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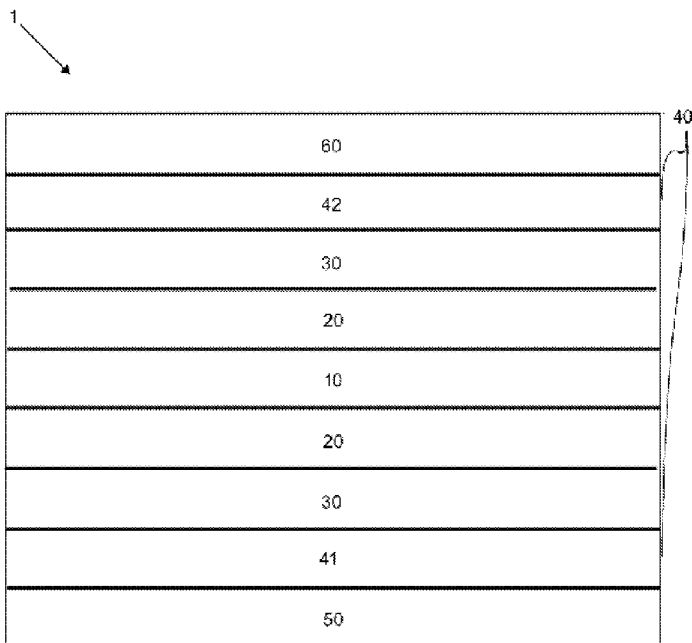


FIGURE 1

(57) Abstract: The invention is a thermoformable packaging film (1) for use in the packaging of food products such as meat and meat products, milk and dairy products, seafood, and bakery products, having an inner layer (50) and an outer layer (60) on the other side facing the food product to be placed in the film layers in which it is formed in the event that it becomes a package, and having a barrier layer (10) in the middle. The packaging film (1) comprises a compatibilizer layer (20) positioned between the inner layer (50) and the barrier layer (10), as well as the outer layer (60) and the barrier layer (10), to connect the other film layers, and the barrier layer (10) is of ethylene vinyl alcohol material with a weight of at most 5% of the total packaging film (1) weight and a thickness of at least 1 micron, with other layers from a polyolefin-based mono material.

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A PACKAGING FILM

5 TECHNICAL FIELD

The invention relates to a thermoformable and recyclable packaging film for use in the packaging of food, in particular meat, meat products, milk and dairy products, seafood, and bakery products, as well as non-food products, such as medical products.

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BACKGROUND

Packages are used in the food and non-food sectors, and the packages used especially for food products must be created in a way that will ensure that the products remain intact until the end of their shelf life and have certain visual criteria. Polymers with different properties are used according to the product in the package in order to obtain the properties specified in the packaging films that make up the packages. For example, EVOH as a barrier in a packaging film to be used in food products such as meat and meat products, milk and dairy products, seafood and bakery products, a polyolefin-based compatibilizer that will allow EVOH to adhere to polyolefin, PA, which can provide heat resistance in the outer parts, PP, polyolefin, ionomer, PA, on the source side, raw materials such as EVA, Polyolefin, Plastomer, and ionomer can be used.

In addition to protecting the product and presenting a good visual to the customer, the packaging is now expected to be recyclable. In addition to being recyclable, the need for a packaging film with technical properties that ensure the proper protection of the product in the created packaging has arisen. As a standard, coextruded films made of PA and PE do not undergo the same recycling cycles due to their T_m and T_g , and these films are not considered recyclable.

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As a result, all the above-mentioned problems have made it necessary to make an innovation in the related technical field.

BRIEF DESCRIPTION OF THE INVENTION

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The present invention relates to a packaging film for eliminating the above-mentioned disadvantages and bringing new advantages to the related technical field.

One object of the invention is to produce a recyclable packaging film with high mechanical strength and heat resistance and suitable for thermoforming.

- 5 Another object of the invention is to produce a packaging film with a homogeneous structure suitable for deep drawing, at the same time, with reduced haze.

The present invention is a thermoformable and recyclable packaging film for use in the packaging of food products such as meat and meat products, milk and dairy products,
10 seafood, and bakery products, and having one inner layer facing the food product to be placed inside and one outer layer on the other side and a barrier layer in the middle part of the film layers in which it is formed in case it becomes a package, in order to achieve all the above-mentioned objectives and which will emerge from the detailed explanation below. Accordingly, its novelty is that it comprises a compatibilizer layer positioned between the
15 inner layer and the barrier layer, as well as the outer layer and the barrier layer, to connect the other film layers, and the barrier layer is of ethylene vinyl alcohol material with a weight of at most 5% of the total packaging film weight and a thickness of at least 1 micron, with other layers from a polyolefin-based mono material.

