Title: A FACE LAYER, A LABEL AND A LABEL LAMINATE COMPRISING A FACE LAYER AND A METHOD FOR PROVIDING A LABEL LAMINATE

Abstract: The invention relates to a face layer, a label laminate and a label comprising the face layer. According to an embodiment, a face layer comprises polyethylene terephthalate at least 80 wt.%. The face layer may be monaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4. Further the invention relates to a use of the face layer for self-adhesive label laminate, to a printed label laminate and to a method for providing a label laminate.
A face layer, a label and a label laminate comprising a face layer and a method for providing a label laminate

Field of the Application

The application concerns a face layer for label laminates. Further the application concerns a label laminate comprising a face layer, a release liner and an adhesive layer, and labels provided thereof. The application also concerns manufacturing of a label laminate.

Background of the Application

It is general practice to apply a label to a surface of an item to provide decoration, and/or to display information about the product being sold, such as the content of the item, a trade name or logo. The label comprises at least a face layer. The label may further comprises an adhesive layer in order to bond the label to the surface of an article. The face layer and release liner are typically laminated together having an adhesive layer in between, which laminated structure is referred to as a label laminate. The release liner is used to protect the adhesive layer but also to allow easier handling of the label to up to the point where the label face layer is dispensed and adhered to a surface of an item.

Summary of the Application

It is an object of the application to provide a face layer, a label and a label laminate comprising a face layer. Another object is to provide a printed label laminate. Still another object of the application is to provide a method for manufacturing a label laminate.

According to an embodiment a face layer for a label laminate comprises polyethylene terephthalate at least 80 wt.%, and the face layer is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4.
According to an embodiment a label laminate comprises a release liner including a release liner substrate coated with a release layer, an adhesive layer and a face layer, wherein the face layer comprises polyethylene terephthalate at least 80 wt.%, and wherein the face layer is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4.

According to an embodiment a printed label laminate comprises a release liner including a release liner substrate coated with a release layer, an adhesive layer and a face layer. The face layer comprises polyethylene terephthalate at least 80 wt.%, and the face layer is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4. Further at least one surface of the face layer comprises printing. The adhesive layer comprises pressure sensitive adhesive and the adhesive layer is arranged between the release layer of the release liner and the printed face layer.

According to an embodiment a label comprises an adhesive layer and a face layer. The face layer comprises polyethylene terephthalate at least 80 wt.%, and the face layer is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4. The adhesive layer is on the surface of the face layer and configured to provide attachment of the label onto a surface of an item.

According to an embodiment a combination of an item and a label comprises a label comprising an adhesive layer and a face layer attached onto the surface of the item through the adhesive layer. The face layer comprises polyethylene terephthalate at least 80 wt.%, and the face layer is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4.

According to an embodiment a method for providing a label laminate according to embodiments comprises: forming an initial non-oriented face layer structure by melt processing technique; stretching the initial non-oriented face layer structure uniaxially in a machine direction for providing a machine direction oriented face layer; providing a release liner substrate;
coating one surface of the release liner substrate with a release agent layer; applying an adhesive layer over the release agent layer and/or over the face layer; and laminating the release liner substrate with the face layer for providing a label laminate having the adhesive layer in between the release layer of the release liner substrate and the face material layer. The method may further comprise printing of the face layer.

Further embodiments of the application are presented in dependent claims.

According to an example, a face layer comprises less than 10 wt.% preferably less than 5 wt.%, more preferably less than 2 wt.% of polymer(s) other than polyethylene terephthalate.

According to an example, a face layer comprises polyethylene terephthalate between 80 and 100 wt.%, preferably between 90 and 100 wt.%.

According to an example, a face layer comprises the orientation ratio between 4 and 9 in the machine direction of the monoaxially oriented face layer.

According to an example, a face layer comprises the orientation ratio between 5 and 8 in the machine direction of the monoaxially oriented face layer.

According to an example, the face layer has the ratio of the 1% secant modulus in the machine direction of the face layer to the 1% secant modulus in the cross direction of the face layer between 2 and 4.

According to an example, the face layer has the tensile strength in machine direction of the face layer between 250 and 400 MPa.

According to an example, the face layer has the ratio of the tensile strength in the machine direction of the face layer to the tensile strength in the cross direction of the face layer between 3 and 5.
According to an example, the face layer has an elongation at break in the machine direction of the face layer less than elongation at break in the cross direction of the face layer.

According to an example, the face layer the ratio of the elongation at break in the machine direction of the face layer to the elongation at break in the cross direction of the face layer between 0.4 and 0.9.

According to an example, the face layer has 1% secant modulus in the machine direction of the face layer between 4000 and 8000 MPa.

According to an example, the face layer has 1% secant modulus in the machine direction of the face layer between 5000 and 7500 MPa, for example at least 6000 MPa.

According to an example, the adhesive layer comprises pressure sensitive adhesive, and the adhesive layer is arranged between the release layer of the release liner and the face layer.

According to an example, the face layer includes printing.

According to an example, the release liner substrate comprises polyethylene terephthalate at least 80 wt.%, and the release liner substrate is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4.

Description of the Drawings

In the following some examples and embodiments of the invention will be described in more detail with reference to appended drawings, in which,

Fig. 1 shows, in a perspective view, an example embodiment of a laminated structure for labels,
Detailed Description of the Application

In this description and claims, the percentage values relating to an amount of raw materials are percentages by weight (wt.%) unless otherwise indicated. The following reference numbers and denotations are used in this application:

- Sx, Sy, Sz: orthogonal directions
- TD: transverse direction
- CD: cross direction
- MD: machine direction
- MRK1: graphics (printing)
- 1: a label
2 a face layer,
4 an adhesive layer,
6 a release liner,
8 a label laminate structure (a label laminate web),
10 a substrate (a backing material),
11 a waste material,
12 a release coating layer,
13 a cutting device,
14 a core layer,
16 a first skin layer,
18 a second skin layer,
20 an item,
112 a printed face layer,
114 a core layer of a face,
116 a first skin of a face,
118 a second skin of a face,
120 a protective layer.

