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(54) STARCH COATED PAPERBOARD

(57) There is provided a coated paperboard comprising a paperboard substrate and one or more coating layers provided on the printing side of the paperboard wherein:
- the one or more coating layers comprise binders and pigment;
- the binders comprise at least one synthetic binder and at least one starch-based binder; and
- the starch-based binder is present in an amount of 70-95 wt.% based on the total dry amount of binder in the one or more coating layers.

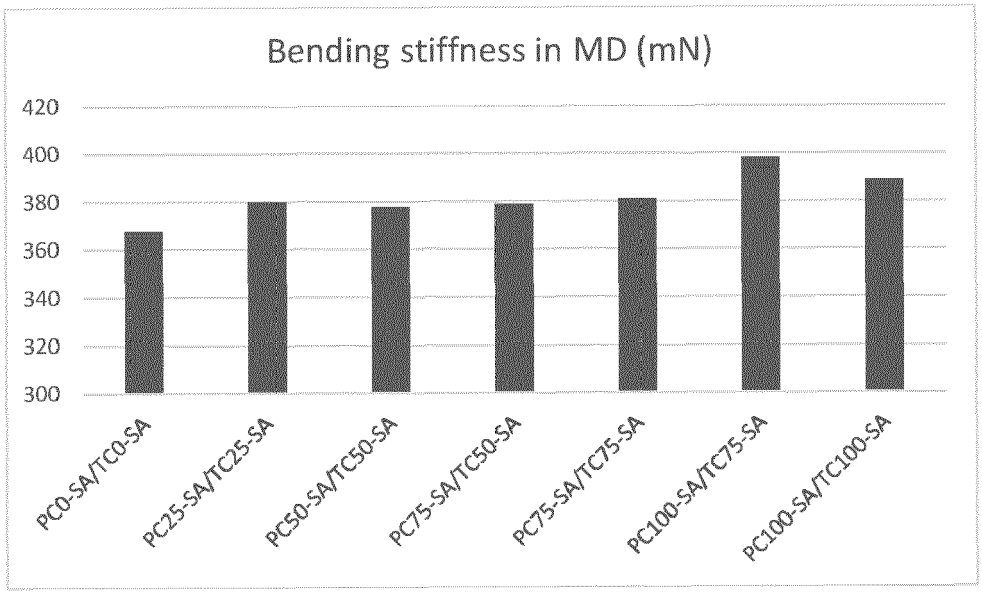

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of pigment-coated paperboards, more specifically pigment-coated paperboards for use as liquid packaging boards.

BACKGROUND

[0002] Pigment-coated paperboard is commonly provided with at least one coating layer, e.g. a pre-coating and a top coating, in order to induce certain surface properties such as printability. The pigment coatings usually comprise a binder and a pigment.

[0003] The commonly used binders in paper coating compositions are synthetic binder such as styrene and acrylic (co) polymers. While these binders give rise to desirable properties to the coated paperboard, they are often fossil-based and nondegradable.

[0004] Furthermore, in applications such as liquid packaging boards (LPB) there is a desire to have a good printability of the final packaging material. Hence, the surface of the outer layer needs to be suitable for printing.

SUMMARY

[0005] There is a general desire to reduce the grammage of paperboard, e.g. LPB, in order to reduce the cost of the product. However, the possibility to do so is often limited by bending stiffness requirements. If the bending stiffness of coated paperboards can be increased by other means, a reduction in grammage is possible. The inventors have realized that the bending stiffness of a paperboard can be significantly increased by coating it with at least one coating layer comprising at least one pigment and a mixture of a starch-based binder and a synthetic binder. In addition to the increase in bending stiffness, the binder mixture also gives rise to a good printing surface and reduces the environmental impact of the coating layer (since starch is a renewable material).

[0006] Accordingly, the present disclosure provides a coated paperboard comprising a paperboard substrate and one or more coating layers (such as at least two layers) provided on the printing side of the paperboard wherein:

- the one or more coating layers comprise binders and pigment;
- the binders comprise at least one starch-based binder and at least one synthetic binder; and
- the starch-based binder is present in an amount of 70-95 wt.% based on the total amount of binder in the one or more coating layers.

[0007] The weight percentages (wt.%) of the present disclosure refer to dry weight.

[0008] The paperboard according to the present disclosure has an increased bending stiffness as a result of the at least one coating layer comprising the mixture of a starch-based binder and a synthetic binder. The improved bending stiffness enables a reduction in the grammage of the paperboard substrate and hence leads to a cost reduction while maintaining good convertibility. The binder mixture further maintains an adequate printing surface or even improves the printability of the paperboard surface. A further advantage of the present disclosure is that a large part of the binders is bio-based and compostable, hence improving the environmental profile of the coated paperboard.

[0009] In one embodiment, the starch-based binder is present in an amount of 72-95 wt.%, such as 80-95 wt.% based on the total amount of binder in the one or more coating layers.

[0010] In one embodiment, the coated paperboard comprises one coating layer comprising the starch-based binder. The one coating layer is present as the only coating layer comprising the starch-based binder on a first side of the paperboard substrate, i.e. the coating layer is provided on a printing side of the paperboard.

