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(54) PAPER FOR FLOW WRAPPING PROCESS

PAPIER FÜR SCHLAUCHBEUTELVERPACKUNGSVERFAHREN

PAPIER POUR UN PROCESSUS D'EMBALLAGE EN FLUX

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Description**TECHNICAL FIELD**

5 **[0001]** The present disclosure relates to the field of paper-based materials.

BACKGROUND

10 **[0002]** Flow wrapping is a horizontal-motion process in which products of any shape are wrapped in a wrapping material. It is used to pack single solid items, such as confectionery bars or multiple products already collated in trays. Traditionally, the wrapping material has been a clear plastic film or a printed opaque plastic film. The package resulting from the flow wrapping process has a longitudinal fin seal and end fin seals. The longitudinal fin seal is typically folded over so that the fin lies flat on the backside wall of the package rather than projecting from it.

15 **SUMMARY**

[0003] The present disclosure aims to provide a paper-based material that can replace plastic films in flow wrapping processes. The inventors have realized that such a paper-based material, to be commercially successful, should meet the majority, preferably all, of the following criteria:

- 20
- ductility of the coating, i.e. cracking resistance during processing or usage;
 - minor or even non-existing blocking during processing;
 - 25 - providing a grease barrier (preventing fat from the packed/wrapped product from staining and/or weakening the paper-based material);
 - recyclable according to applicable standards;
 - 30 - protecting the packed/wrapped product from ambient moisture;
 - heat-sealable so that a flow wrapping package can be produced without further sealant layers;
 - satisfactory printability when using existing printing technology; and
 - 35 - acceptable cost of production, preferably on existing machinery or requiring only minor investments in new equipment.
 - sealant layer adhesion (i.e. capable of binding a sealant composition applied in a high-speed process).

40 **[0004]** Accordingly, the present disclosure provides the following listing of itemized embodiments:

1. A coated paper product for use in a flow wrapping process comprising:

- 45
- a paper substrate comprising a first and second side;
 - a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises ethylene-acrylic acid (EAA) or vinyl acetate acrylate copolymer (VAcA) or styrene-acrylate (SA); and
 - 50 - a second coating layer on the first coating layer, wherein the second coating layer comprises EAA and talc, and wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:5 and 100:100;
 - wherein the coat weight of the first coating layer is 4-10 g/m²,
 - wherein the coat weight of the second coating layer is 3-9 g/m² . and
 - 55 - the grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m².

2. The coated paper product of any one of the preceding items, wherein the grammage measured according to ISO

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536:2020 of the paper substrate is 42-55 g/m².

3. The coated paper product of any one of the preceding items, wherein the grammage measured according to ISO 536:2020 of the coated paper product is 52-71 g/m², such as 56-68 g/m².

4. The coated paper product of any one of the preceding items, wherein the paper substrate is a machine-glazed (MG) kraft paper.

5. The coated paper product of item 4, wherein the first side of the paper substrate is the non-glazed side of the MG paper and wherein the glazed side is optionally printed.

6. The coated paper product of item 4 or 5, wherein the Bendtsen roughness according to ISO 8791-2:2013 of the glazed side of the paper substrate is below 90 ml/min, preferably 70 ml/min or lower, more preferably below 55 ml/min.

7. The coated paper product of items 4-6, wherein the Bendtsen roughness according to ISO 8791-2:2013 of the glazed side of the coated paper product is below 90 ml/min, preferably 70 ml/min or lower, more preferably below 55 ml/min.

8. The coated paper product of items 4-7, wherein the PPS roughness according to ISO 8791-4:2007 of the glazed side of the coated paper product is below 6.00 µm, such as below 5.00 µm, such as below 4.00 µm.

9. The coated paper product of any one of the preceding items, wherein at least 80 dry wt.% of the fibres used to form the paper substrate are never-dried.

10. The coated paper product of any one of the preceding items, wherein the first coating layer comprises talc and/or calcium carbonate (CaCO₃).

11. The coated paper product of item 9, wherein the first coating comprises talc in a EAA or VAcA or SA to talc ratio between 100:30 and 100:110, such as between 100:30 and 100:75 or CaCO₃ in a EAA or VAcA or SA to CaCO₃ ratio between 100:20 and 100:70, such as between 100:30 and 100:65.

12. The coated paper product of any one of the preceding items, wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:5 and 100:70, such as 100:10 and 100:60, such as 100:15 and 100:60, such as 100:15 and 100:40.

13. The coated paper product of any one of the preceding items, wherein the paper product is heat-sealable.

14. The coated paper product of item 13, wherein the maximum heat seal strength measured according to ASTM F88 & EN 868-5 of the coated paper product is at least 2.8 N measured on a 15 mm test strip sealed for 0.5 s at 160 °C and 3 bar.

15. The coated paper product of any of the preceding items, wherein the first and/or second coating layer comprises clay, such as kaolin clay.

16. The coated paper product of item 15, wherein the clay is a platy clay, preferably having a form factor of at least 20, such as at least 30, such as at least 40.

17. The coated paper product of any one of the preceding items, wherein the density measured according to ISO 534:2011 of the paper substrate is 800-900 kg/m³.

18. The coated paper product of any one of the preceding items, wherein the thickness measured according to ISO 534:2011 of the paper substrate is 50-64 µm, such as 52-61 µm.

19. The coated paper product of any one of the preceding items, wherein the thickness measured according to ISO 534:2011 of the coated paper product is 55-70 µm, such as 57-67 µm.

20. The coated paper product of any one of the preceding items, wherein the density measured according to ISO 534:2011 of the coated paper product is 950-1100 kg/m³.

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21. The coated paper product of any one of the preceding items, wherein the paper substrate is bleached, e.g. has an ISO Brightness according to ISO 2470 of at least 77.

22. The coated paper product of any one of the preceding items, wherein the recyclability measured according to PTS Method PTS-RH 021/97 of the coated paper product is at least 80%.

23. The coated paper product of any one of the preceding items, wherein the hexane/heptane vapor transmission rate (HVTR) measured according to the method described in the description of the coated paper product is below 200 g/(m² day).

