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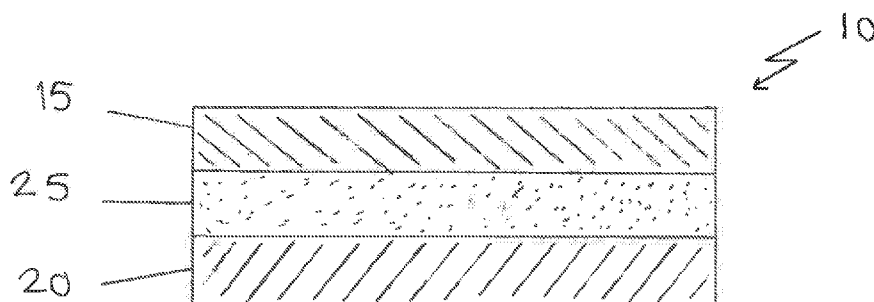


Figure 1

(57) Abstract: A multilayer film or sheet is provided and comprises a first layer of polyethylene having a first density and a second layer of polyethylene having a second density, the first and second densities being different, and at least one core or inner layer which is a polyethylene based layer having oxygen barrier properties.



MULTILAYER FILM

The present invention relates generally to films (a thin continuous polymeric material) and sheets prepared from polyethylene resins. More specifically, the invention relates to multi-layer films and sheets made from particular polyethylene compositions and polyethylene based organic mixtures.

Polyethylene is a polymer of ethylene; especially: any of various partially crystalline lightweight thermoplastics $(\text{CH}_2\text{CH}_2)_x$ that are resistant to chemicals and moisture, have good insulating properties, and are used, for example, in packaging and insulation. Polyethylene is a family of materials with densities ranging typically from 0.86g/cm^3 to 0.965g/cm^3 .

According to an aspect of the present invention there is provided a multilayer film or sheet comprising a first layer of polyethylene having a first density and a second layer of polyethylene having a second density, the first and second densities being different, and at least one core or inner layer of a polyethylene based layer having oxygen barrier properties.

According to a further aspect of the present invention there is provided a multilayer film or sheet comprising a first surface layer of polyethylene having a first density and a second, opposite surface layer of polyethylene having a second density, the first and second densities being different, and at least one core or inner layer of a polyethylene based layer having oxygen barrier properties.

In some embodiments the barrier layer/s comprise a mixture of organic raw material based on PE.

According to an aspect of the present invention there is provided a multilayer film or
5 sheet comprising a first layer of polyethylene having a first density and a second layer of polyethylene having a second density, the first and second densities being different, and an inner layer of a polyethylene based organic mixture having oxygen barrier properties.

10 According to an aspect of the present invention there is provided a multilayer film comprising a first layer of polyethylene having a first density and a second layer of polyethylene having a second density, the first and second densities being different, and an inner layer of a polyethylene based organic mixture having oxygen barrier properties.

15

According to an aspect of the present invention there is provided a multilayer sheet comprising a first layer of polyethylene having a first density and a second layer of polyethylene having a second density, the first and second densities being different, and an inner layer of a polyethylene based organic mixture having oxygen barrier
20 properties.

In some embodiments the film or sheet is a three-layer structure. Other embodiments have more than three layers, for example five layers.

The inner layer may have a thickness in the range $4\mu\text{m}$ to $120\mu\text{m}$, for example approximately $8\mu\text{m}$ or $12\mu\text{m}$ for a film and approximately $50\mu\text{m}$ or $60\mu\text{m}$ for a sheet structure.

- 5 In some embodiments the first layer is an outside layer and the second layer is an inside layer i.e. the first and second layers are the “skin” at the top and bottom (in section) of the film.

In some embodiments the first density is higher than the second density. This allows,
10 for example, a temperature differential to be formed in a film if two sections of film are heat sealed together, for example with two respective inside layers facing each other.

The first density may be in the range 0.910g/cm^3 to 0.965g/cm^3 . For example the first density may be approximately 0.931g/cm^3 for a film and approximately 0.920g/cm^3 for a
15 sheet structure.

For a film structure the second density may be in the range 0.80g/cm^3 to 0.90g/cm^3 .
For example the second density may be approximately 0.88g/cm^3 .

20 For a sheet structure the second density may be in the range 0.90g/cm^3 to 0.965g/cm^3 .
For example the second density may be approximately 0.92g/cm^3

The density of the core or inner layer may be in the range 0.95g/cm^3 to 1.5g/cm^3 . For example the density of the core layer may be approximately 1.1g/cm^3 .