- 20 In a preferred embodiment of the invention, it comprises a functional layer, to provide physical durability.

In a preferred embodiment of the invention, it comprises a base layer each, to improve mechanical properties and heat interaction.

25

In a preferred embodiment of the invention; the compatibilizer layer comprises linear low-density polyethylene grafted with maleic anhydride.

- In a preferred embodiment of the invention; the compatibilizer layer comprises a specific
30 blend of linear low-density polyethylene and polyethylene copolymer grafted with maleic anhydride.

In a preferred embodiment of the invention; the base layers comprise linear low-density polyethylene 1-hexene copolymer.

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In a preferred embodiment of the invention; the base layers comprise a linear low-density polyethylene 1-hexene copolymer and a low-density polyethylene material.

In a preferred embodiment of the invention; the functional layer comprises an inner functional layer facing the inner layer and an outer functional layer facing the outer layer, and the outer functional layer comprises a blend of medium-density polyethylene 1-hexene copolymer and low-density polyethylene, and the inner functional layer comprises a blend of linear low-density polyethylene 1-hexene copolymer and low-density polyethylene so that the packaging film maintains its physical strength and structural properties when interacting with heat and is easier to shape.

In a preferred embodiment of the invention; the outer functional layer comprises a blend of medium-density polyethylene 1-hexene copolymer and low-density polyethylene.

In a preferred embodiment of the invention; the inner functional layer comprises a blend of linear low-density polyethylene 1-hexene copolymer and low-density polyethylene.

In a preferred embodiment of the invention; the outer layer comprises ethylene 1-hexene copolymer and low-density polyethylene to provide the heat resistance of the packaging film.

In a preferred embodiment of the invention, the inner layer comprises 1-octene copolymer plastomer to be welded at low temperature with a top film during the packaging process and linear low-density polyethylene

In a preferred embodiment of the invention, the thickness of the packaging film is between 60 microns and 300 microns.

In a preferred embodiment of the invention, the packaging film is in a structure obtained by the blow extrusion method in a water-cooled extruder.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a schematic view of the packaging film of the invention.

DETAILED DESCRIPTION OF THE INVENTION

In this detailed description, the packaging film (1) of the invention is described only by means of examples that will not have any limiting effect for a better understanding of the subject matter.

- 5 The packaging film (1) of the invention is a flexible multi-layer film suitable for thermoforming for use in the packaging of food and non-food products such as meat and meat products, milk and dairy products, seafood, and bakery products. The said packaging film (1) is especially used as a sub-film for packaging. The packaging film (1) comprises a barrier layer (10) in the middle, and a compatibilizer layer (20) on both sides of the barrier layer (10).
- 10 Except for the compatibilizer layers (20), there is at least one polyolefin-based film layer. In the preferred embodiment of the invention, there are three polyolefin-based film layers apart from the compatibilizer layers (20), and thus the total packaging film (1) has nine layers. When at least two of the polyolefin-based film layers on each side are combined and treated in this way, the packaging film (1) can have a five-layer or seven-layer configuration.
- 15 However, the polyolefin content of the packaging film (1) almost does not change.

In more detail, in the case that the packaging film (1) becomes a package, the inward-facing side of the barrier layer (10) is defined as the inner side and the other side as the outer side. According to this; starting from the barrier layer (10), there is a compatibilizer layer (20), a

20 base layer (30), an inner functional layer (41), and an inner layer (50) on the inner side, respectively. On the outer side, there is a compatibilizer layer (20), a base layer (30), an outer functional layer (42), and an outer layer (60) in the continuation of the barrier layer (10) outwards, respectively. The structural properties of the film layers of the packaging film (1) are described below.

25 Ethylene vinyl alcohol (EVOH) material is used in the barrier layers (10) of the packaging film (1). The EVOH material may have different contents. The ratio of the EVOH material to the total material used for the total packaging film (1) is provided at a maximum of 5% by weight. The barrier layer (10) has a thickness that will provide adequate barrier properties. This

30 thickness is provided so that the weight of the EVOH material does not exceed 5% by the weight of the total packaging film (1). In another embodiment, this thickness is provided so that the weight of the EVOH material does not exceed 3 wt% of the total packaging film (1). The packaging film (1) thus obtained complies with the regulations for recyclable packaging made of mono material.

