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(54) **Multi-compartment tray-less package with a rigid frame**

(57) A tray-less multi-compartment plastic flexible package, preferably used for food or medical packaging applications, and methods for its manufacture are described.

The present package does not require a supplemental tray being sufficiently rigid as such, thanks to the partial crystallization of crystallizable films along a frame in correspondence of the sealing area. The absence of a tray makes the present packages particularly "green" resulting in a significant reduction of plastic material as well as of manufacturing and disposal costs.

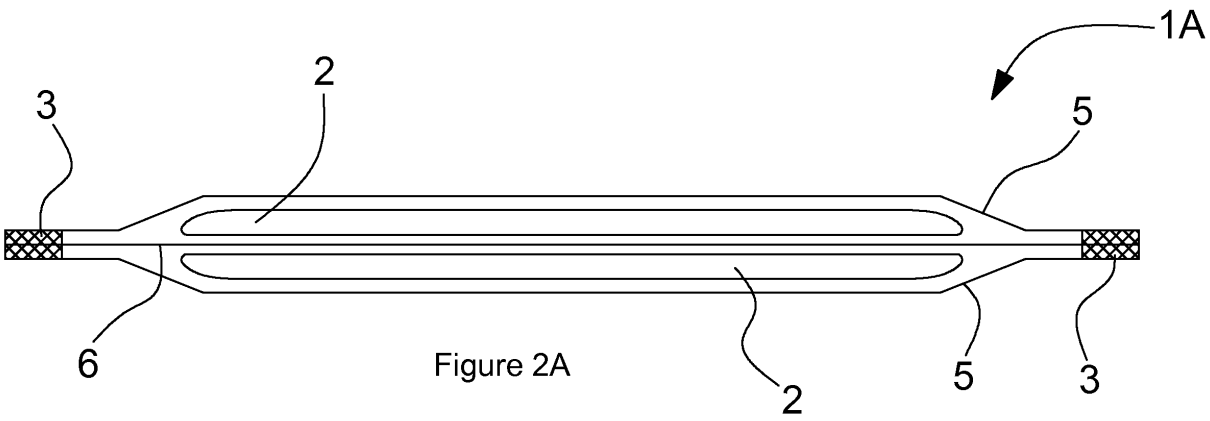

Figure 2A

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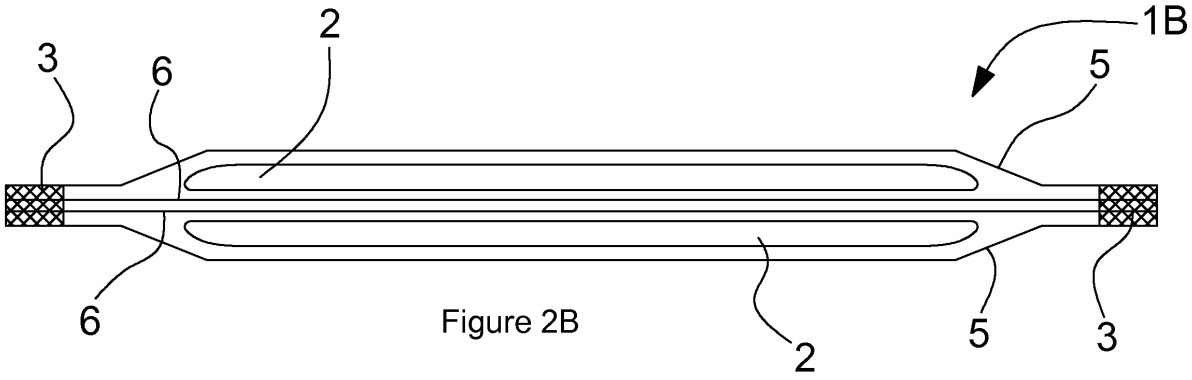


Figure 2B

Description

TECHNICAL FIELD

[0001] The present invention relates to a multi-compartment tray-less package wherein at least two products in stack are contained into individual compartments delimited by films, in particular to a multi-compartment tray-less package characterized by a peripheral rigid frame obtained by partial heat-induced crystallization of the films along the sealing area during the sealing operation.

BACKGROUND ART

[0002] In the field of packaging, there are several applications in which traditional mono-compartment packages, namely packages in which the whole product is enclosed in a single compartment, are not satisfactory while a multi-compartment arrangement - in which each single item or portion of a product is packaged individually - would be particularly advantageous.

[0003] For instance, in the field of food packaging, in particular of packaging of sliced products (cheese, processed meat, salmon, etc.) the existing mono-compartment packages show some drawbacks: in particular after opening, leftovers are subjected to rapid drying and unpleasant organoleptic changes and, unless consumed quite soon or frozen, they are generally wasted.

[0004] Furthermore, the shelf life of food products traditionally packaged under modified atmosphere or under vacuum, is drastically shortened when the mono-compartment package is opened.

[0005] Finally, different food products not always can be combined in the same mono-compartment package because of odor migration (e.g. salami and dry ham) or taste cross contamination (e. g. cheese and processed meat). Another disadvantage of mono-compartment packages -particularly if comprising important amount of sliced food products - is that the slices stick to each other and are difficult to be separated, so very often are damaged when removed from the package.

[0006] In the medical field, sterilized items such as cannulae, plasters, needles, bandages etc, when packaged in mono-compartment packages, must all be used immediately after removal otherwise contamination by environment bacteria or drying of dipped medicated items may occur.

[0007] In order to overcome the above problems, multi-compartment packaging systems, which provide for individually packaged items or for packaging of single quantity of products, have been provided.

[0008] US4069348 (L.D. Schreiber Cheese Company) discloses a sealed package wherein a plurality of portions of products in a stack are hermetically sealed into individual compartments by internal films which are releasably sealed to a backing board. When an individual portion of product is removed, all others remain hermetically sealed. WO8702965 (Garwood LTD) discloses a method to manufacture a package for skin wrapped food comprising a base - i.e. a rigid tray - and a lid with a gas between the base and the lid in order to preserve the food properties. The package also comprises a flexible and gas permeable web of skin wrapping plastics material over the base and the food. A multi-compartment version of this package comprising a rigid container is disclosed. Useful plastics materials are polyvinyl chloride (PVC) and polyethylene (PE).

[0009] WO8800907 (Garwood LTD) discloses an improvement of the method of WO8702965. The package comprises a rigid tray made of PVC and polyethylene terephthalate (PET) which contains skin wrapped food. Said food is plastered with a flexible and gas permeable web made of plastic material which is sealed onto the rim of the tray. The package also comprises a gas-impermeable lid made of PET/PVC/PET which can have a compartment to store sauce or cutlery.

[0010] DE4440727 (Beiersdorf AG) discloses a package containing at least 2 plasters which are separated by a layer of material and which are enclosed between upper and lower cover layers, wherein the layers may be made of several different polymers. The layers are bonded together by sealing, cold sealing, gluing or their combinations.

[0011] The existing multi-compartment packages, even if able to solve most of the problems mentioned above, all the same still show many drawbacks.

[0012] In fact, multi-compartment packages known in the art need a supporting tray or a thick backboard to confer rigidity to the system. Trays significantly increase the volume of the packages and the ratio between the weight of the plastic materials and the weight of the packaged item, resulting in less sustainable packages.

[0013] In addition the presence of trays enhances manufacture and disposal costs: in facts it brings additional manufacturing steps related to the production and shaping of the supporting tray, causing further waste of energy and time and, at the end, increasing costs.

[0014] Finally, the tray and the lids or wrapping films of multi-compartment packages of the prior art are made of different materials, thus making recycling and/or disposal of the entire package more troublesome.

[0015] In conclusion, there is still the need for a light and sustainable multi-compartment package which allows:

- to preserve single portions of different or same product(s), also of air sensitive products, and to use them individually,
- to easy open the compartment which contains each single portion,
- to avoid cross contaminations (odors, taste, bacteria)
- to prevent sticking and breaking of sliced products

said package being sufficiently rigid to be handled, transported, stored and exposed even in the absence of an additional thick plastic support structure, such as a tray.

SUMMARY OF THE INVENTION

[0016] We have now found a new multi-compartment tray-less package wherein at least two products in stack are contained into individual compartments wherein each compartment is comprised between two internal films, or an internal film and an outermost film, characterized in that the films consist of films, preferably peelable films, comprising a crystallizable polymer and that the package further comprises a continuous rigid frame obtained by partial heat-induced crystallization of the crystallizable polymer during the sealing operation. Such a package does not require any supplemental tray, with the advantage of reducing overall costs and lowering its environmental impact. Said package shows several advantages such as preventing drying of leftovers, maintaining sterility, avoiding cross contamination among different products etc ... with a significantly reduced consumption of material compared to conventional tray or backboard based multi-compartment packages.

[0017] It is thus a first object of the present invention a tray-less multi-compartment package of individually sealed compartments comprising

i) two outermost films,
ii) at least two products in stack,
iii) at least one internal film interposed between the at least two products in stack,
iv) a peripheral circumferential continuous seal which seals the films in stack together and delimits at least two sealed compartments in stack, each compartment enclosing at least a product of said at least two products in stack, characterized in that the films comprise a crystallizable polymer and the crystallizable polymer is at least partially crystallized in correspondence of the sealing area thus providing a peripheral circumferential continuous rigid frame.

[0018] A second object of the present invention is a method for manufacturing the multi-compartment package of the present invention, such a method comprising the steps of:

i) providing two outermost and at least one internal, optionally pre-cut, crystallizable films;
ii) providing at least two products to be packaged;
iii) stacking an outermost film, the product(s), the internal film(s) - alternating the products and the internal film(s) - and the other outermost film, up to the desired number of compartments is obtained;
iv) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame, and
v) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the multi-compartment package;

or, alternatively the steps of:

a) providing two outermost and at least one internal, optionally pre-cut, crystallizable films;
b) providing at least two products to be packaged;
c) placing in stack an outermost film, a product and an internal film;
d) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame;
e) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the first compartment of the package;
f) placing a stack of "a product/ a film" or of "a film/ a product / a film", onto the compartment formed in steps c) to e);
g) repeating point d) to f) for each new compartment, up to the desired number of compartments is obtained, thus providing the multi-compartment package;

or, alternatively the steps of:

A) providing two outermost and at least two internal, optionally pre-cut, crystallizable films;

B) providing at least two products to be packaged;
C) placing in stack a film, a product and a film;
D) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame;
E) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the first compartment of the package;
F) manufacturing at least another compartment following steps A to E;
G) stacking the first and the new compartment(s), optionally placing a product in between adjacent compartments;
H) sealing or gluing together the first and the other new compartment(s), simultaneously or one after the other if more than two, up to the desired number of compartments is obtained, thus providing the multi-compartment package.