25

The first layer of a thin film may have a thickness in the range $4\mu\text{m}$ to $25\mu\text{m}$. For example the first layer may be a thickness of approximately $15\mu\text{m}$.

The second layer may have a thickness in the range $4\mu\text{m}$ to $30\mu\text{m}$. For example the
5 second layer may have a thickness of approximately $15.0\mu\text{m}$.

The overall thickness of the film may be in the range $30\mu\text{m}$ to $200\mu\text{m}$. For example the thickness of the film may be approximately $120\mu\text{m}$.

10 The thickness of a sheet may be in the range $200\mu\text{m}$ to $1000\mu\text{m}$. The first layer may have a thickness in the range $20\mu\text{m}$ to $200\mu\text{m}$. The second layer may have a thickness in the range $20\mu\text{m}$ to $200\mu\text{m}$.

A barrier layer may have a thickness in the range $5\mu\text{m}$ to $100\mu\text{m}$, for example
15 approximately $10\mu\text{m}$ for a film and approximately $30\mu\text{m}$ for a sheet structure

In some embodiments the film is formed by a co-extrusion process (the extrusion of multiple layers of material simultaneously), for example a blown film co-extrusion process (involving the extrusion a tube of molten polymer through an annular die and
20 inflating to a size greater than its initial diameter to form a thin film bubble). Sheets may be formed, for example, using a sheet die.

The present invention also provides a three-layer coextruded polyethylene film comprising an inside layer of polyethylene having a first density and an outside layer of
25 polyethylene having a second density, the first and second densities being different, and

a core or inner layer of a polyethylene based organic mixture between the inside and outside layers, the core or inner layer having oxygen barrier properties.

In some embodiments the barrier material is only used in the core layer.

5

In some embodiments the material used to provide the barrier in the barrier/core layer is a PE-compatible organic, food approved mixture.

The present invention also provides a product, such as a pouch, flow wrap, tray or lid, formed from a film or sheet as described herein. In some embodiments all of the layers of the product are polyethylene or polyethylene based organic mixture, enabling it to be easily recycled through standard polyethylene recycling channels.

The present invention also provides for the use of commercially available adhesion enhancers in layers adjacent to a barrier layer to ensure cohesion of the overall structure. Layer concentration of this additive may be between 10% and 100% and typically 20% when not in a discrete layer of its own.

The present invention also provides for the preparation of a polyethylene film for use in the manufacture of a disposable pouch and pouches formed therefrom.

The present invention also provides a stand-up pouch which is easily recyclable in the polyethylene recycling stream, the pouch being formed from film as described herein, and formed by sealing opposing panels of film together, with respective inside layers sealed together.

In some aspects and embodiments a film is designed to seal inside layer to inside layer with a temperature differential to the outside layer. In other aspects and embodiments a tray structure provides an upper surface to seal to a suitable lid. In other aspects
5 and embodiments a lid structure provides with a lower surface to seal to a suitable tray.

Different aspects and embodiments of the invention may be used separately or together.

10

Further particular and preferred aspects of the present invention are set out in the accompanying independent and dependent claims. Features of the dependent claims may be combined with the features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

15

The present invention will now be more particularly described, by way of example, with reference to the accompanying drawings.

The example embodiments are described in sufficient detail to enable those of
20 ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternative forms and should not be construed as limited to the examples set forth herein.

Accordingly, while embodiments can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling
5 within the scope of the appended claims should be included. Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate.

Unless otherwise defined, all terms (including technical and scientific terms) used
10 herein are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealised or overly formal sense unless expressly so defined herein.

In the following description, all orientational terms, such as upper, lower, vertical,
15 horizontal, radially and axially, are used in relation to the drawings and should not be interpreted as limiting on the invention.

In Figure 1 a co-extruded multilayer film is generally indicated 10.

20 The film 10 comprises a first, “outside” layer of polyethylene 15, a second, “inside” layer of polyethylene 20 and a core, barrier layer of polyethylene 25.

The layer 15 is formed from polyethylene having a higher density than the layer 20. The layer 25 is formed from a PE-compatible organic, food approved oxygen barrier
25 compound resin.