In this application term "label" 1 refers to a product that comprises at least a face layer 2 and an adhesive layer 4. Through an adhesive layer the label is attached to an item. Further the label typically includes graphical patterns (printing) on its face layer. Advantageously, the face layer 2 is laminated together with a release liner 6 having the adhesive layer 4 in between so as to provide a label laminate structure. During manufacturing of a label 1, the adhesive layer may be applied onto the surface of the face layer 2, and/or onto the surface of the release liner 6 prior to lamination step.

Term "label laminate web" 8 refers to a continuous structure for labels comprising a face layer 2, an adhesive layer 4 and a release liner 6. Individual labels are die-cut from the continuous label laminate web 8. When the label 1 is used i.e. labelled to an item, the face layer 2 is attached to the surface of an item through the adhesive layer 4. The release liner 6 is removed prior to labelling.

Term "face layer" 2 refers to the top layer of the label 1, also called as a face stock, or a face material layer. The face layer 2 is the layer that is adhered to
the surface of an item during labelling through the adhesive layer. The face layer may further comprise printing MRK1 on its surface(s). Printing provides information and/or visual effect, such as information of the content of the item labelled. The printing may exist on a top surface, reverse side or both top and reverse side of the face layer. A label consisting of a face layer, printing layer and an adhesive layer may be referred to as “a printed label”.

Term "release liner" 6 refers to a structure comprising or consisting of a backing material layer 10 as a release liner substrate and a release coating layer 12 on a surface of the substrate. In other words, the backing material 10 is usually coated with a thin layer of release agent, such as silicone. The release coating layer provides a non-adherent surface and low adhesion release effect against the adhesive layer. The release liner protects the adhesive layer during shipment and storage. It further allows for efficient handling of individual labels after the labels are die-cut and the surrounding matrix (waste material) is stripped off to the point where the individual labels are dispensed on a labelling line. During dispensing the liner is peeled off from the adhesive surface and discarded. The release liner may be further recycled or re-used. The release liner substrate 10 will also be referred to as a substrate, a backing material or a backing film hereinafter.

Fig. 1 presents an example embodiment of a laminated label web structure 8 comprising a face layer 2, a release liner 6, and an adhesive layer 4. The adhesive layer may be applied onto the face layer 2 and/or onto the release liner 6 during the label laminate web manufacturing. Referring to Fig. 1, the adhesive layer 4 is arranged between the release layer 12 of the liner 6 and the face layer 2. In other words, in the label laminate structure the release layer of the release substrate is next to the adhesive layer, such as pressure sensitive adhesive. The laminated label structure may further comprise printing MRK1. A top surface of the face layer 2 may be printed. The printing may be subsequently top coated in order to protect the printing. Alternatively or in addition, the reverse side of the face layer adjacent to the adhesive layer 4 may be printed.
Referring to Fig. 9, the label 1 can be attached to the surface of an item 20. The label 1 can be affixed through an adhesive layer 4 to the substrate, i.e. to the surface of an item (article), such as a surface of a bottle.

FACE LAYER

A face layer may have a monolayer structure also referred to as a single layer structure consisting only one layer. Alternatively, the face layer may have multilayer structure comprising at least two layers.

Total thickness of a machine direction oriented multilayer or monolayer face structure may be between 8 and 60 µm or between 12 and 50 µm, preferably between 18 and 50 µm, or between 18 and 30 µm. A machine direction oriented face layer comprising polyester may have a thickness of, for example, 12 µm, 18 µm, 23 µm, 30 µm, 36 µm or 50 µm.

With reference to Fig. 7, a face layer 2 of a label, may have a multilayer structure consisting of a core layer 114, a first skin layer 116 and a second skin layer 118.

A print layer (printing) may exist on a top surface, reverse side or both top and reverse side of the face layer 2. Referring to Fig. 7, the printing MRK1 may be provided on a top surface of the face layer 2. Printing MRK1 may be provided on a surface of the first skin layer 116. The face layer may also include a protective layer(s) 120, such as lacquer, on top of the printing MRK1. Surface(s) of the face layer, i.e. adhesive and/or print receiving surface may be surface treated prior to subsequent application of further layers, such as adhesive layer and printing.

In a multilayer face layer structure, the thicknesses of separate layers may be different. For example, the core layer 114 may be relatively thick compared to skin layer(s) 116, 118. In other words, the thickness of the core layer may be greater than the thickness of the first skin layer and/or the second skin layer. Symmetric multilayer face structure with respect to the thickness of the skin layers may be preferred. For example, in a three layer structure skin layers on both sides of the core layer have equal thicknesses.
A face layer may be paper based, such as coated paper or uncoated paper, plastic based or a combination of these. Preferably the face layer is plastic (polymeric) based. The plastic based face layer may comprise polymers, such as polyolefin, polyester, polystyrene, polyurethane, polyamide, poly(vinyl chloride) or any combinations of these. Alternatively, the face layer may comprise biodegradable polymers, such as lactic acid, starch or cellulose based. The face layer may include homopolymers, copolymers or it may consists of a polymer blend. For example, the face layer may comprise mixtures of polyolefins, such as polyethylene (PE) and polypropylene (PP). In a multilayer face layer structure the composition of layers may be different. Alternatively, the layers may have same composition. For example, in a three layer multilayer face structure, the skin layer(s) may have special ingredients (minor components) not included in the core layer.

According to an embodiment, a face layer comprises or consists polyester polymers(s). The face layer includes less than 10 wt.%, preferably less than 5 wt.%, more preferably less than 2 wt.% of polymer(s) other than polyester. Preferably the face layer comprises polyethylene terephthalate (PET) as a main polymer. Main polymer refers to a polymer having highest proportion in the face layer composition. The face layer comprises at least 50 wt.%, preferably at least 80 wt.% or at least 90 wt.% of polyethylene terephthalate. In the face layer total amount of PET may be between 50 and 100 wt.%, preferably between 80 and 100 wt.% or between 90 and 100 wt.%. According to an embodiment, total amount of PET may be between 50 and 98 wt.%, preferably between 80 and 98 wt.% or between 80 and 90 wt.%.