DEFINITIONS

[0019] As used herein the term "tray-less package" refers to a package in which a rigid tray, container, receptacle, backing board, plate and equivalent rigidity-conferring supporting means commonly used in the packaging field, placed outside the sealed compartments and to which the films are connected (i.e. sealed, glued etc..), is absent.

[0020] The term tray-less package does not exclude the presence of pads or other flexible, semi-rigid or rigid supports enclosed within one or more of the sealed compartments i.e. does not exclude completely enclosed supporting means. Said enclosed supporting means are not sealed together with the films in stack but are completely enclosed within the sealed compartment.

[0021] Similarly, the term tray-less does not exclude that the present package may be further placed into a container, providing that it is not connected to it by circumferential sealing, gluing etc.

[0022] As used herein the term "multi-compartment package" refers to a package having more than one compartment in stack. This package contains more than one portion and / or more than one item of one or more products in stack, each portion and/or each item being enclosed in an individually sealed compartment.

[0023] As used herein the terms "compartment" and "sealed compartment" refer to a part of the present package delimited by two adjacent films - i.e. two internal films or an internal film and a outermost film - sealed together along a peripheral circumferential continuous seal. Each compartment encloses at least a product.

[0024] As used herein the term "outermost film" refers to a plastic film wherein one of its outer surfaces is in contact with the product and the other one is in contact with the outside.

[0025] As used herein the term "product(s)" refers to both countable and uncountable products. In case of countable products, the term "products" refers to at least two items of said product(s) while in case of uncountable products, it refers to at least two portions.

[0026] As used herein the term "two products" refers to two items or portions of products packaged in the present package. Said "two products" maybe the same or different. If the two products are the same, the package contains either two items or two portions of that same product.

[0027] As used herein the term "single portion of product" refers to an amount of product which is contained in a compartment of the package object of the present invention.

[0028] Any arrangement of the one or more portions and/or items of the one or more product(s) in the sealed compartments of the present multi-compartment package is intended to be within the scope of the present invention - i.e. different items or portions of one product, each one singularly enclosed in a sealed compartment such as sterilized bandages or slices of ham; different items or portions of two or more products each one singularly enclosed in a sealed compartment such as slices of cheese / slices of ham / slices of salami each one packaged in a different compartment; different items or portions of a single product, more than one item or portion being enclosed in a sealed compartment such as two sterilized patches in the same compartment; different items or portions of two or more products, more than one item or portion of different products being enclosed in the same compartment such as a sterilized bandage and a plaster together in the same compartment etc.

[0029] As used herein the term "internal film" refers to a plastic film of the package wherein one of its surface is in contact with the product(s) enclosed in a first compartment and the other surface is in contact either with the product(s) of a second compartment or with the surface of another internal film.

[0030] As used herein, the term "film" includes flexible plastic webs, regardless of whether it is a film or a sheet or a laminate. Typically, the film used in the package object of the present invention has a thickness from 100 μm to 5 μm; more preferably from 60 μm to 7 μm, even more preferably from 40 μm to 10 μm.

[0031] Preferably the outer films and the internal film(s) have the same thickness, however they may also be of different thickness.

[0032] As used herein, the phrase "which seals the films in stack together" when referred to the peripheral circumferential continuous seal means that all or, in alternative, some of the films in stack are sealed together while some others may be glued.

[0033] In case only some of the films are sealed together, the package may be assembled by stacking the sealed compartments and by gluing them together, as described for instance in a third variant of the manufacturing process of the present package. In such a case, the crystallinity induced in the sealing area of each single independent compartments is sufficient to confer a suitable rigidity to the final frame after assembly of the package by gluing.

[0034] As used therein, the term "frame" means the rigid peripheral circumferential continuous partially crystallized edge obtainable by sealing the outermost and internal plastic film(s) of the package to each other in stack.

[0035] As used herein the term "rigid" refers to the flexural rigidity of the frame. Independently of the test method adopted to evaluate the rigidity of the frame, in the present contest "rigid" means that the frame obtained by sealing the outermost and internal plastic film(s) of the package to each other in stack has a rigidity higher than the rigidity of the same stack of outermost and internal plastic film(s) before sealing.

[0036] Flexural resistance to bending can be measured for instance by Dynamic Mechanical Analysis (DMA) according to ASTM 4065 or with a dynamometer in line with ASTM D790 and can be expressed in N/m^2 as resistance of the frame to bending.

[0037] Rigidity requirements of the present package may change depending on the products packaged, its final use and destination etc... However the skilled person is able to select both crystallizable polymer(s) and optimal sealing conditions in order to impart to the package the stiffness required by the intended use.

[0038] The stack of outermost and internal plastic film(s) before sealing is rather flexible. After sealing, the at least partial crystallization of the films induced by heat and pressure in correspondence of the sealing area, forms the frame and imparts a rigidity which is higher than the rigidity of the starting stack of films. The frame, depending on the level of crystallization induced, on the thickness and width of the sealing area etc.., may still be partially flexible or semi-rigid, but it has to be understood that its rigidity is always higher than the rigidity of the starting stack of films before sealing.

[0039] As used herein, the term "sealing" refers to the bonding of plastic films obtainable by application of all those sealing techniques which are able to induce an at least partial crystallization of the crystallizable polymer(s) of the films along the sealing area, such as for instance hot bar sealing or ultrasonic welding techniques.

[0040] As used herein, the terms "crystallizable", when referred to polymers, plastic films or sheets, means that the polymer, the film or sheet comprising the polymer can crystallize under sealing conditions, e.g. upon heating and/or compression.

[0041] As used herein, the terms "crystallized or crystalline" polymer, resin, polyester etc.. refer to homopolymers and copolymers, compounded formulations or recyclates, having a definite melting temperature.

[0042] As used herein, the term "crystallizable polymer(s)" refers to polymer, homopolymers, copolymers, blends, compounded formulations or recyclates, resins, etc able to crystallize at the sealing conditions adopted during the sealing step. Examples of suitable crystallizable polymers are crystallizable polypropylene(s) homo- or copolymers, high density polyethylenes (HDPEs), medium density polyethylenes (MDPEs), polyesters, biodegradable polyesters such as poly-lactic acids (PLAs), polyamides such as PA6, preferably added with nucleating agents, polystyrenes (PS), more preferably crystallizable polyesters, and their blends.

[0043] As used therein, the expressions "polymer or polypropylene or polyethylene or polyester (based)", when referred to the film or film composition means that the film is a mono- or multilayer film comprising at least 30% by weight, with respect to the total weight of the film, of a crystallizable polymer or polypropylene or polyethylene or polyester, preferably of a crystallizable polyester, more preferably at least 50%, 60%, 70%, 80%, 90% or 95%.

[0044] When the crystallizable polymer is for instance a polyester, with the term "crystallizable polyester" a polyester able to crystallize at temperatures typically ranging from 140°C to 220°C - temperatures generally adopted in the sealing stage of the manufacturing process - is meant.

[0045] As used herein the phrase "the polymer is at least partially crystallized" refers to a polymer which is at least partially crystalline. As used herein the phrase "at least partially crystalline polymer" refers to a polymer, preferably a polyester, which has a percentage of crystallinity higher than 15%, preferably higher than 20%, more preferably higher than 25%, even more preferably higher than 30%.

[0046] The melting temperature of the polymer(s) and their crystallinity can be evaluated by Differential Scanning Calorimeter (DSC) or by other equivalent procedures well known in the art.

[0047] For instance, DSC may be used to determine the degree of crystallinity of thermoplastic polymers through the measurement of the enthalpy of fusion (measurable following ASTM E793) and its normalization to the enthalpy of fusion of a 100 % crystalline polymer (see B. Wunderlich, Thermal Analysis, Academic Press, 1990, pp. 417-431).

[0048] In the present context, the crystallinity of the crystallizable polymer(s) before the sealing step is substantially uniform across the whole film(s). However in the final package according to the present invention the crystallinity of the crystallizable polymer in correspondence of the sealing area, i.e. in correspondence of the frame, is higher than the crystallinity of the same polymer in areas other than the sealing area.

[0049] "Higher than the crystallinity of the same polymer in areas other than the sealing area" means that the difference in the percentage of crystallinity of the polymer(s) of the frame with respect to the polymer(s) of the other parts of the present package is at least 5% preferably higher than 8%, more preferably higher than 10%

[0050] As used herein, the phrases "seal layer", "sealing layer", "heat seal layer", and "sealant layer", refer to an outer layer involved in the sealing of the film to itself, to another film and/or to another article which is not a film.

[0051] As used herein the term "peelable", referred to a film or a sheet means that the films sealed to each other provide for a seal which is strong enough to guarantee the hermeticity of the package during its lifecycle but which can be easily opened by tearing apart by hand the two films that were joined by the seal.

[0052] In the present invention when peelable films are used, each peelable film is capable of forming a seal, under the application of heat and/or pressure, to a surface layer of another film of the package and the seal is breakable without fracture of the film. A method of measuring the strength of a peelable seal, also referred to as "peel strength" is described in ASTM F-88-00. Acceptable peel strength values generally range from 200 g/25 mm to 850 g/25 mm, from 300 g/25 mm to 830 g/25 mm, from 350 g/25 mm to 820 g/25 mm, from 400 g/25 mm to 800 g/25 mm.

[0053] As used herein, "EVOH" refers to ethylene/vinyl alcohol copolymer. EVOH includes saponified or hydrolyzed ethylene/vinyl acetate copolymers with a degree of hydrolysis preferably at least 50%, and more preferably, at least 85%. Preferably, the EVOH comprises from about 28 to about 48 mole % ethylene, more preferably from about 32 to about 44 mole % ethylene.

