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(54) **COATED BARRIER PAPER**

(57) The present disclosure provides coated paper product comprising:
- a paper substrate comprising a first and a second side;
- a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof; and
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.

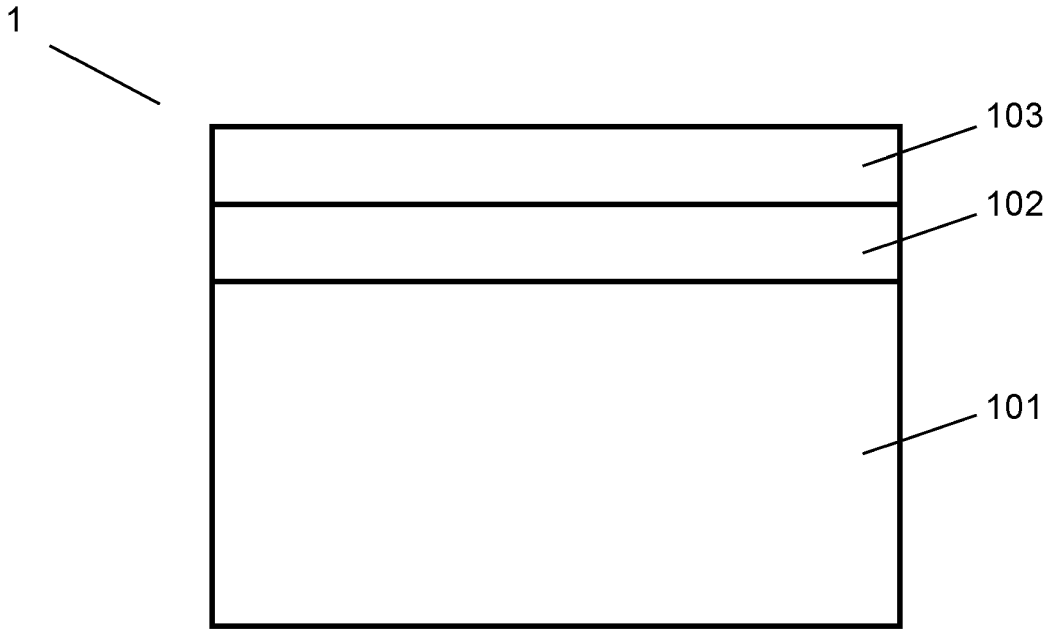

Fig. 1

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Description

TECHNICAL FIELD

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

BACKGROUND

[0002] The current legislative trends regarding packaging are driving consumers and brands to change their packaging from plastic to paper. There are many large market segments where barrier papers are required to effectively replace traditional plastic packaging and demand for paper-based solutions is growing strongly. Examples include flow wrapped products, bags and other wrappings.

[0003] 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.

[0004] The vertical form fill sealing (VFFS) machine is a type of automated assembly-line product packaging system. It is commonly used in the packaging industry for food and a wide variety of other products. The machine often constructs plastic bags out of a flat roll of plastic film, while simultaneously filling the bags with product and sealing the filled bags. Both solids and liquids can be bagged using this packaging system.

[0005] Overwrapping is the process of wrapping an item inside a protective material. The item is overwrapped by the packaging material plastic and sealed, thereby making a sealed package.

SUMMARY

[0006] The present disclosure aims to provide a paper-based material that can replace plastic films in packaging in for example flow wrapping processes, sealed paper bags, e-commerce bags, tissue wrapping and bedding wrappings. The inventors have realized that such a paper-based material, to be commercially successful, should meet the majority, preferably all, of the following criteria:

- ductility of the coating, i.e. cracking resistance during processing or usage;
- minor or even non-existing blocking during processing;
- providing a grease barrier (preventing fat from the packed/wrapped product from staining and/or weakening the paper-based material);
- repulpable according to applicable standards;
- protecting the packed/wrapped product from ambient moisture;
- heat-sealable so that a sealed package can be produced without further sealant layers;
- satisfactory printability when using existing printing technology; and
- 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).

[0007] Accordingly, the present disclosure provides the following listing of itemized embodiments:

1. A coated paper product comprising:

- a paper substrate comprising a first and a second side;
- a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises a binder being polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof;

and

- 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.

2. The coated paper product of item 1, wherein the coat weight of the first coating layer is at least 0.5 g/m^2, such as 1-10 g/m^2.

3. The coated paper product of item 1 or 2, wherein a heat-seal layer is provided on at least part of the second side of the paper substrate.

4. The coated paper product of any one of the items 1-3, wherein the first coating layer comprises pigment.

5. The coated paper product of item 4, wherein the pigment in the first coating layer is talc and/or calcium carbonate ($CaCO_3$) and/or clay and/or mica.

6. The coated paper product of item 5, wherein the first coating layer comprises talc in a binder to talc ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75, or $CaCO_3$ in a binder to $CaCO_3$ ratio between 100:20 and 100:70, such as between 100:30 and 100:65 or kaolin clay in a binder to kaolin clay ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or mica in a binder to mica ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or bentonite clay in a binder to bentonite clay ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75.

7. The coated paper product of any one of the items 4-6, wherein the total pigment content is 5-70 % by dry weight of the first coating layer, such as 10-50 % by dry weight of the first coating layer.

8. A method of producing a coated paper comprising the steps of:

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

- coating a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises a binder being polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof; and

- coating a second coating layer on the second 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 third coating layer is between 100:5 and 100:70.

9. The method of producing a coated paper product according to item 8, wherein all the coating layers are applied in-line.

10. The method for producing a coated paper product according to item 8 or 9, wherein the second coating layer is applied using a blade coater, rod coater, air-knife coater, rotogravure coater or curtain coater.

11. The method for producing a coated paper product according to any one of the items 8-10, wherein the first coating layer is applied using a size press, film press, blade coater, rod coater, air-knife coater, rotogravure coater or curtain coater.

12. The method for producing a coated paper product according to any one of the items 8-11, wherein the first coating layer is produced in one single coating step or in a plurality of coating steps.

13. The method for producing a coated paper product according to item 12,
wherein the first coating layer is produced in a plurality of coating steps and a first sub-layer of the first coating layer forming a part of the first coating layer is applied in a first coating step and a second sub-layer of the first coating layer is applied in the same coating step as the second coating layer.