[0011] The coat weight of the one coating layer may be 10-23 g/m^2, such as 10-18 g/m^2, such as 10-16 g/m^2. An advantage of the single coating layer is that a reduction in coat weight may be obtained. A reduction in coat weight is desirable as it leads to a cost reduction as well as a reduced environmental impact.

[0012] In another embodiment, the coated paperboard comprises at least two coating layers provided on a printing side of the paperboard comprising the starch-based binder. The at least two coating layers may be at least one pre-coating and at least one top coating.

[0013] In a preferred embodiment, the starch-based binder is present in the pre-coating in an amount of 95-100 wt.% based on the total dry amount of binder and in the pre-coating in an amount of 60-90 wt.%, such as 65-85 wt.%, based on the total dry amount of binder in the top coating. This enables a particularly high increase in bending stiffness.

[0014] The coat weight of the at least one pre-coating may be 4-13 g/m^2, such as 6-10 g/m^2, such as 7-9 g/m^2. Furthermore, the coat weight of the at least one top coating may be 4-15 g/m^2, such as 5-14 g/m^2, such as 6-12 g/m^2.

[0015] The ratio between pigment and the binders in the one or more coating layers maybe 100:13 to 100:25, such as 100:14 to 100:22, such as 100:15 to 100:22. Such a ratio between pigment and binder may lead to a particularly good coating cohesion enabling a strong coating. The ratios discussed herein are dry weight ratios.

[0016] If the paperboard comprises at least one pre-coating and at least one top coating, the ratio between pigment and the binders in the at least one pre-coating maybe 100:13 to 100:20, such as 100:13 to 100:18. Further, the ratio between pigment and the binders in the top coating may be of 100:14 to 100:25, such as 100:15 to 100:22.

[0017] The synthetic binder may be a styrene-acrylic binder and/or styrene-butadiene binder, preferably the synthetic binder is styrene-acrylic binder.

[0018] The starch-based binder may be provided in the form of starch particles, preferably in the form of a dispersion of starch particles. The starch particles are preferably nanoparticles having particle diameter of less than 1000 nm, such as 50-1000, such as 200-1000 nm.

[0019] The pigment of the one or more coating layers may be clay, calcium carbonate and/or talc. In one embodiment, the one or more coating layers comprise calcium carbonate and clay. In another embodiment, the one or more coating layers comprise calcium carbonate, optionally as the only pigment. The embodiments comprising calcium carbonate and/or clay may give rise to a particularly good surface for printability.

[0020] The paperboard substrate may have a density of 550-900 kg/m3 and/or a grammage of between 100 and 400 g/m^2, e.g. between 120 and 300 g/m^2, such as between 125 and 260 g/m^2.

[0021] In an embodiment, the coated paperboard is a liquid packaging board.

[0022] In a further embodiment, the paperboard substrate of the liquid packaging board comprises at least two, such as at least three layers and each layer comprises hydrophobic size. The hydrophobic size may be alkenyl succinic anhydride (ASA), alkyl ketene dimer (AKD) and/or rosin size. Preferably, each layer comprises at least one of AKD and ASA.

[0023] The hydrophobic size is preferably added as internal sizing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Fig 1 shows the bending stiffness in machine direction of paperboards coated with compositions comprising biolatex and/or SA-latex.

Fig 2 shows the bending stiffness in cross-direction of paperboards coated with compositions comprising biolatex and/or SA-latex.

Fig 3 shows the bending stiffness in machine direction of paperboards coated with compositions comprising biolatex and/or SB-latex.

Fig 4 shows the bending stiffness in cross-direction of paperboards coated with compositions comprising biolatex and/or SB-latex.

Fig 5 shows the visual appearance of paperboards coated with compositions comprising biolatex and/or SB-latex.

Fig 6 shows the STFI mottle at full tone of paperboards coated with compositions comprising biolatex and/or SB-latex.

DETAILED DESCRIPTION

[0025] The present disclosure relates to a coated paperboard comprising a paperboard substrate and one or more coating layers wherein the binders in the one or more coating layers comprise at least 70 wt.% of a starch-based binder. The coated paperboard according to the present disclosure has a significantly higher bending stiffness compared to paperboards coated with conventional coating layers, e.g. coating layers only comprising styrene-acrylic or styrene-butadiene binder. The increased bending stiffness may allow for a reduction in grammage of the paperboard substrate and hence a cost reduction while maintaining good convertibility and package rigidity.

[0026] The paperboard substrate may comprise at least two layers, such as at least three layers wherein the top layer of the paperboard substrate is provided with the one or more coating layers. The top layer of the paperboard substrate is typically bleached. Each layer of the paperboard substrate may comprise hydrophobic size such as ASA, AKD and/or rosin size.

[0027] The paperboard substrate may comprise other conventional additives such as fillers and colouring agents.

[0028] The one or more coating layers comprise binders and pigment. Furter, the binders comprise at least one starch-based binder and at least one synthetic binder.