[0054] As used herein, the phrase "machine direction", herein abbreviated "MD" or longitudinal direction "LD", refers to a direction "along the length" of the film, i.e., in the direction of the film as the film is formed during extrusion and/or coating.

[0055] As used herein, the phrase "transverse direction", herein abbreviated "TD", or crosswise direction refers to a direction across the film, perpendicular to the machine or longitudinal direction.

[0056] As used herein, the phrases "orientation ratio" and "stretching ratio" refer to the multiplication product of the extent to which the plastic film material is expanded in the two directions perpendicular to one another, i.e. the machine direction and the transverse direction. Thus, if a film has been oriented to three times its original size in the longitudinal direction (3:1) and three times its original size in the transverse direction (3:1), then the overall film has an orientation ratio of 3*3 or 9:1.

[0057] As used herein, the phrases "heat-shrinkable," "heat-shrink," and the like, refer to the tendency of the film to shrink upon the application of heat, i.e., to contract upon being heated, such that the size of the film decreases while the film is in an unrestrained state.

[0058] As used herein, the phrases "low heat-shrinkable," "low heat-shrink" or simply "low shrink films" and the like, refer to films with a free shrink in both machine and transversal directions, as measured by ASTM D 2732, lower than 10 % at 140 °C, more preferably lower than 5%.

[0059] As used herein, the term "polymer" refers to the product of a polymerization reaction, and is inclusive of homo-polymers and co-polymers.

[0060] As used herein, the term "homopolymer" is used with reference to a polymer resulting from the polymerization of a single monomer, i.e., a polymer consisting essentially of a single type of mer, i.e., repeating unit.

[0061] As used herein, the term "copolymer" refers to polymers formed by the polymerization reaction of at least two different monomers. The term "copolymer" is inclusive of terpolymers, random co- or terpolymers, block co- or terpolymers, and graft co- or terpolymers.

[0062] As used herein, the term "polyolefin" refers to the polymer or co-polymer resulting from the polymerisation or copolymerisation of unsaturated aliphatic, linear or cyclic, straight or branched, hydrocarbon monomers that may be substituted or unsubstituted. More specifically, included in the term polyolefin are film-forming homo-polymers of olefin, co-polymers of olefin, co-polymers of an olefin and an non-olefinic co-monomer co-polymerizable with the olefin, such as vinyl monomers, and the like. Specific examples include polyethylene homo-polymer, polypropylene homo-polymer, polybutene homo-polymer, ethylene-□-olefin co-polymer, propylene-□-olefin co-polymer, butene-□-olefin co-polymer, ethylene-unsaturated ester co-polymer, ethylene-unsaturated acid co-polymer, (e.g., ethylene-(C_1-C_4)alkyl acrylate or methacrylate copolymers, such as for instance ethylene-ethyl acrylate co-polymer, ethylene-butyl acrylate co-polymer, ethylene-methyl acrylate co-polymer, ethylene-methyl methacrylate co-polymer, ethylene-acrylic acid co-polymer, and ethylene-methacrylic acid co-polymer), ionomer resin, polymethylpentene, etc.

[0063] For the purpose of the present description and of the claims which follow, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about".

BRIEF DESCRIPITION OF DRAWINGS

[0064]

Fig. 1 is a top view of a the package 1 of present invention, the package being provided with a tab (4) for the easy peeling of the film(s).

Fig. 2a is a cross section view of a first embodiment (1A) of the package of Fig.1.

Fig. 2b is a cross section view of a second embodiment (1 B) of the package of Fig.1.
Figs. 3A-3B and 3C-3E are other cross-section views of the first (1A) and second embodiment (1B) illustrated in Fig. 2a and 2b.
Fig. 4 is a perspective view of another embodiment of the package of present invention, the package being provided with an aperture (7) allowing vertical displaying of the package.
Fig. 5 is a perspective view of still another embodiment of the package of present invention, the package being provided with a hook (8) for vertical display of the package.
Figs. 6A to E show the profile of some sealing bars suitable for the manufacture of the present package.
Figs 7A and 7B illustrate a first method for manufacturing embodiment 1A and, respectively, embodiment 1B of a three compartment package according to the present invention.
Figs 8A and 8B illustrate a second method for manufacturing embodiment 1A and, respectively, embodiment 1 B of a three compartment package according to the present invention.
Figs 9A and 9B illustrate a third method for manufacturing embodiment 1A and, respectively, embodiment 1B of a three compartment package according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0065] The first object of the present invention is a tray-less multi-compartment package of individually sealed compartments comprising

i) two outermost films,
ii) at least two products in stack,
iii) at least one internal film interposed between the at least two products in stack,
iv) a peripheral circumferential continuous seal which seals the films in stack together and delimits at least two sealed compartments in stack, each compartment enclosing at least a product of said at least two products in stack, characterized in that the films comprise a crystallizable polymer and the crystallizable polymer is at least partially crystallized in correspondence of the sealing area, thus providing a peripheral circumferential continuous rigid frame.

[0066] The present package is a multi-compartment package comprising at least two compartments in stack, each compartment comprising at least a portion or a item of at least one product.
[0067] In one embodiment, the present package is a bi--portion package comprising two compartments in stack.
[0068] In another embodiment the present package is a more than two i.e. tri or more- portion package comprising more than two compartments in stack.
[0069] The total number of compartments depends, inter alia, on the thickness of the product contained, i.e. the greater is the thickness of the product and the lower is the number of compartments of the package object of the present invention.
[0070] Internal plastic films are positioned between two subsequent portions of product(s) in the stack and are sealed, preferably peelably sealed, to each other along the frame.
[0071] In a preferred embodiment, the packages are advantageously provided with a tab facilitating the opening.
[0072] In one embodiment of the multi-compartment package of the present invention (embodiment 1A), only one internal film (6) is interposed between two adjacent products (2).
[0073] In this embodiment (1A), each internal film is in common between two adjacent compartments (as shown in Fig. 2A for a bi-compartments package) and the removal, one after the other, of the films -i.e. first an outer film and then the next internal film(s) - provides for the direct opening of each compartment.
[0074] In the embodiment 1A, in which two adjacent portions or items of same or different products share a single internal plastic film, the package is obtained by alternating the films and the products to be packaged in this order, up to the desired number of compartments is obtained.
[0075] In another embodiment of the multi-compartment package of the present invention (embodiment 1 B), as represented in Fig. 2B, two internal films (6) are interposed between two adjacent products.
[0076] In the embodiment 1B, two adjacent portions/items of product(s) are completely enclosed by their own films. It is thus possible for the user to detach each single sealed compartment separately but keeping the different portions still packaged. Each single compartment may thus be opened and the product used when and where desired.
[0077] The package object of the present invention generally comprises from 2 to 20 compartments, preferably from 2 to 10, more preferably from 2 to 5.
[0078] The number of films required for the package according to the present invention preferably ranges from at least n+1 to at most 2n, being n the number of compartments desired.
[0079] For the preferred range of compartments from 2 to 10, the package preferably comprises from 3 to 20 films. According to a first method of the present invention, the films can be hermetically sealed to each other by a single sealing step at the end of the stacking operation with an appropriate sealing bar which induces the partial crystallization of the

sealing area, as represented in Figs. 7A and 7B.

[0080] Preferably, when suitably shaped, the sealing bar may also thermoform the sealing area, thus further increasing the rigidity of the frame.

[0081] In case a sealing bar with a thermoforming profile is used, films with lower orientation ratios will be preferably selected.

[0082] Alternatively, a first sealed compartment, containing the product, can be added with alternated product/film or film/product/film sequences in stack, each new added sequence being sealed progressively, as represented in Figs. 8A and 8B.

[0083] Alternatively, each compartment comprising two films and a portion of product may be sealed separately and then, the stacked compartments, sealed/glued together in subsequent steps, as represented in Figs. 9A and 9B.

[0084] In a preferred embodiment, the internal plastic film(s) (6) and the outermost plastic films (5) of the package according to the first object of the present invention are sealable and peelable films which allow the easy opening of each compartment and/or the easy detachment of each single compartment. Preferably the peelable films comprise a peelable coating or a peelable sealant.

[0085] The outermost films and the internal film(s) used in the present package may be the same or different, preferably they are the same.

[0086] The outermost films used in the package object of the present invention may be transparent, opaque, colored by pigment additives or may have printing thereon or stickers or labels depending on the desired end use.

[0087] Preferably one of the two outermost films (5) is printed; in this case the packaging machine can house two rolls: one for the printed outermost film and the other for the non-printed films of the package. Alternatively, the machine can be provided with an in-line printing system, as those commercialised for example by DIGI and a second roll of material is not needed.

[0088] Preferably the internal films (6) of the film used in the package object of the present invention are transparent. Preferably the film used in the package object of the present invention has a thickness from 100 μm to 5 μm; more preferably from 60 μm to 7 μm, even more preferably from 40 μm to 10 μm.

[0089] The present multi- compartment packages allow for a significant reduction of packaging material with respect to the weight of the product packaged therein.

[0090] Accordingly, in the present multi-compartments package, the ratio between the weight of the packaging material (i.e. the total weight of the films) (B) with respect to the total weight of the package (A), calculated as percentage by weight, according to the following formula: (B)/(A) x 100,
is preferably lower than 15%, more preferably lower than 10%, even more preferably lower than 7%.

[0091] In the prior art multi-compartment packages - in which a tray or a backboard is present - said ratio is significantly higher, as more than 15%, typically more than 20% .

[0092] The shape of the frame and that of the (pre)-cut films according to the present invention are not limited. For example they can independently be rectangular, round, oval, triangular or in general polygonal or they can follow the shape of the packaged product, thus having a better pack appearance and becoming more attractive for the consumer.

[0093] The package (1) can have for example a rectangular shape as showed in Figure 1.

[0094] Each portion of the product (2) is enclosed in a respective sealed compartment. The sealing step provides the package with a rigid frame (3) formed by the superimposed and heat-crystallized films.

[0095] According to an embodiment of the invention, the package is advantageously provided with a tab (4) for the easy peeling of the film(s).