14. The method for producing a coated paper product according to item 13, wherein the first coating layer consists

of the first and second sub-layers.

15. The method for producing a coated paper product according to item 12, wherein the first coating layer is produced in a plurality of coating steps and a first sub-layer of the first coating layer forming a part of the first coating layer is applied in a first coating step and a second sub-layer of the first coating layer is applied in a separate coating step and the second coating layer is applied in yet another coating step.

16. The method for producing a coated paper product according to item 15, wherein the first coating layer consists of the first and second sub-layers.

17. The method for producing a coated paper product according to any one of the items 8-16, wherein the binder of the first coating layer is (PVOH), starch, starch-based biolatex, or a mixture thereof that is dispersed or dissolved in water when coating the first coating layer on the paper substrate.

18. The method for producing a coated paper product according to any one of the items 8-17, wherein a heat-seal layer is coated on at least part of the second side of the paper substrate.

19. The method for producing a coated paper product according to any one of the items 8-12 or 15-18 comprising drying between coating the first coating layer and second coating layer.

20. A coated paper product comprising:

- a paper substrate comprising a first and a 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) or acrylic latex; and
- 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,
- a heat-seal coating layer provided on at least part of the second side,
- wherein the coat weight of the first coating layer is at least 4 g/m^2, and
- wherein the coat weight of the second coating layer is at least 3 g/m^2.

21. The coated paper product of any one item 20, wherein the coat weight of the first coating layer is 4-10 g/m^2.

22. The coated paper product of any one of items 1-7 or 20-21, wherein the coat weight of the second coating layer is 3-9 g/m^2.

23. The coated paper product of any one of the items 1-7 or 20-22, wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-135 g/m^2, 40-100 g/m^2, such as 40-90 g/m^2, such as 40-60 g/m^2, such as 42-55 g/m^2.

24. The coated paper product of any one of the items 1-7 or 20-23, wherein the grammage measured according to ISO 536:2020 of the coated paper product is 52-142 g/m^2, 52-110 g/m^2, such as 52-95 g/m^2, such as 52-71 g/m^2, such as 56-68 g/m^2.

25. The coated paper product of any one of the items 1-7 or 20-24, wherein the paper substrate is a machine-glazed (MG) kraft paper or a machine finished (MF) kraft paper.

26. The coated paper product of item 25, wherein the paper substrate is a MG paper and the first side of the paper substrate is the non-glazed side of the MG paper.

27. The coated paper product of any one of the items 1-7 or 20-26, wherein the paper substrate is a MG paper and 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.

28. The coated paper product of any one of the items 1-7 or 20-27, wherein the paper substrate is a MG paper and 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.

29. The coated paper product of any one of the items 1-7 or 20-28, wherein at least 80 dry wt.% of the fibres used to form the paper substrate are never-dried.

30. The coated paper product of any one of the items 1-7 or 20-29, wherein the first coating layer comprises talc and/or calcium carbonate ($CaCO_3$) and/or clay and/or mica.

31. The coated paper product of any one of the items 1-7 or 20-30, wherein the total pigment content of the second coating layer is 4-70 % by dry weight, such as 5-50 % by dry weight of the third coating layer.

32. The coated paper product of any one of the items 20-31, wherein the first coating comprises talc in a EAA or VAcA or SA or acrylic latex to talc ratio between 100:5 and 100:110, such as 100:30 and 100:110, such as between 100:30 and 100:75 or $CaCO_3$ in a EAA or VAcA or SA or acrylic latex to $CaCO_3$ ratio between 100:20 and 100:70, such as between 100:30 and 100:65 or EAA or VAcA or SA or acrylic latex to kaolin clay in a ratio between 100:5 and 100:110, such as 100:30 and 100:110, such as between 100:30 and 100:75 or EAA or VAcA or SA or acrylic latex to mica in a ratio between 100:5 and 100:110, such as 100:30 and 100:110, such as between 100:30 and 100:75 or EAA or VAcA or SA or acrylic latex to bentonite clay in a ratio between 100:5 and 100:110, such as 100:30 and 100:110, such as between 100:30 and 100:75.

33. The coated paper product of any one of the items 1-7 or 20-32, wherein the dry weight ratio of EAA to talc in the second coating layer is between 100:10 and 100:70, such as between 100:10 and 100:60, such as between 100:15 and 100:60, such as between 100:15 and 100:40.

34. The coated paper product of any one of the items 1-7 or 20-33, wherein the paper product is heat-sealable.

35. The coated paper product of item 34, 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.

36. The coated paper product of any of the items 1-7 or 20-35, wherein the first and/or second coating layer comprises clay, such as kaolin clay or bentonite clay.

37. The coated paper product of item 36, 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.

38. The coated paper product of any one of the items 1-7 or 20-37, wherein the density measured according to ISO 534:2011 of the paper substrate is 750-950 kg/m^3.

39. The coated paper product of any one of the items 1-7 or 20-38, wherein the thickness measured according to ISO 534:2011 of the paper substrate is 45-150 μm, such as 50-120 μm, such as 50-64 μm, such as 52-61 μm.

40. The coated paper product of any one of the items 1-7 or 20-39, wherein the thickness measured according to ISO 534:2011 of the coated paper product is 50-156 μm, such as 55-126 μm, such as 55-70 μm, such as 57-67 μm.

41. The coated paper product of any one of the items 1-7 or 20-40, wherein the density measured according to ISO 534:2011 of the coated paper product is 950-1100 kg/m^3.

42. The coated paper product of any one of the items 1-7 or 20-41, wherein the paper substrate is bleached, e.g. has an ISO Brightness according to ISO 2470 of at least 77, or unbleached, e.g. has an ISO Brightness according to ISO 2470 of below 60.

43. The coated paper product of any one of the items 1-7 or 20-42, wherein the repulpability measured according to PTS Method PTS-RH 021/97 of the coated paper product is at least 80%.

44. The coated paper product of any one of the items 1-7 or 20-43, 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/(m^2 day).

45. The coated paper product of any one of the items 1-7 or 20-44, 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/(m^2 day).

46. The coated paper product of any one of the items 1-7 or 20-45, 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/(m^2 day).

47. The coated paper product of any one of the items 1-7 or 20-46, 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.

48. The coated paper product of any one of the items 1-7 or 20-47, 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.