[0029] The starch-based binder may be provided in the form of a dispersion of starch particles wherein the starch particles are present as colloids. The dispersion may further comprise dissolved starch polymer. The starch particles are preferably nanoparticles having particle diameter of less than 1000 nm, such as 50-1000, such as 200-1000 nm. The starch particles may further be cross-linked.

[0030] The synthetic binder may be a waterborne colloid dispersion of synthetic polymers such as fossil-based polymers, i.e., a latex. The synthetic polymer may be based on acrylic and/or styrenic monomers. Preferably, the synthetic binders are styrene-acrylic binders and/or styrene-butadiene binders. Using styrene-acrylic binders in the present invention, can give rise to an especially high increase in bending stiffness while using styrene-butadiene may in addition to an increase in bending stiffness also give rise to an improved printing surface.

[0031] The one or more coating layers may comprise 70-95 wt.%, such as 72-95 wt.%, such as 80-95 wt.% starch-based binder based on the total amount of binder in the one or more coating layers. By using at least one coating layer comprising 70-95 wt.% of the starch-based binder, a significant increase in bending stiffness of the coated paperboard is obtained while simultaneously maintaining a good surface for printing. In some cases, an improvement of the printability of the surface is also obtained. A particularly high increase in bending stiffness and/or improvement of the printing surface may be obtained when the amount of starch-based binder is 80-95 wt.% based on the total amount of binder in the one or more coating layers.

[0032] The one or more coating layers may be present in an amount of 10-25 g/m^2, such as 12-22 g/m^2, such as 14-20 g/m^2. It is desirable to keep the coating amount as low as possible to reduce the cost and the environmental impact of the one or more coating layers.

[0033] The ratio between pigment and the binders in the one or more coating layers may be 100:13 to 100:25, such as 100:14 to 100:22, such as 100:15 to 100:22. If the coated paperboard comprises more than one coating layer, such as two coating layers, the combined ratio between pigment and binder for both coating layers may be 100:13 to 100:25. The specific ratio between pigment and binder may lead to a particularly good cohesion of the coating which enables a strong coating. Another effect may be an improved PE adhesion which is advantageous since it prevents delamination during forming of packages from the paperboard.

[0034] According to one embodiment, the coated paperboard comprises one coating layer comprising the starch-based binder. In this embodiment, a first side of the paperboard substrate is coated with said coating and the first side preferable does not comprise any additional coating layer comprising a starch-based binder. The coating layer is provided on a printing side of the paperboard. Coating layers which do not comprise a starch-based binder may be applied on top of the inventive coating layer and/or between the paperboard substrate and the inventive coating layer.

[0035] In case of a single coating layer, the coat weight may be 10-23 g/m^2, such as 10-18 g/m^2, such as 10-16 g/m^2.

[0036] An effect of applying a single coating layer on the first side of the paperboard substrate may be that a smaller coating amount is needed. This may result in a reduction of cost as well as environmental impact. Furthermore, applying a single coating layer requires less equipment.

[0037] According to another embodiment, the coated paperboard comprises at least two coating layers comprising a starch-based binder, such as at least one pre-coating and at least one top coating applied to a first side of the paperboard substrate.

[0038] The coated paperboard may further comprise at least one coating layer on a second side of the paperboard substrate. The coating layer on the second side of the paperboard substrate may comprise a starch-based binder.

[0039] The pre-coating may have a coat weight of 4-13 g/m^2, such as 6-10 g/m^2, such as 7-9 g/m^2. The coat weight of the top coating may be 4-15 g/m^2, such as 5-14 g/m^2, such as 6-12 g/m^2.

[0040] Application of the one or more coating layers may occur by e.g. curtain coating, blade coating and/or using a size press.

[0041] In the embodiment wherein the coated paperboard comprises at least one pre-coating and at least one top coating, the ratio between pigment and the binders in the at least one pre-coating maybe 100:13 to 100:20, such as 100:13 to 100:18. Likewise, the ratio between pigment and the binders in the top coating may be 100:14 to 100:22, such as 100:15 to 100:20.

[0042] The paperboard substrate may have a density of 550-900 kg/m^3 and/or a grammage of between 100 and 400 g/m^2, e.g. between 120 and 300 g/m^2, such as between 125 and 260 g/m^2.

[0043] In an embodiment, the coated paperboard is a liquid packaging board.

EXAMPLES

[0044] A pilot study was performed using pre-coatings and top coatings comprising different amounts of starch-based binder wherein the amount ranged from 0 wt.% to 100 wt.%.

[0045] The paperboard substrate was a three-ply paperboard. All plies comprised hydrophobic size (AKD + rosin size).

[0046] The starch-based binder, herein denoted "biolatex", was a dispersion of cross-linked nano-sized starch particles, EcoSphere 2330, obtained from EcoSynthetix. Styrene-acrylic and styrene-butadiene lattices were used as the synthetic binders.

[0047] All the tested samples comprised a pre-coating and a top coating.

[0048] The pre-coating was applied in an amount of 8.5 g/m^2 for pre-coatings PC0-SA - PC100-SA and in an amount of 8 g/m^2 for pre-coatings PC0-SB - PC100-SB.