In addition, the face layer may comprise minor components, such as inorganic additives or organic additives. Minor components, such as pigments or inorganic fillers may be used to provide, for example, a desired colour for the face layer. Additives may include, for example, titanium dioxide, calcium carbonate and blends thereof. The face layer may also comprise minor amounts of other additives and/or modifiers, e.g. plasticisers, stabilizers, anti-static agents, slip/anti-blocking agents. Total amount of minor component(s) is less than 10 wt.%, preferably less than 5 wt.% or less than 2 wt.% of the face layer composition.
Due to the colouring agents, e.g. opaque and white face layer may be achieved. Carbon black may be introduced to provide black or grey face layer. Anti-blocking additive(s) may be used in the skin layer(s) of the multilayer structure. Anti-blocking additive may be at least one of the following: silicate, synthetic silica and synthetic kaolin. An amount of anti-blocking compound consisting of anti-blocking additive and polymeric carrier may be less than 3 wt.%, preferably less than 2 wt.%, for example 2 wt.% or 1 wt.%. Anti-blocking additive may have effect on surface roughness of the face layer. For example, in the skin layer composition total amount of anti-blocking additive(s) may be between 0.05 and 0.5 wt.%.

Polymer based face layer may be monoaxially (uniaxially) oriented in machine direction (MD). Machine direction refers to the movement of the face layer i.e. longitudinal direction of the continuous face layer (winding direction of the face layer). Direction perpendicular to the machine direction is referred to as a transverse direction (TD) or a cross direction (CD) of the face layer. In the figures of the present application MD corresponds to the direction \( S_x \) and CD to the direction \( S_y \).

According to an embodiment, the face layer structure oriented monoaxially in a machine direction of the face layer so as to provide a monoaxially in MD oriented face layer. MD oriented face layer may have a stretching ratio greater than 4, for example, between 4 and 9, preferably between 5 and 8 in MD. Stretching (orientation) ratio of the monoaxially in machine direction oriented face layer may be 4.5 or 5, preferably 6 or 7 or 8.

Any of the above described face layers may be used for label structures further comprising an adhesive layer. In addition, a release liner may be applied so as to provide a label laminate.

**RELEASE LINER**

According to an embodiment, a substrate of a release liner is provided. Fig. 2 presents an example embodiment of a release liner 6 having a release coating layer 12 on top of the release liner substrate 10. Further, the release liner may comprise at least one adhesive layer on top of the release coating layer 12.
In a label laminate structure, the release liner 6 is used to protect the adhesive layer 4 and to allow easier handling of the label web 8 up to the point where the labels 1 are die cut, dispensed and adhered to a surface of an item.

The release liner may comprise at least one of the following as a release liner substrate: glassine paper, kraft paper and polymeric film. Preferably the release liner substrate is polymer based. Preferably, the polymer based substrate is uniaxially oriented in machine direction of the substrate. Orientation degree of the machine oriented substrate may be at least 4.

According to an embodiment, the substrate 10 of the release liner 6 is polymer based. In other words, the substrate may be mainly based on polymeric raw materials. The substrate may comprise polyester, such as polyethylene terephthalate (PET).

The polymer based release liner substrate 10 may have a single layer (monolayer) structure. Alternatively, the release liner substrate may comprise several layers so as to provide a multilayer structure. For example, the multilayer substrate comprises at least 2 layers. For example, the substrate consists of a multilayer structure having three or five layers. Referring to Fig. 6, the release liner substrate 10 may have a three layer structure. The three layer structure may comprise a core layer 14, a first skin layer 16 and a second skin layer 18 opposing sides of the core layer 14. In a three layer substrate structure the release coating layer may be applied at least onto the one skin layer. Specific skin composition may have effect on anchorage of the silicone layer to the release liner substrate.

According to an embodiment, the polymer based release liner substrate is uniaxially (monoaxially) oriented in a machine direction of the substrate. Machine direction refers to the movement of the release liner substrate i.e. longitudinal direction of the continuous release liner substrate (winding direction of the release liner substrate). MD oriented release liner substrate may have stretching ratio greater than 4, for example between 4 and 9, preferably between 5 and 8 in MD. Stretching (orientation) ratio of the
monoaxially in machine direction oriented release liner substrate may be 4.5 or 5, preferably 6 or 7 or 8.

In a multilayer release liner substrate structure the layers can be of equal or different thicknesses. According to an embodiment, thicknesses of the individual layers are different. Preferably the multilayer has a symmetric structure with respect to the thickness of the layers. For example, in a three layer structure the skin layers have preferably the same thickness. Symmetric multilayer structure may effect on lay-flat properties. Symmetric structure may provide good overall flatness of the substrate. Good overall flatness refers to absence of e.g. creases, wrinkles or wavy edges. Further, good lay-flatness refers to absence of curling of the substrate.

According to an embodiment, in a three layer structure, thickness of the core layer may be 60% and thickness of each skin layer 20% of the total thickness of the substrate. Alternatively, the structure may comprise very thin skin layers. Skin layer may have thickness of 1% or 2%, preferably 5% or 10% of the total thickness of the substrate. Skin layer thickness may be, for example, between 1 and 30%, or between 1 and 20% of the total substrate thickness. Core layer thickness may be at least 40% of the total thickness of the substrate. Preferably the thickness of the core layer is at least 50% or at least 60% of the total thickness of the substrate. For example, core layer thickness is between 40 and 98%, preferably between 50 and 90% of the total thickness of the substrate.

Total thickness of a machine direction oriented multilayer or monolayer release liner substrate may be between 8 and 40 μm, preferably between 12 and 40 μm, and more preferably between 15 and 30 μm. The machine direction oriented substrate comprising polyester may have a thickness of, for example, 23 μm, 18 μm or 12 μm. Thin substrate may effect on sustainable development. Further it has effect on an amount of waste material to be disposed of, recycled or re-used.