49. The coated paper product of any one of the items 1-7 or 20-48, 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.

50. The coated paper product of any one of the items 1-7 or 20-49, 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.

51. The coated paper product of any one of the items 1-7 or 20-50, 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/m^2 at the 1.0 s checkpoint.

52. The coated paper product of any one of the items 1-7 or 20-51, wherein a sealant layer, such as cold-seal layer, is arranged on part of the second coating layer.

53. The coated paper product of any one of the items 1-7 or 20-52, wherein the ash content is below 10 % calculated according:

(A% ash in B g/m^2 base paper + X1 % pigment in Y1 g/m^2 in first coating layer + X2 % pigment in Y2 g/m^2 second coating layer) / Z g/m^2; 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.

54. The coated paper product of any one of the items 1-7 or 20-53, wherein the second side is a print side.

55. The coated paper product of any one of the items 3-7 or 9-43, wherein the heat-seal coating layer on at least part of the second side comprises binder and, optionally, pigment.

56. A flow-wrapped product obtained by flow-wrapping a product in a coated paper product according to any one of the items 1-7 or 20-55, wherein the flow-wrapped product has a longitudinal fin seal and end fin seals.

57. A sealed bag produced from a coated paper product according to any one of the items 1-7 or 20-55, such as a gusseted bag or a pillow bag, having a longitudinal seal and each end portion is sealed by a fin seal.

58. Use of a coated paper product according to any one of the items 1-7 or 20-55 for wrapping a product, such as

flow-wrapping a product, in sealable paper bags, such as a gusseted bag or a pillow bag, in e-commerce packaging, in bedding packaging, such as pillow packaging, or in tissue wrapping.

59. A method of producing a coated paper comprising the steps of:

- providing a paper substrate comprising a first and a 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) or acrylic 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; and
- coating at least part of the second side of the paper substrate with a heat-seal layer,
- wherein the coat weight of the first coating layer is at least 4 g/m^2, and
- wherein the coat weight of the second coating layer is at least 3 g/m^2.

60. A method of producing a coated paper product according to item 59, wherein the first and second coating layers are applied in-line.

61. The method of item 59 or 60 comprising drying between coating with the first coating layer and coating the second coating layer

62. 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 1-7 or 20-55, wherein said flow-wrapping step comprises formation of a fin seal by sealing the coated paper product.

63. The method of flow wrapping a product of item 62, wherein the sealing is conducted by heat-sealing.

64. The method of flow wrapping a product of item 63, 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.

65. The method of flow wrapping a product of items 3-7 or 20-55 further comprising printing the second side of the paper substrate prior to coating with the heat-seal layer.

66. The method of flow wrapping a product of item 65 further comprising printing the second side of the coated paper product and the printing and the application of heat-seal coating layer on the second side and/or the application of the sealant layer onto part of the second coating layer are carried out in the same machine.

67. The method of flow wrapping a product of any one of the items 62-66, wherein the base paper is an MG paper.

68. The method of flow wrapping a product of any one on the items 62-67, wherein the coated paper product is formed into a bag, filled and sealed in a machine, such as a form fill sealing (FFS) machine, such as a vertical form fill sealing (VFFS) machine or horizontal form fill sealing (HFFS) machine.

69. Method of forming a filled bag, in which a coated paper product according to any one of the items 1-7 or 20-55 is formed into a bag, filled and sealed in a machine, such as a form fill sealing (FFS) machine, such as a vertical form fill sealing (VFFS) machine or a horizontal form fill sealing (VFFS) machine.

70. Method of forming a wrapped item comprising the steps of:

a) providing a paper product of any one of items items 1-7 or 20-55;

b) wrapping an item with the paper product; and

c) heat-sealing at least part of the paper product so that a sealed wrapping is formed.

71. The method of item 70, wherein the paper product is sealed to itself in step c).

72. The method of item 70, wherein the paper product is sealed to a second paper product in step c).

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

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.

Fig 2 is a schematic illustration of an embodiment of the coated paper product 2 of the present disclosure. The paper product consists of a paper substrate 101, a first coating layer 102, a second coating layer 103 and a heat seal layer 104.

DETAILED DESCRIPTION

[0009] As a first aspect of the present disclosure, there is provided a coated paper product comprising:

- a paper substrate comprising a first and a second side;
- a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises a binder being polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof; and
- 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

[0010] The coat weight of the first coating layer is typically at least 0.5 g/m^2, such as 1-10 g/m^2. In particular if the binder in the first coating layer is PVOH, a preferred grammage of the first coating layer is about 0.5-3 g/m^2 due to the water content of PVOH.

[0011] By PVOH it is also meant derivatives of PVOH including ethylated PVOH. An example of PVOH is the product with the trade name "Poval" from Kuraray. An example of an ethylated PVOH is the product with the trade name "Exceval" from Kuraray. An ethylated PVOH typically has an ethylene content of about 5-10 % by weight, whereas a non-ethylated PVOH is typically free of ethylene groups.

[0012] By starch-based biolatex is meant starch particles that are dispersed in water, has a low solubility in water, and acts as a polymeric binder. The size of the starch particles are approximately 100 times smaller than regular starch granules. Typical sizes is in the range of 50-200 nanometers.

[0013] A heat-seal layer may be provided on at least part of the second side of the paper substrate. Such heat-seal layer typically comprises binder and, optionally, pigment. The heat-seal layer may be provided in one or may strips to cover at least part of the second side. Alternatively, the heat seal-layer covers the second side completely. A heat-seal layer on the second side is for example advantageous if the coated paper product is to be sealed with a second paper, wherein that second paper is not heat-sealable by itself. An example of such seal is a lap seal.

[0014] The first coating layer may comprise pigment. In such case, the pigment in the first coating layer is talc and/or calcium carbonate ($CaCO_3$) and/or kaolin clay and/or mica and/or bentonite clay. Typically the first coating layer comprises talc in a binder to talc ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75, or $CaCO_3$ in a binder to $CaCO_3$ ratio between 100:20 and 100:70, such as between 100:30 and 100:65 or kaolin clay in a binder to kaolin clay ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or mica in a binder to mica ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or bentonite clay in a binder to bentonite clay ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75. Typically, bentonite clay contains parts of montmorillonite (MMT). Preferably, the total pigment content is 5-70 % by dry weight of the first coating layer, such as 10-50 % by dry weight of the first coating layer. The first coating layer may also be free of pigments.