[0049] The top coatings were applied in an amount of 11.5 g/m^2 for top coatings TC0-SA - TC100-SA and in an amount of 7 g/m^2 for top coatings TC0-SB - TC100-SB.

Table 1. The pre-coatings with biolatex and styrene-acrylic binder (SA-latex). "Biolatex (%)" means the amount of biolatex based on the total dry amount of binder in the coating layer. The viscosity of the pre-coatings was around 1000 cP and the dry content of the pre-coatings was 60-65 wt.%.

Pre-coating	PC0-SA	PC25-SA	PC50-SA	PC75-SA	PC100-SA
Biolatex (%)	0	25	50	75	100
$CaCO_3$* (parts)	80	80	80	80	80
Clay** (parts)	20	20	20	20	20
SA-latex (parts)	14	10.5	7	3.5	-
Biolatex (parts)	-	3.5	7	10.5	14
RM***	0.45	0.35	0.25	0.25	0.35
*The $CaCO_3$ used is Hydrocarb 60 from Omya. ** The clay used is Capim BK-1. ***Rheology modifier.					

Table 2. The pre-coatings with biolatex and styrene-butadiene binder (SB latex). "Biolatex (%)" means the amount of biolatex based on the total dry amount of binder in the coating layer. The viscosity (measured using Brookfield, spindle 4 at 100 rpm) of the pre-coatings was around 1000 cP and the dry content of the pre-coatings was 60-65 wt.%.

Pre-coating	PC0-SB	PC25-SB	PC50-SB	PC0-SB*	PC75-SB	PC100-SB
Biolatex (%)	0	25	50	0	75	100
$CaCO_3$** (parts)	70	70	70	70	70	70
Clay (parts)	30***	30***	30***	30****	30****	30****
SB-latex (parts)	14	10.5	7	14	3.5	-
Biolatex (parts)	-	3.5	7	-	10.5	14
RM (parts)	0.79	0.56	0.42	0.75	0.26	0.60
*This is the reference for PC75-SB and PC100-SB. ** The $CaCO_3$ used is Hydrocarb 60 from Omya. ***The clay used is Kaolux HS. ****The clay used is Capim BK-1.						

Table 3. Top coatings with biolatex and styrene-acrylic binder (SA-latex). "Biolatex (%)" means the amount of biolatex based on the total dry amount of binder in the coating layer. The viscosity of the top coatings was around 1000 cP and the dry content of the top coatings was 59-63 wt.%.

Top coating	TC0-SA	TC25-SA	TC50-SA	TC75-SA	TC100-SA
Biolatex (%)	0	25	50	75	100
$CaCO_3$-1* (parts)	40	40	40	40	40
$CaCO_3$-2** (parts)	40	40	40	40	40
Clay*** (parts)	20	20	20	20	20

(continued)

Top coating	TC0-SA	TC25-SA	TC50-SA	TC75-SA	TC100-SA
SA-latex (parts)	17	12.75	8.5	4.25	-
Biolatex (parts)	-	4.25	8.5	12.75	17
RM (parts)	0.4	0.3	0.2	0.15	0.25
*The $CaCO_3$-1 is Hydrocarb 90 from Omya. **The $CaCO_3$-2 is Covercarb 75 from Omya. *** The clay is Capim BK1.					

Table. 4 Top coatings with biolatex and styrene-butadiene binder (SB-latex). "Biolatex (%)" means the amount of biolatex based on the total dry amount of binder in the coating layer. The viscosity of the top coatings was around 1000 cP and the dry content of the top coatings was 60-62 wt.%.

Top coating	TC0-SB	TC25-SB	TC50-SB	TC0-SB*	TC75-SB	TC100-SB
Biolatex (%)	0	25	50	0	75	100
$CaCO_3$** (parts)	85	85	85	85	85	85
Clay*** (parts)	15	15	15	15	15	15
SB-latex (parts)	18	13.5	9	18	4.5	-
Biolatex (parts)	-	4.5	9	-	13.5	18.0
RM (parts)	1	0.32	0.28	0.8	0.40	0.50
* This is the reference for TC75-SB and TC100-SB. **The $CaCO_3$ was Hydrocarb 90 from Omya. ***The clay was Kaofine 90.						

[0050] Different pre-coatings and top coatings were evaluated together. A sample denoted as PC50-SB/TC75-SB has a pre-coating with 50 wt.% starch-based binder and a top coating with 75 wt.% starch-based binder. All tested pre-coatings and top coatings exhibited good runnability on the pilot coater. The reference paperboards were coated with coating compositions comprising 100 wt. % synthetic binder (SA or SB-latex) and were denoted PC0-SA/TC0-SA and PC0-SB/TC0-SB.

[0051] The samples comprising 100 wt.% biolatex (PC100-SA/TC100-SA and PC100-SB/TC100-SB) are discussed under the respective binder mixtures even if they do not comprise a binder mixture. This is because the compositions (ratios and pigment types) vary slightly between the compositions comprising SA-latex compared to those comprising SB-latex.