According to an embodiment, the release liner substrate comprises or consists mainly of polyester polymer(s). The substrate includes less than 10 wt.%, preferably less than 5 wt.%, more preferably less than 2 wt.% of
polymer(s) other than polyester. Preferably the release liner substrate comprises polyethylene terephthalate (PET) as a main polymer. Main polymer refers to a polymer having highest proportion in the substrate. The release substrate comprises at least 50 wt.%, preferably at least 80 wt.% or at least 90 wt.% of polyethylene terephthalate. Total amount of PET may be between 50 and 100 wt.%, preferably between 80 and 100 wt.% or between 90 and 100 wt.%.

According to an embodiment, total amount of PET is between 50 and 98 wt.%, preferably between 80 and 98 wt.% or between 80 and 90 wt.%.

In a multilayer substrate structure the composition of layers may be different. Alternatively, the layers may have same composition. In a multilayer substrate structure at least one layer comprises at least 80 wt.% polyester.

In addition, the release liner substrate may include minor component(s), such as anti-blocking additive(s), slip additive(s), ultra violet (UV) stabilizer(s) and/or colouring agent(s). Total amount of minor component(s) is less than 10 wt.%, preferably less than 5 wt.% or less than 2 wt.% of the release liner substrate composition.

Due to the colouring agents, e.g. white liner substrates may be achieved. Minor components may be, for example, TiO_2, talc and calcium carbonate. Anti-blocking additive(s) may be used in the skin layer(s) of the multilayer substrate structure. Anti-blocking additive may be at least one of the following: silicate, synthetic silica and synthetic kaolin. An amount of anti-blocking compound consisting of anti-blocking additive and polymeric carrier may be less than 3 wt.%, preferably less than 2 wt.%, for example 2 wt.% or 1 wt.%.

Anti-blocking additive may have effect on surface roughness of the substrate. For example, in the skin layer composition total amount of anti-blocking additive(s) may be between 0.05 and 0.5 wt.%.

Referring to Fig. 2, a release layer 12 comprising release agent may be applied onto the surface of a release liner substrate 10 so as to form a release liner 6. Referring to Fig. 5, the release layer 12 comprising agent provides a low release force and ensures separation of the label 1 containing face layer 2 and adhesive layer 4 from the release liner 6 without affecting
the properties of the adhesive layer 4. Thus, the release layer allows easy delamination of the label laminate and easy application of the label 1 comprising the face layer 2 and the adhesive layer 4 onto the article to be labelled.

A release coating layer 12 of a release liner 6 may comprise or consist of a material having high repellence properties towards the adjacent adhesive layer, such as an adhesive consisting of pressure sensitive adhesive. The release coating may consist of silicone, for example, cross linkable silicone which can be applied to the release liner substrate and cured into a cross-linked silicone, i.e. into a poly dimethyl siloxane network (PDMS). In order to achieve a silicone release coating layer a solvent-based, emulsion-based or solventless silicone systems may be used. The silicone may be cured, for example, by heat, UV radiation, LED or electron beam. Preferably, the release layer consists of silicone which is thermal curing, UV radiation curing or mixture of these.

The release coating layer may consist of silicone. Silicone content may be less than 2 g/m², less than 1.5 g/m² or less than 1 g/m² (dry grammage). The amount of silicone may be at least 0.01, 0.02 or 0.1 g/m². The amount of silicone may be between 0.1 and 1.5 g/m² or between 0.4 and 1.5 g/m² or between 0.6 and 1 g/m², for example 1 g/m². Due to the release agent, such as silicone, the release liner 6 can be easily removed from the adhesive layer 4 of the face layer 2 during labelling i.e. prior to application of the label to the surface of an item, as shown in Fig. 5. Plastic (polymer based) release liner substrates are preferred in order to achieve good evenness, such as smooth surface.

Any of the above described release liner substrates may be used for release liners of a label laminate structures further comprising a face layer and adhesive layer.

According to an embodiment, a label laminate comprising or consisting of a face layer 2, a release liner 6 and adhesive layer 4, is provided.
According to an example, a label laminate structure 8 includes a monoaxially in machine direction oriented face layer comprising at least 80 wt.% polyethylene terephthalate and having orientation ratio at least 4. Further it includes a release liner substrate which is be paper based. Alternatively, the release liner substrate is polypropylene (PP) based, such as biaxially oriented PP (BOPP) or monoaxially in machine direction oriented PP (MDO-PP). Optionally, the release liner substrate is biaxially oriented PET.

In order to provide label laminate structure the above described release liner substrates are coated with release agent layer comprising silicone for providing a release liner and subsequently laminated with the face layer. The adhesive layer between the face layer and the release liner comprises or consist of pressure sensitive adhesive, such as acrylic based adhesive.

A label 1 and a label laminate 8 structure may comprise an adhesive layer 4 consisting of a pressure sensitive adhesive (PSA). The labels consisting of PSA can be adhered to most surfaces through an adhesive layer without the use of a secondary agent, such as a solvent, or heat to strengthen the bond. The PSA forms a bond when pressure is applied onto the label at room temperature, adhering the label to the product to be labelled. Room temperature refers to an ambient temperature, such as between 18 and 25 degrees C. The label comprising pressure sensitive adhesive may be referred to as a pressure sensitive adhesive (PSA) label. Pressure sensitive adhesive labels may also be referred to as self-adhesive labels. Label laminates comprising pressure sensitive adhesive may be referred to as self-adhesive label laminates.
The adhesive layer 4 may consist of at least one of the following, a water based adhesive, a solvent based adhesive and a hot melt adhesive. If the adhesive layer is to be applied onto the face layer 2, the adhesive layer may consist of, for example, UV-curable hot melt which is cured by UV light after coating. Solvent based adhesive may comprise polyurethane. Chemical composition of the pressure sensitive adhesive may be based on acrylic polymers. Tackifiers may be used in order to improve adhesion properties of acrylic adhesives. Alternatively, the adhesive may be a rubber based adhesive comprising synthetic or natural rubber. Rubber based adhesives contain, in addition, tackifier resin(s).

