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(54) **PAPERBOARD HAVING LIGHT BARRIER PROPERTIES**

(57) There is provided a paperboard comprising at least one ply, wherein the at least one ply comprises a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply.

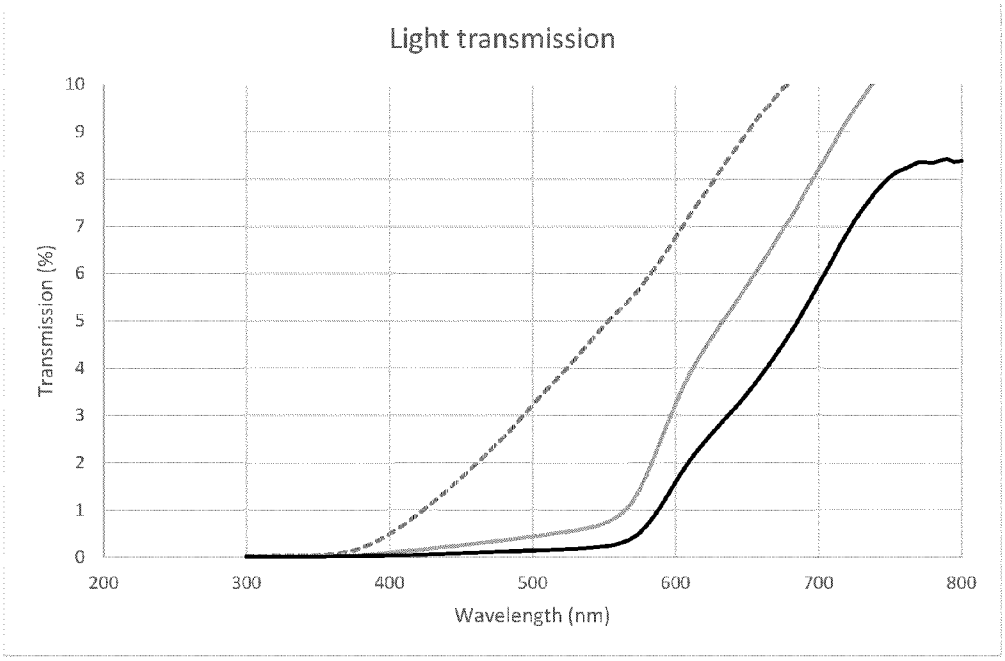

Fig. 2

EP 4 575 086 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of paperboards and in particular to paperboards used in liquid packaging of light sensitive foodstuff.

BACKGROUND

[0002] Liquid packaging board (LPB) is commonly used to package liquids such as dairy products and fruit juices. These liquid foodstuffs can be light sensitive, wherein they degrade when exposed to light. The degradation leads to a shortened shelf-life, off-taste and/or loss of nutritional value. Hence, in order to provide an adequate packaging material for prolonged durability of the foodstuffs, the light transmission needs to be reduced.

[0003] Commonly, the light transmission of a paperboard is reduced by applying aluminium foil to the paperboard, which gives light barrier properties to the paperboard. However, the use of aluminium provides disadvantages such as poor carbon footprints and issues with recyclability.

[0004] In view of the above, there is a need to develop a more sustainable paperboard with light barrier properties which is suitable for food contact and thereby may be used in packaging of light sensitive foodstuffs.

SUMMARY

[0005] According to the present disclosure, a paperboard comprising at least one ply is provided, wherein the at least one ply of the paperboard comprises a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply.

[0006] The addition of a red pigment in a dry amount of at least 2.5 kg/tonne dry fibre per ply has been found to reduce the light transmission of the paperboard in the wavelength region of 300-550 nm. Exposure to light of these wavelengths may cause degradation of foodstuffs such as dairy products and fruit juices. The degradation leads to a reduction of the nutritional value as well as the shelf-life of the foodstuffs, and/or off-taste. By adding a red pigment to a paperboard, the light transmission of the paperboard is significantly reduced, and the light barrier properties of the paperboard are improved. The red pigment is furthermore food contact safe. The improved light barrier properties as disclosed herein makes the paperboard according to the present disclosure suitable to be used as a LPB for packaging light sensitive foodstuffs.