24. The coated paper product of any one of the preceding items, wherein the water vapor transmission rate (WVTR) measured according to ISO 15106-1 at 23°C and 50% relative humidity (RH) of the coated paper product is below 30 g/(m² day).

25. The coated paper product of any one of the preceding items, wherein the water vapor transmission rate (WVTR) measured according to ISO 15106-1 at 30°C and 80% relative humidity (RH) of the coated paper product is below 105 g/(m² day).

26. The coated paper product of any one of the preceding items, wherein average show through time of palm kernel oil measured according to Standard ISO 16532-1 of the coated paper product is at least 45 minutes.

27. The coated paper product of any one of the preceding items, wherein minimum show through time of palm kernel oil measured according to Standard ISO 16532-1 of the coated paper product is at least 10 minutes.

28. The coated paper product of any one of the preceding items, wherein a contact angle measured according to TAPPI T 558 between water and the surface formed by the second coating layer is less than 95° at the 1.0 s checkpoint.

29. The coated paper product of any one of the preceding items, wherein a contact angle measured according to TAPPI T 558 between di-iodomethane (DIM) and the surface formed by the second coating layer is less than 60° at the 1.0 s checkpoint.

30. The coated paper product of any one of the preceding items, wherein the surface energy derived from the contact angle measurements of water and di-iodomethane (DIM) measured according to TAPPI T 558 is at least 30 mJ/m² at the 1.0 s checkpoint.

31. The coated paper product of any one of the preceding items, wherein a sealant layer, such as cold-seal layer, is arranged on part of the second coating layer.

32. The coated paper product of any one of the preceding items, wherein the ash content is below 10 % calculated according:

$$(A\% \text{ ash in } B \text{ g/m}^2 \text{ base paper} + X1 \% \text{ pigment in } Y1 \text{ g/m}^2 \text{ in first coating layer} + X2 \% \text{ pigment in } Y2 \text{ g/m}^2 \text{ second coating layer}) / Z \text{ g/m}^2; \text{ wherein}$$

A is the total ash content in the base paper and B is the grammage of the base paper;

X1 and X2 are the pigment contents in the first and second coating layers, respectively;

Y1 and Y2 are the coating grammages of the first and second coating layers, respectively; and

Z is the total grammage of the coated paper.

33. Use of a coated paper product according to any one of the preceding items for flow-wrapping a product.

34. A method of producing a coated paper product for use in a flow wrapping process comprising the steps of:

- providing a paper substrate comprising a first and second side; and

- coating the first side of the paper substrate with a first coating layer, wherein the first coating layer comprises ethylene-acrylic acid (EAA) latex or vinyl acetate acrylate copolymer (VAcA) latex or styrene-acrylate (SA);
- coating a second coating layer on the first coating layer, wherein the second coating layer comprises ethylene-acrylic acid (EAA) latex and talc; wherein the dry weight ratio of EAA latex to talc in the second coating layer is between 100:5 and 100:100;
- wherein the coat weight of the first coating layer is at least 4-10 g/m²;
- wherein the coat weight of the second coating layer is at least 3-9 g/m²; and
- wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m².

35. A method of producing a coated paper product according to item 34, wherein the first and second coating layers are applied in-line.

36. The method of item 34 or 35 comprising drying between coating with the first coating layer and coating the second coating layer

37. A method of flow-wrapping a product comprising a step of flow-wrapping the product in a coated paper product according to any one of the items 1-32, wherein said flow-wrapping step comprises formation of a fin seal by sealing the coated paper product.

38. The method of flow wrapping a product of item 37, wherein the sealing is conducted by heat-sealing.

39. The method of flow wrapping a product of item 37, wherein the method further comprises the step of applying a sealant layer, preferably a cold-seal layer, onto part of the second coating layer prior to formation of a fin seal and sealing is conducted by sealing said sealant layer.

40. The method of flow wrapping a product of items 37-39 further comprising printing the glazed side of the coated paper product.

41. The method of flow wrapping a product of item 39 further comprising printing the glazed side of the coated paper product and the printing and the application of the sealant layer are carried out in the same machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Fig 1 is a schematic illustration of an embodiment of the coated paper product 1 of the present disclosure. The paper product consists of a paper substrate 101, a first coating layer 102 and a second coating layer 103. The paper is a machine glazed (MG) paper and the first coating layer 101 is applied to the non-glazed side, thereby the glazed side is a printed surface.

DETAILED DESCRIPTION

[0006] As a first aspect of the present disclosure, there is provided a coated paper product for use in a flow wrapping process comprising:

- a paper substrate comprising a first and second side;
- a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises ethylene-acrylic acid (EAA) or vinyl acetate acrylate copolymer (VAcA) or styrene-acrylate (SA);
- a second coating layer on the first coating layer, wherein the second coating layer comprises EAA and talc, and wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:5 and 100:100;
- wherein the coat weight of the first coating layer is at least 4-10 g/m²;
- wherein the coat weight of the second coating layer is at least 3-9 g/m²; and

- wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m².

[0007] The second coating layer is preferably applied on the first coating layer, i.e. directly on top of the first coating layer forming a dual superposed coating arrangement.

[0008] The paper substrate is preferably a machine-glazed (MG) paper. The MG paper may be calendered. The MG paper is typically a kraft paper, and typically at least 80%, preferably at least 90%, by dry weight of the fibres used to produce the MG paper are never-dried fibres (i.e. virgin fibres). An MG paper has glazed side and a non-glazed side. The glazed side is the side that faced the Yankee cylinder (a polished metal cylinder sometimes referred to as a MG cylinder) used for drying the paper web in the MG papermaking machine. The contact with the polished metal surface during drying makes the glazed side smoother than the non-glazed side. Typically, the first coating layer is applied to the less smooth, non-glazed, side of the paper substrate. Onto the first coating layer, the second coating layer is applied. The opposite side, i.e. the smooth, glazed side, in such case is typically printed. It is beneficial to apply the coating on the non-glazed side to provide the glazed side for printing. The glazed side may be coated with a thin layer of starch (≤ 1 g/m²) for curl prevention. A lacquer may be provided on the optional print, e.g. to modify gloss, friction and/or release properties.