[0096] Figures 2a and 2b show cross section views along the line A-A of the package of Figure 1 representing two different embodiments (1A and 1 B), each one comprising two outer films (5) and one or two internal films (6) respectively. In particular Figure 2a illustrates embodiment 1A in which only one internal film is interposed between the two products in stack while Figure 2b illustrates embodiment 1 B in which two films are interposed.

[0097] Figures 3A-3B and 3C-3E show the mechanism of opening of the packages illustrated under Figures 2A and 2B, in particular, they are cross-section views along the diagonal line B-B of said packages as disclosed in Figure 1.

[0098] Figs. 3A - 3B show the opening of the package 1A having a single internal film (6) (embodiment A). By pulling one of the outermost films in correspondence of the tab (4), the respective compartment is directly opened and the content exposed for prompt use while the remaining package is still sealed.

[0099] Figs. 3C-3E show the opening of the package 1 B having of two internal films (6) (embodiment B). By pulling together one of the outermost films (5) and the adjacent internal film (6) in correspondence of the tab (4), the respective sealed compartment is detached: both the compartments are still sealed and the content still packaged in independent packages for a later use.

[0100] According to a further embodiment of the invention shown in Fig. 4 the package is advantageously designed such as to have an aperture (7) allowing hanging up the package to a vertical display.

[0101] According to another embodiment of the invention shown in Fig. 5 the package is advantageously designed such as to have a hook (8) allowing to hang up the package to a vertical display.

[0102] Those skilled in the art know tools, equipment and techniques to obtain such sealing shapes or hooks or apertures in the package and to provide it with a tab facilitating its opening.

[0103] Preferably in the package object of the present invention the compartments are filled with a modified atmosphere. Modified atmosphere packaging (MAP) is a technique used for prolonging the shelf-life of perishable goods. MAP packages according to the present invention are manufactured following methods known in the art, such as "gas-flushing" and "compensated vacuum".

[0104] In another embodiment, the compartments of the present multi-compartment package are under vacuum, thus advantageously extending the shelf-life of the enclosed perishable food products (vacuum packaging). In that case, air is removed from the compartments before sealing, then the compartments are hermetically sealed without any gas flushing or compensation.

[0105] In the package object of the present invention, the films comprise crystallizable polymer(s), namely polymer(s), homopolymer(s), copolymer(s), blends, compounded formulations or recyclates, resins which can crystallize at the sealing conditions adopted during the sealing step, i.e. upon heating and/or compression.

[0106] Crystallizable polymers are for instance crystallizable polypropylene(s) homo- or copolymers, high density polyethylenes (HDPEs), medium density polyethylenes (MDPEs), polyesters, biodegradable polyesters such as polylactic acids (PLAs), polyamides such as PA6, preferably added with nucleating agents, polystyrenes (PS), more preferably crystallizable polyesters, and their blends

[0107] The amount of the crystallizable polymer in the films of the present package with respect to the total weight of the films is at least 30% by weight, preferably at least 50%, 60%, 70%, 80%, 90% or 95%.

[0108] Preferably the package according to the first object of the present invention comprises polyester-based films each one having the same thickness and composition. In alternative, the films of the present package may be of different thickness and/or composition.

[0109] The crystallizable polyester resins preferably used for the present invention are able to crystallize upon heating, i.e. at temperatures - typically ranging from 140°C to 220°C - generally adopted in the sealing stage of the manufacturing process.

[0110] Crystallizable polyester resins preferably used for the present invention are able to crystallize under heating and/or under compression - e.g. by setting the sealing machine at temperatures typically ranging from 140°C to 220°C, preferably 170 to 200°C and/or at a pressure generally ranging from 2 to 8 bar, preferably 4 to 7 bar - temperature and pressure settings generally adopted in the sealing stage of the manufacturing process.

[0111] The films are mono- or multilayer films, preferably peelable films, each comprising at least 30% by weight, with respect to the total weight of the film, of a crystallizable polyester resin preferably at least 50%, 60%, 70%, 80%, 90% or 95%.

[0112] In the film suitable for the package according to the first object of the present invention, the percentage of crystallinity of the crystallizable polymer, preferably of the crystallizable polyesters and/or copolyesters, will be higher than 15%, preferably higher than 20%, more preferably higher than 25%, even more preferably higher than 30% in correspondence of the sealing area, after the sealing step.

[0113] The percentage of crystallinity of the polyesters and co-polyesters suitable for the invention is evaluated by Differential Scanning Calorimetry (DSC), as known in the art (see B. Wunderlich, Thermal Analysis, Academic Press, 1990, pp.417-431).

[0114] Polyesters are polymers containing ester groups in their backbone chain obtained from the reaction of a diol with a diacid. In homopolyesters only one species of diol and of diacid are employed, while in co-polyesters at least one of the carboxylic acids or of the diols is used in combination of at least two species.

[0115] Suitable crystallizable polyesters for the films of the present package include homo-polyesters, such as poly(ethylene terephthalate), poly(ethylene 2,6-naphthalate), poly(1,2-propylene terephthalate), poly(ethylene 2,5-dimethyl-terephthalate), poly(butylene terephthalate), poly(ethylene isophthalate), poly(ethylene 5-t-butyl-isophthalate), poly(butylene 2,6-naphthalate), and the like homopolymers, and co-polyesters where the diacid component is still mainly based on aromatic diacids such as terephthalic acid, isophthalic acid, alkyl substituted-terephtahlic acid, alkyl-substituted isophthalic acid.

[0116] Suitable crystallizable homo-polyester and co-polyester resins are typically characterized by a high melting point (Tm), such as a Tm higher than 220 °C, preferably higher than 230 °C.

[0117] Specific examples include Eastapak Copolyester 9921 sold by Eastman and Ramapet N180 sold by Indorama. Crystallizable biodegradable polyester resins can also be used.

[0118] Example of crystallizable biodegradable polyesters are: polyglycolide (PGA) and its copolymers with caprolactone, lactide or trimethylene carbonate, polylactide (PLA), poly(lactide-co-glycolide) (PLGA), Poly(butylene succinate) (PBS) and poly(ethylene succinate), poly(butylene adipate-co-terephtalate (PBAT). A suitable PLA is commercialized for example under the trade name of NatureWorks® by CargillDow. A suitable PBAT is sold as Ecoflex® by BASF, Eastar Bio® by Eastman Chemical, Origo-Bi® by Novamont.

[0119] A multi-compartment package according to the present invention substantially made of crystallizable biode-

gradable polyester(s) will be particularly preferred as even more eco-friendly.

[0120] Polyesteramides may also be used such as those commercialised by Bayer under the trade name BAK®.

[0121] Preferably, the crystallizable polymers films suitable for the package according to the first object of the present invention consist of two layers, a base layer and a sealing layer.

[0122] Preferably said crystallizable polymers are crystallizable polyester resins. Suitable crystallizable polyester resins for the base layer are those described before.

[0123] In an embodiment, the crystallizable polyester resin of the base layer is blended with an amorphous polyester resin. Said amorphous polyester is characterized by a Tg value lower than 115°C, preferably lower than 95°C, even more preferably lower than 85°C.

[0124] The amount of said amorphous polyester in the base layer of the film of the present package is generally at most 70% by weight with respect to the total weight of the base layer, preferably at most 50% by weight, even more preferably at most 40%.

[0125] Suitable amorphous polyester resins are those deriving from an aliphatic diol and/or a cycloaliphatic diol with one or more dicarboxylic acids, preferably an aromatic dicarboxylic acid. Preferred amorphous polyesters are copolyesters of terephthalic acid with an aliphatic diol and a cycloaliphatic diol, particularly ethylene glycol and 1,4-dicyclohexanedimethanol. The preferred molar ratios of the cycloaliphatic diol to the aliphatic diol are in the range from 10:90 to 60:40, preferably in the range from 20:80 to 40:60, more preferably from 30:70 to 35:65. Specific examples of particularly preferred amorphous polyester are PETG Eastar® 6763, sold by Eastman (glass transition temperature 81°C, density 1.27 g/cc) and Embrace sold by Eastman Chemical, (glass transition temperature 70.6°C, density 1.32 g/cc).

[0126] In another embodiment, the whole film or, if present, said base layer will consist of one or more suitable crystallizable homo- and/or co-polyesters blended with up to preferably about 10 % of a masterbatch containing conventional additives dispersed in a (co)polyester matrix, additives known in the art as nucleating agents, which favor the crystallization process during the sealing step.

[0127] Suitable nucleating agents are for instance those listed in Table 1 of the Literature Review by H. Zhou available at the internet address www.crd.ge.com as 98CRD138. Particularly preferred nucleating agents are inorganic compounds such as talc, silicate, clay, titanium dioxide, and the like. These compounds may be used in an amount lower than 5 % by weight, typically in an amount of 1-2 % by weight on the total weight of the film or base layer. Other preferred nucleating agents are certain compatible polymers such as fluoropolymers (PTFE) that can be blended with the polyester of said film or layer (a) in an amount of up to e.g. 5-8 % by weight.

[0128] Examples of nucleating agents particularly suitable for crystallizing polyesters which can be used in the present application are: (i) alkali metal salts of organic acids, e.g. carboxylic acid; sodium, lithium, potassium benzoates (see D. Garcia, Heterogeneous nucleation of PET, J. of Polymer Science - Polymer physics edition, Vol 22, 2063-2072, 1984 and R. Legras, C. Bailly, M. Daumerie, V. Zichy and others, Chemical nucleation, a new concept applied to mechanism of action of organic acid salts on the crystallization of PET and bisphenol-A-polycarbonate, Polymer, Vol 25, 835-844, 1984) or sodium salts of substituted benzoic acids which contain at least one nitro, halogen, hydroxyl, phenyl or oxyphenyl substituent, and salts of alkali metals including phenolic, phosphonic, phosphinic and sulfonic (see EP0021 648); (ii) lithium and/or sodium salts of aliphatic, cycloaliphatic, aromatic carboxylic acids or heterocyclic polycarboxilic acids, containing up to 20 carbon atoms (see US3761450); (iii) DBS-dibenzylidene sorbitol (see J. of Applied Polymer Science, Vol 36, 387-402, 1988); (iv) trygliceride oil and triglyceride oil in combination with/or chemically bonding to organic acid metal salts (see US5356972) . Nucleating agent preferably used in the present invention are commercially available as Tna S471 by Sukano, Elvaloy PTW and Elvaloy AC by Dupont, Hyperform HPN series by Milliken.

