition represents at most 30 wt% of the dry weight of the fiber-based paper, preferably at most 20 wt%, more preferably at most 10 wt% of the dry weight of the fiber-based paper, and the transparentizing coating composition represents at least 1.5 wt%, preferably at least 3 wt%, more preferably at least 5 wt% of the dry weight of the fiber-based paper. Any combinations of these end points are also possible, the transparentizing coating composition can represent from 1.5 to 30 wt%, more preferably from 3 to 20 wt%, still more

preferably from 3 to 10 wt%, or from 5 to 10 wt% of the dry weight of the fiber-based paper. Other ranges are also possible. As indicated previously, in the case of high grammages of the fiber-based substrate, it is possible to have more than 15 g/m<sup>2</sup> of transparentizing coating composition applied on the fiber-based substrate.

**[0036]** In some embodiments, the wax may be applied on the fiber-based substrate in a dry coat weight of at least 0.05 g/m<sup>2</sup>, preferably at least 0.30 g/m<sup>2</sup>, preferably at least 0.50 g/m<sup>2</sup>, preferably at least 0.70 g/m<sup>2</sup>, preferably at least 1 g/m<sup>2</sup>, preferably at least 1.30 g/m<sup>2</sup>, more preferably at least 1.50 g/m<sup>2</sup> and in a dry coat weight of less than 10 g/m<sup>2</sup>, preferably less than 7 g/m<sup>2</sup>, more preferably less than 5 g/m<sup>2</sup>, still more preferably less than 4 g/m<sup>2</sup>. Any combinations of these end points are also possible, for example in some embodiments, the wax is applied on the fiber-based substrate in a dry coat weight of between 0.05 and 10 g/m<sup>2</sup>; of between 0.05 and 7 g/m<sup>2</sup>, typically between 0.50 and 5 g/m<sup>2</sup>, preferably between 1 and 4 g/m<sup>2</sup>. Other ranges for the amount of wax coated on the fiber-based substrate are also possible. The amount of wax may thus be reduced compared to prior art processed, wherein depending on the basis weight and structure of the fiber-based substrate, dry coat weight of over 2 g/m<sup>2</sup> and up to 15 g/m<sup>2</sup> or even more can be recommended.

**[0037]** In some embodiments, the fiber-based paper may consist or consist essentially of the fiber-based substrate and the transparentizing coating composition.

**[0038]** The fiber-based paper, which comprises the fiber-based substrate and the transparentizing coating composition, may have a basis weight of at least 40.05 g/m<sup>2</sup>, and less than 160 g/m<sup>2</sup>, preferably less than 140 g/m<sup>2</sup>, preferably less than 120 g/m<sup>2</sup>, preferably less than 100 g/m<sup>2</sup>, more preferably less than 80 g/m<sup>2</sup>. Any combinations of these end points are also possible, the fiber-based paper can have a basis weight of between 40.05 g/m<sup>2</sup> and 160 g/m<sup>2</sup>, of between 40.05 g/m<sup>2</sup> and 140 g/m<sup>2</sup>, of between 40.05 g/m<sup>2</sup> and 120 g/m<sup>2</sup>, of between 40.05 g/m<sup>2</sup> and 100 g/m<sup>2</sup>, more preferably of between 40.05 g/m<sup>2</sup> and 80 g/m<sup>2</sup>. Other ranges for the fiber-based paper are also possible.

**[0039]** The fiber-based paper according to the present invention is recyclable or has a recyclability score of at least 75/100, preferably of at least 80/100, more preferably of at least 90/100, according to CEPI method of 2022. In some embodiments, the fiber-based paper may be compostable. In addition, the fiber-based paper provides sufficient mechanical properties for a wide range of applications in terms of for example tearing and burst. Indeed, the fiber-based paper disclosed here-above can have a basis weight sufficiently high to present some mechanical properties (like tear and burst for example) required for its use in several applications as well as the level of transparency needed to enable the end user to see through this fiber-based paper.

**[0040]** The fiber-based paper according to the invention may have a Cobb value of at least 5 g/m<sup>2</sup> for 1 minute and less than 20 g/m<sup>2</sup> for 1 minute when measured according to TAPPI T441 standard. The fiber-based paper according to the invention may have a Cobb value of between 5 and 20 g/m<sup>2</sup> for 1 minute, preferably of between 5 and 15 g/m<sup>2</sup> for 1 minute, more preferably of between 5 and 10 g/m<sup>2</sup> for 1 minute, when measured according to TAPPI T441 standard.

**[0041]** The fiber-based paper according to the invention may have a WVTR (water vapor transmission rate) of less than 350 g/m<sup>2</sup>/24h, preferably of less than 200 g/m<sup>2</sup>/24h, more preferably of less than 100 g/m<sup>2</sup>/24h, more preferably of less than 50 g/m<sup>2</sup>/24h, more preferably of less than 20 g/m<sup>2</sup>/24h, more preferably of less than 10 g/m<sup>2</sup>/24h, still more preferably of less than 5 g/m<sup>2</sup>/24h, when measured according to ISO 2528 standard at 23°C and 85% relative humidity.

**[0042]** Further, the fiber-based paper may have a KIT value of from 2 to 12, preferably from 5 to 12, more preferably from 8 to 12, still more preferably between 10 and 12, when measured according to TAPPI T559 cm-22 standard

**[0043]** Still further, in some embodiments the fiber-based paper may have a Bekk smoothness of at least 5 seconds, preferably at least 15 seconds, preferably at least 30 seconds, more preferably at least 60 seconds, more preferably at least 120 seconds, still more preferably at least 300 seconds, when measured according to TAPPI T479 cm-21 standard.