[0009] The paper substrate may have been treated in a size press or similar to smoothen the surface and thereby avoid too great penetration of the first coating layer into the paper substrate.

[0010] The grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m², such as 42-55 g/m². A suitable thickness (measured according to ISO 534:2011) of the paper substrate is 50-64 μ m, such as 52-61 μ m. A suitable density (measured according to ISO 534:2011) for the paper substrate is 800-900 kg/m³. A too high grammage or thickness makes the paper not suitable for a flow wrapping process as the paper should be flexible. A too low density is not suitable either since such paper is too porous for application of a thin barrier.

[0011] The paper substrate may be bleached, e.g. has an ISO Brightness according to ISO 2470 of at least 77.

[0012] The first coating may comprise a rheology modifier to facilitate the coating operation. The first coating layer typically comprises pigment and the pigment is preferably talc and/or calcium carbonate (CaCO₃).

[0013] Typically, at least 50% by weight of the total pigment content in the second coating layer is talc.

[0014] It is beneficial for combining coating ductility, barrier properties, non-blocking, recyclability, heat sealability and possibility to coat with a sealant layer that the first coating layer comprises EAA or VAcA or SA as well as talc and/or CaCO₃ in the first coating layer and EAA as well as talc in the second coating layer, wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:5 and 100:100.

[0015] The first coating layer preferably comprises talc in a EAA or VAcA or SA to talc ratio of 100:30 and 100:110, such as between 100:30 and 100:75, or CaCO₃ in a EAA or VAcA or SA to CaCO₃ ratio of 100:20 and 100:70, such as between 100:30 and 100:65. The dry weight ratio of EAA to talc in the second coating layer is preferably between 100:5 and 100:70, such as 100:10 and 100:60, such as 100:15 and 100:60, such as 100:15 and 100:40. It is advantageous with such filler to EAA or VAcA or SA ratios in the first and second coating layers with respect to coating ductility, blocking, and heat-sealability.

[0016] The coated paper product is typically heat-sealable. EAA is inherently heat-sealable and by addition of a dry weight ratio of EAA to talc in the second coating layer of between 100:5 and 100:100, this heat-sealability is typically maintained. A higher talc content impairs the sealability. Typically, the maximum heat seal strength measured according to ASTM F88 & EN 868-5 of the coated paper product is at least 2.8 N measured on a 15 mm test strip sealed for 0.5 s at 160 °C and 3 bar. This means that 2.8 N is required to separate the sealed strip. It is advantageous for the coated paper product to be heat-sealable in order to allow the formation of a flow-wrap packaging by sealing the paper to itself.

[0017] The second coating layer typically forms a surface to which a sealant layer can be applied, typically a cold-sealant layer. To facilitate the application of the sealant layer, the contact angle between water and the second coating layer surface is preferably less than 95°, such as less than 90°, such as less than 80°. The contact angle may be measured according to TAPPI T 558. This standard stipulates measuring the contact angle at different checkpoints. Suitably, the contact angle at the 1.0 s checkpoint is selected. Moreover, the contact angle between di-iodomethane (DIM) and the second coating layer surface is preferably less than 60° and the surface energy is at least 30 mJ/m² at the 1.0 s checkpoint measured according to TAPPI T 558. The surface energy is derived from the contact angle measurements by plotting $(1+\cos\theta)/2 \cdot (\sigma_L/\sigma_L^d)^{1/2}$ vs $(\sigma_L^p/\sigma_L^d)^{1/2}$, wherein θ is the contact angle formed between the liquid drop and solid surface, σ_L is the liquid surface tension, and superscripts d and p stand respectively for dispersive and polar components of the liquid surface tension. After plotting, the points are fitted to a straight line to calculate σ_s^p and σ_s^d from the slope and intersection with the vertical axis, respectively. σ_s is the solid surface free energy and the surface energy is the sum of $\sigma_s^p + \sigma_s^d$.

[0018] It is advantageous that the second coating layer typically can either be heat-sealed without the need for an additional sealant layer or coated by and sealed by an additional sealant layer, typically a cold seal layer.

[0019] The coat weight of the first coating layer is 4-10 g/m². The coat weight of the second coating layer is 3-9 g/m². There is preferably a higher coat weight of the first coating layer than the second coating layer. This is advantageous

since the first coating layer typically comprises a higher filler content thereby making the first coating layer more economically favourable and environmentally friendly.

[0020] The grammage measured according to ISO 536:2020 of the coated paper product is typically 52-71 g/m², such as 56-68 g/m². A suitable thickness (measured according to ISO 534:2011) of the coated paper product is 52-68 μm, such as 54-66 μm. A suitable density (measured according to ISO 534:2011) of the coated paper product is 950-1100 kg/m³.

[0021] In a particularly preferred embodiment of the coated paper product the first coating layer comprises EAA to talc in a ratio of between 100:30 and 100:75 and the second coating layer comprises EAA to talc in a ratio of 100:15 to 100:40. Such embodiment is advantageous as it combines barrier properties, barrier crack resistance, blocking resistance, grease resistance, heat sealability and possible application of a sealant layer.

[0022] In another particularly preferred embodiment of the coated paper product the first coating layer comprises VAcA to pigment in a ratio of between 100:30 and 100:75 and the second coating layer comprises EAA to talc in a ratio of 100:15 to 100:70. Such embodiment is beneficial in terms of combining recyclability with barrier crack resistance, blocking resistance, low ash content and possible application of a sealant layer.

[0023] In yet another particularly preferred embodiment of the coated paper product the first coating layer comprises VAcA to pigment in a ratio of between 100:30 and 100:75 and the second coating layer comprises EAA to talc in a ratio of 100:15 to 100:40. Such embodiment is beneficial in terms of combining barrier crack resistance, blocking resistance, grease resistance, recyclability, low ash content and possible application of a sealant layer.

[0024] As a second aspect of the present disclosure, there is provided use of a coated paper product according to the first aspect for flow-wrapping a product.

[0025] The examples and embodiments discussed above in connection to the first aspect apply to the second aspect *mutatis mutandis*.