[0052] The bending stiffness was measured in machine direction (MD) and cross-direction (CD) according to ISO 2493.

[0053] All the samples coated with coating layers comprising biolatex exhibited an increase in bending stiffness in both MD and CD compared to the references (comprising only SA- or SB-latex as the binder).

[0054] The paperboard samples coated with coating compositions comprising a mixture of biolatex and SA-latex exhibited a maximum increase in bending stiffness of 8.2 % (PC100-SA/TC75-SA) and a minimum of 2.7 % (PC25-SA/TC25-SA) in MD, see Fig. 1. In CD, the maximum increase was 14.5 % (PC100-SA/TC75-SA) and the minimum was 3.9 % (PC50-SA/TC50-SA), see Fig. 2. Hence, the maximum increase in bending stiffness, in both MD and CD, was reached when the total amount of biolatex in the two coating layers was 85.6 wt.% (PC100-SA/TC75-SA).

[0055] The samples coated with coating compositions comprising a mixture of biolatex and SB-latex exhibited an increase in bending stiffness of 9.0 % for PC75-SB/TC75-SB and 8.1 % for PC100-SB/TC75-SB in MD, see Fig. 3. In CD, an increase of 7.9 % was obtained for PC75-SB/TC75-SB and an increase of 7.3 % was obtained for PC100-SB/TC75-SB, see Fig.4.

[0056] The printability of the coated paperboards was evaluated by optical appearance and STFI mottle. The optical appearance was evaluated according to the following: a panel of trained judges determine the, in a series comparable, print result of a 50 % printed surface in cyan. 2.0 is the max (best) result and 0.0 is the worst result in this particular series. The method only compares individual appearance in a particular set of samples. STFI mottle was measured according to Research Institutes of Sweden (RISE) standard using Mottling Expert program version 1.37.

[0057] All the tested samples coated with coating compositions comprising a mixture of biolatex and SB-latex exhibited an improved optical appearance, see Fig. 5. The samples comprising 75 wt.% (PC75-SB/TC75-SB) and 88.3 wt.%

(PC100-SB/TC75-SB) of biolatex based on the total dry amount of binder in both coating layers exhibited significantly better optical appearance. The sample comprising 100 wt.% biolatex (PC100-SB/TC100-SB) showed a slight improvement of optical appearance compared to the reference comprising 100 wt.% SB-latex (PC0-SB/TC0-SB) but the increase was significantly lower than for PC75-SB/TC75-SB and PC100-SB/TC75-SB.

[0058] The tested samples coated with coating compositions comprising a mixture of biolatex and SB-latex exhibited a reduced STFI mottle at full tone, see Fig. 6. The sample comprising 88.3 wt. % biolatex (PC100-SB/TC75-SB) showed the largest reduction of STFI mottle while the sample comprising 100 wt.% biolatex (PC100-SB/TC100-SB) showed the highest STFI mottle.

[0059] The results show that by coating a paperboard with coating layers in which the binders comprise at least 70 wt.% biolatex and a SA-latex, a significant increase in bending stiffness is obtained. Especially high bending stiffness was obtained when the coating layers comprised 85.6 wt.% biolatex.

[0060] The results further show that by coating a paperboard with coating layers in which the binders comprise at least 70 wt.% biolatex and a SB-latex, a significant increase in bending stiffness is obtained while improving the printing surface (improved optical appearance and reduced STFI mottle and surface roughness). An especially good printing surface was obtained when the coating structure comprised 88.3 wt.% biolatex.

Claims

1. A coated paperboard comprising a paperboard substrate and one or more coating layers provided on a printing side of the paperboard, wherein:

   - the one or more coating layers comprise binders and pigment;
   - the binders comprise at least one synthetic binder and at least one starch-based binder; and
   - the starch-based binder is present in an amount of 70-95 wt.% based on the total dry amount of binder in the one or more coating layers.

2. The coated paperboard according to claim 1 wherein the starch-based binder is present in an amount of 72-95 wt.%, such as 80-95 wt. % based on the total dry amount of binder in the one or more coating layers.

3. The coated paperboard according to any one of claims 1 and 2, wherein the one or more coating layers is one coating layer.

4. The coated paperboard according to claim 3 wherein the coat weight of the coating layer is 10-23 g/m^2, such as 10-18 g/m^2, such as 10-16 g/m^2.

5. The coated paperboard according to any one of claims 1 and 2, wherein the one or more coating layers comprise at least two coating layers, such as at least one pre-coating and at least one top coating.

6. The coated paperboard according to claim 5 wherein the coat weight of the at least one pre-coating is 4-13 g/m^2, such as 6-10 g/m^2, such as 7-9 g/m^2.

7. The coated paperboard according any one of claims 5 and 6 wherein the coat weight of the at least one top coating is 4-15 g/m^2, such as 5-14 g/m^2, such as 6-12 g/m^2.

8. The paperboard according to any one of preceding claims wherein the dry weight ratio between pigment and the binders in the one or more coating layers is 100:10 to 100:25 such as 100:13 to 100:22, such as 100:14 to 100:22.