[0129] Examples of nucleating agent that can be used in the present invention suitable for crystallizing polypropylenes are the compounds supplied by Milliken under the trade name of Millad.

[0130] The amount of nucleating agent generally depends on the type of polymer used. According to the conventional practice, the nucleating agent is generally used in an amount of from 2% to 5%, more preferably from 2.5% to 4%, even more preferably of about 3%.

[0131] Preferably the nucleating agents have a particle size not higher than 10 microns.

[0132] The base layer may have a thickness between about 10 and 90 μm, more preferably between about 15 and 60 μm, even more preferably between about 20 and 35 μm.

[0133] The heat-sealable layer can comprise at least a first amorphous polyester resin and optionally a further polyester resin.

[0134] Said amorphous polyester is characterized by a Tg value lower than 115°C, preferably lower than 95°C, even more preferably lower than 85°C. Suitable amorphous polyester resins are those deriving from an aliphatic diol and a cycloaliphatic diol with one or more dicarboxylic acids, preferably

[0135] an aromatic dicarboxylic acid. Preferred amorphous polyesters are copolyesters of terephthalic acid with an aliphatic diol and a cycloaliphatic diol, particularly ethylene glycol and 1,4-dicyclohexanedimethanol. The preferred molar ratios of the cycloaliphatic diol to the aliphatic diol are in the range from 10:90 to 60:40, preferably in the range from 20:80 to 40:60, more, preferably from 30:70 to 35:65. Specific examples of particularly preferred amorphous polyester

are PETG Eastar® 6763, sold by Eastman (glass transition temperature 81 °C, density 1.27 g/cc) and Embrace sold by Eastman Chemical, (glass transition temperature 70.6°C, density 1.32 g/cc).

[0136] A blend of two or more amorphous polyesters is also suitable for the heat sealable layer of the films of the present package.

[0137] Suitable further polyesters can be added in the sealant layer. Such polyester can be those deriving from an aliphatic diol, preferably ethylene glycol and one or more aromatic dicarboxylic acid, preferably terephthalic acid. Polyethylene terephthalate and its copolyesters are preferred. Specific examples include Eastapak Copolyester 9921 sold by Eastman and Ramapet N180 sold by Indorama.

[0138] The amount of the first amorphous polyester in the heat-sealable layer of the film of the present package is preferably at least 30% by weight with respect to the total weight of the heat-sealable layer, preferably at least 50% by weight, even more preferably at least 60% by weight.

[0139] The amount of the further polyester in the heat-sealable layer of the film of the present package is generally at most 70% by weight with respect to the total weight of the heat-sealable, preferably at most 50% by weight, even more preferably at most 30%.

[0140] In an embodiment, the internal film(s) (6) and the outermost films (5) of the package according to the first object of the present invention are made of peelable films thus allowing the easy opening of each compartment and /or its separation from the others.

[0141] In a preferred embodiment, the films are peelable crystallizable polyester-based films.

[0142] Peelability can be imparted to the films by admixing further resins in the sealant layer, usually from 3 to 40% by weight, more frequently 10 to 25% by weight of an appropriate thermoplastic resin. Suitable thermoplastic resins that contribute to lowering the sealing strength of a polyester sealant layer of a film are polyethylens, polyamides, polystyrenes, in particular styrene-butadiene block copolymers, ionomers, ethylene/unsaturated carboxylic acid copolymers, like ethylene/(meth)acrylic acid copolymers and ethylene/cyclic olefin copolymers, like ethylene/norbornene copolymers. These resins have low compatibility with the polyester resin layer and the resulting phase separation confers the desired peelability. Specific examples are PRIMACOR 3440 by Dow, an ethylene/acrylic acid copolymer and Bynel 4104 by Du Pont de Nemours, an anhydride-modified linear low-density polyethylene (LLDPE) .

[0143] The thickness of the heat-sealable layer is generally between about 5 and 40% of the thickness of the base layer. The heat-sealable layer may have a thickness of up to about 25 μm, preferably up to about 15 μm, more preferably between about 0.5 and 10 μm, and more preferably between about 0.5 and 7 μm.

[0144] Additional layers can be present in the film of the present invention.

[0145] For example, an outer layer can be present, having a thickness up to about 25 μm, preferably up to about 15 μm, more preferably between about 0.5 μm and 10 μm, and even more preferably between about 0.5 μm and 7 μm. The outer layer is the outermost layer of the structure.

[0146] Preferably, the polyester resins suitable for the composition of the outermost layer are selected among the list of crystallizable polyester resins reported above.

[0147] In an embodiment, the crystallizable polyester films useful for the package according to the first object of the present invention comprise at least two layers: the sealant and the base layer.

[0148] In a preferred embodiment, the crystallizable polyester films comprise at least three layers: the sealant, the base layer and the outer layer.

[0149] In a preferred embodiment, the same crystallizable polyester resin, either alone or in blend, is used for the base and the outer layer. Preferred resins are Eastapak Copolyester 9921 sold by Eastman and Ramapet N180 sold by Indorama.

[0150] In an embodiment, the same amorphous polyester resin is used in the base layer and in the sealant layer. Preferred resins are PETG Eastar® 6763 sold by Eastman and Embrace sold by Eastman Chemical.

[0151] In case of two or three layers films, the crystallizable polyester is preferably present at a percentage in weight ranging from 50 to 70% with respect to the total weight of the film and the amorphous polyester is preferably present at a percentage in weight ranging from 25 to 35% with respect to the total weight of the film.

[0152] The films of the present package can further comprise a gas-barrier layer, which may be medium or high barrier to gases, especially to oxygen, depending on the product to be packaged.

[0153] As used herein the term "medium barrier film" refers to a film having an oxygen transmission rate (OTR) lower than 200 cc/sqm/day, preferably lower than 100 cc/sqm/day at 100% RH and 23°C.

[0154] Alternatively, the multilayer film object of the present invention can comprises at least a high gas-barrier layer and can exhibit an oxygen transmission rate (OTR) lower than 50, preferably lower than 30, more preferably lower than 20 cc/m^2day bar at 23°C and 100% relative humidity.

[0155] The OTR of plastic films can be measured following ASTM D3985.

[0156] Well known gas-barrier resins and their blends suitable for the barrier films are for example,

[0157] ethylene-vinyl alcohol copolymers (EVOH), polyamides and acrylonitrile-based copolymers. Once the gas-barrier resin has been selected, its thickness will be set to provide for the desired permeability properties.

[0158] In the film, tie layers, to improve interlayer adhesion, may be present.

[0159] Tie layers may be disposed between the respective layers in case where a sufficient adhesion is not ensured between adjacent layers. The adhesive resin may preferably comprise one or more polyolefins, one or more modified polyolefins or a blend of the above. Specific, not limitative, examples thereof may include: ethylene-vinyl acetate copolymers, ethylene-(meth)acrylate copolymers, ethylene- alpha -olefin copolymers, any of the above modified with carboxylic or preferably anhydride functionalities, elastomers, and a blend of these resins.

[0160] One or more of the layers of the film of the present invention may contain any of the additives conventionally employed in the manufacture of polymeric films. Thus, agents such as pigments, lubricants, anti-oxidants, radical scavengers, oxygen scavengers, UV absorbers, odour absorbers, thermal stabilisers, anti-blocking agents, surface active agents, slip aids, optical brighteners, gloss improvers, viscosity modifiers may be incorporated as appropriate. In particular, to improve the processing of the film in high speed packaging equipment slip and/or anti-blocking agents may be added to one or both of the outer layers. The additives may be added in the form of a concentrate in a polyester carrier resin. As an alternative slip agents may be added by coating, for instance by plasma coating or by spraying (e.g. with a Weko equipment). The amount of additive is typically in the order of 0.2 to 5% by weight of the total weight of the layer.

[0161] In another embodiment, the films (5 and/or 6) of the present package can be mono-layer films; in this case, suitable crystallizable polyester resins, optionally blended to amorphous polyesters, are the same - both in terms of kind and percentages - as the ones for the base layer listed above.

[0162] The monolayers films suitable for the present packages are sealable, preferably the monolayers films are also peelable.

[0163] In order to impart the required peelability and sealability, the films can be coated, either during or after their manufacturing, with well known suitable compositions.

[0164] Typical coating composition and method are for examples described in WO9619333, WO0154886, WO2011083342.

[0165] The coating composition can be applied to the film by any suitable conventional technique, for example by spraying, dip coating, roll coating, bead coating, reverse roller coating or slot coating, impregnation.

[0166] The grammage of the applied coating layer is typically in the range from 0.1 to 5.0 g/m^2, more frequently 0.3 to 3.0 g/m^2, and particularly 0.5 to 2.0 g/m^2. The thickness of the coating layer is typically in the range from 0.3 to 10 μm, more preferably 0.5 to 5.0 μm, and particularly 1.0 to 2.0 μm.

[0167] The coating can be applied onto one surface of the film or onto both the surfaces.

[0168] For films coated on both their surfaces, the same ranges of grammage and thickness listed above are applicable to each coating layer.

[0169] Before the deposition of the coating layer onto the film, the surface to be coated may advantageously be subjected to a chemical or physical treatment in order to improve the bond between that surface and the applied coating layer. One of the preferred treatments is to expose the surface to be coated to a high voltage electrical stress accompanied by corona discharge. Alternatively, the substrate may be pre-treated with an agent known in the art to have a solvent or swelling action on the film. For example, for polyester films, suitable agents include halogenated phenols dissolved in an organic solvent, as a solution of p-chloro-m-cresol, 2,4-dichlorophenol, 2,4,5- or 2,4,6-trichlorophenol or 4-chlororesorcinol in acetone or methanol.

[0170] Such coatings can also be applied to a multilayer film. In this case there is no need to impart peelability to the film by adding - in the sealant layers - resins having low compatibility with the resin of the sealant layer.

[0171] The films of the present package are low-shrink films as defined above.

[0172] These films have no or negligible shrink at temperatures below 140°C. The shrink (in each direction) is generally at most 15% at temperatures below 100°C, below 120°C, and even below 140°C.