[0026] As a third aspect of the present disclosure there is provided a method of producing a coated paper product for use in a flow wrapping process comprising the steps of:

- providing a paper substrate comprising a first and second side; and
- coating the first side of the paper substrate with a first coating layer, wherein the first coating layer comprises ethylene-acrylic acid (EAA) latex or vinyl acetate acrylate copolymer (VAcA) latex or styrene-acrylate (SA) latex;
- coating a second coating layer on the first coating layer, wherein the second coating layer comprises ethylene-acrylic acid (EAA) latex and talc, and wherein the dry weight ratio of EAA latex to talc in the second coating layer is between 100:5 and 100:100;
- wherein the coat weight of the first coating layer is at least 4-10 g/m²;
- wherein the coat weight of the second coating layer is at least 3-9 g/m²; and
- wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m².

[0027] In one embodiment, the method comprises drying between the application of the first coating layer and the application of the second coating layer. Drying is typically performed with non-contact drying, such as IR and/or hot air, or contact drying, such as a drying cylinder, or a combination of non-contact and contact drying.

[0028] The coating is typically conducted with blade coating. The coating may also be conducted with rod coating, air-knife coating, rotogravure coating and/or curtain coating. The first and second coating layers may be applied with the same coating technique or different coating techniques.

[0029] The first and second coating layers may be applied in-line (also referred to as on-line). In such case, the productivity is increased by eliminating the handling operations linked to off-line treatment and by eliminating, or at least reducing, the amount of waste. When an in-line process is conducted, the coating weight is typically below 10 g/m² in both the first and second coating layers to allow for sufficient drying between coating steps as well as prior to reeling. A non-blocking coating is in such case also advantageous.

[0030] The examples and embodiments discussed above in connection to the first and second aspects apply to the third aspect *mutatis mutandis*.

[0031] A typical product to be packed in the paper-based material of the present disclosure is a protein bar, a snack bar or a chocolate bar.

EXAMPLES

Coating of paper

[0032] Pigment (talc (Finntalc C15B2), kaolin clay (Barrisurf LX), CaCO_3 (Setacarb HG-ME 75%)) was added to and dispersed in an ethylene acrylic acid (EAA) latex (Michem Flex HS 1130) having a solids content of about 45% or vinyl acetate acrylate copolymer (VAcA) latex (CHP 125) having a solids content of about 50%.

[0033] A machine-glazed (MG) base paper produced from never-dried bleached SW pulp was coated on the non-glazed side with a pilot-scale blade coater.

[0034] The properties of the MG base paper is shown in Table 1 below.

Table 1. Properties of a MG kraft paper produced from never-dried bleached SW pulp.

Property	Unit	Standard method	Value
Grammage	g/m^2	ISO 536	48.15
Thickness	μm	ISO 534	56.80
Density	kg/m^3	ISO 534	847.71
Tensile Strength MD	kN/m	ISO 1924-3	4.40
Tensile Strength CD	kN/m	ISO 1924-3	2.50
Tensile Index MD	kNm/kg	ISO 1924-3	91.38
Tensile Index CD	kNm/kg	ISO 1924-3	51.92
Stretch at break MD	%	ISO 1924-3	1.85
Stretch at break CD	%	ISO 1924-3	4.12
TEA MD	J/m^2	ISO 1924-3	53.75
TEA CD	J/m^2	ISO 1924-3	74.58
TEA Index MD	J/g	ISO 1924-3	1.12
TEA Index CD	J/g	ISO 1924-3	1.55
PPS 1 MPa glazed side	μm	ISO 8791-4	5.80*
Bendtsen Roughness glazed side	ml/min	ISO 8791-2	34
Bendtsen Roughness non-glazed side	ml/min	ISO 8791-2	254
Bending Resistance MD	mN	ISO 2493-1	22
Bending Resistance CD	mN	ISO 2493-1	13
Bending Resistance Index MD	Nm^6/kg^3	ISO 2493-1	197.1
Bending Resistance Index CD	Nm^6/kg^3	ISO 2493-1	116.5
Puncture Resistance Force	N	EN 14477	2.81
Puncture Resistance Strain	mm	EN 14477	0.47
Puncture Resistance Work	mJ	EN 14477	0.58

[0035] *Unusually high, the value is normally between 2.4 and 4.1 μm .

[0036] A first coating layer comprising latex and pigment was coated onto the paper. The coated paper was dried by IR and a drying cylinder. Thereafter a second coating layer comprising latex and pigment was coated so that the paper was coated on one side with a dual superposed coating. The coating was dried by IR, hot air and a drying cylinder. The composition of each coating is presented in Table 2.

Table 2. Compositions and coat weights of first and second coating layers.

Sample	First coating layer						Second coating layer				
	EAA latex	VAcA latex	Talc	Kaolin Clay	CaCO ₃	Coating grammage (g/m ²)	EAA latex	Talc	Kaolin Clay	CaCO ₃	Coating grammage (g/m ²)
1	100			100		8.10	100		100		7.20
2	100		100			6.90	100	100			6.70
3	100		50	50		8.10	100	50	50		8.00
4	100			50		6.60	100		50		5.40
5	100		100			9.30	100	100			9.10
6	100		100			9.30	100	12			8.00
7	100				40	7.80	100			40	8.40
8	100				40	7.80	100	12			7.00
9	100				80	9.20	100			80	9.90
10	100				80	9.20	100	12			5.20
11	100		50			5.76	100	50			5.00
12	100		50			5.76	100	25			4.50
13		100	50			5.63	100	50			4.50
14		100	50			5.63	100	25			5.20
15		100			50	8.10	100	50			5.20
16		100			50	8.10	100	25			5.00

Barrier properties

WVTR

[0037] To evaluate the barrier properties against water vapour, the water vapour transmission rate (WVTR) was measured according to ISO 15106-1 at 23 °C and 50% relative humidity (RH) as well as at 30°C and 80% RH.