[0015] It is beneficial that the first coating layer comprises PVOH, starch, starch-based biolatex, SB latex or a mixture thereof as well as talc and/or $CaCO_3$ 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 100:70. The first coating layer may also be free of pigments. The first coating layer preferably comprises talc in a PVOH, starch, starch-based biolatex, SB latex or a mixture thereof to talc ratio of between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75, or $CaCO_3$ in a PVOH, starch, starch-based biolatex, SB latex or a mixture thereof latex to $CaCO_3$ ratio of between 100:20 and 100:70, such as between 100:30 and 100:65.

[0016] As a second aspect of the present disclosure, there is provided a method of producing a coated paper comprising the steps of:

- providing a paper substrate comprising a first and a second side; and
- coating a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises a binder being polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof; and
- coating a second coating layer on the second 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 third coating layer is between 100:5 and 100:70.

[0017] All the 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/m^2 in the 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.

[0018] The second coating layer is typically applied using a blade coater, rod coater, air-knife coater, rotogravure coater or curtain coater. The first coating layer is typically applied using a size press, film press, blade coater, rod coater, air-knife coater, rotogravure coater or curtain coater. The first and second coating layers may be applied with the same coating technique or different coating techniques.

[0019] The first coating layer may be produced in one single coating step or in a plurality of coating steps. In the latter case, the first coating layer is built up by a plurality of sub-layers applied in various runs. In such case, each of the sub-layers preferably have identical composition so that the formed first coating layer is homogenous. At least part of the first coating layer, i.e. a first sub-layer of the first coating layer, may be applied in a first coating step. The rest of the first coating layer, e.g., a second sub-layer, in a separate coating step and the second coating layer in yet another separate coating step. Alternatively, a first sub-layer of the first coating layer, may be applied in a first coating step, whereas a second sub-layer of the first coating layer and the second coating layer are coated in a second and same coating step. Preferably, in case the first coating layer is built up by a plurality of sub-layers, the first coating layer consists of the first and second sub-layers. A curtain coater is preferably used to allow for application of different superposed coating compositions at the same time. Consequently, in the case of two coating steps two curtain coaters are used.

[0020] The first coating layer and the second coating layer may, alternatively, be applied in separate coating steps.

[0021] 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.

[0022] In case the binder of the first coating layer is PVOH, starch, starch-based biolatex, or a mixture thereof it is preferred that the binder is dispersed or dissolved in water when coating the first coating layer on the paper substrate.

[0023] A heat-seal layer may be coated on at least part of the second side of the paper substrate. Such heat-seal layer comprises binder and, optionally, pigment.

[0024] 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.

[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 coated paper product comprising:

- a paper substrate comprising a first and a 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) or acrylic latex; and
- 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,

- a heat-seal coating layer provided on at least part of the second side,
- wherein the coat weight of the first coating layer is at least 4 g/m^2, and
- wherein the coat weight of the second coating layer is at least 3 g/m^2.

[0027] The paper substrate is typically a machine-glazed (MG) paper or a machine finished (MF) paper. The paper substrate may be calendered. The MG or MF 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 or MF paper are never-dried fibres (i.e. virgin fibres).

[0028] 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, i.e. the first side of the paper substrate. Onto the first coating layer, the second coating layer is applied. 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 ($\leq$ 1 g/m^2) for curl prevention. The Bendtsen roughness according to ISO 8791-2:2013 of the glazed side of the paper substrate is typically below 90 ml/min, preferably 70 ml/min or lower, more preferably below 55 ml/min. The PPS roughness according to ISO 8791-4:2007 of the glazed side of the coated paper product is typically below 6.00 μm, such as below 5.00 μm, such as below 4.00 μm.

[0029] An MF paper is produced by a drying technique using a large number of smaller, steam-heated cylinders to dry the paper which is alternately wrapped one way and then the other way so that both sides of the paper receive the same finish. The finish on both sides of an MF paper is similar to the non-glazed side of an MG paper.

[0030] The second side is typically a print side. A lacquer may be provided on the optional print, e.g. to modify gloss, friction and/or release properties.

[0031] The heat-seal coating layer on at least part of the second side typically comprises binder and, optionally, pigment.

[0032] The grammage measured according to ISO 536:2020 of the paper substrate is typically 40-135 g/m^2, 40-100 g/m^2, such as 40-90 g/m^2, such as 40-60 g/m^2, such as 42-55 g/m^2. A suitable density (measured according to ISO 534:2011) for the paper substrate is 750-950 kg/m^3. A too low density is disadvantageous since such paper is too porous for application of a thin barrier. Typically the thickness measured according to ISO 534:2011 of the coated paper product is 50-156 μm, such as 55-126 μm, such as 55-70 μm, such as 57-67 μm.

[0033] Typically, if the paper is used for flow wrapping, a suitable thickness (measured according to ISO 534:2011) of the paper substrate is 50-80 μm, such as 50-64 μm, such as 52-61 μm. A too high grammage or thickness makes the paper not suitable for a flow wrapping process as the paper should be flexible.

[0034] The paper substrate may be bleached, e.g. has an ISO Brightness according to ISO 2470 of at least 77 or unbleached, e.g. has an ISO Brightness according to ISO 2470 of below 60.

[0035] The coatings may comprise a rheology modifier to facilitate the coating operation.

[0036] The first coating layer typically comprises pigment and the pigment is preferably talc and/or calcium carbonate ($CaCO_3$) and/or clay and/or mica and/or bentonite clay. Typically, the first coating comprises talc in a EAA or VAcA or SA or acrylic latex to talc ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or $CaCO_3$ in a EAA or VAcA or SA or acrylic latex to $CaCO_3$ ratio between 100:20 and 100:70, such as between 100:30 and 100:65 or EAA or VAcA or SA or acrylic latex to kaolin clay in a ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or EAA or VAcA or SA or acrylic latex to mica in a ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75 or EAA or VAcA or SA or acrylic latex to bentonite clay in a ratio between 100:5 and 100:110, such as between 100:30 and 100:110, such as between 100:30 and 100:75.