#### Method of producing the fiber-based paper

**[0044]** As disclosed above, the invention also relates to a method of producing the fiber-based paper of the invention. The method comprises the steps of providing or producing a fiber-based substrate, said fiber-based substrate having a first side and a second side opposite to the first side; and applying a transparentizing coating composition on at least one area of at least one side of the fiber-based substrate to form a fiber-based paper comprising at least one transparent area, wherein the at least one transparent area on the fiber-based paper has a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard, and wherein the transparentizing coating composition comprises at least one wax having a melting point above 60°C.

**[0045]** In embodiments, the method of producing the fiber-based paper comprising at least one transparent area thus comprises a step of providing or producing a fiber-based substrate. The fiber-based substrate has a first side and a second side opposite to the first side. A transparentizing coating composition comprising the at least one wax is applied on at least one area of at least one side of the fiber-based substrate to form a coated fiber-based substrate. Accordingly, the method comprises a step of forming a coated fiber-based substrate. In some embodiments, the coated fiber-based substrate may be calendered to obtain the fiber-based paper with the at least one transparent area having a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard. If needed, the method can further implement a rolling step of the fiber-based paper.

**[0046]** The transparentizing coating composition may comprise the wax and optionally additives. If present, the additives are present in an amount of less than 20%, preferably less than 10%, preferably less than 5%, more preferably less than 3% based on the total dry weight of the transparentizing coating composition. The additives may comprise rheology modifiers, anti-foam additives, wetting agents, coloring agents such as pigments dyes or oxides, binders, dispersants, lubricants, optical brightening agents, preservatives, or UV stabilizers. According to an embodiment, the transparentizing coating composition comprises a coloring agent in addition to the wax in order to produce a colored transparentized area on the fiber-based substrate.

**[0047]** The transparentizing coating composition may be applied by a technique selected from roll-to-roll coating, blade coating, spray coating, Meyer rod coating, air knife coating, direct gravure, offset gravure, reverse gravure, deep coating, smooth roll coating, curtain coating, bead coating, slot coating, twin HSM coating, film press coating, size press coating, and/or transfer film method. Printing technologies, for example flexography, heliography, or inkjet printing, may also be used to deposit the coating. The choice of the coating method can be adjusted by a person skilled in the art depending on the viscosity of the transparentizing coating composition and/or on the type of the fiber-based substrate, including its basis weight, porosity and thickness. In some embodiments, the transparentizing coating composition may be applied by size press coating, which allows to use a minimum amount of coating while ensuring that the penetration of the coating in the depth of the paper is high. In other embodiments, the transparentizing coating composition can be applied by direct gravure, reverse gravure or blade coating.

**[0048]** When the method comprises a calendaring step, said calendaring step is performed after the step of applying the transparentizing coating composition and preferably at a temperature which is higher than the melting temperature of the wax.

**[0049]** The method of the invention may also comprise an at least partial drying step of the coated fiber-based substrate before the optional calendaring step. This at least partial drying step can be performed by gravity or heating. In case this partial drying is performed by heat, it can decrease the viscosity of the transparentizing coating composition and facilitate the penetration of the transparentizing coating composition in the fiber-based substrate.

**[0050]** With reference to Figure 1, this one shows a flow chart illustrating a method of producing at least one transparent area 1 on a fiber-based paper. First, the method of the invention for producing at least one transparent area on a fiber-based paper comprises a step of providing or producing a fiber-based substrate 3. The fiber-based substrate has a first side and a second side opposite to the first side. A transparentizing coating composition comprising at least one wax having a melting point above 60°C is applied on at least one area of at least one side of the fiber-based substrate to form a coated fiber-based substrate. Accordingly, the method 1 comprises a step of forming a coated fiber-based substrate 5. The coated fiber-based substrate is then at least partially dried during an at least partially drying step 7 to obtain the fiber-based paper with at least one transparent area of at least 60% when measured according to DIN 53147:1993-01 standard. If needed, the method can further implement a rolling step 13 of the fiber-based paper.

**[0051]** According to a preferred embodiment, the coated fiber-based substrate after the at least partial drying step 7 contains at most 20 wt% water, preferably at most 10 wt% water, most preferably at most 7 wt%.

**[0052]** Optionally, the coated fiber-based substrate can be calendered during a calendaring step 9. This calendaring step 9 is preferably performed just after the step of at least partially drying the coated fiber-based substrate 7. If the coated fiber-based substrate is still wet after the calendaring step 9, the method can implement a drying step 11 in order to dry the fiber-based paper comprising the at least one transparent area before the rolling step 13.

**[0053]** According to a specific embodiment, if this calendaring step 9 is performed, it is preferable that the coated fiber-based substrate is quite dried. The inventors surprisingly found that having a water content of at most 20 wt% based on the total weight of the coated fiber-based substrate prevents breaks during the calendaring step 9. According to this specific embodiment, there is no need to implement the drying step 11 before the rolling step 13.

**[0054]** The inventors surprisingly found that the calendaring step 9 further improves the transparency of the at least one transparent area of the fiber-based paper.

**[0055]** The transparentizing coating composition is applied on at least one area of at least one side of the fiber-based substrate. The transparentizing coating composition may also be applied on the entire area of at least one side of the fiber-based substrate. The transparentizing coating composition may also be applied on at least one area of both sides (the first and second sides) of the fiber-based substrate. In some embodiments the transparentizing coating composition may be applied on the entire area of both sides of the fiber-based substrate. However, applying a transparentizing coating composition on one side of the fiber-based substrate, either on at least one area or on the entire area of the fiber-based substrate, already provides good results in terms of transparency. The at least one area on which the transparentizing coating composition is applied covers a surface of the fiber-based substrate from at least 1%, preferably from at least 5%, more preferably from at least 10% of the surface of the fiber-based substrate, to the entire area of the fiber-based substrate to form an at least one transparent area on the fiber-based paper.

**[0056]** Preferably, the method is performed on-line on a paper machine. In some embodiments, the method is performed on-line directly after the production of a paper web on the paper machine. According to another embodiment, the transparentizing coating composition can be provided on an already produced fiber-based substrate to enhance its

transparency.