HVTR

[0038] To evaluate mineral oil migration barrier properties, the hexane/heptane vapour transmission rate (HVTR) was measured. The determination of the hexane vapour transmission rate (HVTR) was performed in a permeability cup (evaporation chamber) with a sealable closure fixable with screws. The closure has an open surface area which is sealed with the barrier material. A volume of hexane or heptane (9-10 ml) is filled into the evaporation chamber onto a sponge (to reach a liquid/gas equilibrium as quickly as possible) and the weight of hexane/heptane vapour that goes through the exposed surface of a functional barrier, is expressed in gram per square meter of the surface area per day. The samples were prepared by using a punch and visually inspected to see that there were no surface defects or damages (e.g. creases or pin holes). Under controlled experimental conditions (23° ± 1°C and 50 ± 2% relative humidity), the paper sample was fixed into the closure head, the barrier coatings facing the inner side. The chamber was closed as quickly as possible. The filled evaporation chamber is then weighed after 1, 2, 4 hrs and 1 day. The HVTR was then calculated according to:

$$\text{HVTR [g/m}^2 \text{ day)]} = \text{weight difference [g]} * 10000 [\text{cm}^2/\text{m}^2] * 24 [\text{h/d}]/(\text{area}[\text{cm}^2] * \text{time[h]})$$

[0039] The results of WVTR and HVTR measurements are presented in Table 3 and the sample numbering is the

same as in Table 2.

Table 3. Results of WVTR and HVTR measurements.

Sample	WVTR (23°C/50%RH)	WVTR (30°C/80%RH)	HVTR (g/m ² *d)
1	7.86	71.43	
2	6.67	40.89	
3	4.10	31.90	
4	6.19	40.10	
5	4.91	41.51	
6	7.15	53.89	
7	9.58	58.73	
8	8.78	46.06	
9	9.02	66.77	
10	9.00	52.73	
11	10.42	63.57	179.3
12	6.80	30.08	191.1
13	20.45	101.74	57.9
14	18.64	75.33	91.3
15	18.92	80.93	43.6
16	24.40	95.31	98.6

Runnability & handling

Folded paper oil resistance - crack-resistance measurement

[0040] By measuring the folded oil resistance from the barrier side, the ductility is measured, i.e. how well the formed barrier resists cracking. The methods is described in detail herein.

[0041] Rape seed oil was mixed with 1 % colorant (Sudan blue II) and stirred on a magnetic stirrer until fully mixed.

[0042] 3 samples (14×14 cm) of each coated paper were prepared. The samples were one by one arranged in a folding punch with the barrier side downwards. The folding punch has a V-shaped punch and a V-shaped weight is arranged on top so that when the sample is pushed down by the weight, a 90° fold-line along the entire paper is formed. The weight was applied on the opposite side of the paper from the barrier coating pushing the barrier side downwards. Two additional fold-lines were formed on the paper. All three fold-lines were evenly distributed with a distance of about 4 cm. After the third fold-line had been formed, the paper was turned 90° and three additional fold-lines were made in the same way, thereby obtaining a grid pattern.

[0043] In a cobb ring a blotting paper was arranged with one paper sample on top of the blotting paper. The paper sample had the barrier coated side upwards. The coloured rape seed oil (10 ml) was dosed into the ring and evenly distributed over the paper sample immediately. After 2 minutes the paper sample was taken out from the ring and excess oil was removed with additional blotting papers and lint-free drying paper.

[0044] Within 10 minutes from the removal, the paper sample was scanned in a computer scanner and the number of visible blue dots counted manually. The blue dots appear where the barrier has cracked and oil could enter into the paper. The criteria for evaluation are shown in Table 4 below. The analysis was performed in triplicate and the presented result in Table 6 is the average result.

Table 4. Criteria for evaluation of barrier ductility measurements.

Number of dots	Category
<5	Excellent
<15	Good

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(continued)

Number of dots	Category
15-30	Average
>30	Poor

Blocking

[0045] After coating of the paper with the first and second coatings layers the paper was reeled up. After about 24 h, the paper was reeled out and blocking was evaluated according to the following criteria presented in Table 4.

Table 5. Criteria for evaluation of blocking resistance.

	Blocking
Possible to reel out the paper without any sticking of the coating	No
Possible to reel out the paper but the coating was sticking to some extent	Yes, some
Not possible to reel out the paper due to major sticking of the coating	Yes

Heat-sealing

[0046] The maximum heat seal strength was measured according to ASTM F88 & EN 868-5 and settings were 0.5 s, 160 °C and 3 bar on 15 mm wide samples. The results are presented in Table 6.

Table 6. Results from evaluation of runnability & handling properties.

Sample	Barrier crack resistance	Blocking	Heat seal Fmax (N)
1	Poor	No	2.86±0.15
2	Poor	No	2.85±0.21
3	Poor	No	2.90±0.19
4	Average	No	2.86±0.12
5	Poor	No	
6	Good	No	
7	Average	No	
8	Good	No	
9	Poor	No	
10	Average	No	
11	Good	No	2.95±0.21
12	Excellent	No	3.02±0.27
13	Good	No	
14	Excellent	No	
15	Excellent	No	
16	Excellent	No	

Contact angle and surface energy

[0047] Water and di-iodomethane (DIM) contact angle was measured according to TAPPI T 558 on the surface of the second coating layer to evaluate the wetting of the surface. The surface energy is derived from the contact angle measurements by plotting $(1+\cos\theta)/2 \cdot (\sigma_L/\sigma_L^d)^{1/2}$ vs $(\sigma_L^p/\sigma_L^d)^{1/2}$, wherein θ is the contact angle formed between the liquid

drop and solid surface, σ_L is the liquid surface tension, and superscripts d and p stand respectively for dispersive and polar components of the liquid surface tension. After plotting, the points were fitted to a straight line to calculate σ_s^p and σ_s^d from the slope and intersection with the vertical axis, respectively. σ_s is the solid surface free energy and the surface energy is the sum of $\sigma_s^p + \sigma_s^d$.

[0048] The contact angle as well as surface energy reflects the ability of the surface to be coated, i.e. wetted, with a sealant layer. The measurement was conducted at the 1.0 s checkpoint. The results are presented in Table 7.