[0037] The dry weight ratio of EAA to talc in the second coating layer is preferably between 100:10 and 100:70, such as between 100:10 and 100:60, such as between 100:15 and 100:60, such as between 100:15 and 100:40. It is advantageous with such filler to EAA or VAcA or SA or acrylic latex ratios in the first and second coating layers with respect to coating ductility, blocking, barrier properties and heat-sealability. Typically, at least 50% by weight of the total pigment content in the second coating layer is talc. Typically, the total pigment content of the second coating layer is 4-70 % by dry weight, such as 5-50 % by dry weight of the third coating layer.

[0038] 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 100:70, this heat-sealability is typically maintained. A higher talc content impairs the sealability as well as the barrier crack resistance. 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.

[0039] 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/m^2 at the 1.0 s checkpoint measured according to TAPPI T 558. The surface energy is derived from the contact angle measurements by plotting $(1+\cos\theta)/2*(\sigma_L/\sigma_L{}^d)^{1/2})$ 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 $\sigma_s{}^p$ and $\sigma_s{}^d$ 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 $\sigma_s{}^p + \sigma_s{}^d$.

[0040] 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. In the latter case, a sealant layer, typically a cold-seal layer, is arranged on at least part of the second coating layer.

[0041] The coat weight of the first coating layer is typically 4-10 g/m^2.

[0042] The coat weight of the second coating layer is typically 3-9 g/m^2. There is preferably a higher coat weight of the first coating layer than the second coating layer. This is advantageous especially if the first coating layer comprises a higher filler content thereby making the first coating layer more economically favourable and environmentally friendly.

[0043] The first and/or second coating layer may comprise clay, such as kaolin clay. In such case, the clay is preferably a platy clay, preferably having a form factor of at least 20, such as at least 30, such as at least 40.

[0044] The repulpability measured according to PTS Method PTS-RH 021/97 of the coated paper product is typically at least 80%. There are four sublevels of repulpability (level A+, A, B, C). A repulpability of at least 80 % is classified as level A repulpable.

[0045] The hexane/heptane vapor transmission rate (HVTR) measured according to the method described in the description of the coated paper product is typically below 200 g/(m^2 day). HVTR barrier properties is a measure of mineral oil migration barrier properties.

[0046] 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 typically below 30 g/(m^2 day). Further WVTR measured according to ISO 15106-1 at 30°C and 80% relative humidity (RH) of the coated paper product is typically below 105 g/(m^2 day).

[0047] Average show through time of palm kernel oil measured according to Standard ISO 16532-1 of the coated paper product is typically at least 45 minutes. Further minimum show through time of palm kernel oil measured according to Standard ISO 16532-1 of the coated paper product is typically at least 10 minutes. A resistance to palm kernel oil is a measure of grease resistance.

[0048] Typically, the ash content is below 10 % calculated according:

(A% ash in B g/m^2 base paper + X1 % pigment in Y1 g/m^2 in first coating layer + X2 % pigment in Y2 g/m^2 second coating layer) / Z g/m^2; 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.

[0049] The dry weight ratio of EAA to talc in the second coating layer is preferably between 100:10 and 100:70, such as between 100:10 and 100:60, such as between 100:15 and 100:60, such as between 100:15 and 100:40. It is advantageous with such ratios in the first and second coating layers with respect to coating ductility, blocking, barrier properties and heat-sealability.

[0050] 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 100:70, this heat-sealability is typically maintained. A higher talc content impairs the sealability as well as the barrier crack resistance. 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.

[0051] 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/m^2 at the 1.0 s checkpoint measured according to TAPPI T 558. The surface energy is derived from the contact angle measurements by plotting $(1+\cos\theta)/2*(\sigma_L/\sigma_L{}^d)^{1/2})$ 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 $\sigma_s{}^p$ and $\sigma_s{}^d$ 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 $\sigma_s{}^p + \sigma_s{}^d$.

[0052] 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. A heat seal layer on at least part of the second side of the paper substrate may also be provided.

[0053] 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.

[0054] 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 repulpability with barrier crack resistance, blocking resistance, low ash content and possible application of a sealant layer.

[0055] 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, repulpability, low ash content and possible application of a sealant layer.

[0056] In yet another particularly preferred embodiment of the coated paper product the first coating layer comprises acrylic latex to pigment in a ratio between 100:30 and 100:110 and the second coating layer comprises EAA to talc in a ratio between 100:50 and 100:70. Such embodiment is beneficial in terms of combining mineral oil barrier properties as well as water vapour barrier properties with barrier crack resistance, blocking resistance, grease resistance, repulpability and possible application of a sealant layer.

[0057] The examples and embodiments discussed above in connection to the first and second aspects apply to the third aspect *mutatis mutandis.* In particular, the paper substrate, second coating layer, coated paper product and optional heat-seal coating layer of the first and second aspect apply to the paper substrate, second coating layer, coated paper product and heat-seal coating layer of the third aspect.

[0058] As a fourth aspect of the present disclosure, there is provided a flow-wrapped product obtained by flow-wrapping a product in a coated paper product according to the first aspect or in a coated paper product according to the third aspect, wherein the flow-wrapped product has a longitudinal fin seal and end fin seals. A flow-wrapped product is obtainable from a HFFS machine.

[0059] The examples and embodiments discussed above in connection to the first, second and third aspects apply to the fourth aspect *mutatis mutandis.*

[0060] As a fifth aspect of the present disclosure, there is provided a sealed bag, such as a gusseted bag or a pillow bag, having a longitudinal seal and each end portion is sealed by a fin seal produced from a coated paper product according to the first aspect or from a coated paper product according to the third aspect.

[0061] A filled gusseted bag is obtainable from a VFFS machine. Such bag has a longitudinal seal adhering two overlapping ends of the paper material to each other to form a lap seal. In an alternative embodiment of the filled bag, the longitudinal seal is a fin seal. Further, the bag has a top end sealed by a fin seal and a bottom end sealed by a fin seal.

[0062] A filled pillow bag is obtainable from a VFFS machine. Such bag has a longitudinal seal adhering two overlapping ends of the paper material to each other to form a lap seal. In an alternative embodiment of the filled bag, the longitudinal seal is a fin seal. Further, the bag has a top end sealed by a fin seal and a bottom end sealed by a fin seal.