[0057] With reference to Figures 2 and 3, there are represented two pictures showing a fiber-based paper 20 comprising at least one transparent area 21 and at least one non-transparent area 23. The fiber-based substrate used for the preparation of these samples of fiber-based paper 20 had an original transparency of 59%, corresponding also to the transparency of the non-transparent areas 23 as well. The transparentizing coating composition comprises a biobased wax (made of a blend of soybean wax and rice bran wax) having a melting point of about 70°C and a refractive index of 1.53 was applied to the fiber-based substrate by a direct roll gravure technique in order to enable the formation of several transparent areas 21 having different shapes on the fiber-based substrate.

[0058] More particularly, Figure 2 shows a picture of a fiber-based paper 20 holding transparent areas 21 in the form of lines. The transparentizing coating composition was applied on the fiber-based substrate in an amount such that it is present in the transparentized areas 21 of the fiber-based paper 20 in a dry coat weight of 1.9 g/m<sup>2</sup>. After the coating of transparentizing coating composition, the transparency of the transparent area 21 is of 70% when measured according to DIN 53147:1993-01 standard. Each line forming a transparent area 21 extends on a surface of approximately 5% of the total surface of the fiber-based substrate. In order to further improve the transparency of the transparent areas 21, the fiber-based paper has been calandered using a pressure of 300 kN/m and a temperature of 120°C. After this calendaring step, the transparent areas 21 of the fiber-based paper have a transparency level of 78% when measured according to DIN 53147:1993-01 standard.

[0059] Figure 3 shows a picture of a fiber-based paper 20 holding transparent areas 21 in the form of pyramids. The transparentizing coating composition was applied on the fiber-based substrate in an amount such that it is present in the transparentized area 21 of the fiber-based paper 20 in a dry coat weight of 1.5 g/m<sup>2</sup>. After the coating of transparentizing coating composition, the transparency of the transparent area 21 is of 69% when measured according to DIN 53147:1993-01 standard. Each pyramid forming a transparent area 21 extends on a surface of approximately 1% of the total surface of the fiber-based substrate. In order to further improve the transparency of the transparent areas 21, the fiber-based paper has been calandered using a pressure of 300 kN/m and a temperature of 120°C. After this calendaring step, the transparent areas 21 of the fiber-based paper have a transparency level of 77% when measured according to DIN 53147:1993-01 standard.

[0060] It is to be understood that the embodiments of the invention disclosed are not limited to the particular structures, process steps, or materials disclosed herein, but are extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting.

[0061] Reference throughout this specification to one embodiment or an embodiment means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Where reference is made to a numerical value using a term such as, for example, about or substantially, the exact numerical value is also disclosed.

[0062] As used herein, a plurality of items, structural elements, compositional elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a de facto equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary. In addition, various embodiments and example of the present invention may be referred to herein along with alternatives for the various components thereof. It is understood that such embodiments, examples, and alternatives are not to be construed as de facto equivalents of one another, but are to be considered as separate and autonomous representations of the present invention.

[0063] Furthermore, the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. In the following description, numerous specific details are provided, such as examples of lengths, widths, shapes, etc., to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of the invention.

## EXPERIMENTAL

### Measurement methods

[0064]

Grammage or basis weight: ISO 536 standard

Thickness: ISO 534 standard

Transparency: DIN 53147:1993-01 standard using a test equipment model BCMTS M Type 40605, with Touchscreen M software of the company Frank PTI. This test equipment uses a Konica Minolta CM-3630 Spectrophotometer. In order to measure the transparency of the transparent area, said transparent area should cover at least an area comprising a circle of 9 mm of diameter to allow testing.

Pulp freeness: Schopper-Riegler method and Schopper-Riegler (SR) freeness tester

Refractive index: ISO 489:2022: Plastics - Determination of refractive index

Cobb: TAPPI T441 standard

WVTR: ISO 2528 standard at 23°C and 85% relative humidity

KIT (grease resistance): TAPPI T559 cm-22 standard

Base paper

**[0065]** In the following examples, different fiber-based substrates have been used, said fiber-based substrate comprising cellulosic fibers and/or regenerated cellulose fibers. More particularly, the following fiber-based substrate have been used:

- A corresponds to a cellulosic based substrate comprising 83% softwood fibers and 17% hardwood fibers refined at a level of 70°SR, having a basis weight of 40 g/m<sup>2</sup> and having an initial level of transparency of 59% when measured according to DIN 53147:1993-01 standard
- B corresponds to a cellulosic based substrate comprising 85% softwood and 15% hardwood fibers refined at a level of 85°SR, having a basis weight of 40 g/m<sup>2</sup> and having a transparency of 82% when measured according to DIN 53147:1993-01 standard
- C corresponds to a cellulosic based substrate comprising 100% softwood fibers refined at a level of 72°SR and which is further supercalendered. This fiber-based has a basis weight of 64 g/m<sup>2</sup> and an initial transparency of this fiber-based substrate is of 51.4% when measured according to DIN 53147:1993-01

Waxes

**[0066]** The following transparentizing coating compositions were used:

- Y corresponds to a natural wax (blend of soybean wax and rice bran wax) having a melting temperature of 70°C and a refractive index of 1.53; and
- Z corresponds to a natural wax (soy wax) having a melting temperature of about 44.5°C and a refractive index of 1.45.

**Example 1:** Grammage and fiber composition of the fiber-based substrate

**[0067]** In some embodiments, where the effect of change in grammage, fiber composition and calendering of the fiber-based substrate was tested in the present method, the at least one transparent area on the fiber-based paper may have transparency levels indicated in Table 1.

**[0068]** After coating, the fiber-based substrates were calendered at 140°C, pressure 100 kN/m, speed 5 m/min on a laboratory calender.