35 The compatibilizer layers (20) connect the EVOH and polyolefin-based film layers within the packaging film (1). Since EVOH comprises a polar group and polyolefins are nonpolar, the

compatibilizer layers (20) are included in the packaging film (1), thus overcoming the difficulty of co-extruding polar groups and nonpolar chains. Compatibilizer layers (20) are provided at minimum thickness. In a preferred embodiment, the compatibilizer layer (20) consists of linear low-density polyethylene grafted with maleic anhydride alone. In an alternative
5 embodiment, the compatibilizer layer (20) is formed from a specific blend of linear low-density polyethylene grafted with maleic anhydride and a polyolefin-based polymer.

The base layers (30) meet the requested mechanical properties and heat interaction of the packaging film (1). Accordingly, the opposing base layers (30) comprise a linear low-density
10 polyethylene 1-hexene copolymer symmetrically, since they are exposed to heat with almost the same effect. Alternatively, PE and PE copolymers can be used as base layers (30). In one embodiment, the base layers (30) are formed from a specific blend of linear low-density polyethylene 1-hexene copolymer and low-density polyethylene. Again, in these layers, structures with relatively higher density and homogeneous free ends are preferred. Thereby,
15 the heat dissipation between the layers of the packaging film (1) becomes more efficient.

Due to the structural properties of the functional layers (40), the physical durability of the packaging film (1) and the preservation of its structural properties when interacting with heat are ensured. In addition, forming of the packaging film (1) is facilitated by the structural
20 feature of the functional layer (40). Since the heat source contacts the packaging film (1) from the outer layer (60) during the packaging process, the outer layer (60) of the packaging film (1) interacts the most with the heat. Therefore, the interaction with the heat in the outer functional layer (42) is higher than the inner functional layer (41) and the material content of the inner functional layer and the outer functional layer (42) varies. Since high-density and
25 straight-chain films interact with heat harder, a mixture of medium-density polyethylene 1-hexene copolymer and low-density polyethylene is used in the outer functional layer (42) by using this advantage of the polymer. The inner functional layer (41) comprises a linear low-density polyethylene 1-hexene copolymer and a low-density polyethylene mixture.

The inner layer (50) is the layer that is welded with a top film during packaging, in other words, the structures of the polymer chains are broken down and combined with the help of heat. Therefore, the inner layer (50) is provided in a structure that can be easily affected by heat, weld at low temperatures, and form strong chains after welding. Accordingly, the inner
30 layer (50) comprises a 1-octene copolymer plastomer. In one embodiment, the inner layer (50) comprises a mixture of 1-octene copolymer plastomer and linear low-density PE. In alternative embodiments, other polyethylene copolymers and plastomers can be used in the inner layer (50), and low-density, straight-chain structures are preferred.
35

The outer layer (60) comprises ethylene 1-hexene copolymer and low-density polyethylene and provides high heat resistance.

5 The inner layer (50), outer layer (60), and compatibilizer layers (20) in the packaging film (1) consist of polyethylene-based materials in the preferred embodiment as mentioned above. As polyolefin, any polymerized or copolymerized olefin can be used instead of polyethylene. The said olefins can be butene or octene olefin copolymers, ethylene-propylene copolymers, and butene octene terpolymers. These olefins can be supplied in linear, branched, cyclo,
10 substituted, unsubstituted or modified forms.

The packaging film (1) is considered recyclable since the ratio of EVOH in the total packaging film (1) by weight does not exceed 5% and the other material that makes up the packaging film (1) apart from EVOH is polyolefin of the same type.

15 The total thickness of the packaging film (1) is between 50 microns and 300 microns. With the increase in thickness, the amount of deep drawing, mechanical strength, and hardness of the film increase. In addition, thicker packaging films (1) are preferred for packages that are more difficult to pack, in other words, with hard and sharp corners.

20 The packaging film (1) is produced by the blowing extrusion method in a water-cooled extruder. The production method mentioned is carried out using cold water at about 10 °C. In this production method, since the packaging film (1) coming out of the extruder head cools rapidly, more amorphous regions are formed on it compared to other methods, and the
25 packaging film (1) has a transparent appearance. In addition, the flexibility of the packaging film (1) increases, and it becomes easier to form.

Packaging film (1) with the structural details given above has low haze, high heat resistance, high puncture resistance, and high breaking strength and can work in forming machines in
30 wide temperature ranges. The packaging film (1) can take form in forming machines at forming temperatures between 90-130 °C and forming times between 0.5-3 seconds. The haze value of the packaging film (1) before forming can be between 5-20% depending on the thickness and structure.

35 The following are the comparative test results for various thicknesses of the packaging film comprising polyamide and polyethylene, and the packaging film (1) of the invention. The puncture resistance test was performed as per ASTM F 1306 standard; the haze was

measured as per ASTM D1003 standard, and the modulus of elasticity was measured as per ASTM D882 standard.