[0007] The use of a red pigment improves the light barrier properties of the paperboard while only having a small visual impact on the paperboard, which is advantageous from a packaging perspective.

[0008] The light transmission through the paperboard in the wavelengths 300-550 nm may be less than 1 %, preferably less than 0.7 % when measured using a UV-VIS spectrophotometer.

[0009] The paperboard may be a multiply paperboard comprising two or more plies wherein at least one of the plies comprises a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply.

[0010] The red pigment may be present in an amount of at least 4 kg dry pigment/tonne dry fibre per ply, such as at least 5 kg dry pigment/tonne dry fibre per ply. These amounts are associated with a particularly low light transmission. Optionally, at least one of the plies of the paperboard comprise the red pigment in an amount within the range of from 4 kg to 20 kg dry pigment/tonne dry fibre per ply. An amount within the range of from at least 4 kg dry pigment/tonne dry fibre per ply and up to 20 kg dry pigment/tonne dry fibre per ply has been found to provide a paperboard with a particularly low light transmission while minimizing the visual impact of the red pigment on the paperboard.

[0011] The red pigment may comprise, or consist of, mineral pigments such as iron oxides. Using iron oxides as the red pigment may be associated with lower carbon footprint and are particularly suitable for use in packaging materials. Preferably, the red pigment is free from organic pigments. This is generally associated with a lower carbon footprint.

[0012] The paperboard may comprise two plies, three plies, four plies or five plies. Preferably, the paperboard is a three-ply paperboard comprising a top ply, a middle ply and a back ply wherein the middle ply is arranged between the top ply and the back ply. Preferably, the middle ply and/or back ply comprises the red pigment, more preferably, only the middle ply comprises the red pigment. The visual effect of the red colour is minimized if it is only present in the middle ply.

[0013] Preferably, the top ply is free from the red pigment. By only adding the red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre to the middle and/or back ply, any possible negative effects the red pigment might have on the visual appearance of the paperboard are minimized.

[0014] The ply or plies comprising the red pigment, preferably the middle and/or back ply, may have a grammage of 30-140 g/m^2. Preferably, the middle ply has a grammage of 40-140 g/m^2 when comprising the red pigment and the back ply has a grammage of 30-80 g/m^2 when comprising the red pigment. The fact that the ply comprising the red pigment has a grammage within the range of from 30 to 140 g/m^2 may further reduce light transmission and/or require a lower amount of red pigment to achieve an equal reduction in light transmission.

[0015] The paperboard may have a grammage of 150-350 g/m^2, such as 170-320 g/m^2.

[0016] The top ply may comprise bleached pulp. Preferably, the top ply only comprises bleached pulp such as bleached softwood and/or bleached hardwood pulp.

[0017] The middle ply may comprise bleached pulp. In addition, the middle ply may comprise chemithermomechanical pulp (CTMP) and/or broke.

[0018] The back ply may comprise bleached pulp, unbleached pulp and/or broke. Preferably, the back ply comprises unbleached pulp and/or broke.

[0019] At least one of the plies of the paperboard may further comprise a hydrophobic sizing agent such as alkyl succinic aldehyde (ASA), alkyl ketene dimer (AKD) and/or rosin size. The hydrophobic sizing agent may be added in an amount of at least 0.3 kg/tonne dry fibre per ply.

[0020] The paperboard may be a liquid packaging board (LPB).

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig 1 shows the paperboard arrangement of the evaluated paperboards in example 1. The paperboards comprise a top ply (1), a middle ply comprising the pigment (2) and a back ply (3).

Fig 2 shows the light transmission of a reference paperboard (Ref1, grey dashed) and two paperboards according to the present disclosure, one comprising 6 kg dry pigment/tonne dry fibre (R1, grey) and the other one comprising 12 kg dry pigment/tonne dry fibre (R2, black) of a red pigment in the middle ply.