As represented in Figure 2, when two portions of the film are sealed together the two layers 15a, 15b become outside layers and the two layers 20a, 20b are sealed to each other and become inside layers. The film can be heat sealed together using existing
5 commercially available equipment because of the density gradient between the layers 15a, 15b and the layers 20a, 20b.

In some embodiments the layers are formed based on heat resistance (which may correspond with density but not necessarily) with a PE layer with a higher heat
10 resistance being formed as an outside layer and a layer with a lower resistance formed as an inside layer, providing a temperature resistance differential across the thickness of the film.

Figure 3 shows a film 130 formed according to a further embodiment.
15

The film 130 comprises, from “outside” to “inside”, an outside layer of medium density PE 135, a layer of high density PE 140, a further layer of high density PE 145, a barrier layer of PE 150, and an inside layer of low density PE 155. For sealing purposes then
20 inside layer 155 would seal against another such layer, with the layer 130 forming both external faces.

Figure 4 shows a sheet 260 formed according to a further embodiment.

The film 260 comprises, from “outside” to “inside”, an outside layer of medium density PE 265, a barrier layer of PE 270, a layer of high density PE 275, a further barrier layer of PE 280, and an inside layer of low density PE 285.

- 5 Films and sheets formed in accordance with the present invention can be used to produce, for example, recyclable stand-up pouches, tray, lids and flow wrap packs with oxygen barrier properties.

Figure 5 shows the results of tests performed in relation to a variety of different films
10 (all of which are five layer films with two barrier layers) formed in accordance with the present invention.

Although illustrative embodiments of the invention have been disclosed in detail herein, with reference to the accompanying drawings, it is understood that the
15 invention is not limited to the precise embodiments shown and that various changes and modifications can be effected therein by one skilled in the art without departing from the scope of the invention as defined by the appended claims and their equivalents.

CLAIMS

1. A multilayer film or sheet comprising a first layer of polyethylene having a first density and a second layer of polyethylene having a second density, the first and
5 second densities being different, and at least one core or inner layer which is a polyethylene based layer having oxygen barrier properties.
2. A film or sheet as claimed in claim 1, in which the core or inner layer has a thickness in the range $5\mu\text{m}$ to $20\mu\text{m}$.
10
3. A film or sheet as claimed in claim 2, in which the core or inner layer has a thickness of approximately $10\mu\text{m}$ or $15\mu\text{m}$.
4. A film or sheet as claimed in any preceding claim, in which the first layer is an
15 outside layer and the second layer is an inside layer.
5. A film or sheet as claimed in any preceding claim, in which the first density is higher than the second density.
- 20 6. A film or sheet as claimed in any preceding claim, in which the first density is in the range 0.929g/cm^3 to 0.965g/cm^3 .
7. A film or sheet as claimed in claim 6, in which the first density is approximately 0.931g/cm^3 .

8. A film or sheet as claimed in any preceding claim, in which the second density is in the range 0.80g/cm^3 to 0.90g/cm^3 .

5

9. A film or sheet as claimed in claim 8, in which the second density is approximately 0.88g/cm^3 .

10. A film or sheet as claimed in any preceding claim, in which the density of the core or an inner layer is in the range 1.0g/cm^3 to 1.5g/cm^3 .

10

11. A film or sheet as claimed in claim 10, in which the density of the core or an inner layer is approximately 1.1g/cm^3 .

12. A film or sheet as claimed in any preceding claim, in which the first layer has a thickness in the range $5\mu\text{m}$ to $25\mu\text{m}$.

15

13. A film or sheet as claimed in claim 12, in which the first layer has a thickness of approximately $16\mu\text{m}$.

20

14. A film or sheet as claimed in claim 13, in which the second layer has a thickness in the range $5\mu\text{m}$ to $30\mu\text{m}$.

15. A film or sheet as claimed in claim 14, in which the second layer has a thickness of approximately $13\mu\text{m}$.

25

16. A film as claimed in any preceding claim, in which the thickness of the film is in the range 30 μ m to 200 μ m.

5 17. A film or sheet as claimed in any preceding claim, in which the thickness of the sheet is in the range 200 μ m to 1000 μ m.

18. A film or sheet as claimed in any preceding claim, in which the first layer has a thickness in the range 20 μ m to 200 μ m.

10

19. A film or sheet as claimed in any preceding claim, in which the second layer has a thickness in the range 20 μ m to 200 μ m.