[0173] Usually, in case of polyester based films, the shrink (in each direction) does not exceed 15% over the common heat-sealing temperature range of polyester films, namely in the range of from 140 to 200°C. The shrink generally does not exceed 15% (in each direction) at 180°C, at 160°C, and even at 150°C.

[0174] Depending on the resins employed and on the particular final application, these films can be manufactured by coextrusion, extrusion coating, and/or lamination of preformed cast films, followed by mono- or biaxial orientation and, optionally, by an annealing or heat-setting step, or they may be prepared by lamination of preformed films of which at least part of them have been mono- or bi-axially oriented.

[0175] Typically, coextrusion equipment are used, where each resin is extruded through an extruder and all the layers are joined into the extrusion die. Typically, for polyester films, flat die is used.

[0176] The film of the present invention is, preferably, also oriented. A tubular or, preferably, flat film orientation process can be used to produce a biaxially oriented film.

[0177] Preferably, the flat film is oriented with a tenterframe apparatus.

[0178] In a tubular process, also known as "double bubble" process, simultaneous biaxial orientation is obtained by coextruding thermoplastic resins in a tube shape which is subsequently quenched, reheated and then expanded by internal gas pressure to induce transverse orientation, and withdrawn at a rate which will induce longitudinal orientation.

An example of equipment suitable for this technique is disclosed by US4841605. In alternative, a triple-bubble orientation process may also be used, in such a case a final relaxation or annealing step being included, as known in the art.

[0179] Another possible tubular process suitable for manufacturing the films of the present package is the "hot blown" process.

[0180] In a flat film process, the film-forming thermoplastic resins are extruded through a T-die and rapidly quenched upon a chill roll to ensure that the resins are quenched to the amorphous state.

[0181] In order to improve the adhesion of the film on the chill roll electrostatic pinning can be used, as known in the art and as described in US5494619.

[0182] Orientation is then, optionally, effected by flat stretching, simultaneously or sequentially, the quenched extrudate at a temperature above the glass transition temperature of the thermoplastic resins.

[0183] In the sequential flat orientation method a flat, quenched extrudate is firstly oriented in one direction, usually the longitudinal direction, i.e. the forward direction through the film stretching machine, and then in the transverse direction. Longitudinal stretching of the extrudate is conveniently carried out over a set of rotating rolls (MDO), which rotate at different speeds. At least one of the first pairs of rolls is heated, for example by inner circulation of hot oil. Transverse stretching is usually carried out in a tenter apparatus (TDO), which comprises a certain number of heating zones and suitable stretching means.

[0184] To manufacture the multilayer films of the present package, the polymers for the various layers are fed to separate extruders. The melts are extruded through a multilayer T-die and quenched over a chill roll. Longitudinal stretching (MDO) of the extrudate is conveniently carried out at a temperature range from 60 to 120°C, preferably from 70 to 100°C.

[0185] In the transverse stretching (TDO), the temperatures of the film are in the range from 90° C (preheating zone) to 130° C (stretching zone), preferably from 90°C (preheating zone) to 110°C (stretching zone). The longitudinal stretching ratio is in the range from 2.0:1 to 5.0:1, preferably from 2.3:1 to 4.8:1. The transverse stretching ratio is generally in the range from 2.4:1 to 6.0:1, preferably from 2.6:1 to 5.5:1.

[0186] In the simultaneous flat orientation method a flat, quenched extrudate is simultaneously oriented in both the longitudinal and in the transverse direction through a simultaneous tenter apparatus.

[0187] Said extrudate is fed to the pre-heating zone of a simultaneous tenter apparatus, with or without a prior passage through an IR heated oven. The temperature of the oven in said pre-heating zone, the length thereof and the time spent by the traveling web in said zone (i. e. the web speed) can suitably be varied in order to bring the film up to the desired temperature for bi-axial orientation. In a preferred embodiment the orientation temperature is comprised between about 90 °C and about 140 °C and the temperature of the pre-heating zone is kept between about 90 °C and about 150 °C. In said pre-heating zone the film is clipped but it is not yet stretched. Thereafter, the resulting hot, optionally irradiated, and clipped film is directed to the stretching zone of the simultaneous tenter. Any simultaneous stretching means can be used in said zone. Preferably however the clips are propelled throughout the opposed loops of the tenter frame by means of a linear synchronous motor. A suitable line for simultaneous stretching with linear motor technology has been designed by Bruckner GmbH and advertised as LISIM line. An alternative line for simultaneous stretching of the extruded flat tape is the Andritz line, based on a pantograph, equipped with two separated monorails on each side of the orientation unit. The configuration of the tenter can be varied depending on the stretching ratios desired.

[0188] The temperature in the stretching zone is kept close to the selected orientation temperature.

[0189] In case, annealing is carried out at a temperature of from 130 to 220° C, the temperature depending on the desired shrink. Subsequently, the film is wound up in a customary manner.

[0190] Following said optional annealing or heat-setting step the film is transferred to a cooling zone where generally air, either cooled or kept at the ambient temperature, is employed to cool down the film. The temperature of said cooling zone is therefore typically comprised between about 20° C and about 40° C. At the end of the line, the edges of the film, grasped by the clips and not oriented, are trimmed off and the obtained bi-axially oriented, heat-shrinkable or heat-set film is then wound up, with or without prior slitting of the film web to the suitable width.

[0191] The second object of the present invention is a method for manufacturing the multi-compartment package of the present invention, such a method comprising the steps of:

i) providing two outermost and at least one internal, optionally pre-cut, crystallizable films;
ii) providing at least two products to be packaged;
iii) stacking an outermost film, the product(s), the internal film(s) - alternating the products and the internal film(s) - and the other outermost film, up to the desired number of compartments is obtained;
iv) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame, and
v) optionally, simultaneously or afterwards, cutting the stack of films all around all around outside the frame thus providing the multi-compartment package;

or, alternatively the steps of:

a) providing two outermost and at least one internal, optionally pre-cut, crystallizable films;
b) providing at least two products to be packaged;
c) placing in stack an outermost film, a product and an internal film;
d) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame;
e) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the first compartment of the package;
f) placing a stack of "a product/ a film" or of "a film/ a product / a film", onto the compartment formed in steps c) to e);
g) repeating point d) to f) for each new compartment up to the desired number of compartments is obtained, thus providing the multi-compartment package

or, alternatively the steps of:

A) providing two outermost and at least two internal, optionally pre-cut, crystallizable films;
B) providing at least two products to be packaged;
C) placing in stack a film, a product and a film;
D) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame;
E) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the first compartment of the package;
F) manufacturing at least another compartment following steps A to E;
G) stacking the first and the new compartment(s), optionally placing a product in between;
H) sealing or gluing together the first and the other new compartment(s), simultaneously or one after the other if more than two, up to the desired number of compartments is obtained, thus providing the multi-compartment package.

[0192] Independently of the method used, a partial crystallization of the films along the sealing area occurs during the sealing operation thus providing the rigid frame.

[0193] Figs 7A and 7B illustrate the first method for manufacturing embodiment 1A and, respectively, embodiment 1 B of a three compartment package according to the present invention. In this scheme for the sake of clarity, only steps iii) (stacking) and iv) (sealing) of the present manufacturing process are represented, being the other steps of i) providing the films, optionally pre-cut, ii) providing the products and, v) optionally cutting the stack of films to provide the final package are also meant to be included.

[0194] The first method of manufacturing the present package disclosed above is preferably used.

[0195] According to this first and preferred embodiment, the outermost films, the internal film(s) and the products are alternated and stacked up to the desired number of compartments is obtained, then all the films in stack are sealed and cut. The films may also be pre-cut before the stacking step; in this case the further cutting step can be optional. During the sealing step, the films are heat crystallized thus forming the rigid frame of the package.

[0196] In embodiment 1A) of the present package only one internal film is present.

[0197] Accordingly, in the manufacturing process of this package, the sequence of films and products to be stacked is : "film / (product / film)$_n$".
being n an integer number higher than 1 representing the number of compartments desired.

[0198] In a two-compartments package according to embodiment 1A (n=2) the sequence of films and products in stack is: "film / product / film / product /film", wherein the products and the films can be the same or different.

[0199] In a more than two-compartments package (n>2) according to embodiment 1A, the sequence of films and products in stack is: "film /(product / film) n>2 ", wherein the products and the films can be the same or different.

[0200] In embodiment 1A of the present package two adjacent compartments share the same internal film and the compartments are opened preferably one after the other in the same order they have in the package.

[0201] In another embodiment (1B), each compartment has its own internal films, namely there are two internal films between each couple of adjacent products in stack.

[0202] In the manufacturing process of the package according to embodiment 1B, the sequence of films and products to be stacked is:

"(film / product / film)n
n being an integer number higher than 1 representing the number of compartments desired.

[0203] In a two-compartments package according to embodiment 1 B (n=2) the sequence of films and products in

stack is: "film / product / film / film / product /film", wherein the products and the films can be the same or different.

[0204] In case of n compartments, where n is higher than 2, the sequence of films and products in stack is: "(film / product / film)n>2"

[0205] In embodiment 1 B two adjacent products will be separated by two internal films.

[0206] This embodiment 1 B allows the consumer to detach sealed compartments, in the meanwhile keeping each portion still packaged and to open them, later and independently.

[0207] To facilitate the detachment of each single sealed compartment from the others, the bonding between adjacent compartments may be suitably weakened, for instance by imparting higher peel properties to the surfaces of the films directly involved in said bonding.

[0208] In an advantageous embodiment 1B, the bonding between the films of adjacent compartments (inter-compartments bonding) will be weaker than the bonding within the films of each compartment (intra-compartment bonding) thus allowing a clean detachment of each sealed compartment and avoiding untimely opening of the same. A different bonding may also be obtained for instance by selecting different means for intra- and inter-compartments bonding, such as sealing vs gluing etc.

[0209] In such a case, the preferred manufacturing process will be according to the third embodiment of said process. If the strength of the bonding imparted by gluing is lower than those conferred by sealing, the detachment of each still sealed compartment will be facilitated.