**[0069]** The results in Table 1 show that fiber-based substrates having a relatively high grammage (such as 64 g/m<sup>2</sup>) when coated with a low amount of a transparentizing coating composition (such as 1.7 g/m<sup>2</sup>) and subsequently calendered, resulted in transparent areas having a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard. More particularly, Table 1 shows an increase of the transparency of about 30% even with a fiber-based substrate having a grammage of more than 60 g/m<sup>2</sup>.

**[0070]** Furthermore, Table 1 shows that it is also possible to further increase the transparency of an already transparent paper (transparency of more than 80%) to reach a transparency close to 90%.

Table 1. Grammage and composition of base paper

| Substrate | Grammage substrate (g/m <sup>2</sup> ) | Transparency substrate (%) | Chemistry | Dry coat weight of transparentizing coating composition (g/m <sup>2</sup> ) | Coating technique | Transparency coated substrate (%) | Transparency fiber-based paper (after calendering) (%) | Transparency evolution between coated substrate and fiber-based paper (%) | Transparency evolution between substrate and fiber-based paper (%) |
|-----------|----------------------------------------|----------------------------|-----------|-----------------------------------------------------------------------------|-------------------|-----------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------|
| A (NC)    | 40                                     | 59                         | NA        | NA                                                                          | NA                | NA                                | NA                                                     | NA                                                                        | NA                                                                 |
| C (NC)    | 64                                     | 51.4                       | NA        | NA                                                                          | NA                | NA                                | NA                                                     | NA                                                                        | NA                                                                 |
| C (NC)    | 64                                     | 51.4                       | Z         | 1.7                                                                         | Size Press        | 59.1                              | 63.1                                                   | 7                                                                         | 23                                                                 |
| A (NC)    | 40                                     | 59                         | Y         | 2.8                                                                         | Size Press        | 71.4                              | 82.8                                                   | 16                                                                        | 40                                                                 |
| A (NC)    | 40                                     | 59                         | Y         | 2.6                                                                         | Hand-Coater       | 74.8                              | 86.9                                                   | 16                                                                        | 47                                                                 |
| B (C)     | 40                                     | 81.8                       | Y         | 4.6                                                                         | Hand-Coater       | 85.98                             | 88.6                                                   | 3                                                                         | 8                                                                  |

**Example 2:** Change in dry coat weight

**[0071]** The influence of the coat weight of the transparentizing coating composition has also been investigated and the results are presented in Table 2.

**[0072]** This table shows that at least with transparentizing coating composition Y the coat weight can be very low (as low as 2.3 g/m<sup>2</sup>) in order to reach a transparency of the fiber-based substrate of at least 80% when measured according to DIN 53147:1993-01 standard. For these examples, the coated fiber-based substrates have been calendered at a pressure of 300 kN/m and at a temperature of 120°C.

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Table 2. Change in coat weight

| Substrate | Gramma<br>ge<br>substrate<br>(g/m <sup>2</sup> ) | Transparency<br>substrate (%) | Chemistry | Dry coat weight<br>of<br>transparentizing<br>coating<br>composition<br>(g/m <sup>2</sup> ) | Transparency<br>coated<br>substrate (%) | Transparency<br>evolution<br>between<br>substrate and<br>coated<br>substrate (%) | Transparency<br>fiber-based<br>paper (after<br>calendering)<br>(%) | Transparency<br>evolution<br>between coated<br>substrate and<br>fiber-based<br>paper (%) | Transparency<br>evolution<br>between<br>substrate and<br>fiber-based<br>paper (%) | Starting mate-<br>rial |
|-----------|--------------------------------------------------|-------------------------------|-----------|--------------------------------------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------|
| A (NC)    | 40                                               | 59                            | NA        | NA                                                                                         | NA                                      | NA                                                                               | NA                                                                 | NA                                                                                       | NA                                                                                | Starting mate-<br>rial |
| A (NC)    | 40                                               | 59                            | Y         | 9,6                                                                                        | 78,5                                    | 33                                                                               | 86,6                                                               | 10                                                                                       | 47                                                                                | Experimental           |
| A (NC)    | 40                                               | 59                            | Y         | 5,9                                                                                        | 77,1                                    | 31                                                                               | 87,3                                                               | 13                                                                                       | 48                                                                                |                        |
| A (NC)    | 40                                               | 59                            | Y         | 4,8                                                                                        | 75,2                                    | 27                                                                               | 87,7                                                               | 17                                                                                       | 49                                                                                |                        |
| A (NC)    | 40                                               | 59                            | Y         | 2,6                                                                                        | 74,8                                    | 27                                                                               | 86,9                                                               | 16                                                                                       | 48                                                                                |                        |
| A (NC)    | 40                                               | 59                            | Y         | 2,6 + 2,6                                                                                  | 79,6                                    | 35                                                                               | 87,7                                                               | 10                                                                                       | 49                                                                                |                        |
| A (NC)    | 40                                               | 59                            | Y         | 2,3                                                                                        | 71,9                                    | 22                                                                               | 84,05                                                              | 17                                                                                       | 42                                                                                |                        |

**Example 3:** Recyclability and fiber recovery test and barrier properties of the fiber-based paper

**[0073]** In the following example, the recyclability and more particularly the recyclability score yield of the fiber-based papers have been tested according to CEPI method of 2022. According to this CEPI method of 2022, the fiber-based papers (containing the fiber-based substrate and the transparentizing coating composition) are dispersed in water at about 45°C under stirring at 10600 rpm for 10 minutes (repulped) and handsheets are then prepared with the collected fibers in order to determine if these collected fibers are reusable for making new paper substrates. Typically, this method enables to determine if the transparentizing coating composition is removed from the fibers forming the fiber-based papers.