20. A film or sheet as claimed in any preceding claim, in which the first density is in
15 the range 0.900g/cm³ to 0.965g/cm³.

21. A film or sheet as claimed in any preceding claim, in which the or at least one of the barrier layers has a thickness in the range 5 μ m to 50 μ m.

20 22. A three-layer coextruded polyethylene film or sheet comprising an inside layer of polyethylene having a first density and an outside layer of polyethylene having a second density, the first and second densities being different, and a core layer of polyethylene formed between the inside and outside layers, the core layer having oxygen barrier properties.

25

23. A film or sheet as claimed in claim 22, in which the barrier material is only used in the core or an inner layer.

24. A five-layer film or sheet comprising: an inside layer of polyethylene having a first density; a polyethylene-based barrier layer; a central layer of polyethylene; a polyethylene-based oxygen barrier layer; and an outside layer of polyethylene having a second density, the first and second densities being different.

25. A multilayer film or sheet comprising a first layer of polyethylene having a higher heat resistance and a second layer of polyethylene having a lower heat resistance, and a core or inner layer of polyethylene layer having oxygen barrier properties arranged between the first and second layers.

26. A film as claimed in claim 25, in which the first layer is arranged as an outside layer and the second layer is arranged as an inside layer so that, when sealed together, two opposing second layers seal against each other.

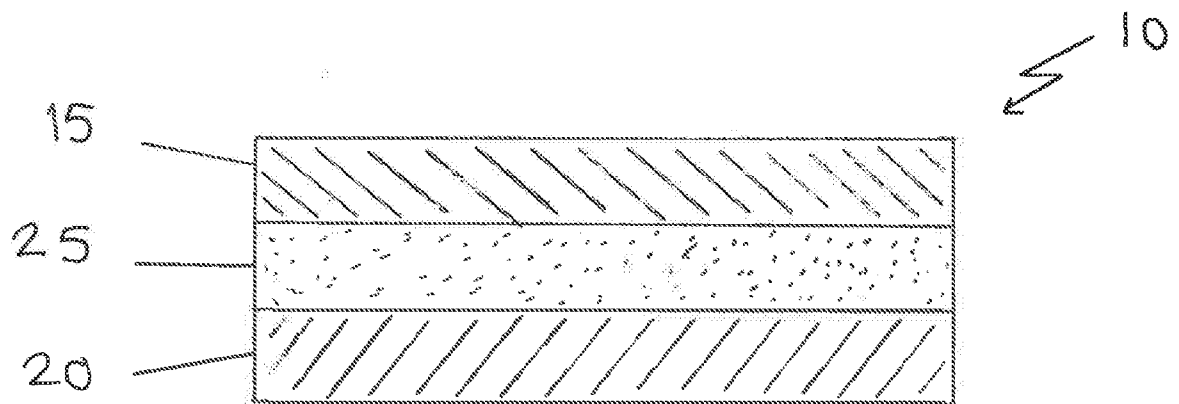
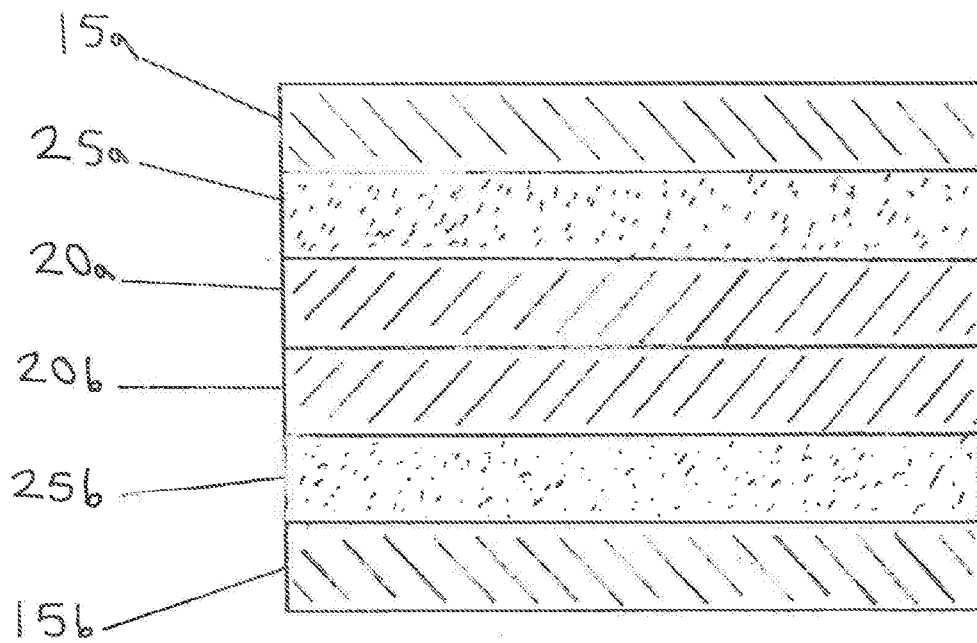
27. A pouch, flow wrap pack, tray or lid formed from a film or sheet as claimed in any preceding claim.