[0210] According to a second variant of the manufacturing process of the present multi-compartment package, represented in Figs. 8A and 8B, a first compartment is made by stacking in sequence a film, a product and a film and by sealing the stacked films; afterwards, a new stack of a product and one / two film(s) - arranged as "product / film" for manufacturing the package of embodiment 1A or as "film / product / film" for embodiment 1B - is added onto the first compartment previously manufactured and the thus formed stack of films and products are sent again to the sealing station, were the films are sealed, crystallized and cut if needed.

[0211] Each new product to be packaged is added - covered by one or sandwiched between two film(s) - to the package already made in the previous steps, up to the desired number of compartments is obtained. This stepwise process has the advantage of repeating the sealing/crystallizing step several times thus providing the multi-compartment package with a more rigid frame. A higher rigidity may be advantageous in case of heavier or more delicate products. This process may also be preferred when there is the need to alternate different products.

[0212] However, in case of a package with a higher number of compartments (i.e. more than 3) it may be advantageous to replace one or more of the sealing steps d) of the present second method with one or more gluing steps as the rigidity conferred by the sealing steps already performed may suffice for the final use of the package. Gluing steps may be carried out, for instance, as described below for the third manufacturing method.

[0213] Figs 8A and 8B illustrate this second method for manufacturing embodiment 1A and, respectively, embodiment 1 B of a three compartment package according to the present invention.

[0214] In this scheme for the sake of clarity, only steps c and f) (stacking), d) (sealing) and g) (their repetition) of the present manufacturing process are represented, being the other steps of a) providing the films, optionally pre-cut, b) providing the products and, e) optionally cutting the stack of films to provide the final package are also meant to be included.

[0215] For the method of this second embodiment, the sequence of components in the final package is "film/ (product/film)$_n$" for embodiment 1A or "(film/product/film)$_n$" for embodiment 1B being n the total number of compartments (n>1).

[0216] In the third variant of the of the present manufacturing method, two or more pre-made compartments, are joined together by sealing or, in alternative, by gluing.

[0217] Figs 9A and 9B illustrate this third method for manufacturing embodiment 1A and, respectively, embodiment 1 B of a three compartment package according to the present invention.

[0218] In this scheme for the sake of clarity, only steps C) (stacking a film, a product and a film), D) (sealing), G) (stacking each new compartment onto the previous one(s), optionally placing a product in between) and H) (sealing or gluing) of the present manufacturing process are represented, being the other steps of A) (providing the films, optionally pre-cut), B) (providing the products), E) (optionally cutting the stack of films), F) (manufacturing at least another compartment), to provide the final package are also meant to be included.

[0219] In the present method, the pre-made compartments may be sealed or glued simultaneously in stack or added and sealed /glued stepwise, one after the other.

[0220] If the pre-made compartments are stacked or added without any further product interposition, a multi-compartment package according to embodiment 1B will be obtained.

[0221] In alternative, if a product is inserted between each couple of adjacent compartments, a multi-compartment package according to embodiment 1A may be manufactured. In this case, especially for food products, the compartments are preferably joined together by sealing rather than by gluing to prevent undesired product contaminations.

[0222] As used herein the term "gluing" refers to placing a discrete or continuous layer of an adhesive, preferably along the frame, onto at least one of the facing surfaces of two adjacent compartments to be glued and joining the compartments by applying a pressure sufficient to let them adhere to each other.

[0223] The term "adhesive" is used herein to indicate any material that enables the adhesion of two compartments to each other.

[0224] The thickness of the layer of adhesive can be comprised between 0.2 and 10 μm, more preferably from 0.5 to 5 μm , still more preferably from 1 to 3 μm.

[0225] The adhesives suitable for joining the compartments according to this embodiment are well known in the art. For instance suitable adhesives may be the aqueous dispersions sold by Paramelt under the trade name of Aquaseal or the compositions described in WO2005021638 or in WO2009055275 under the code DPOD 8501.

[0226] The so called "cold seal" materials may be used, as those supplied for example by Fabrico (division of EIS), Basic Adhesive, Printpack Inc.

[0227] Adhesive materials known as "hot melt pressure sensitive adhesives (HMPSA)," are also suitable for the invention, for example those commercialized by Bostik and Henkel

[0228] Systems for applying hot melt adhesives are e.g. hot melt handguns, roll coaters, benchtop extruders, automatic extrusion, fiberization system.

[0229] Various adhesive coatings are described, for example, in WO2005021638 and WO2011083342.

[0230] The adhesive layer has to be deposited onto the external surfaces of the compartments to be joined, preferably along the frame.

[0231] In case of cold seal, this has to be done on both the surface to be joined.

[0232] The layer of adhesive can be discrete or continuous along the frame.

[0233] The adhesive may be applied along the frame as described, for instance, in WO2011083342.

[0234] In a preferred variant of this third embodiment for manufacturing multi-compartments packages according to embodiment 1B, the pre-made compartments are joined by gluing. Advantageously it is possible to select gluing conditions and adhesives in such a way to obtain inter-compartments bonding weaker than the intra-compartment bonding, thus facilitating the removal of each still sealed compartment.

[0235] The methods of manufacturing the present package described above may be implemented with suitable packaging machines such as tray lidding and thermoforming machines with contour sealing and cutting.

[0236] Specific example of suitable machines that can be adapted to run the process of the present invention include for instance Multivac 400 and Multivac T550 by Multivac Sep. GmbH, Mondini E380, E390 or E590 or Trave by Mondini S.pA, Ross A20 or Ross S45 by Ross-Reiser, Meca-2002 or Meca-2003 by Mecaplastic, the tray lidding machines manufactured by Sealpac, Ulma Taurus and Ulma Scorpius supplied by Ulma Packaging, Ishida QX and the like machines.

[0237] Thermoforming machines are suitable for the process described above, without significant modifications. Especially in case of food products to be packaged, a slicer can be advantageously added in order to slice the product.

[0238] In one embodiment, an additional conveyor carrying the weighted product(s) to the stacking zone can also be advantageously provided. Afterwards, the product(s) can be positioned onto the belt carrying the films and the stacking of films and products is repeated up to the desired number of compartments is achieved. Then, the stacked films and products are carried to the thermoforming zone, where sealing, crystallization and cutting occur. In another embodiment, a pre-cutting unit to pre-cut the film is advantageously provided in order to cut the films from the roll at a measure suitable for the package. Same existing tray lidding packaging lines supplied e.g by Risco and Vemag are already equipped with pre-cutting unit, for instance those for the packaging of minced meat.

[0239] In a preferred embodiment, the cutting of the package is performed after the sealing step.

[0240] In another embodiment, the cutting of the package is performed at the same time of the sealing step.

[0241] In case a tab for easy opening is desired, the cutting blade will be shaped in such a way to provide the tab when cutting the films, as known to the person skilled in the art.

[0242] In case the films are of different composition or the outermost films are printed, the packaging machine has to provide the housing for more than one roll of films.

[0243] Sealing is preferably carried out by means of a heated frame by setting the machine at temperatures, in case of polyester based films, of from 140 to 220°C, 170 to 200°C and at a pressure of 2 to 8 bar, 4 to 7 bar. Sealing times are typically in the order of 0.01 to 2.0 seconds, more frequently 0.5 to 1.0 seconds.

[0244] However, other known sealing techniques such as ultrasonic welding may also be used, providing that they are able to induce an at least partial crystallization of the films along the sealing area.

[0245] In case of HDPE or polypropylene based films, lower sealing temperatures are generally selected, for instance in the range of 120 to 180°C providing that the selected temperatures are suitable for at least partially crystallizing the polymers under the operational sealing conditions.

[0246] The sealing bar can have different shapes such as to obtain, for example, a flat or a thermoformed area where the films are sealed to each other, the thermoformed option being preferred, as it provides for a higher rigidity of the frame. Such sealing bars are commercialized by packaging machine suppliers.

[0247] Figs. 6 A-E illustrate cross-sections of some suitable sealing bars. In particular the sealing bar profile can be flat or rounded. In a preferred embodiment the sealing bar has a thermoforming profile, as shown in Figs. 6A or 6E,

namely the bar will seal the films along the sealing area in the meanwhile imparting a desired shape to the at least partially crystallized frame, further increasing its rigidity. For instance, according to the profile of the sealing bars illustrated in Fig. 6A or 6E, there will be areas where, upon sealing, a higher pressure will be applied onto the stacked films and, correspondingly, a higher degree of crystallization will be imparted to the frame.

[0248] Typically, the width of the sealing area of the package, i.e. the width of the frame, is from 1 mm to 20 mm, preferably from 2 mm to 15 mm, still more preferably from 3 to 10 mm.

[0249] The dimensions, in terms of area extension, of the packaged product are not limited, provided that they do not exceed the dimensions of the cut films, and allow a suitable frame to be formed.

[0250] The film dimensions can be adjusted according to the product dimensions and to the needed width of the frame.

[0251] The width of the frame has to be sufficient to confer the suitable stiffness to the package, depending inter alia on the total weight of the packaged products and on the package dimensions.

[0252] The multi-compartment package object of the present invention may be particularly useful for the storage of products which are thin and flexible such as sliced food products or medical product like surgery gloves, sterilized wipes, beauty wipes, patches, gauzes, strips or soaked plasters or bands.

[0253] Preferably the package object of the present invention is used to store sliced food products such as cheese and processed meat. Other possible thin or sliced foods comprise fish and meat carpaccio, smoked fishes, piadina, crepes disks ready to be filled, sweet and salt dough ready to be cut and/or cooked in the oven or fried or filled with a stuffing and then cooked. It is also possible to insert different food products in the same package in order to allow the consumer to have in a single package a specific combination of food products.

[0254] For the purpose of the present description and of the claims which follow, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about". Also, all ranges include any combination of the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

EXAMPLES

[0255] A three-layer film having the composition reported in Table 1 and a total thickness of 33 μm was coextruded through a 3-layer feedblock.