Referring to Fig. 3, individual labels 1 of desired configuration may be cut with a cutting device 13 from a continuous label laminate web structure 8. In particular, the labels 1 may be die-cut from the web 8. Referring to Figs. 3 and 4, after cutting, the labels are attached to a common liner 6, which remains uncut. Thus, a plurality of labels remains attached to a common continuous liner 6. Alternatively, the labels 1 may be completely separate, i.e. also the liner 6 may be cut. Referring to Fig. 3, the waste material (matrix) 11 is stripped from the liner and the continuous liner 6 comprising individual labels 1 is re-wound into a roll. Thus, the re-wound roll comprises the liner carrying only number of individual labels of desired shape. The re-wound roll may be subsequently fed into printing machine which applies printed graphics to the individual labels. Alternatively, the label laminate web 8 may be printed prior to cutting into individual labels. During dispensing process the individual labels comprising graphical patterns (printing) are removed from the release liner and applied to particular items.

Referring to Fig. 5, the label 1 may be separated from the liner 6 e.g. by pulling the liner 6 in the direction -S₂ with respect to the label 1. Thus, a surface of the adhesive layer 4 may be exposed so that said surface can be attached to an item. Separation may be done in label dispensing process prior to application of the label to the surface of an article.

A method for manufacturing a face layer and further a label laminate according to embodiments of the invention comprises forming an initial non-oriented structure for a face layer through melt processing technique from the
polymeric raw materials including polyethylene terephthalate at least 80 wt.%.

Polymer based monolayer structures may be provided by known melt processing techniques e.g. by extrusion process, such as blown film extrusion or cast extrusion. The multilayer structures can be made by co-extrusion, coating, or any other laminating process. In co-extrusion the layers of the multilayer structure are formed simultaneously by using a suitable co-extrusion die. The layers are adhered to each other to provide a unitary co-extrudate. The multilayer structures may be co-extruded through blown film extrusion technology. Alternatively, the multilayer structures may be cast, i.e. produced by cast extrusion technology. During extrusion process the polymeric raw material is heated to a molten state and extruded through a die in the form of sheet. The extruded sheet is subsequently cooled to provide initial non-oriented structure.

The method further comprises stretching of the continuous non-oriented structure in a machine direction of the structure with a specific orientation ratio providing a machine direction oriented structure for the face layer. Orientation (stretching) may be performed in an in-line or an off-line process. In-line process refers to a process in which the stretching is provided during the film manufacturing process i.e. directly after the melt processing of the initial structure. During orienting (stretching) the randomly oriented polymer chains of the non-oriented structure, such as film or sheet, are oriented in the direction of stretching (drawing). Stretching provides an oriented (stretched) initial structure. Orientation under uniaxial stress provides orientation of polymer chains of the initial structure in the direction of stress provided. In other words, the polymer chains are oriented at least partially in the direction of stretching (drawing). Thus, the oriented product such as oriented face layer, comprises or consists of polymer chains having specific orientation degree in the direction of stretching. The degree of orientation of the polymer chains depends on amount of stretching of the substrate. Thus, the polymer chains in the product having higher orientation degree are more oriented when compared to the product having lower orientation degree.
Through a machine direction orientation process, the melt processed non-oriented initial structure is uniaxially stretched in the machine direction of the initial structure so as to form uniaxially oriented initial structure. Machine direction refers to the movement of the initial structure i.e. longitudinal direction of the continuous initial structure (winding direction of the initial structure). Direction perpendicular to the machine direction is referred to as a transverse direction (TD) or cross direction (CD) of the initial structure. In the figures of the present application MD corresponds to the direction $S_x$ and CD to the direction $S_y$. Stretching is normally done by means of a machine direction orienter via rolls with gradually increasing speed. Alternatively, the stretching is done by means of orienter via rolls with rapidly increasing speed. The stretching occurs due to a difference in speed between the last and the first rolls. The rolls are heated sufficiently to bring the initial non-oriented structure to a suitable temperature, which is normally below the melting temperature ($T_m$), or around the glass transition temperature ($T_g$) of the polymer. A machine direction orientation (stretching) process is a one-step process followed by annealing.

An amount of orientation (stretching) is referred to as a stretching ratio also referred to as an orientation degree. Orientation degree is a thickness of the oriented (stretched) product relative to that of the non-oriented (non-stretched) initial structure. The initial non-oriented structure thickness is the thickness after extrusion and subsequent chilling of the structure. When stretching the initial non-oriented structure, the thickness of the non-oriented structure diminishes in the same ratio as the non-oriented structure is stretched or elongated. For example, an initial non-oriented structure may have a thickness of 100 micrometres before orientation. After the uniaxial orientation (stretching) and annealing the oriented product may have a fivefold diminished thickness of 20 micrometres. Thus, the orientation degree of the oriented product is 5.

For example, uniaxial machine direction stretching ratio (orientation degree) of a face layer comprising polyethylene terephthalate at least 80 wt.% is greater than 4, for example between 4 and 9, preferably between 5 and 8.
Annealing may be performed after stretching for providing an annealed (heat-set) structure. Annealing may be performed in an annealing section, which allows stress relaxation of the oriented structure by keeping the oriented structure at an elevated temperature for a period of time. Annealing may be performed at a temperature between 190 and 240 degrees C so as to provide an oriented product, such as oriented release liner substrate and oriented face layer. After annealing, cooling of the oriented product to an ambient temperature may be provided. The ambient temperature may be between 18 and 25 degrees C. Annealing may enhance dimensional stability of the oriented structure, such as oriented face layer and oriented release liner substrate. Annealing may provide effect of reduced shrinking capability of the oriented product in subsequent converting steps, storage and/or shipping. Heat shrinkage of the oriented product may be less than 10% or less than 5%, preferably less than 2% at temperatures between 20 and 50 degrees C. For example, heat shrinkage of the oriented product is between 0.5 and 10% or preferably between 0.5 and 5% at temperatures between 20 and 50 degrees C.