[0063] The examples and embodiments discussed above in connection to the first, second, third and fourth aspect apply to the fifth aspect *mutatis mutandis.*

[0064] As a sixth aspect of the present disclosure, there is provided use of a coated paper product according to the first aspect or a coated paper product according to the third aspect for wrapping a product, such as flow-wrapping a product, in sealable paper bags, such as a gusseted bag or a pillow bag, in e-commerce packaging, in bedding packaging, such as pillow packaging, or in tissue wrapping.

[0065] The examples and embodiments discussed above in connection to the first, second, third, fourth and fifth aspect

apply to the sixth aspect *mutatis mutandis.*

[0066] As a seventh aspect of the present disclosure there is provided a method of producing a coated paper comprising the steps of:

- providing a paper substrate comprising a first and a 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) or acrylic 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; and
- coating at least part of the second side of the paper substrate with a heat-seal layer,
- wherein the coat weight of the first coating layer is at least 4 g/m^2, and
- wherein the coat weight of the second coating layer is at least 3 g/m^2.

[0067] The examples and embodiments discussed above in connection to the first, second, third, fourth, fifth and sixth aspect apply to the seventh aspect *mutatis mutandis*.

[0068] As an eighth aspect of the present disclosure there is provided a method of flow-wrapping a product comprising a step of flow-wrapping the product in a coated paper product according to the first aspect of the present disclosure or a coated paper product according to the third aspect of the present disclosure, wherein said flow-wrapping step comprises formation of a fin seal by sealing the coated paper product.

[0069] Typically, the sealing is conducted by heat-sealing. Alternatively, the method further comprises the step of applying a sealant layer, preferably a cold-seal layer, onto part of the third coating layer prior to formation of a fin seal and sealing is conducted by sealing said sealant layer.

[0070] The base paper is typically an MG paper. In such case, the method may further comprise the step of printing the glazed side of the coated paper product. The printing of the glazed side of the coated paper product and the printing and the application of the sealant layer may be carried out in the same machine. Typically, the coated paper product is formed into a bag, filled and sealed in a machine, such as a form fill sealing (FFS) machine, such as a vertical form fill sealing (VFFS) machine or horizontal form fill sealing (HFFS) machine.

[0071] A typical product to be flow-wrapped in the paper-based material of the present disclosure is a protein bar, a snack bar or a chocolate bar.

[0072] The examples and embodiments discussed above in connection to the first, second, third, fourth, fifth, sixth and seventh aspect apply to the eighth aspect *mutatis mutandis.*

[0073] As a ninth aspect of the present disclosure there is provided a method of forming a filled bag, in which a coated paper product according to the first aspect of the present disclosure or a coated paper product according to the third aspect of the present disclosure is formed into a bag, filled and sealed in a machine, such as a form fill sealing (FFS) machine, such as a vertical form fill sealing (VFFS) machine or horizontal form fill sealing (HFFS) machine.

[0074] A typical product to be packed in a sealed barrier bag made from the paper-based material of the present disclosure are dry foods, such as confectionary or baked goods. Alternatively, the product is cosmetics and toiletries.

[0075] The examples and embodiments discussed above in connection to the first, second, third, fourth, fifth, sixth, seventh and eighth aspect apply to the ninth aspect *mutatis mutandis.*

[0076] As a tenth aspect of the present disclosure there is provided a method of forming a wrapped item comprising the steps of:

a) providing a coated paper product according to the first disclosure or a coated paper product according to the third disclosure;

b) wrapping an item with the paper product; and

c) heat-sealing at least part of the paper product so that a sealed wrapping is formed.

[0077] The paper product may be sealed to itself in step c). In such case, the wrapped item can be produced from a single paper product by folding the paper product followed by heat-sealing. Alternatively, the paper product is sealed to

a second paper product in step c). In such case, the overwrapped item can be produced without the need for folding any of the paper products.

[0078] A typical item, i.e. product, that is wrapped is tissue wrapping, such as wrapping of rolls of kitchen paper towels and/or toilet paper, or bedding wrappings, such as pillows and duvets.

[0079] The examples and embodiments discussed above in connection to the first, second, third, fourth, fifth, sixth, seventh, eighth and ninth aspect apply to the tenth aspect *mutatis mutandis*.

EXAMPLES

Coating of paper

[0080] 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% or acrylic latex (Rhobarr 214, DOW) having a solids content of about 45%.

[0081] 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 for samples 1-17 & 20-23.

[0082] 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
*Unusually high, the value is normally between 2.4 and 4.1 μm.			

[0083] Two samples (sample 18-19) were produced by coating a machine finished (MF) base paper with a grammage of 70 g/m^2 (sample 18) and a grammage of 80 g/m^2 (sample 19) in the same way as on the MG base paper.

[0084] A first coating layer comprising latex and pigment (samples 1-16 & 18-22) or latex but no pigment (sample 17) 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 (samples 1-18 & 22-23) or latex but no pigment (samples 20-21) 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 (parts by weight) and coat weights of first and second coating layers.

		First coating layer							Second coating layer				
Sample	Paper substrate	EAA latex	VAcA latex	Acrylic latex	Talc	Kaolin Clay	$CaCO_3$	Coating grammage (g/m^2)	EAA latex	Talc	Kaolin Clay	$CaCO_3$	Coating grammage (g/m^2)
1	MG	100				100		8.10	100		100		7.20
2	MG	100			100			6.90	100	100			6.70
3	MG	100			50	50		8.10	100	50	50		8.00
4	MG	100				50		6.60	100		50		5.40
5	MG	100			100			9.30	100	100			9.10
6	MG	100			100			9.30	100	12			8.00
7	MG	100					40	7.80	100			40	8.40
8	MG	100					40	7.80	100	12			7.00
9	MG	100					80	9.20	100			80	9.90
10	MG	100					80	9.20	100	12			5.20
11	MG	100			50			5.76	100	50			5.00
12	MG	100			50			5.76	100	25			4.50
13	MG		100		50			5.63	100	50			4.50
14	MG		100		50			5.63	100	25			5.20
15	MG		100				50	8.10	100	50			5.20
16	MG		100				50	8.10	100	25			5.00
17	MG	100						6.0	100	20			6.0
18	MF 70 g/m^2	100			70			8.5	100	70			7.8
19	MF 80 g/m^2	100			50			8	100	50			8
20	MG		100		20			7.5	100				7.5
21	MG		100		75			7.7	100				8.1
22	MG	100					40	7.8	100	80			6
23	MG			100	100			6.4	100	68			8

Barrier properties

WVTR

[0085] 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

[0086] 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:

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

[0087] 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
17	6.6	22.5	
18	7.1	42.5	

(continued)

Sample	WVTR (23°C/50%RH)	WVTR (30°C/80%RH)	HVTR (g/m^2*d)
19	5	67	
20	4.5	38.8	
21	5.6	41.8	
22	15.9	90	
23	8	39.9	23

[0088] The inventors have realized that the greatest contribution to the barrier properties is provided by the composition of the second barrier coating. It is, thus, fair to assume that other binders in the first coating layer than the ones evaluated herein will provide good barrier properties as long as the second coating layer is according to the present disclosure.