Cold-seal wetting

[0049] To further evaluate the possibility to coat the surface with an additional sealant, a cold-seal (Loctite Liofol CS 22-422, Henkel) was applied onto the second coating by using a lab rod coater. If a uniform coating was formed, i.e. did coating did not form pearls, the surface could be wet by the cold-seal.

Table 7. Water contact angle, Di-iodomethane (DIM) contact angle and surface energy.

Sample	Water contact angle (°)	DIM contact angle (°)	Total surface energy (mJ/m ²)	Cold-seal wetting
1				
2				
3				
4				
5				
6				
7				
8				
9	76.9	52.7	36.2	Yes
10	96.1	59.0	29.2	Yes
11	90.9	54.6	32.0	Yes
12	89.6	55.2	31.8	
13	92.2	55.8	31.2	
14	91.4	56.8	30.8	
15	92.5	55.6	31.3	
16	93.1	56.9	30.5	

Grease resistance

Show through time

[0050] The show through times of palm kernel oil is a measure of grease resistance and was measured according to Standard ISO 16532-1. Minimum time as well as average time are presented in Table 8.

Table 8. Show through time of palm kernel oil.

Sample	Average show through (min)	Minimum show through (min)
1	313	190
2	130	80
3	243	120
4	213	120
5	165	113

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(continued)

Sample	Average show through (min)	Minimum show through (min)
6	189	109
7	103	103
8	70	53
9	193	115
10	160	148
11	90	54
12	537	43
13	48	36
14	576	335
15	60	10
16	182	34

Recyclability & ash content

Recyclability

[0051] The recyclability was measured according to PTS Method PTS-RH 021/97 and the results are presented in Table 8.

Ash content

[0052] To fulfil food-grade packaging legislation in Italy it is required that the ash content is below 10 %.

[0053] The ash content was calculated according: (3% ash in 48 g/m² base paper + X1 % pigment in Y1 g/m² in first coating layer + X2 % pigment in Y2 g/m² second coating layer) / Z g/m²; wherein

- X1 and X2 are the pigment contents in the first and second coating layer, respectively;
- Y1 and Y2 are the coating grammages of the first and second coating layer, respectively; and
- Z is the total grammage of the coated paper.

[0054] The calculated ash contents are presented in Table 8.

Table 8. Recyclability according to PTS Method PTS-RH 021/97 and ash content.

Sample	Recyclability	Ash content (total)
1		14%
2		13%
3		15%
4		9%
5		17%
6		11%
7		10%
8	80.1%	7%
9		16%
10	77.6%	10%

(continued)

Sample	Recyclability	Ash content (total)
11	79.7%	8%
12	81.0%	7%
13	86.9%	8%
14	84.6%	7%
15	84.9%	9%
16	85.1%	8%

[0055] There are four sublevels of recyclability (level A+, A, B, C). The result of the assessment according to the PTS Method PTS-RH 021/97 was that the coated paper product samples having a recyclability of at least 80 % were classified as level A recyclable.

Claims

1. A coated paper product for use in a flow wrapping process comprising:

- a paper substrate comprising a first and second side;
- a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises ethylene-acrylic acid (EAA) or vinyl acetate acrylate copolymer (VAcA) or styrene-acrylate (SA);
- a second coating layer on the first coating layer, wherein the second coating layer comprises EAA and talc, and wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:5 and 100:70;
- wherein the coat weight of the first coating layer is 4-10 g/m²;
- wherein the coat weight of the second coating layer is 3-9 g/m²; and
- wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m².

2. The coated paper product of claim 1, wherein the grammage measured according to ISO 536:2020 of the paper substrate is 42-55 g/m².

3. The coated paper product of any one of the preceding claims, wherein the grammage measured according to ISO 536:2020 of the coated paper product is 52-71 g/m², such as 56-68 g/m².

4. The coated paper product of any one of the preceding claims, wherein the paper substrate is a machine-glazed (MG) kraft paper.

5. The coated paper product of claim 4, wherein the first side of the paper substrate is the non-glazed side of the MG paper and wherein the glazed side is optionally printed.

6. The coated paper product of any one of the preceding claims, wherein at least 80 dry wt.% of the fibres used to form the paper substrate are never-dried.

7. The coated paper product of any one of the preceding claims, wherein the first coating layer comprises talc and/or calcium carbonate (CaCO₃).

8. The coated paper product of claim 7, wherein the first coating layer comprises talc in a EAA or VAcA or SA to talc ratio between 100:30 and 100:110, such as between 100:30 and 100:75, or CaCO₃ in a EAA or VAcA or SA to CaCO₃ ratio between 100:20 and 100:70, such as between 100:30 and 100:65.

9. The coated paper product of any one of the preceding claims, wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:10 and 100:60, such as 100:15 and 100:60, such as 100:15 and 100:40.

10. The coated paper product of any one of the preceding claims, wherein the paper product is heat-sealable.

11. The coated paper product of claim 10, wherein the maximum heat seal strength measured according to ASTM F88 & EN 868-5 of the coated paper product is at least 2.8 N measured on a 15 mm test strip sealed for 0.5 s at 160 °C and 3 bar.

12. Use of a coated paper product according to any one of the preceding claims for flow-wrapping a product.

13. A method of producing a coated paper product for use in a flow wrapping process comprising the steps of:

- providing a paper substrate comprising a first and second side; and
- coating the first side of the paper substrate with a first coating layer, wherein the first coating layer comprises ethylene-acrylic acid (EAA) latex or vinyl acetate acrylate copolymer (VAcA) latex or styrene-acrylate (SA) latex;
- coating a second coating layer on the first coating layer, wherein the second coating layer comprises ethylene-acrylic acid (EAA) latex and talc, and wherein the dry weight ratio of EAA latex to talc in the second coating layer is between 100:5 and 100:70;
- wherein the coat weight of the first coating layer is at least 4-10 g/m²;
- wherein the coat weight of the second coating layer is at least 3-9 g/m²; and
- wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-60 g/m².