Also a method for providing a machine direction oriented release liner substrate comprising polyethylene terephthalate may comprise the above presented steps accordingly.

The method may further comprise surface treating of the oriented product.

Surface(s) of the face layer, i.e. adhesive and/or print receiving surface may be surface treated, for example, by flame treatment, corona treatment, plasma treatment. Surface treatment may have effect on adhesion of the adhesive and/or printing layer.

Surface of the release liner substrate may be surface treated prior to applying a release agent layer. Surface treatment of the substrate may be provided e.g. by exposure to an electric corona discharge. Surface treatment may provide enhanced wetting property of the substrate allowing uniform application of the release agent layer.
Next, the method of providing a release liner comprises coating of the release liner substrate with a release layer comprising release agent. The release agent layer may be applied, for example, as an aqueous emulsion using e.g. roll coating, gravure coating, roll brush coating, spray coating air knife coating, slot coating, or dipping. Subsequently heat may be applied in order to evaporate the water and cure and bind the coating to the substrate. A method for manufacturing a label laminate according to embodiments further comprises laminating step for attaching a release liner to a face material layer. An adhesive layer is applied over the face material layer and/or over the release agent layer of the release liner prior to lamination step.

A face according to at least some embodiments is clear, thus being substantially transparent to visible light. Transparent no-label look appearance of the label is advantageous, for example, in applications where the objects beneath the label, i.e. the surface of a bottle, should be visible through the label. The haze level of a face layer should be lower than 35%, preferably equal to or lower than 25% or lower than 10%, when tested according to the standard ASTM D1003. For example, haze is between 0.5 and 9. A face according to some embodiments is opaque. Opaque face layer may have an opacity of at least 70%, at least 75%, or at least 80%, for example between 70 and 95% or between 70 and 80%.

1% secant modulus may be used to describe the stiffness of the material. It may be measured according to ISO 527-3 standard for plastic films. 1% secant modulus may be used to describe the rigidity of the product. Generally high modulus product requires more stress to produce a specific amount of strain (elongation). In polymer based products, such as label face layers and release liner substrates, the modulus may be directional. Directional modulus means that the modulus in a first direction may differ from the modulus in a second direction of the product. For example, the modulus may be different in MD and in CD of the release liner substrate or the face layer.

At least some/all embodiments of the face layer have effect on conformability of labels. Conformable label refers to a label being capable to conform smoothly and without wrinkles to the contour of the article even when this is
curved in two-dimensions. To obtain a conformable label, also suitable conformability of the face layer is required. Fig. 8 present an example of a conformable face layer structure. At least some/all embodiments of the face layer have directional modulus. Directional modulus of the face layer may have effect on the conformability of the label.

A face according to at least some/all embodiments has 1% secant modulus in machine direction (MD) at least 4000 MPa, preferably at least 5000 MPa or at least 6000 MPa, when tested according to ISO 527-3 standard for plastic films. For example, 1% secant modulus may be between 4000 and 8000 MPa, preferably between 5000 and 7500 MPa or 6000 and 7000 MPa. A face layer comprising 1% secant modulus in MD between 4000 and 8000 MPa, more preferably between 6000 and 7000 MPa may have effect on providing sufficient rigidity for the face layer in the machine direction. Sufficient rigidity is needed, for example, during dispensing of the labels. Sufficient rigidity may also have effect on stability of the face layer during subsequent die-cutting process.

At least some/all embodiments have 1% secant modulus in cross direction (CD) less than that in machine direction (MD) of the face layer. Preferably the 1% secant modulus is at least two times higher in MD than in CD of the face layer. 1% secant modulus in CD may be at least 1000 MPa, 1500 MPa or 2000 MPa, when tested according to ISO 527-3 standard for plastic films. For example, 1% secant modulus in CD may be between 1000 and 4000 MPa, or between 1500 and 3500 MPa. 1% secant modulus of the face layer in CD below 3500 MPa, for example 3000 MPa, may have an effect of increased flexibility of the face layer. For example, biaxially oriented film has 1% secant modulus in CD of between 4000 and 5000 MPa.

At least some/all embodiments have 1% secant modulus in machine direction (MD) of the face layer at least twice that of cross direction (CD) of the face layer. In other words, ratio of 1% secant modulus in MD to 1% secant modulus in CD (1% secant modulus in MD divided by 1% secant modulus in CD, MD/CD) of the face layer is at least 2. MD/CD ratio of 1% secant modulus may be between 2 and 4, or between 2 and 3.5. For example, ratio of 1% secant modulus in MD to 1% secant modulus in CD (MD/CD) of the
face layer is 2 or 2.5, preferably 3 or 3.5. or 4. 1% secant modulus ratio MD/CD of at least 2 may provide an effect of conformability of the face layer.

At least some/all embodiments have an elongation at break both in machine direction and in cross direction of the face layer less than 50% or less than 40%, preferably less than 30%. Elongation at break in MD may be between 5 and 50%, or between 5 and 30%, or between 15 and 30%. Elongation at break in CD and in MD may be equal. Thus, the ratio of MD elongation at break to CD elongation at break (MD/CD) is 1. Elongation at break in MD of the face layer may be less than elongation in CD of the face layer. Difference between the elongation at break in CD and MD may be less than 30%, preferably less than 20 or less than 10%. For example, the ratio of elongation at break in machine direction of the face layer to the elongation at break in cross direction (MD/CD) of the face layer may be between 0.4 and 0.9, or between 0.5 and 0.9, preferably between 0.4 and 0.8 or between 0.5 and 0.8. Elongation less than 50% in both CD and MD of the face layer may have effect on die-cutting performance of the face layer. For example, uniform and even die-cutting operation in both directions may be achieved. The specific elongation may also have effect on waste matrix stripping. For example, even up-take of waste matrix may be achieved.