Runnability & handling

Folded paper oil resistance - crack-resistance measurement

[0089] 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.

[0090] Rape seed oil was mixed with 1 % colorant (Sudan blue II) and stirred on a magnetic stirrer until fully mixed.

[0091] 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.

[0092] 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.

[0093] 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
15-30	Moderate
>30	Poor

Blocking

[0094] 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

(continued)

	Blocking
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

[0095] 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	Moderate	No	2.86±0.12
5	Poor	No	
6	Good	No	
7	Moderate	No	
8	Good	No	
9	Poor	No	
10	Moderate	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	
17	Excellent	No	
18	Excellent	No	3.9
19	Good		5
20	Poor		
21	Poor		
22	Poor	Yes, some	
23	Good	No	

[0096] A high barrier crack resistance in combination with blocking resistance as well as good barrier properties against both water vapour and mineral oil was obtained for both pigmented pre-coating (samples 11-16,18-19 & 23) as well as a pre-coating free of pigments (sample 17). The same applies to the lower grammage MG paper (samples 11-17 & 23) as well as the higher grammage MF paper (samples 18-19), and heat-sealibilty was obtained independently of MG paper (samples 11-12) or MF paper (sample 18).

[0097] Just as for the barrier properties, it is fair to assume that greatest contribution to blocking is caused by the second coating layer. Hence, other binders in the first coating layer than the ones evaluated herein will provide good blocking barrier properties as long as the second coating layer is according to the present disclosure.

Contact angle and surface energy

[0098] 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 $(1+\cos\theta)/2^{*}(\sigma_L/\sigma_L{}^{d})^{1/2})$ 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 $\sigma_s{}^{p}$ and $\sigma_s{}^{d}$ 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 $\sigma_s{}^{p} + \sigma_s{}^{d}$.

[0099] 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

[0100] 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.

[0101] The total surface energy is the key factor to wetting. Moreover, it is believed by the inventors that it is the top-coating that contributes the most to the total surface energy. A similar top-coat to that in samples 9-11 is therefore fair to assume that such top-coat is also wettable with a 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	
17				
18	97		25.9	
19				
20				
21				
22				
23				

[0102] Just as for the barrier properties and blocking properties, it is fair to assume that greatest contribution to possibility to apply a sealant layer is caused by the second coating layer. Hence, other binders in the first coating layer than the ones evaluated herein will provide the possibility of providing a sealant layer as long as the second coating layer is according to the present disclosure.

Grease resistance

Show through time

[0103] 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
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
17		
18	1044	281
19	603	
20		
21		
22	49	37
23	379	93

Repulpability & ash content

Repulpability

[0104] The repulpability was measured according to PTS Method PTS-RH 021/97 and the results are presented in Table 8.

Ash content

[0105] To fulfil food-grade packaging legislation in Italy it is required that the ash content is below 10 %.

[0106] The ash content was calculated according: (3% ash in 48 g/m^2 base paper + X1 % pigment in Y1 g/m^2 in first coating layer + X2 % pigment in Y2 g/m^2 second coating layer) / Z g/m^2; 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.

[0107] The calculated ash contents are presented in Table 8.

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

Sample	Repulpability	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%
11	79.7%	8%
12	81.0%	7%
13	86.9%	8%
14	84.6%	7%
15	84.9%	9%
16	85.1%	8%
17		
18	80.0%	
19		
20		
21		
22		
23	86.4%	

[0108] There are four sublevels of repulpability (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 repulpability of at least 80 % were classified as level A repulpable.

[0109] Both for the lower grammage MG paper and the higher grammage MF paper a level A repulpable classification was measured and obtained for samples 8, 12-16, 23 (MG paper) and 18 (MF paper).

Claims

1. A coated paper product comprising:

   - a paper substrate comprising a first and a second side;
   - a first coating layer on the first side of the paper substrate, wherein the first coating layer comprises polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof; and
   - 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.

2. The coated paper product of claim 1, wherein the coat weight of the first coating layer is at least 0.5 g/m^2, such as 1-10 g/m^2.

3. The coated paper product of claim 1 or 2, wherein the coat weight of the second coating layer is at least 3 g/m^2, such as 3-9 g/m^2.

4. The coated paper product of any one of the preceding claims, wherein the first coating layer comprises pigment.

5. The coated paper product of any one of the preceding claims, wherein the grammage measured according to ISO 536:2020 of the paper substrate is 40-135 g/m^2, such as 40-100 g/m^2, such as 40-90 g/m^2, such as 40-60 g/m^2, such as 42-55 g/m^2.

6. 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 100:70, such as between 100:10 and 100:60, such as between 100:15 and 100:60, such as between 100:15 and 100:40.

7. A method of producing a coated paper comprising the steps of:

   - providing a paper substrate comprising a first and a second side; and
   - coating the first side of the paper substrate with a first coating layer, wherein the first coating layer comprises polyvinyl alcohol (PVOH), starch, starch-based biolatex, styrene-butadiene (SB) latex or a mixture thereof; and
   - coating a second coating layer on the second 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.

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

9. A coated paper product comprising:

   - a paper substrate comprising a first and a 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) or acrylic latex; and
   - 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,
   - a heat-seal coating layer on at least part of the second side,
   - wherein the coat weight of the first coating layer is at least 4 g/m^2, and
   - wherein the coat weight of the second coating layer is at least 3 g/m^2.

10. A flow-wrapped product obtained by flow-wrapping a product in a coated paper product according to any one of the claims 1-7 or 9, wherein the flow-wrapped product has a longitudinal fin seal and end fin seals.