9. The coated paperboard according to any one of claims 5-7 wherein the at least one pre-coating comprises pigment and the binders in a dry weight ratio of 100:13 to 100:20, such as 100:13 to 100:18.

10. The coated paperboard according to any one of claims 5-7 and 9 wherein the at least one top coating comprises pigment and the binders in a dry weight ratio of 100:14 to 100:22, such as 100:15 to 100:20.

11. The coated paperboard according to any one of claims 5-7 and 9-10, wherein the starch-based binder is present in the pre-coating in an amount of 95-100 wt.% based on the total dry amount of binder and in the pre-coating in an amount of 60-90 wt.%, such as 65-85 wt.%, based on the total dry amount of binder in the top coating.

12. The coated paperboard according to any one of the preceding claims wherein the starch-based binder is provided in the form of starch particles.

13. The coated paperboard according to any one of the preceding claims wherein the synthetic binder is styrene-acrylic binder and/or styrene-butadiene binder.

14. The coated paperboard according to any one of the preceding claims wherein the paperboard substrate has a grammage of 100-400 g/m^2, such as 120-300 g/m^2, such as 125 and 260 g/m^2 according to ISO 536:2019.

15. The coated paperboard of any one of the preceding claims, which is a liquid packaging board (LPB).

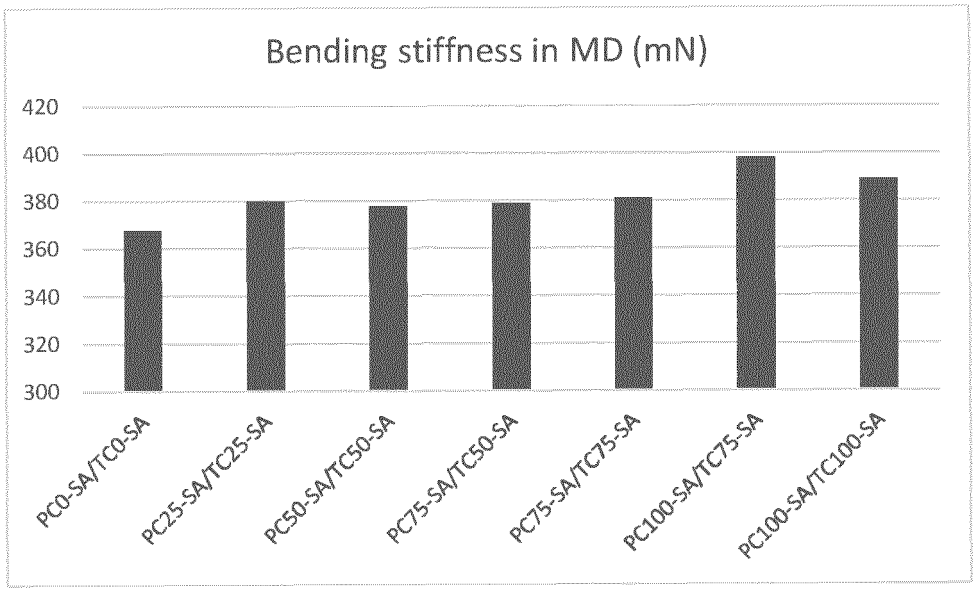

Bending stiffness in MD (mN)
420
400
380
360
340
320
300
PC0-SA/TC0-SA
PC25-SA/TC25-SA
PC50-SA/TC50-SA
PC75-SA/TC50-SA
PC75-SA/TC75-SA
PC100-SA/TC75-SA
PC100-SA/TC100-SA