**[0074]** For this example, fiber-based substrate A has been used. This fiber-based substrate has a Cobb 1 min of 21.9 g/m<sup>2</sup> when measured according to TAPPI T441 standard, a water vapor transmission rate of 1256 g/m<sup>2</sup>/24h when measured according to ISO 2528 standard at 23°C and a relative humidity of 85%, and a KIT value of 0 when measured according to TAPPI T559 cm-22 standard. The coating amounts and results are presented in Table 3 below.

**[0075]** The obtained fiber-based papers presented in Table 3 have then been calendered with one nip at a pressure 3000 daN, a temperature of 120°C and at a speed of 5 m/min. The recyclability score of these calendered fiber-based papers has then been determined. The results are presented in Table 4 below.

Table 3.

| Sample       | Base substrate | Grammage base substrate (g/m <sup>2</sup> ) | Wax | Dry coat weight of transparentizing coating composition (g/m <sup>2</sup> ) | Percentage of transparentizing coating composition in the fiber-based paper | Coating method | Transparency coated base substrate (%) | Transparency evolution between base substrate and coated base substrate (%) | Cobb 1 min coated base substrate (g/m <sup>2</sup> ) | WVTR coated base substrate (23°C, 85% RH) (g/m <sup>2</sup> /24h) | KIT coated base substrate (Grease resistance) |
|--------------|----------------|---------------------------------------------|-----|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------|----------------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------|
| Raw material | A (NC)         | 40                                          | NA  | NA                                                                          | NA                                                                          | NA             | NA                                     | NA                                                                          | NA (initial: 21.9)                                   | NA (initial: 1256)                                                | 0                                             |
| Inventive 1  | A (NC)         | 40                                          | Y   | 3,5                                                                         | 8,04                                                                        | Size press     | 72,6                                   | 23,05                                                                       | 15,2                                                 | 165                                                               | 12                                            |
| Inventive 2  | A (NC)         | 40                                          | Y   | 3,5                                                                         | 8,04                                                                        | Hand-coater    | 77,4                                   | 31,19                                                                       | 15,6                                                 | 327                                                               | 12                                            |
| Comparative  | A (NC)         | 40                                          | Z   | 3,1                                                                         | 7,19                                                                        | Hand-coater    | 75,1                                   | 27,29                                                                       | 18,1                                                 | 693                                                               | 0                                             |

Table 4

|              | Transparency<br>fiber-based<br>paper (after<br>calendering)<br>(%) | Transparency<br>evolution<br>between<br>coated<br>substrate and<br>fiber-based<br>paper (%) | Transparency<br>evolution<br>between<br>substrate and<br>fiber-based<br>paper (%) | Cobb 1<br>min<br>fiber-<br>based<br>paper<br>(g/m <sup>2</sup> ) | WVTR<br>fiber-based<br>paper<br>(23°C, 85%<br>RH)<br>(g/m <sup>2</sup> /24h) | KIT fiber-<br>based<br>paper<br>(Grease<br>resistance) | Sheet<br>adhesion | Visual<br>impurities | Repulpability<br>(%)                                                  | Recyclability<br>Score fiber-<br>based paper |
|--------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------|-------------------|----------------------|-----------------------------------------------------------------------|----------------------------------------------|
| Raw material | NA                                                                 | NA                                                                                          | NA                                                                                | NA (in-<br>ital:<br>21,9)                                        | 1029                                                                         | 0                                                      | Level 1           | Level 1              | 99,9                                                                  | 99,9/100                                     |
| Inventive 1  | 82,8                                                               | 14                                                                                          | 32,9                                                                              | 14,9                                                             | 139                                                                          | 10                                                     | Level 1           | Level 1              | 99,9                                                                  | 99,9/100                                     |
| Inventive 2  | 83,3                                                               | 8%                                                                                          | 41%                                                                               | 15,4                                                             | 248                                                                          | 10                                                     | Level 1           | Level 1              | 99,9                                                                  | 99,9/100                                     |
| Comparative  | 83,1                                                               | 11%                                                                                         | 34%                                                                               | 20,9                                                             | 504                                                                          | 0                                                      | Level 1           | Level 4              | 99.9 (pollu-<br>tion of dish-<br>tegrator and<br>sieves -- ><br>Fail) | 69,9/100                                     |

[0076] As can be seen from Table 3, the use of a transparentizing coating composition comprising a wax enables the improvement of the transparency of the fiber-based substrate. In particular, the use of a wax having a melting point of 70°C in the transparentizing coating composition enabled the development of water vapor barrier properties as well as the grease barrier properties in the fiber-based paper. On the other hand, the use of a wax having a melting point of 44.5°C in the transparentizing coating composition did not allow any improvement of the grease barrier properties (shown by the KIT test result) and the water vapor transmission rate remains quite high.

[0077] As can be seen from Table 4, the calendaring of the samples enabled a further improvement of the transparency of the fiber-based paper and also for the water barrier properties (shown by the decrease of the Cobb 1 min) and as well as for the water vapor barrier properties. Furthermore, the comparative fiber-based paper did not develop any grease barrier property with the calendaring of same.

[0078] Inventors surprisingly found that the use of a transparentizing coating composition comprising a wax having a melting point of at least 70°C enabled to have fiber-based papers having a recyclability scores according to CEPI method of 2022.

[0079] Figures 4a and 4b represent pictures of handsheets 30 prepared with repulped fibers obtained from the inventive fiber-based paper. As better seen on Figure 4b, no pollution in the handsheet is seen, which means that the wax used in the transparentizing coating composition was removed from the fibers during the repulping process. Without wishing to be bound by theory, the inventors believe that using a wax having a melting temperature above the temperature of the water used for the repulping of the paper (70°C according to the inventive examples) in the transparentizing coating composition prevented the melting of the wax during this repulping process, said wax being extracted from the fibers as particles under the stirring conditions used during the repulping step. Therefore, according to the CEPI method of 2022, the visual aspect of this handsheet had a level of 1, having no impact on the recyclability score and enabling the inventive examples to have a recyclability score of 99.9/100 according to the CEPI method of 2022.