11. A sealed bag produced from a coated paper product according to any one of the claims 1-7 or 9, such as a gusseted bag or a pillow bag, having a longitudinal seal and each end portion is sealed by a fin seal.

12. Use of a coated paper product according to any one of the claims 1-7 or 9 for wrapping a product, such as flow-wrapping a product, in sealable paper bags, such as a gusseted bag or a pillow bag, in e-commerce packaging, in bedding packaging, such as pillow packaging, or in tissue wrapping.

13. 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 claims 1-6 or 8, wherein said flow-wrapping step comprises formation of a fin seal by sealing the coated paper product.

14. Method of forming a filled bag, in which a coated paper product according to any one of the claims 1-7 or 9 is formed into a bag, filled and sealed in a machine, such as a form fill sealing (FFS) machine, such as a vertical form fill sealing (VFFS) machine or horizontal form fill sealing (VFFS) machine.

15. Method of forming a wrapped item comprising the steps of:

a) providing a paper product of any one of claims 1-7 or 9;
b) wrapping an item with the paper product; and
c) heat-sealing at least part of the paper product so that a sealed wrapping is formed.

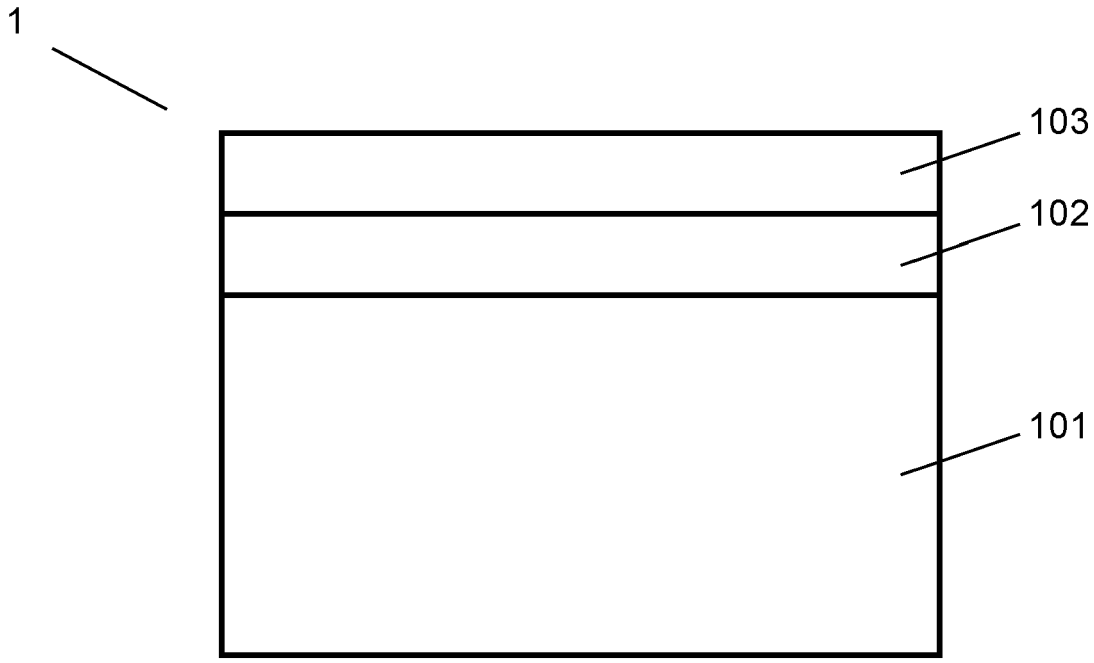

Fig. 1

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 4175

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2023 010964 A (JUJO PAPER CO LTD) 20 January 2023 (2023-01-20) * paragraphs [0052], [0086] * * paragraph [0078] - paragraph [0080] * -----	1-4,6-8, 10-15	INV. D21H19/40 B32B29/00 D21H19/54 D21H19/82
X	JP 2022 011700 A (OJI HOLDINGS CORP) 17 January 2022 (2022-01-17) * paragraph [0013] - paragraph [0020] * -----	1,5,7, 10-15	D21H27/10
Y	WO 2019/099787 A1 (IMERYS USA INC [US]) 23 May 2019 (2019-05-23) * paragraph [0033] - paragraph [0041] * * paragraph [0004] - paragraph [0024] * * paragraph [0080] - paragraph [0084] * -----	9-15	
Y	EP 3 929 355 A1 (SUSTAINABLE CARBOHYDRATE INNOVATION CO LTD [TW]) 29 December 2021 (2021-12-29) * paragraph [0038] - paragraph [0044] * * paragraph [0051] * -----	9-15	
Y	JP 2023 027649 A (OJI HOLDINGS CORP) 2 March 2023 (2023-03-02) * paragraph [0024] - paragraph [0026] * -----	9-15	TECHNICAL FIELDS SEARCHED (IPC) D21H B32B
A	JP 6 939976 B1 (OJI HOLDINGS CORP) 22 September 2021 (2021-09-22) * claims 1-11 * -----	1-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 August 2023	Billet, Aina

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 16 4175

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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30-08-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2023010964 A	20-01-2023	NONE	
JP 2022011700 A	17-01-2022	JP 7268648 B2	08-05-2023
		JP 2022011700 A	17-01-2022
		JP 2023086819 A	22-06-2023
WO 2019099787 A1	23-05-2019	BR 112020009159 A2	27-10-2020
		CA 3080929 A1	23-05-2019
		CN 111902513 A	06-11-2020
		EP 3710547 A1	23-09-2020
		JP 2021503563 A	12-02-2021
		US 2020361196 A1	19-11-2020
		WO 2019099787 A1	23-05-2019
EP 3929355 A1	29-12-2021	CN 113832774 A	24-12-2021
		EP 3929355 A1	29-12-2021
		TW 202200868 A	01-01-2022
		US 2021394983 A1	23-12-2021
JP 2023027649 A	02-03-2023	NONE	
JP 6939976 B1	22-09-2021	AU 2021280006 A1	05-01-2023
		CN 115667629 A	31-01-2023
		EP 4159919 A1	05-04-2023
		JP 6939976 B1	22-09-2021
		JP 2021188241 A	13-12-2021
		US 2023243106 A1	03-08-2023
		WO 2021241427 A1	02-12-2021

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