20

28. A stand-up pouch, flow wrap pack or lid which is easily recyclable in the polyethylene recycling stream, the pack being formed from film as claimed in any of claims 1 to 26, and formed by sealing opposing panels of film together, with respective inside layers sealed together.

25

29. A tray formed from a sheet containing an inner layer comprised, in part or entirely, of a polyethylene based organic oxygen barrier mixture which is easily recyclable in the polyethylene recycling stream where the first layer is heat sealable to a suitable lidding film.

**Figure 1****Figure 2**

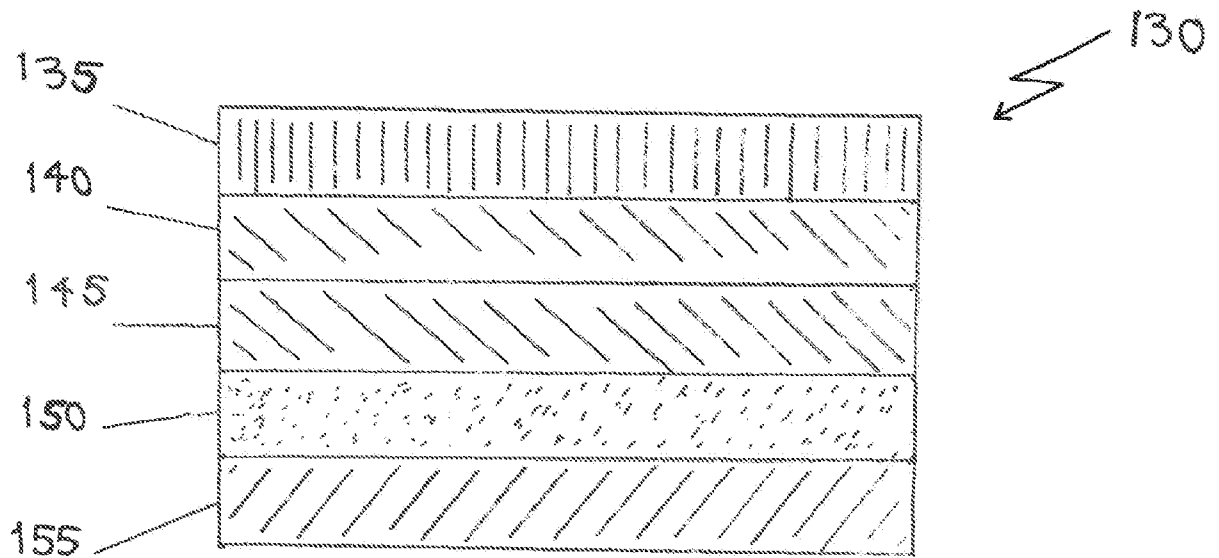


Figure 3

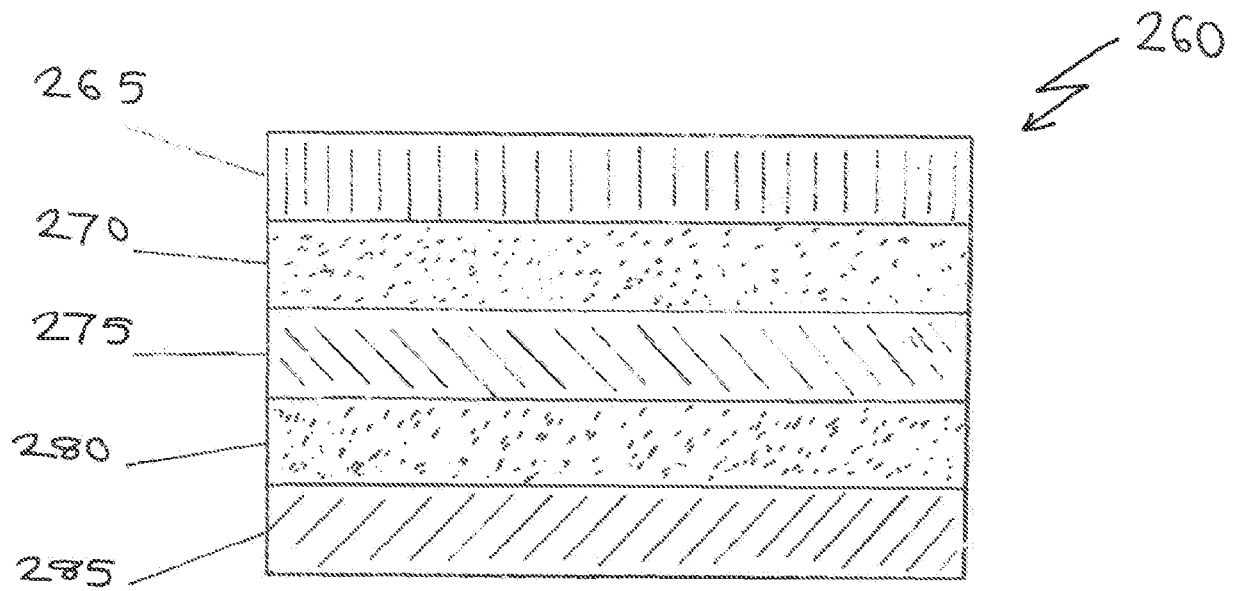


Figure 4

YZ2061 - 60		YZ2061 - 80		YZ2062 - 100		YZ2063 - 100		YZ2045 - 140		YZ2063 - 140	
μ		80μ		μ		μ		140 μ		140 μ	
Natural		Natural		White		Natural		White		Natural	
MD Tensile											
Stiffness (N/mm)		9.3		10.5		19.3		14.8		17.2	
Elastic Modulus (N/mm)		18.0		20.3		37.3		28.5		33.2	
Load (N)		43.7		47.6		77.8		67.1		80.9	
Elongation (%)		540		656		557		683		718	
TD Tensile											
Stiffness (N/mm)		8.5		13.6		18.4		15.3		19.9	
Elastic Modulus (N/mm)		16.4		26.3		35.5		29.5		38.4	
Load (N)		30.4		44.4		40.0		50.9		73.4	
Elongation (%)		488		1061		274		496		884	

Seal Initiation Temperature °C 90 90 90 90 90 90 90 90