Patentansprüche

1. Beschichtetes Papierprodukt zur Verwendung in einem Schlauchbeutelverpackungsverfahren, aufweisend:

- ein Papiersubstrat, das eine erste und eine zweite Seite aufweist;
- eine erste Deckschicht auf der ersten Seite des Papiersubstrats, wobei die erste Deckschicht Ethylen-Acrylsäure (EAA) oder Vinylacetat-Acrylat-Copolymer (VAcA) oder Styrol-Acrylat (SA) aufweist;
- eine zweite Deckschicht auf der ersten Deckschicht, wobei die zweite Deckschicht EAA und Talk aufweist, und wobei das Trockengewichtsverhältnis von EAA zu Talk in der zweiten Deckschicht zwischen 100:5 und 100:70 liegt;
- wobei das Beschichtungsgewicht der ersten Deckschicht 4 - 10 g/m² beträgt;
- wobei das Beschichtungsgewicht der zweiten Deckschicht 3 - 9 g/m² beträgt; und
- wobei das Flächengewicht des Papiersubstrats, gemessen gemäß ISO 536:2020, 40 - 60 g/m² beträgt.

2. Beschichtete Papierprodukt nach Anspruch 1, wobei das gemäß ISO 536:2020 gemessene Flächengewicht des Papiersubstrats 42 - 55 g/m² beträgt.

3. Beschichtete Papierprodukt nach einem der vorhergehenden Ansprüche, wobei das gemäß ISO 536:2020 gemessene Flächengewicht des beschichteten Papierprodukts 52 - 71 g/m², beispielsweise 56 - 68 g/m², beträgt.

4. Beschichtetes Papierprodukt nach einem der vorhergehenden Ansprüche, wobei das Papiersubstrat ein einseitig geglättetes (MG) Kraftpapier ist.

5. Beschichtetes Papierprodukt nach Anspruch 4, wobei die erste Seite des Papiersubstrats die nicht geglättete Seite des MG-Papiers ist und wobei die geglättete Seite optional bedruckt ist.

6. Beschichtetes Papierprodukt nach einem der vorhergehenden Ansprüche, wobei mindestens 80 % Trockengewicht der zur Bildung des Papiersubstrats verwendeten Fasern nie getrocknet sind.

7. Beschichtetes Papierprodukt nach einem der vorhergehenden Ansprüche, wobei die erste Deckschicht Talk und/oder Calciumcarbonat (CaCO₃) aufweist.

8. Beschichtetes Papierprodukt nach Anspruch 7, wobei die erste Deckschicht Talk in einem Verhältnis von EAA oder VAcA oder SA zu Talk zwischen 100:30 und 100:110, beispielsweise zwischen 100:30 und 100:75, oder CaCO₃ in einem Verhältnis von EAA oder VAcA oder SA zu CaCO₃ zwischen 100:20 und 100:70, beispielsweise zwischen 100:30 und 100:65, aufweist.

9. Beschichtetes Papierprodukt nach einem der vorhergehenden Ansprüche, wobei das Trockengewichtsverhältnis von EAA zu Talk in der zweiten Deckschicht zwischen 100:10 und 100:60, beispielsweise zwischen 100:15 und

100:60, beispielsweise zwischen 100:15 und 100:40, beträgt.

10. Beschichtetes Papierprodukt nach einem der vorhergehenden Ansprüche, wobei das Papierprodukt heißsiegelbar ist.

11. Beschichtetes Papierprodukt nach Anspruch 10, wobei die maximale Heißsiegelfestigkeit des beschichteten Papierprodukts, gemessen gemäß ASTM F88 & EN 868-5, mindestens 2,8 N beträgt, gemessen an einem 15 mm langen Teststreifen, der 0,5 s lang bei 160 °C und 3 Bar versiegelt wurde.

12. Verwendung eines beschichteten Papierprodukts nach einem der vorhergehenden Ansprüche zum Schlauchbeutelverpacken eines Produkts.

13. Verfahren zur Herstellung eines beschichteten Papierprodukts zur Verwendung in einem Schlauchbeutelverpackungsverfahren, aufweisend die Schritte:

- Bereitstellen eines Papiersubstrats, das eine erste und eine zweite Seite aufweist; und
- Beschichten der ersten Seite des Papiersubstrats mit einer ersten Deckschicht, wobei die erste Deckschicht Ethylen-Acrylsäure- (EAA) Latex oder Vinylacetat-Acrylat-Copolymer- (VAcA) Latex oder Styrol-Acrylat-(SA) Latex aufweist;
- Beschichten der ersten Deckschicht mit einer zweiten Deckschicht, wobei die zweite Deckschicht Ethylen-Acrylsäure-Latex (EAA) und Talk aufweist und wobei das Trockengewichtsverhältnis von EAA-Latex zu Talk in der zweiten Deckschicht zwischen 100:5 und 100:70 liegt;
- wobei das Beschichtungsgewicht der ersten Deckschicht mindestens 4 - 10 g/m² beträgt;
- wobei das Beschichtungsgewicht der zweiten Deckschicht mindestens 3 - 9 g/m² beträgt; Und
- wobei das Flächengewicht des Papiersubstrats, gemessen gemäß ISO 536:2020, 40 - 60 g/m² beträgt.

Revendications

1. Produit en papier revêtu destiné à être utilisé dans un processus d'emballage en flux, comprenant :

- un substrat de papier comprenant une première et une deuxième face ;
- une première couche de revêtement sur la première face du substrat de papier, dans lequel la première couche de revêtement comprend de l'acide éthylène-acrylique (EAA) ou un copolymère d'acétate de vinyle et d'acrylate (VAcA) ou du styrène-acrylate (SA)
- une deuxième couche de revêtement sur la première couche de revêtement, dans lequel la deuxième couche de revêtement comprend de l'EAA et du talc, et dans lequel le rapport en poids sec entre l'EAA et le talc dans la deuxième couche de revêtement est compris entre 100:5 et 100:70 ;
- dans lequel le poids de la couche de la première couche de revêtement est compris entre 4 et 10 g/m² ;
- dans lequel le poids de la deuxième couche de revêtement est compris entre 3 et 9 g/m² ; et
- dans lequel le grammage mesuré selon la norme ISO 536:2020 du substrat de papier est compris entre 40 et 60 g/m².