Fig. 1

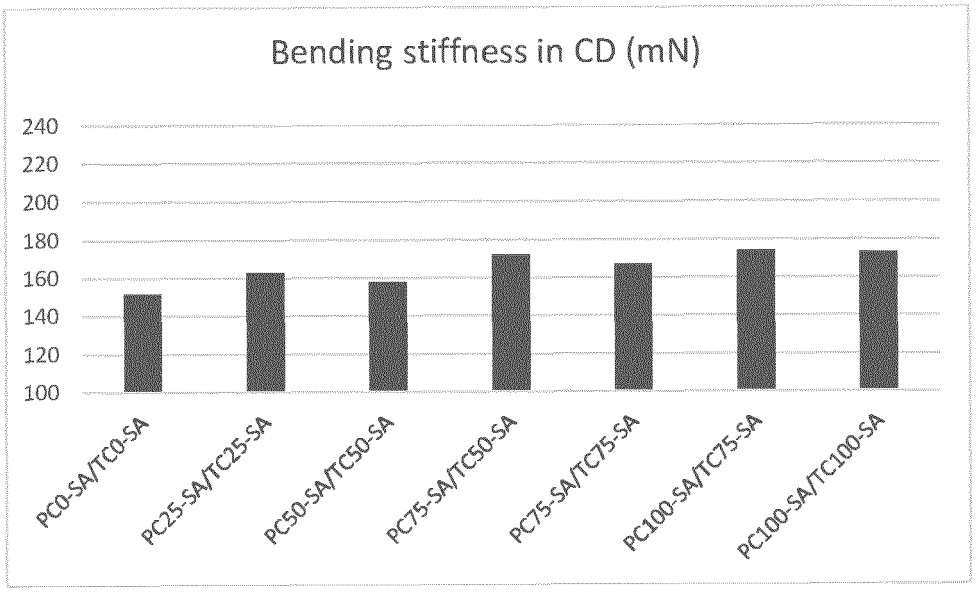

Bending stiffness in CD (mN)
240
220
200
180
160
140
120
100
PC0-SA/TC0-SA
PC25-SA/TC25-SA
PC50-SA/TC50-SA
PC75-SA/TC50-SA
PC75-SA/TC75-SA
PC100-SA/TC75-SA
PC100-SA/TC100-SA

Fig. 2

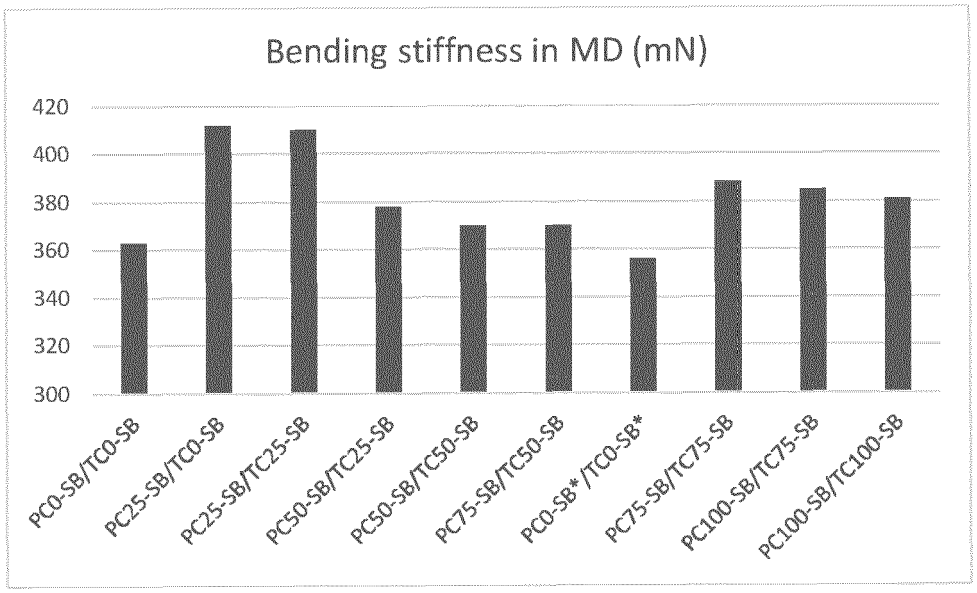

Bending stiffness in MD (mN)
420
400
380
360
340
320
300
PC0-SB/TC0-SB
PC25-SB/TC0-SB
PC25-SB/TC25-SB
PC50-SB/TC25-SB
PC50-SB/TC50-SB
PC75-SB/TC50-SB
PC0-SB*/TC0-SB*
PC75-SB/TC75-SB
PC100-SB/TC75-SB
PC100-SB/TC100-SB