Fig 3 shows the light transmission of a reference paperboard (Ref1, grey dashed) and two paperboards comprising 2.5 kg dry pigment/tonne dry fibre (B1, grey) and 5 kg dry pigment/tonne dry fibre (B2, black) of a blue pigment in the middle ply.

DETAILED DESCRIPTION

[0022] The present disclosure is based on the realization that the addition of a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre to a paperboard reduces the light transmission through the paperboard in the wavelength range of 300-550 nm and thus forms a paperboard having light barrier properties and which is furthermore safe to use with foodstuff. The use of the paperboard with light barrier properties according to the present disclosure in packaging of light sensitive foodstuff enables prolonged shelf-life of the packaged foodstuffs and preservation of their nutritional value.

[0023] The paperboard may comprise one to five plies, preferably the paperboard is a multiply paperboard comprising at least two plies. A 2-ply paperboard may comprise a top ply and a back ply. A 3-ply paperboard comprises a top ply, a middle ply and a back ply wherein the middle ply is arranged between the top ply and the back ply. A 4-ply paperboard comprises a top ply, two middle plies and a back ply. A 5-ply paperboard comprises a top ply, three middle plies and a back ply. The 3-ply paperboard is preferred as it converts to an LPB having excellent properties.

[0024] The ply or plies of the paperboard may comprise softwood pulp and/or hardwood pulp. The pulp may be bleached or unbleached.

[0025] The top ply represents the printing ply and may comprise bleached pulp. Preferably, 100% of the pulp in the top ply is bleached pulp such as bleached softwood and/or bleached hardwood. The bleached pulp may be associated with a good printing surface and has an appealing visual appearance and typically has poor light barrier properties. Additionally, the top ply may be coated.

[0026] The middle ply may comprise bleached pulp. The middle ply may further comprise chemithermomechanical pulp (CTMP) and/or broke. Preferably, the middle ply is free from unbleached pulp.

[0027] The back ply may comprise bleached pulp, unbleached pulp and/or broke. Preferably, the back ply comprises unbleached pulp and/or broke.

[0028] One or more of the plies of the paperboard may comprise hydrophobic sizing agent such as alkenyl succinic anhydride (ASA), alkyl ketene dimer (AKD) and/or rosin size. The hydrophobic sizing agent may be present in an amount of at least 0.3 kg/tonne dry fibre per ply, such as 0.5 kg/tonne dry fibre per ply.

[0029] A red pigment is added to at least one ply of the paperboard, preferably the red pigment is added to the middle and/or back ply. The red pigment was found by the present inventors to reduce the light transmission through the paperboard in the wavelength range of 300-550 nm, thereby improving the light barrier properties, and hence providing improved applicability of the paperboard in packaging of light sensitive foodstuff. Preferably, the light transmission in the wavelength range of 300-550 nm is less than 1 %, more preferably less than 0.7 %. This is associated with an improved shelf-life of the packaged foodstuffs.

[0030] The red pigment is a material which is suitable for colouring materials red. may comprise, or consist of, mineral

pigments such as iron oxides. Using iron oxides as the red pigment may be associated with lower carbon footprint and is particularly suitable for use in food packaging containers. Preferably, the red pigment is free from organic pigments.

[0031] The paperboard may further comprise other conventional additives such as fillers and other colour pigments in addition to the red pigment. This is however optional.

[0032] The paperboard may have a grammage of less than 350 g/m^2, such as 150-350 g/m^2, such as 170-320 g/m^2.

[0033] The light barrier properties of the paperboard may be influenced by the grammage of the paperboard. The higher the grammage of the paperboard is, the more material the light will have to transmit through. The amount of red pigment needed to reduce the light transmission to a certain level may be influenced by the grammage of the paperboard. For example, a paperboard having a grammage of 180 g/m^2 may require more red pigment per tonne dry fibre than a paperboard having a grammage of 250 g/m^2 in order to reduce the light transmission to the same level. However, the red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre will give satisfactory light barrier properties independent of the grammage of the paperboard. The use of paperboard with higher grammage may reduce the light transmission but induces higher cost and material consumption.