MD denotes the machine direction and CD donates the machine width direction horizontally to the MD direction by 90 degrees.

Structure	Thickness (μ)	Haze (%)	Puncture resistance (N)	Elasticity modulus (N/mm ²) (MD)	Elasticity modulus (N/mm ²) (CD)
PA-PE structure	100	~5 - ~9	23-30	~430	~430
Packaging film (1) of the invention	100	~8 - ~10	20-27	~350	~350
PA-PE structure	130	~6 - ~10	25-35	~410	~400
Packaging film (1) of the invention	130	~8.5 - ~11	23-30	~340	~340
PA-PE structure	150	~6 - ~12	27-37	~400	~390
Packaging film (1) of the invention	150	~10 - ~12	25-30	~330	~330
PA-PE structure	200	~7 - ~15	35-45	~400	~390
Packaging film (1) of the invention	200	~11 - ~15	28-35	~290	~300
PA-PE structure	250	~8 - ~16	45-55	~400	~390
Packaging film (1) of the invention	250	~12 - ~16	33-40	~275	~280

Table 1 – Comparative test results of PA-PE structure and packaging film of the invention

According to the test results given in Table 1, although polyamide (PA) is not used in the packaging film (1), the details of which are explained above, it is seen that the values do not deviate significantly and are preserved. When examined in detail, it is observed that haze

does not increase; the puncture resistance and elasticity modules do not decrease significantly and still have close values. This shows that while the packaging film (1) of the invention is suitable for recycling, it also meets the requested results and the values do not change at an unacceptable rate.

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The protection scope of the invention is given in the attached claims and cannot be strictly limited to what has been described in this detailed description for illustrative purposes. It is clear that those skilled in the art can put forth similar embodiments in the light of what has been described above, without departing from the main theme of the invention.

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REFERENCE NUMERALS IN THE FIGURES

1 Packaging film

10 Barrier layer

15 20 Compatibilizer layer

30 Base layer

40 Functional layer

41 Inner functional layer

42 Outer functional layer

20 50 Inner layer

60 Outer layer

CLAIMS

1. A thermoformable packaging film (1) for use in the packaging of food products such as meat and meat products, milk and dairy products, seafood and bakery products, and having one inner layer (50) facing the food product to be placed inside and one outer layer (60) on the other side and a barrier layer (10) in the middle part of the film layers in which it is formed in case it becomes a package, **characterized in that** it comprises compatibilizer layers (20) each, positioned between the inner layer (50) and the barrier layer (10), as well as the outer layer (60) and the barrier layer (10), to connect the other film layers, and the barrier layer (10) is of ethylene vinyl alcohol material with a weight of at most 5% of the total packaging film (1) weight and a thickness of at least 1 micron, with other layers from a polyolefin-based mono material.
2. A packaging film according to Claim 1, **characterized in that** it comprises a functional layer (40) each, to provide physical durability.
3. A packaging film according to Claim 1, **characterized in that** it comprises a base layer (30) each, to improve mechanical properties and heat interaction.
4. A packaging film according to Claim 1, **characterized in that** the compatibilizer layer (20) comprises linear low-density polyethylene grafted with maleic anhydride.
5. A packaging film according to Claim 1, **characterized in that** the compatibilizer layer (20) comprises a blend of linear low-density polyethylene and polyethylene copolymer grafted with maleic anhydride.
6. A packaging film according to Claim 3, **characterized in that** the base layers (30) comprise linear low-density polyethylene 1-hexene copolymer.
7. A packaging film according to Claim 3, **characterized in that** the base layers (30) comprise a blend of linear low-density polyethylene 1-hexene copolymer and low-density polyethylene.
8. A packaging film according to Claim 2, **characterized in that** the functional layer (40) comprises an inner functional layer (41) facing the inner layer (50) and an outer functional layer (42) facing the outer layer (60), and the outer functional layer (42)

comprising a medium density polyethylene 1-hexene copolymer such that the physical strength of the packaging film (1) and its structural properties when interacting with heat are preserved and easy to form, and the inner functional layer (41) comprising a linear low-density polyethylene 1-hexene copolymer.

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9. A packaging film according to Claim 8, **characterized in that** the outer functional layer (42) comprises a blend of medium-density polyethylene 1-hexene copolymer and low-density polyethylene.

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10. A packaging film according to Claim 8, **characterized in that** the inner functional layer (41) comprises a blend of linear low-density polyethylene 1-hexene copolymer and low-density polyethylene.