[0080] Figures 5a and 5b represent pictures of handsheets 30 prepared with repulped fibers obtained from the comparative example. As better seen on Figure 5b, the produced handsheet contained a lot of wax residues 31 causing a pollution of the handsheet. This means that some wax used in the transparentizing coating composition was not removed during the repulping step and stick to the fibers. Therefore, according to the CEPI method of 2022, the visual aspect of this handsheet had a level of 4, having an impact of minus thirty (-30) on the recyclability score. This comparative example had thus a recyclability score of 69.9/100 only according to CEPI method of 2022.

[0081] Furthermore, with the transparentizing coating composition comprising the wax having a melting point of 44.5°C, the wax polluted the repulping equipment. This pollution factor is not taken into consideration by the CEPI method of 2022 however the use of such transparentizing coating composition comprising low melting temperature waxes, with melting temperatures which are below or close to the typical temperature of the water used for the repulping of the fiber-based paper, will impact the repulping process as it will require long cleaning times after the repulping step.

[0082] While the forgoing examples are illustrative of the principles of the present invention in one or more particular applications, it will be apparent to those of ordinary skill in the art that numerous modifications in form, usage and details of implementation can be made without the exercise of inventive faculty, and without departing from the principles and concepts of the invention. Accordingly, it is not intended that the invention be limited, except as by the claims set forth below.

[0083] The verbs "to comprise" and "to include" are used in this document as open limitations that neither exclude nor require the existence of also un-recited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated. Furthermore, it is to be understood that the use of "a" or "an", that is, a singular form, throughout this document does not exclude a plurality.

#### INDUSTRIAL APPLICABILITY

[0084] At least some embodiments of the present invention find industrial application in in packaging applications, including food packaging and non-food packaging, as well as in office tape base papers, transparent release liners, cosmetic wraps, cloth bags, protective sheets, lids, envelope windows and more.

#### CITATION LIST

Patent Literature:

#### [0085]

EP 4471207 A1  
EP 4471210 A1  
US 2024/0401276 A1

US 2024/0401280 A1  
WO 2024024896 A1

## Claims

1. A fiber-based paper comprising at least one transparent area, wherein the fiber-based paper comprises:
  - a fiber-based substrate, the fiber-based substrate having a first side and a second side opposite to the first side;
  - a transparentizing coating composition on at least one side of the fiber-based substrate;
 wherein the at least one transparent area has a transparency level of at least 60%, when measured according to DIN 53147:1993-01 standard, and wherein the transparentizing coating composition comprises at least one wax having a melting point of at least 60°C.
2. The fiber-based paper according to any one of the preceding claims, which has a recyclability score of at least 75/100, preferably of at least 80/100, more preferably of at least 90/100 according to CEPI method of 2022.
3. The fiber-based paper according to any one of the preceding claims, wherein the at least one transparent area has a transparency level of at least 70%, preferably of at least 78%, more preferably at least 82%, when measured according to DIN 53147:1993-01 standard.
4. The fiber-based paper according to any one of the preceding claims, wherein the at least one wax has a melting point in the range of above 60°C, preferably above 65°C, more preferably above 70°C and below 120 °C, preferably below 100 °C.
5. The fiber-based paper according to any one of the preceding claims, wherein the transparentizing coating composition comprises a wax having a refractive index between 1.40 and 1.55, when measured at 589 nm.
6. The fiber-based paper according to any one of the preceding claims, wherein the wax is a soy-based wax, rice-based wax, carnauba wax, or a mixture thereof.
7. The fiber-based paper according to any one of the preceding claims, wherein the fiber-based substrate has a basis weight of at least 40 g/m<sup>2</sup>, and less than 150 g/m<sup>2</sup>, preferably less than 120 g/m<sup>2</sup>, preferably less than 90 g/m<sup>2</sup>, more preferably less than 80 g/m<sup>2</sup>, still more preferably less than 70 g/m<sup>2</sup>.
8. The fiber-based paper according to any one of the preceding claims, wherein the fiber-based substrate comprises at least 60 wt%, preferably at least 70 wt%, preferably at least 80 wt%, more preferably at least 95 wt%, cellulosic fibers and/or regenerated cellulose fibers, based on the total weight of the fibers forming the fiber-based substrate.
9. The fiber-based paper according to claim 8, wherein the cellulosic fibers and/or regenerated cellulose fibers have a freeness of at least 30°SR, preferably at least 35°SR, and below 95°SR, preferably below 80 °SR, more preferably below 70°SR, using the Schopper-Riegler method.
10. The fiber-based paper according to any one of the preceding claims, wherein the transparentizing coating composition is applied on the fiber-based substrate in a dry coat weight of at least 0.05 g/m<sup>2</sup>, preferably at least 0.30 g/m<sup>2</sup>, preferably at least 0.50 g/m<sup>2</sup>, preferably at least 0.70 g/m<sup>2</sup>, preferably at least 1 g/m<sup>2</sup>, preferably at least 1.30 g/m<sup>2</sup>, more preferably at least 1.50 g/m<sup>2</sup> and in a dry coat weight of less than 10 g/m<sup>2</sup>, preferably less than 7 g/m<sup>2</sup>, more preferably less than 5 g/m<sup>2</sup>, still more preferably less than 4 g/m<sup>2</sup>.
11. The fiber-based paper according to any one of the preceding claims, wherein the transparentizing coating composition represents at most 30 wt% of the dry weight of the fiber-based paper, preferably at most 20 wt%, more preferably at most 10 wt% of the dry weight of the fiber-based paper, and the transparentizing coating composition represents at least 1.5 wt%, preferably at least 3 wt%, more preferably at least 5 wt% of the dry weight of the fiber-based paper.
12. The fiber-based paper according to any one of the preceding claims, consisting or consisting essentially of the fiber-based substrate and the transparentizing coating composition.