[0034] The red pigment is present in at least one ply of the paperboard, preferably in the middle and/or the back ply, in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply. An upper limit may be 20 kg dry pigment/tonne dry fibre per ply, such as 16 kg dry pigment/tonne dry fibre per ply. The addition of at least 2.5 kg dry pigment/tonne dry fibre per ply of the red pigment significantly reduces the light transmission of the paperboard while the addition of more than 20 kg dry pigment/tonne dry fibre per ply may not lead to any further reduction of the light transmission. Thus, the red pigment may be added to at least one of the plies in the paperboard in an amount of 2.5-20.0 kg dry pigment/tonne dry fibre per ply, preferably in an amount of 4-20 kg dry pigment/tonne dry fibre per ply, more preferably 5-16 kg dry pigment/ tonne dry fibre per ply.

[0035] In a 3-ply paperboard, the red pigment may be present in either one of or both the middle ply and the back ply. A lower amount per ply of the red pigment per ply is required if the pigment is present in both plies compared to if the pigment is only present in one ply.

[0036] Preferably, the red pigment is present only in the middle ply. The visual impact of the red pigment will be reduced if it is only present in the middle ply.

[0037] Preferably, the top ply is free from the red pigment in order to preserve the visual appearance of the paperboard. A red pigment may be added to the top ply with the intention to use it as a tinting agent; however, it will then be applied in a much lower amount such as 5-80 g dry pigment/tonne dry fibre.

[0038] The ply or plies comprising the red pigment, preferably the middle ply and/or the back ply, may have a grammage of 30-140 g/m^2. Preferably, the middle ply has a grammage of 40-140 g/m^2 and the back ply has a grammage of 30-80 g/m^2.

[0039] The paperboard according to the present disclosure may further be coated with at least one coating. The coating may comprise binder and pigment. A coating may improve the printing surface of the paperboard and/or induce a barrier against e.g. moisture and oxygen.

[0040] The paperboard according to the present disclosure is suitable for use as a liquid packaging board. Especially, suitable for packaging light sensitive foodstuff which may deteriorate when exposed to light or lose their nutritional value.

EXAMPLES

Example 1

[0041] A lab trial was conducted using a 3-ply paperboard wherein the fibre composition of the three plies can be seen in Table 1. The top ply and the bottom ply were produced in a full-scale machine and the middle ply was produced in lab scale.

Table 1 shows the fibre composition of the three plies in Example 1.

Ply	Fibre composition	Grammage (g/m^2)
Top ply	70 wt. % bleached softwood + 30 wt.% bleached hardwood	42
Middle ply	20 wt.% bleached softwood+45 wt.% CTMP + 35 wt.% broke	76
Back ply	100 wt. % unbleached softwood	53

[0042] Six different paperboards were evaluated in this example. The top ply and back ply were the same for all paperboards while the middle ply varied in respect to the type and amount of pigment present (the fibre composition of the middle ply was the same in all six paperboards). Two different pigments, a red pigment and a blue pigment, were evaluated in different amounts, see Table 2.

Table 2 shows the evaluated paperboards wherein the middle plies comprise different amounts of a red pigment or a blue pigment.

Paperboard	Middle ply	Amount (kg dry pigment/ tonne dry fibre)
Ref1*	No pigment	0
R1	Red pigment	6
R2	Red pigment	12
Ref2*	No pigment	0
B1**	Blue pigment	2.5
B2**	Blue pigment	5
*Ref1 was used as reference for the paperboards comprising the red pigment and Ref2 was used as the reference for the paperboards comprising the blue pigment. **B1-B2 are comparative examples.		

[0043] The red pigment was provided as a 60 wt.% dispersion and the blue pigment was provided as a 25 wt.% dispersion. The pigment dispersions were added in different amounts directly to the wet pulp prior to the formation of the middle ply. Each middle ply was assembled together with a top ply and a back ply wherein the middle ply was arranged between the top ply and the back ply, see Fig. 1. The red pigment used in this example is Pergalite oxide red M-EF and the blue pigment is Pergalite BL R-LW. Both pigments were provided by Solenis.