At least some/all embodiments have the tensile strength in machine direction at least three times that of cross direction of the face layer. In other words, at least some/all embodiments have the ratio of the tensile strength in MD of the face layer to the tensile strength in CD (MD/CD) of face layer at least 3, for example between 3 and 5.

For example, tensile strength in the machine direction of the face layer is at least 200 MPa, preferably at least 250 MPa or at least 300 MPa. For example, tensile strength is between 250 MPa and 400 MPa in machine direction of the face layer. Tensile strength in CD of the face layer may be at least 30 MPa, preferably at least 50 or at least 70 MPa. For example, between 30 and 120 MPa. Tensile strength of the face layer may have effect on the matrix (waste material) stripping process after die-cutting of the labels. In order to avoid problems in subsequent label dispensing process the waste material has to be stripped of between the die-cut labels. The tensile strength
in MD at least 200 MPa, preferably between 250 and 400 MPa may have effect on contiguous removal of the waste matrix and winding up of the die-cut labels.

1% secant modulus of a release liner substrate may be measured according to the standard ISO 527-3. A release liner substrate according to at least some/all embodiments has 1% secant modulus in machine direction (MD) of the substrate at least twice that of cross direction (CD) of the substrate. In other words, ratio of 1% secant modulus in the MD to 1% secant modulus in the CD (1% secant modulus in MD divided by 1% secant modulus in CD, MD/CD) of the substrate is at least 2. MD/CD ratio of 1% secant modulus may be between 2 and 4, or between 2 and 3.5. For example, ratio of 1% secant modulus in MD to 1% secant modulus in CD (MD/CD) of the substrate is 2 or 2.5, preferably 3 or 3.5, or 4.

Release liner substrate according to at least some/all embodiments has 1% secant modulus in machine direction (MD) of the release liner substrate between 4000 MPa and 10000 MPa. Higher 1% secant modulus in MD provides an effect of lower elongation in that direction. Higher 1% secant modulus in MD provides also greater stiffness in that direction. Higher 1% secant modulus in MD may have effect on avoiding stretching of the release liner substrate in MD.

Release liner substrate according to at least some/all embodiments has 1% secant modulus in cross direction of the substrate between 2000 MPa and 5000 MPa. For example, 1% secant modulus of the substrate is 4000 MPa in MD and 2000 MPa in CD of the substrate, preferably 6000 MPa in MD and at most 3000 MPa in CD.

At least some/all embodiments have an elongation at break in MD of the release liner substrate less than 50% or less than 40%, preferably less than 30%. Elongation at break in MD may be between 5 and 50%, or between 5 and 30%, or between 15 and 30%. Lower elongation at break of the release liner substrate in MD may have effect on reducing stretching of the substrate and thus reducing the risk of misplacing the labels in subsequent labelling process.
Release liner substrate according to at least some/all embodiments has elongation in machine direction of the release liner substrate at web tension between 600 and 1200 N/m, for example at 800 N/m, is less than 3%, preferably less than 2, or less than 1%. Low elongation at web tension of between 600 and 1200 N/m may provide more effective and accurate application process of labels, for example, higher dispensing/application speeds may be used.

Release liner substrate according to at least some/all embodiments has elongation at break in CD of the release liner substrate less than 200% or less than 100%, preferably less than 50% or less than 40%. Elongation at break in CD may be between 15 and 100%, or between 20 and 50%, or between 20 and 40%. Low enough elongation of the substrate in CD may have effect on die-cutting, for example, providing better register control. Low elongation in CD of the substrate may also have effect on providing better register control of the print in subsequent printing of the label structure.

At least some/all embodiments, have elongation at break in the machine direction of the release liner substrate equal or less than that in the cross direction of the release liner substrate. Elongation at break in MD of the release liner substrate may be less than elongation at break in CD of the release liner substrate. Difference between the elongation at break in CD and MD may be less than 30%, preferably less than 20 or less than 10%. For example, the ratio of elongation at break in the machine direction of the release liner substrate to the elongation at break in the cross direction (MD/CD) of the release liner substrate may be between 0.4 and 0.9, or between 0.5 and 0.9, preferably between 0.4 and 0.8 or between 0.5 and 0.8.

For example, at least some/all embodiments have 1% secant modulus in machine direction of the release liner substrate 50% greater than the 1% secant modulus in MD of the corresponding biaxially oriented substrate. Biaxially oriented substrate refers to the substrate oriented both in machine and cross directions.

At least some/all embodiments, have tensile strength in machine direction at least three times that of cross direction of the release liner substrate. In other
words, at least some/all embodiments have the ratio of the tensile strength in MD of the release liner substrate to the tensile strength in CD of the release liner substrate at least 3, for example between 3 and 5.

For example, tensile strength in the machine direction of the substrate is at least 200 MPa, preferably at least 250 MPa or at least 300 MPa. For example, tensile strength is between 250 MPa and 400 MPa in machine direction of the substrate. Tensile strength in CD of the substrate may be at least 30 MPa, preferably at least 50 or at least 70 MPa. For example, between 30 and 120 MPa. Preferably, a ratio of tensile strength to elongation in machine direction of the substrate is at least 7, preferably at least 10. For example, between 7 and 25.

Low elongation and high tensile strength of the release liner substrate in MD may have effect on the accurate placing of the labels during dispensing. Further, they may have effect on register control during printing. In addition, problems in tension control during label converting and dispensing processes may be avoided.

Some examples for the machine direction oriented face layers comprising polyethylene terephthalate at least 80 wt.%, having an orientation ratio at least 4, and a thickness between 8 and 60 microns are presented below.