13. The fiber-based paper according to any one of the preceding claims, wherein it has a basis weight of at least 40.05 g/m<sup>2</sup>, and less than 160 g/m<sup>2</sup>, preferably less than 140 g/m<sup>2</sup>, preferably less than 120 g/m<sup>2</sup>, preferably less than 100 g/m<sup>2</sup>, more preferably less than 80 g/m<sup>2</sup>.

14. The fiber-based paper according to any one of the preceding claims, wherein the at least one transparent area extends on a surface of the fiber-based paper from at least 1%, preferably at least 5%, more preferably from at least 10% of the surface of the fiber-based paper to the entire area of the fiber-based paper.

15. A method of producing the fiber-based paper according to any one of claims 1 to 14, comprising the steps of:

- providing or producing a fiber-based substrate, said fiber-based substrate having a first side and a second side opposite to the first side;

- applying a transparentizing coating composition on at least one area of at least one side of the fiber-based substrate to form a fiber-based paper comprising at least one transparent area;

wherein the at least one transparent area on the fiber-based paper has a transparency level of at least 60% when measured according to DIN 53147:1993-01 standard; and

wherein the transparentizing coating composition comprises at least one wax having a melting point above 60°C.

16. The method according to claim 15, wherein the transparentizing coating composition comprises the wax and optionally additives, said additives being present in an amount of less than 20%, preferably less than 10%, preferably less than 5%, more preferably less than 3% based on the total dry weight of the transparentizing coating composition.

17. The method according to any one of claims 15 or 16, wherein the transparentizing coating composition is applied on the fiber-based substrate by a technique selected from roll-to-roll coating, blade coating, spray coating, Meyer rod coating, air knife coating, direct gravure, offset gravure, reverse gravure, deep coating, smooth roll coating, curtain coating, bead coating, slot coating, twin HSM coating, film press coating, size press coating, and/or transfer film method.

18. The method according to any one of claims 15 to 17, wherein it further comprises a calendaring step, said calendaring step being performed after the step of applying the transparentizing coating composition and being preferably performed at a temperature which is higher than the melting temperature of the wax.

19. Use of the fiber-based paper according to any one of claims 1 to 14 in packaging applications.

- 1: Method of producing at least one transparent area
- 3: Providing or producing a fiber-based substrate
- 5: Applying a coating composition -> forming a coated fiber-based substrate
- 7: At least partially drying the coated fiber-based substrate (optional)
- 9: Calendering
- 11: Drying
- 13: Rolling

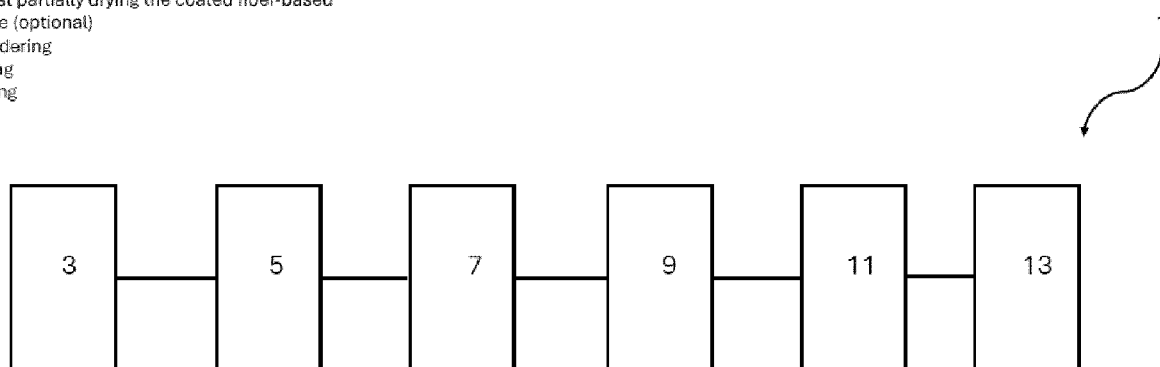
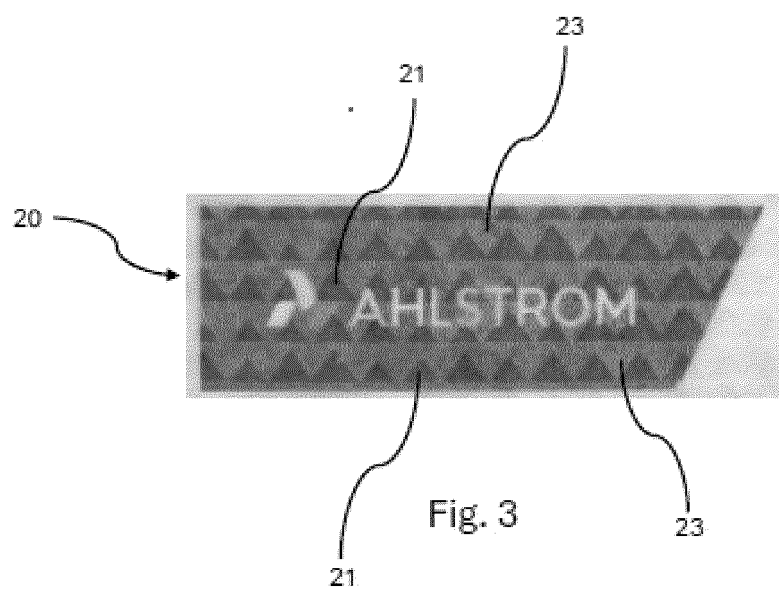
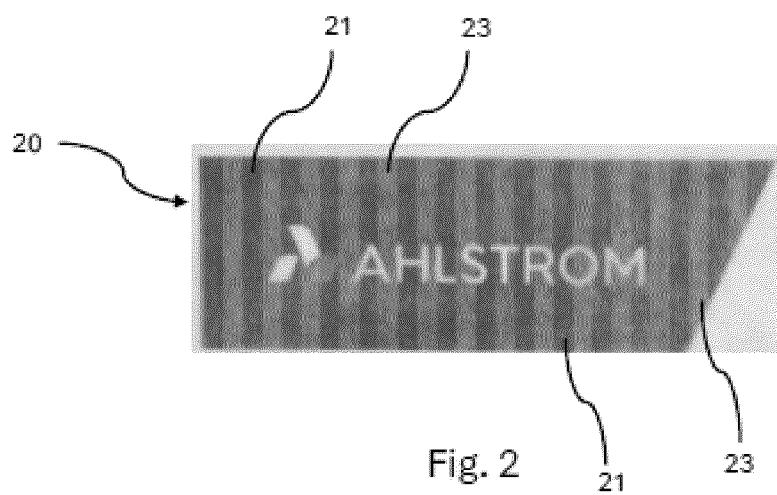