[0044] The light transmission through each paperboard was measured using a UV-VIS spectrophotometer (Perkin-Elmer Lambda 1050) and the diffusely transmitted light was detected by an integrated sphere. The light transmission of the evaluated paperboards can be seen in Fig. 2 and 3.

[0045] It can be observed that the light transmission of the reference paperboards (Ref1 or Ref2), i.e., comprising no pigment, starts to increase at ~350 nm and keeps increasing with increasing wavelength. At 500 nm, the transmission of the paperboards with no pigment is approximately 3 % or more, at 550 nm it is more than 4 %.

[0046] By adding 6 kg dry pigment/tonne dry fibre of the red pigment to the middle ply (paperboard R1), a reduction of the light transmission can be observed when compared to the reference (Ref1), see Fig. 2. The light transmission of paperboard R1 is below 1 % in the whole wavelength region of 300-550 nm.

[0047] An increase in the dosage of the red pigment to 12 kg dry pigment/tonne dry fibre (paperboard R2) showed a further reduction in the light transmission, see Fig. 3. The reduction in light transmission when going from 6 kg dry pigment/tonne dry fibre of the red pigment to 12 kg dry pigment/tonne dry fibre is smaller than when going from 0 kg dry pigment/tonne to 6 kg dry pigment/tonne. Thus, the reduction in light transmission does not seem to be proportional to the added amount of red pigment.

[0048] For comparison, paperboards wherein the middle ply comprised 2.5 kg dry pigment/tonne dry fibre (paperboard B1) or 5 kg dry pigment/tonne dry fibres (paperboard B2) of a blue pigment were also evaluated, see Fig. 3. A reduction in the light transmission can be observed when compared to the reference (Ref2), however, the reduction is only observed at wavelengths above ~500 nm. Thus, paperboards B1 and B2, comprising the blue pigment, do not exhibit a significant reduction of the light transmission in the wavelength region of 300-550 nm compared to the reference.

[0049] In conclusion, paperboards comprising a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply, i.e., paperboards R1 and R2, exhibited a significant reduction of the light transmission in the wavelength region of 300-550 nm. Paperboards R1 and R2, thus, have good light barrier properties and are suitable for use in packaging of light sensitive foodstuffs.

Claims

1. A paperboard comprising at least one ply, wherein the at least one ply comprises a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply.

2. A paperboard according to claim 1, wherein the paperboard is a multiply paperboard, comprising two or more plies and wherein at least one of the plies comprises a red pigment in an amount of at least 2.5 kg dry pigment/tonne dry fibre per ply.

3. The paperboard according to claim 1 or 2, wherein the red pigment is present in an amount of at least 4 kg dry pigment/tonne dry fibre per ply, preferably at least 5 kg dry pigment/tonne dry fibre per ply.

4. The paperboard according to any one of the preceding claims, wherein the ply or plies comprising the red pigment have a grammage of 30-140 g/m^2.

5. The paperboard according to any one of the preceding claims, wherein the paperboard has a grammage of 150-350 g/m^2.

6. The paperboard according to any one of the preceding claims, wherein the red pigment comprises or consists of iron oxides.

7. The paperboard according to any one of the preceding claims, wherein the paperboard comprises a top ply, a middle ply and a back ply wherein the middle ply is arranged between the top ply and the back ply.

8. The paperboard according to claim 7, wherein the middle ply comprises the red pigment.

9. The paperboard according to claim 7, wherein the back ply comprises the red pigment.

10. The paperboard according to any one of claims 7-9, wherein both the middle ply and the back ply comprise the red pigment.

11. The paperboard according to any one of claims 7-10, wherein the middle ply comprises bleached fibres.

12. The paperboard according to any one of claims 7-11, wherein the top ply comprises bleached fibres.

13. The paperboard according to any one of claims 7-12, wherein the top ply is free from the red pigment.

14. The paperboard according to any one of the preceding claims wherein at least one of the plies further comprise a hydrophobic sizing agent such as alkyl succinic aldehyde (ASA), alkyl ketene dimer (AKD) and/or rosin size.