Coefficient of Friction 0.12 - 0.18 0.12 - 0.18 0.12 - 0.18 0.12 - 0.18 0.12 - 0.18 0.12 - 0.18 0.12 - 0.18 0.12 - 0.18

		Micron		35		60		80		100		120		140	
		Code		WVTR - 1		WVTR - 2		WVTR - 1		WVTR - 2		WVTR - 1		WVTR - 2	
				g/m ² /d		cc/m ² /d		g/m ² /d		cc/m ² /d		g/m ² /d		cc/m ² /d	
O ² Standard	White	YZ2045				6.9		1.9		3.4				4.2	
	Clear	YZ2061		9.7		3.4		6.1		3.4		3.1		1.2	
O ² Premium	White	YZ2062				4.0		1.2		2.1				1.7	
	Clear	YZ2063				4.6		1.9		2.6		2.9		0.8	

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2019/051756

A. CLASSIFICATION OF SUBJECT MATTER

INV. B32B27/08 B32B27/18 B32B27/32
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015/157876 A1 (EXXONMOBIL ASIA PACIFIC RES & DEV CO LTD [CN]) 22 October 2015 (2015-10-22) abstract; claims 1-23 paragraphs [0021], [0022], [0055], [0056], [0057] -----	1-29
X	EP 3 293 002 A1 (DOW GLOBAL TECHNOLOGIES LLC [US]) 14 March 2018 (2018-03-14) abstract; claims 1-15 paragraphs [0011], [0043], [0050], [0055], [0087], [0090], [0092] -----	1-29
X	WO 2017/127808 A1 (JINDAL FILMS AMERICAS LLC [US]) 27 July 2017 (2017-07-27) abstract; claims 1-20 paragraphs [0022], [0026], [0029], [0065] page 16; examples 1,2 -----	1-29

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

04/09/2019

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2019/051756

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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