Fig. 1



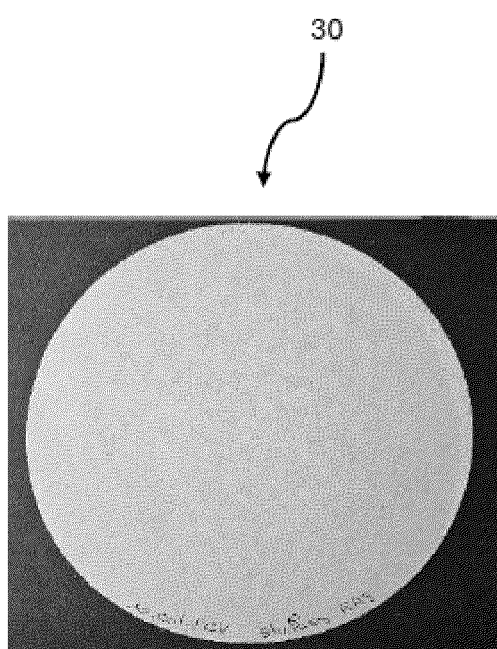


Fig. 4a

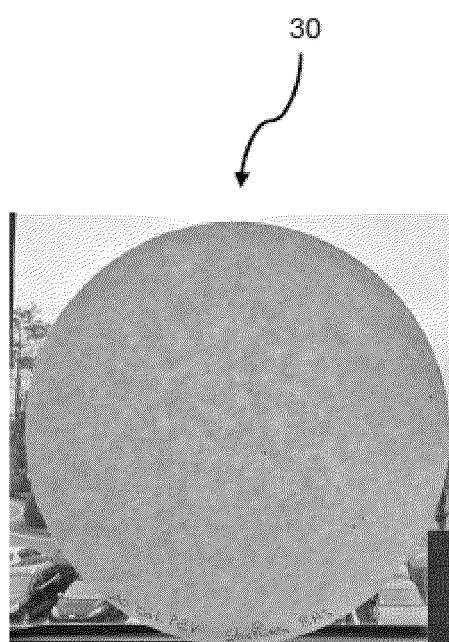


Fig. 4b

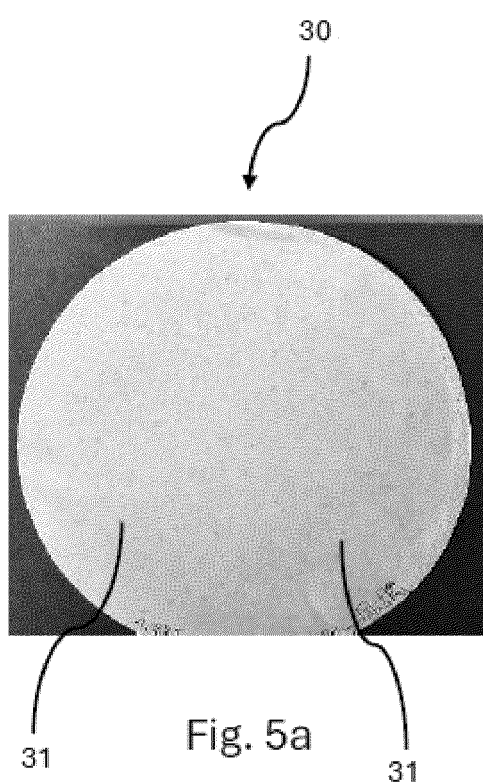


Fig. 5a

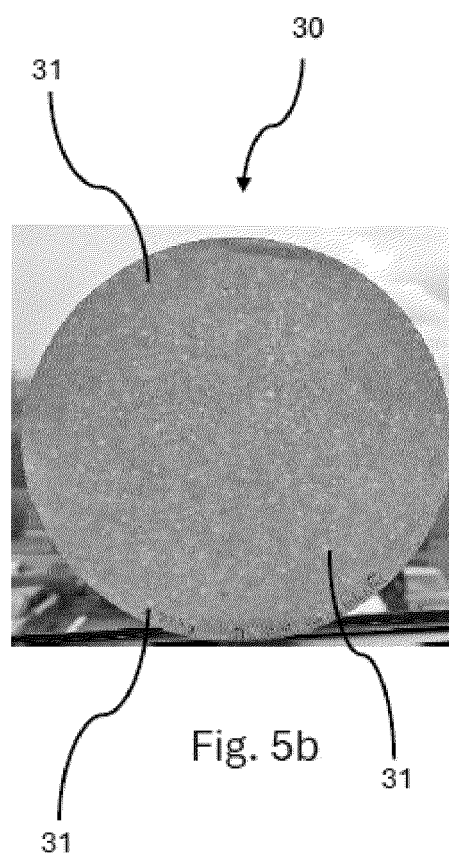


Fig. 5b



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| Place of search                                                                                                                                                                                                         | Date of completion of the search                                                                                                                                                                                                                                                                                                         | Examiner                                                                                                                                                                                                                                                                              |                                                          |
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| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                       |                                                          |



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| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                       |                                         |

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