15. The paperboard according to claim 14, is a liquid packaging board (LPB).

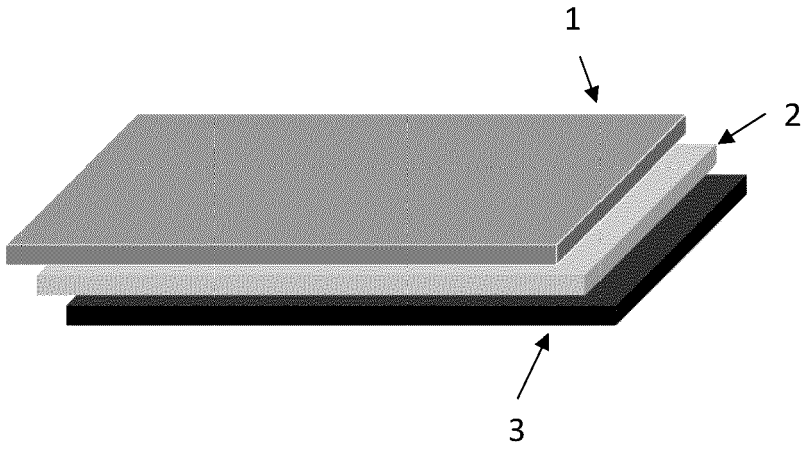
1
2
3

Fig. 1

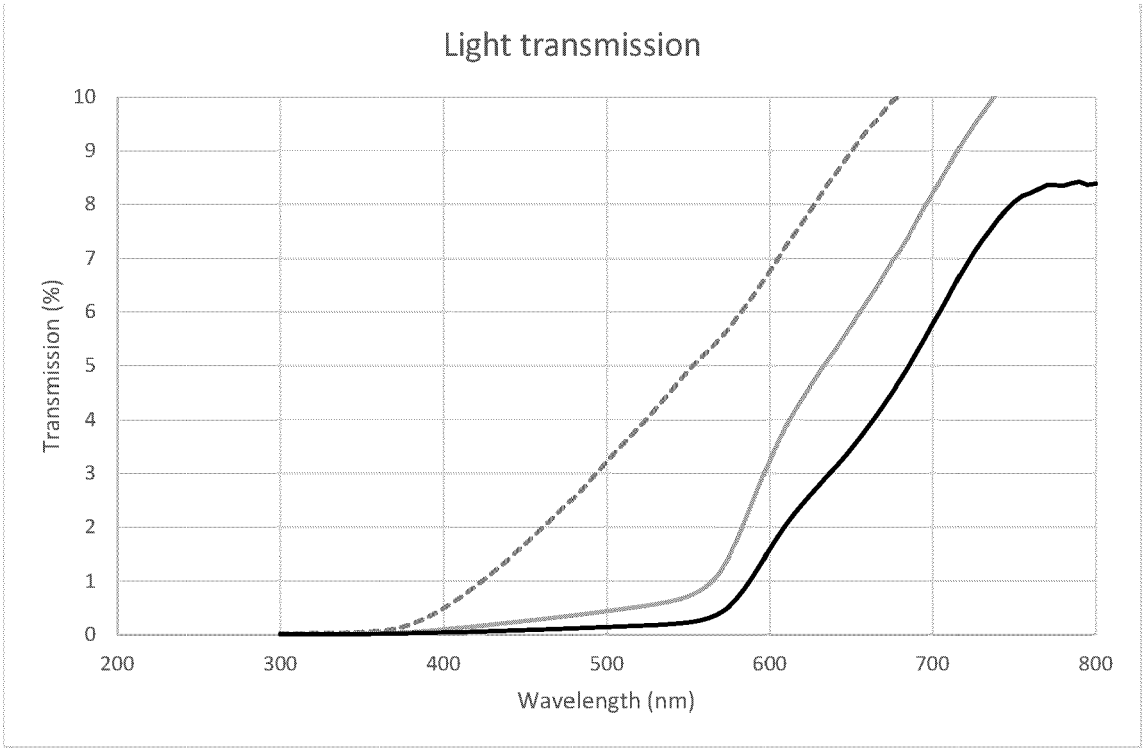
Light transmission
Transmission (%)
0
1
2
3
4
5
6
7
8
9
10
200
300
400
500
600
700
800
Wavelength (nm)