2. Produit en papier revêtu selon la revendication 1, dans lequel le grammage mesuré selon la norme ISO 536:2020 du substrat en papier est compris entre 42 et 55 g/m².

3. Produit en papier revêtu selon l'une quelconque des revendications précédentes, dans lequel le grammage mesuré selon la norme ISO 536:2020 du produit en papier revêtu est compris entre 52 et 71 g/m², par exemple entre 56 et 68 g/m².

4. Produit en papier revêtu selon l'une quelconque des revendications précédentes, dans lequel le substrat de papier est un papier kraft glacé à la machine (MG).

5. Produit en papier revêtu selon la revendication 4, dans lequel la première face du substrat en papier est la face non glacée du papier MG et dans lequel la face glacée est éventuellement imprimée.

6. Produit en papier revêtu de l'une quelconque des revendications précédentes, dans lequel au moins 80 % en poids sec des fibres utilisées pour former le substrat de papier n'ont jamais été séchées.

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7. Produit en papier revêtu selon l'une quelconque des revendications précédentes, dans lequel la première couche de revêtement comprend du talc et/ou du carbonate de calcium (CaCO_3).
- 5 8. Produit en papier revêtu selon la revendication 7, dans lequel la première couche de revêtement comprend du talc dans un rapport EAA ou VAcA ou SA au talc compris entre 100:30 et 100:110, par exemple entre 100:30 et 100:75, ou du CaCO_3 dans un rapport EAA ou VAcA ou SA au CaCO_3 compris entre 100:20 et 100:70, par exemple entre 100:30 et 100:65.
- 10 9. Produit en papier revêtu selon l'une quelconque des revendications précédentes, dans lequel le rapport en poids sec entre l'EAA et le talc dans la deuxième couche de revêtement est compris entre 100:10 et 100:60, par exemple entre 100:15 et 100:60, par exemple entre 100:15 et 100:40.
- 15 10. Produit en papier revêtu selon l'une quelconque des revendications précédentes, dans lequel le produit en papier est thermoscellable.
11. Produit en papier revêtu selon la revendication 10, dans lequel la résistance maximale au thermoscellage mesurée conformément aux normes ASTM F88 et EN 868-5 du produit en papier revêtu est d'au moins 2,8 N, mesurée sur une bande d'essai de 15 mm scellée pendant 0,5 s à 160 °C et 3 bars.
- 20 12. Utilisation d'un produit en papier revêtu selon l'une quelconque des revendications précédentes pour l'emballage en flux d'un produit.
- 25 13. Procédé de fabrication d'un produit en papier revêtu destiné à être utilisé dans un procédé d'emballage en flux, comprenant les étapes consistant à :
- fournir un substrat de papier comprenant une première et une deuxième face ; et
 - enduire la première face du substrat de papier avec une première couche de revêtement, dans lequel la première couche de revêtement comprend du latex d'acide éthylène-acrylique (EAA) ou du latex de copolymère d'acétate de vinyle et d'acrylate (VAcA) ou du latex de styrène et d'acrylate (SA) ;
 - 30 - enduire une deuxième couche de revêtement sur la première couche de revêtement, dans lequel la deuxième couche de revêtement comprend du latex d'acide éthylène-acrylique (EAA) et du talc, et dans lequel le rapport en poids sec entre le latex EAA et le talc dans la deuxième couche de revêtement est compris entre 100:5 et 100:70 ;
 - dans lequel le poids de la première couche de revêtement est compris entre au moins 4 et 10 g/m^2 ;
 - 35 - dans lequel le poids de la seconde couche d'enduction est compris entre au moins 3 et 9 g/m^2 ; et
 - dans lequel le grammage mesuré selon la norme ISO 536:2020 du substrat de papier est compris entre 40 et 60 g/m^2 .
- 40
- 45
- 50
- 55

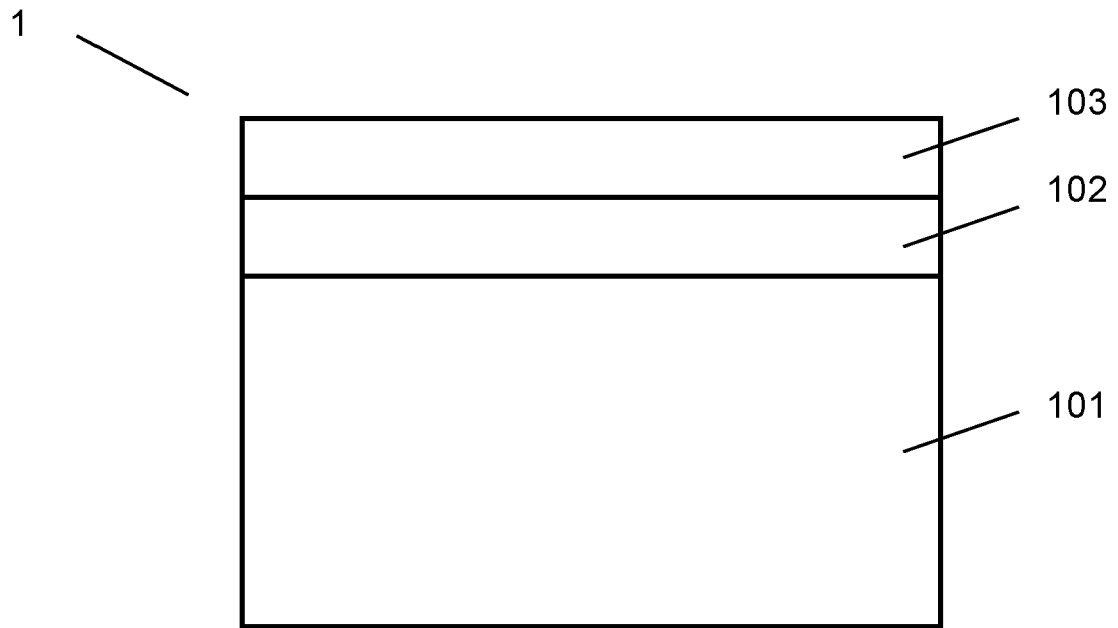


Fig. 1