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11. A packaging film according to Claim 1, **characterized in that** the outer layer (60) comprises ethylene 1-hexene copolymer and low-density polyethylene to provide the heat resistance of the packaging film (1).

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12. A packaging film according to Claim 1, **characterized in that** the inner layer (50) comprises 1-octene copolymer plastomer to be welded at low temperature with a top film during the packaging process and linear low-density polyethylene.

13. A packaging film according to Claim 1, **characterized in that** it has a thickness between 60 microns and 300 microns.

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14. A packaging film according to Claim 1, **characterized in that** it has a structure obtained by the blow extrusion method in a water-cooled extruder.

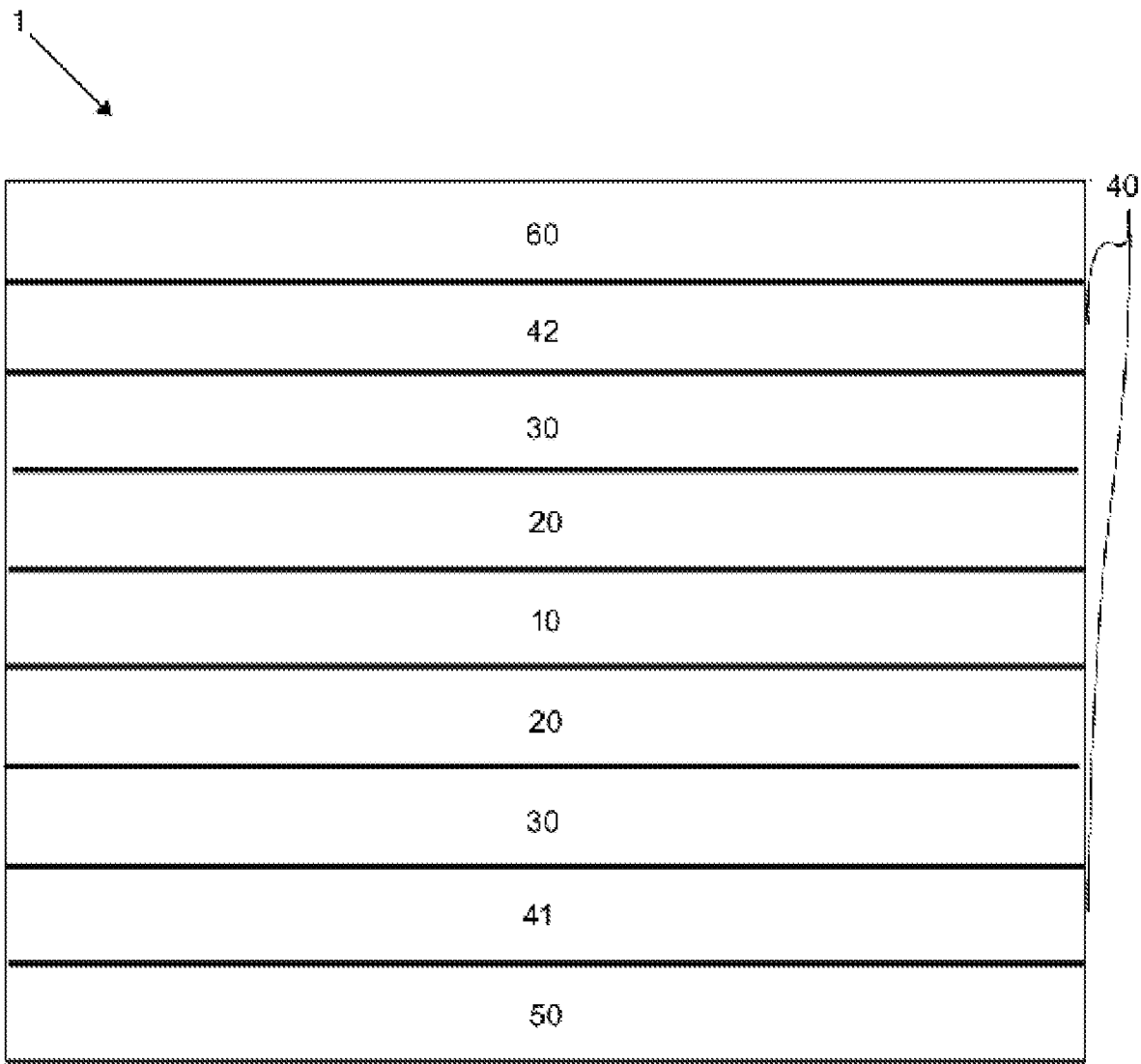


FIGURE 1