According to an example the face layer has the ratio of 1% secant modulus in MD to 1% secant modulus in CD of the face layer at least 2. Preferably, the ratio of 1% secant modulus in MD to 1% secant modulus in CD (MD/CD) of the face layer is between 2 and 4. Face layer may have a tensile strength in machine direction of the face layer between 250 and 400 MPa. In addition, the face layer may have a ratio of tensile strength in the machine direction of the face layer to tensile strength in the cross direction of the face layer between 3 and 5. Further, the face layer may have an elongation at break in the machine direction of the face layer less than elongation at break in the cross direction of the face layer. For example, the ratio of elongation at break in machine direction of the face layer to elongation at break in cross direction of the face layer may be between 0.4 and 0.9. In addition, 1% secant
The modulus in the machine direction of the face layer may be between 4000 and 8000 MPa, preferably between 5000 and 7500 MPa.

The face layer may further be combined with a release liner comprising a release liner substrate and a release layer, and a pressure sensitive adhesive layer so as to form a self-adhesive label laminate structure from which the individual labels may be cut and subsequently applied onto the surface of an item. The face layer of the laminate may be printed so as to provide a printed label laminate.

The release liner substrate of the label laminate may comprise polyethylene terephthalate at least 80 wt.%. The release liner substrate may also be monoaxially oriented in a machine direction of the substrate comprising an orientation ratio at least 4.

The embodiments described above are only example embodiments of the invention and a person skilled in the art recognizes readily that they may be combined in various ways to generate further embodiments without deviating from the basic underlying invention.
Claims:

1. A face layer for a label laminate, wherein the face layer comprises polyethylene terephthalate at least 80 wt.%, and the face layer is monoaxially oriented in a machine direction of the face layer comprising an orientation ratio at least 4.

2. A face layer according to claim 1, wherein the face layer comprises less than 10 wt.% preferably less than 5 wt.%, more preferably less than 2 wt.% of polymer(s) other than polyethylene terephthalate.

3. A face layer according to claim 1 or 2, wherein the face layer comprises polyethylene terephthalate between 80 and 100 wt.%, preferably between 90 and 100 wt.%.

4. A face layer according to any of the preceding claims, wherein the face layer comprises the orientation ratio between 4 and 9 in the machine direction of the monoaxially oriented face layer.

5. A face layer according to any of claims 1-3, wherein the face layer comprises the orientation ratio between 5 and 8 in the machine direction of the monoaxially oriented face layer.

6. A face layer according to any of the preceding claims, wherein the ratio of the 1% secant modulus in the machine direction of the face layer to the 1% secant modulus in the cross direction of the face layer is between 2 and 4.

7. A face layer according to any of the preceding claims, wherein the tensile strength in the machine direction of the face layer is between 250 and 400 MPa.

8. A face layer according to any of the preceding claims, wherein the ratio of the tensile strength in the machine direction of the face layer to the tensile strength in the cross direction of the face layer is between 3 and 5.
9. A face layer according to any of preceding claims, wherein an elongation at break in the machine direction of the face layer is less than elongation at break in the cross direction of the face layer.

10. A face layer according to any of preceding claims, wherein the ratio of the elongation at break in the machine direction of the face layer to the elongation at break in the cross direction of the face layer is between 0.4 and 0.9.

11. A face layer according to any of the preceding claims, wherein 1% secant modulus in the machine direction of the face layer is between 4000 and 8000 MPa.

12. A face layer according to any of claims 1-10, wherein 1% secant modulus in the machine direction of the face layer is between 5000 and 7500 MPa.

13. Use of a face layer according to any of claims 1-12 for a self-adhesive label laminate, wherein the label laminate further comprises a release liner and an adhesive layer comprising pressure sensitive adhesive.

14. A label laminate comprising a release liner including a release liner substrate coated with a release layer, an adhesive layer and a face layer according to any of the claims 1-12.

15. A label laminate according to claim 14, wherein the adhesive layer comprises pressure sensitive adhesive, and wherein the adhesive layer is arranged between the release layer of the release liner and the face layer.

16. A label laminate according to claim 14 or 15, wherein a surface of the face layer includes printing.

17. A label laminate according to any of claims 14-16, wherein the release liner substrate comprises polyethylene terephthalate at least 80 wt.%,

and the release liner substrate is monoaxially oriented in a machine direction of the release liner substrate comprising an orientation ratio at least 4.

18. A printed label laminate comprising a release liner including a release liner substrate coated with a release layer, an adhesive layer and a face layer according to any of the claims 1-12, and wherein at least one surface of the face layer comprises printing, and wherein the adhesive layer comprises pressure sensitive adhesive, and wherein the adhesive layer is arranged between the release layer of the release liner and the printed face layer.

19. A label comprising an adhesive layer and a face layer according to any of the claims 1-12, and wherein the adhesive layer is on the surface of the face layer and configured to provide attachment of the label onto a surface of an item.

20. A combination of an item and a label, the label comprising an adhesive layer and a face layer according to any of the preceding claims 1-12, and wherein the label is attached onto the surface of the item through the adhesive layer.

21. A method for providing a label laminate according to any of claims 14-17, the method comprising:

- forming an initial non-oriented face layer structure by melt processing technique;
- stretching the initial non-oriented face layer structure uniaxially in a machine direction for providing a machine direction oriented face layer;
- providing a release liner substrate;
- coating one surface of the release liner substrate with a release agent layer;
- applying an adhesive layer over the release agent layer and/or over the face layer; and
- laminating the release liner substrate with the face layer for providing a label laminate having the adhesive layer in between the
release layer of the release liner substrate and the face material layer.

22. A method according to claim 21, the method further comprising printing of the face layer.
### A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: B29C, C09J, B32B

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

FI, SE, NO, DK

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

EPO-Internal, WPI

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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Date of the actual completion of the international search 25 August 2014 (25.08.2014)

Date of mailing of the international search report 28 August 2014 (28.08.2014)

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Form PCT/ISA/210 (second sheet) (July 2009)
## INTERNATIONAL SEARCH REPORT

**Information on Patent Family Members**

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**International application No.**
PCT/FI201 3/051 195

**CLASSIFICATION OF SUBJECT MATTER**

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