Fig. 3

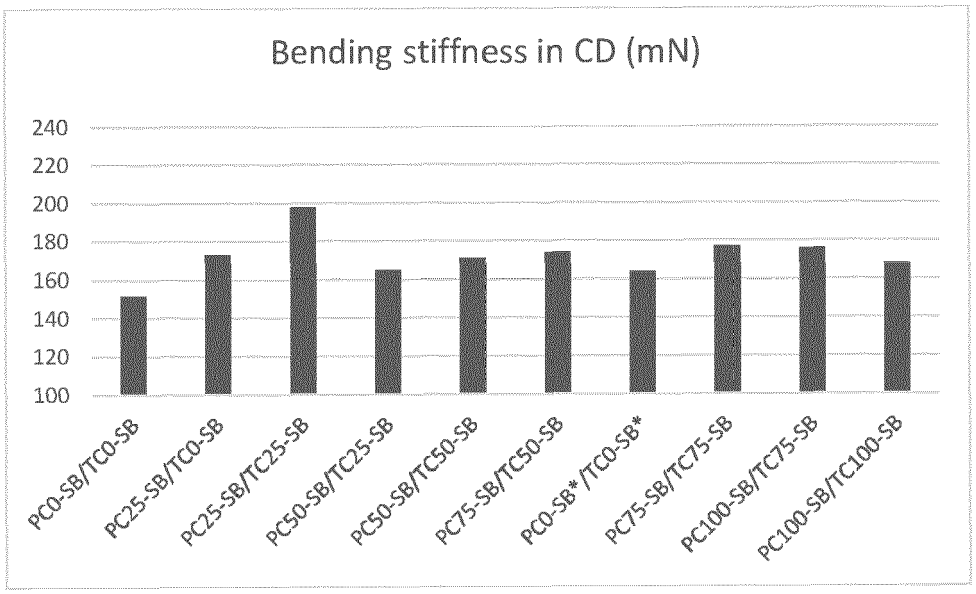
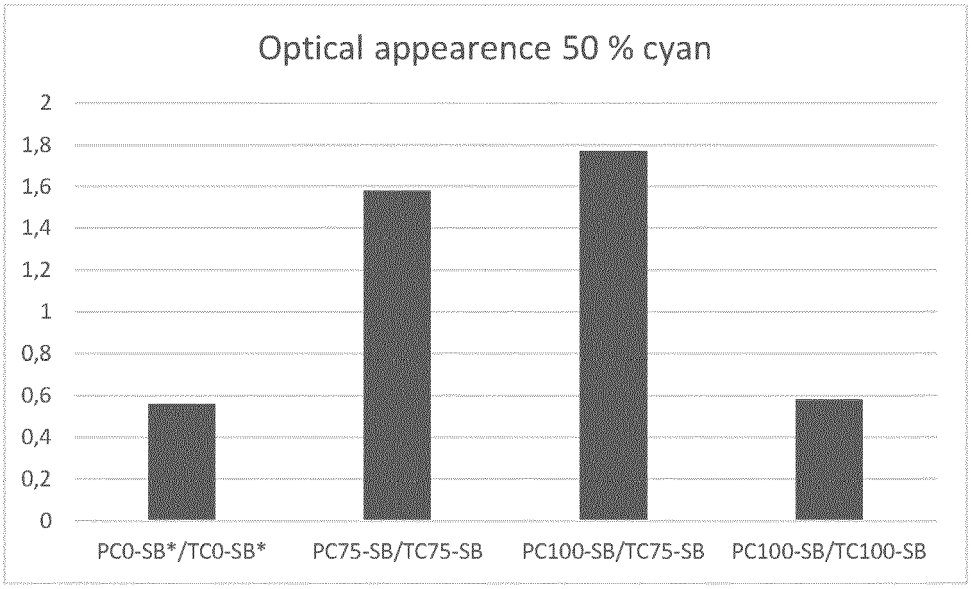

Bending stiffness in CD (mN)
240
220
200
180
160
140
120
100
PC0-SB/TC0-SB
PC25-SB/TC0-SB
PC25-SB/TC25-SB
PC50-SB/TC25-SB
PC50-SB/TC50-SB
PC75-SB/TC50-SB
PC0-SB*/TC0-SB*
PC75-SB/TC75-SB
PC100-SB/TC75-SB
PC100-SB/TC100-SB

Fig. 4


Optical appearence 50 % cyan
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1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
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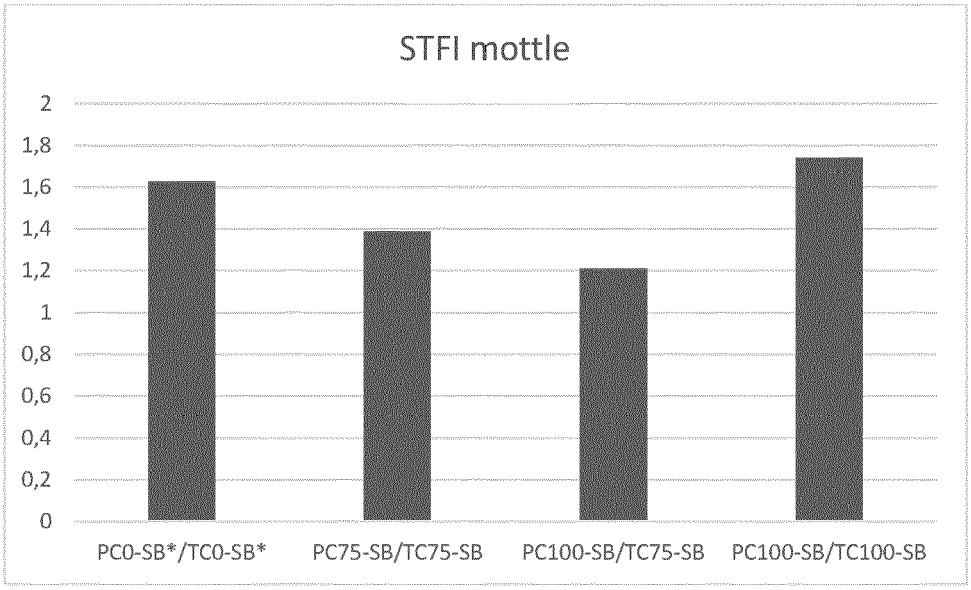
PC0-SB*/TC0-SB*
PC75-SB/TC75-SB
PC100-SB/TC75-SB
PC100-SB/TC100-SB

Fig. 5


STFI mottle
2
1,8
1,6
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1,2
1
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0,6
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0,2
0
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PC75-SB/TC75-SB
PC100-SB/TC75-SB
PC100-SB/TC100-SB

Fig. 6

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EUROPEAN SEARCH REPORT

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EP 23 19 4745

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 January 2024	Karlsson, Lennart

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X : particularly relevant if taken alone
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