Fig. 2

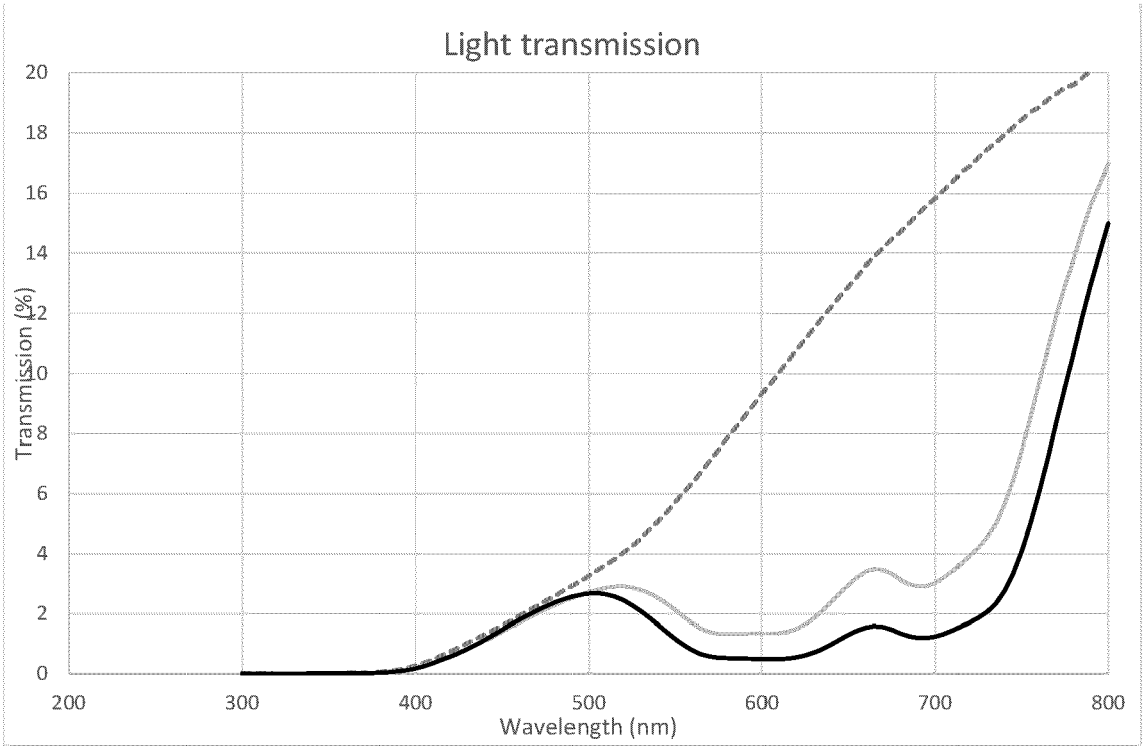
Light transmission
Transmission (%)
20
18
16
14
12
10
8
6
4
2
0
200
300
400
500
600
700
800
Wavelength (nm)

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 8378

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	US 6 033 444 A (AHLINDER BERTIL [SE]) 7 March 2000 (2000-03-07) * claims 1-21 * * column 2, line 60 - line 65 * -----	1-15	INV. D21H17/17 D21H21/16 D21H21/28 D21H27/10 D21H27/30
X	US 2019/203423 A1 (NIEMI PETRI [FI]) 4 July 2019 (2019-07-04) * paragraphs [0038], [0039]; claims 1,26 * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 May 2024	Ponsaud, Philippe

CATEGORY OF CITED DOCUMENTS

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