Table 1

Layer, thickness (μm)	Trade Name, Supplier, Chemical Nature	% ww in the layer	Properties
layer 1, 2.5 μm	EASTAR PETG 6763, Eastman Chemical , Polyethylene Terephthalate / Glycol	60%	Density 1.27 g/cm^3; Glass Transition 81 °C Melt Flow Rate (Cond. 200°C / 05.00 kg (G)) 2.8 g/10 min Viscosity Solution (Brookfield method) 0.75 mPa.sec
	PRIMACOR 3440, DOW, Ethylene / Acrylic Acid Copolymer	15%	Comonomer content 9.7 % Density 0.938 g/cm^3 Melt Flow Rate (Cond. 190°C / 02.16 kg (G)) 10 g/10 min Vicat softening point 76 °C
	EASTAPAK COPOLYESTER 9921, Eastman Chemical, Polyethylene Terephthalate	25%	Density 1.4 g/cm^3 Melting Point (Tm) 255 °C

(continued)

Layer, thickness (μm)	Trade Name, Supplier, Chemical Nature	% ww in the layer	Properties
layer 2, 24 μm	EASTAPAK COPOLYESTER 9921, Eastman Chemical, Polyethylene Terephthalate	60%	Density 1.4 g/cm^3 Melting Point (Tm) 255 °C
	EASTAR PETG 6763, Eastman Chemical, Polyethylene Terephthalate / Glycol	40%	Density 1.27 g/cm^3 Glass Transition 81°C Melt Flow Rate (Cond. 200°C / 05.00 kg (G)) 2.8 g/10 min Viscosity Solution (Brookfield method) 0.75 mPa.sec
layer 3, 6.5 μm	EASTAPAK COPOLYESTER 9921, Eastman Chemical , Polyethylene Terephthalate	98%	Density 1.4 g/cm^3 Melting Point (Tm) 255 °C
	SUKANO G dc S503, Sukano AntiBlock and Slip in Polyethylene Terephthalate / Glycol	2%	Vicat softening point 82°C

[0256] The three layers were then distributed through a flat die, having a multi-manifold system. The melt out of the die was quenched onto a chill rolls; electrostatic pinning was applied to increase the contact between melt and chill roll kept at 19°C.

[0257] The so formed cast film was then biaxially oriented. The stretching was done simultaneously on a tenterframe, at ratios of 3.8:1 in both MD and TD directions, and at temperatures of 98°C in the preheating zones and 96°C in the stretching zones. Before oven exit, the film was annealed at a temperature of 200°C.

[0258] The film properties were reported in Table 2 and 3, as well as the reference ASTM for the test method adopted for the measurements.

Table 2

	free shrink ASTM D2732	
temperature	LD	TD
120°C	0	0
140°C	2	0
160°C	5	2

Table 3

Mechanical Property at 23°C	longitudinal direction (LD)	transversal direction (TD)	ASTM
elastic modulus (Kg/cm^2)	36000	36000	D882
tensile at break (Kg/cm^2)	2250	2200	D882
elongation at break (%)	150	150	D882

[0259] A machine Mondini Tray Lid E380 was used to manufacture 30 packages according to the present invention; Sealing conditions applied were: 190°C, 1 sec, 5 bar.

[0260] Each package (according to embodiment 1A) contained 4 compartments for a total of 5 films; one slice of cooked ham was packaged in each compartment and each slice of cooked ham was about 1 mm thick. Five films were superimposed in stack, alternating them with the products, to obtain four compartments.

[0261] The shape of the packages so obtained is shown in Fig. 1 and each package was provided with a tab (4). The main dimensions of the rectangular package were 160 mm (width) x 205 mm (length), the sealing width was 5 mm and the distance between the two closest opposite seals was 135 mm.

[0262] The packages were judged acceptable in terms of rigidity of the frame by three panelists: in fact only a slight

bending of the packages due to the weight of the products was observed. In addition, the packages were manually opened and the opening was really smooth due to the peelability of the films.

[0263] In conclusion, the multi-compartment flexible package object of the present invention does not require a supplemental tray. In fact the package is sufficiently rigid as such, thanks to the partial heat-induced crystallization of the crystallizable polymer in correspondence of the sealing area. The present package in use is not or is only slightly bent and remained substantially flat during its handling. The absence of an additional tray allows a significant reduction of plastic material as well as of manufacturing and disposal costs.

[0264] The partially crystallized area - which appears as a peripheral circumferential continuous rigid frame - is obtainable during conventional sealing of the package and advantageously does not require additional sealing or forming operations or equipment.

[0265] Notwithstanding the much lower content of plastics, the multi-compartment package object of the present invention, provides for at least the same advantages of conventional multi-compartment packages, for instance:

- preservation of single portions of different or same product(s), allowing their individual use
- improved conservation and durability of the packaged products, including air sensitive foods such as sliced food products or medical products, under modified atmosphere or vacuum;
- no contaminations (bacteria, odor, taste)
- prevention of sticking and breaking of sliced food, such as cheese or processed meat, that occur when a high number of slices of these products are stuffed in the same compartment of conventional packages and are therefrom removed
- easy opening the compartment(s) which contains each single portion.

[0266] The present package is a really "green" product: in fact not only it requires a significantly lower amount of plastics but it can be easily recycled, when made of a single plastic material, or it may also be bio-degradable if composed of biodegradable polyesters, i.e. a multi-compartment package much more eco-friend with respect to conventional multi-compartments packages currently on the market.

Claims

1. A tray-less multi-compartment package of individually sealed compartments comprising

   i) two outermost films,
   ii) at least two products in stack,
   iii) at least one internal film interposed between the at least two products in stack,
   iv) a peripheral circumferential continuous seal which seals the films in stack together and delimits at least two sealed compartments in stack, each compartment enclosing at least a product of said at least two products in stack, **characterized in that** the films comprise a crystallizable polymer and the crystallizable polymer is at least partially crystallized in correspondence of the sealing area thus providing a peripheral circumferential continuous rigid frame.

2. The package according to claim 1 comprising one internal film interposed between two adjacent products.

3. The package according to claim 1 comprising two internal films interposed between two adjacent products.

4. The package according to anyone of claims 1 to 3 comprising from 2 to 20, preferably from 2 to 10, more preferably from 2 to 5 compartments.

5. The package according to anyone of claims 1 to 4 wherein said crystallizable polymer is selected from the group consisting of crystallizable polypropylene(s) homo- or copolymers, high density polyethylenes (HDPEs), medium density polyethylenes (MDPEs), polyesters, polyamides, polystyrenes (PS), preferably crystallizable polyesters, and blends thereof.

6. The package according to anyone of claims 1 to 5 wherein the amount of said crystallizable polymer(s) in said films with respect to the total weight of the films is at least 30% by weight, preferably at least 50%, 60%, 70%, 80%, 90% or 95%.

7. The package according to anyone of claims 1 to 6 wherein said crystallizable polymer is a crystallizable polyester or a blend of crystallizable polyesters which crystallize under sealing temperatures from 140°C to 220°C.

8. The package according to anyone of claims 1 to 7 wherein said crystallizable polymer is a crystallizable polyester or a blend of crystallizable polyesters **characterized by** a melting point (Tm) higher than 220 °C, preferably higher than 230 °C.

9. The package according to anyone of claims 1 to 8 wherein said crystallizable polymer, preferably said crystallizable polyester, has a percentage of crystallinity higher than 15%, preferably higher than 20%, more preferably higher than 25%, even more preferably higher than 30% in correspondence of the sealing area after the sealing step.

10. The package according to anyone of claims 1 to 9 wherein said crystallizable polymer is a blend of at least a crystallizable polyester and at least an amorphous polyester, wherein said amorphous polyester has a Tg value lower than 115°C, preferably lower than 95°C, even more preferably lower than 85°C and, in the blend, the amorphous polyester is at most 70% by weight, preferably at most 50% by weight, even more preferably at most 40% by weight.

11. The package according to anyone of claims 1 to 10 wherein the films are sealable and peelable crystallizable plastic films, preferably sealable and peelable crystallizable polyester-based films.

12. The package according to anyone of claims 1 to 11 wherein the difference in the percentage of crystallinity of the polymer(s) of the frame with respect to the polymer(s) of the other parts of the package is at least 5%, preferably higher than 8%, more preferably higher than 10%.

13. The package according to anyone of claims 1 to 12 wherein the percentage ratio between the weight of the packaging material with respect to the total weight of the package is lower than 15%, preferably lower than 10%, more preferably lower than 7% by weight.

14. A method for manufacturing the multi-compartment package according to anyone of claims 1 to 13 comprising the steps of:

i) providing two outermost and at least one internal, optionally pre-cut, crystallizable films;
ii) providing at least two products to be packaged;
iii) stacking an outermost film, the product(s), the internal film(s) - alternating the products and the internal film(s) - and the other outermost film, up to the desired number of compartments is obtained;
iv) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame, and
v) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the multi-compartment package.

15. A method for manufacturing the multi-compartment package according to anyone of claims 1 to 13 comprising the steps of:

a) providing two outermost and at least one internal, optionally pre-cut, crystallizable films;
b) providing at least two products to be packaged;
c) placing in stack an outermost film, a product and an internal film;
d) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame;
e) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the first compartment of the package;
f) placing a stack of "a product/ a film" or of "a film/ a product / a film", onto the compartment formed in steps c) to e);
g) repeating point d) to f) for each new compartment, up to the desired number of compartments is obtained, thus providing the multi-compartment package.

16. A method for manufacturing the multi-compartment package according to anyone of claims 1 to 13 comprising the steps of

A) providing two outermost and at least two internal, optionally pre-cut, crystallizable films;
B) providing at least two products to be packaged;
C) placing in stack a film, a product and a film;
D) sealing and simultaneously crystallizing the stack of films along a peripheral circumferential continuous sealing area thus providing a peripheral circumferential continuous rigid frame;

E) optionally, simultaneously or afterwards, cutting the stack of films all around outside the frame thus providing the first compartment of the package;
F) manufacturing at least another compartment following steps A to E;
G) stacking the first and the new compartment(s), optionally further placing a product in between adjacent compartments;
H) sealing or gluing together the first and the other new compartment(s), simultaneously or stepwise one after the other if more than two, up to the desired number of compartments is obtained, thus providing the multi-compartment package.

17. The method according to anyone of claims 13 to 16 wherein said films are crystallizable polyester films and said sealing step(s) are carried out at a temperature of 140 to 220°C, preferably 170 to 200°C and/or at a pressure of 2 to 8 bar, preferably 4 to 7 bar.

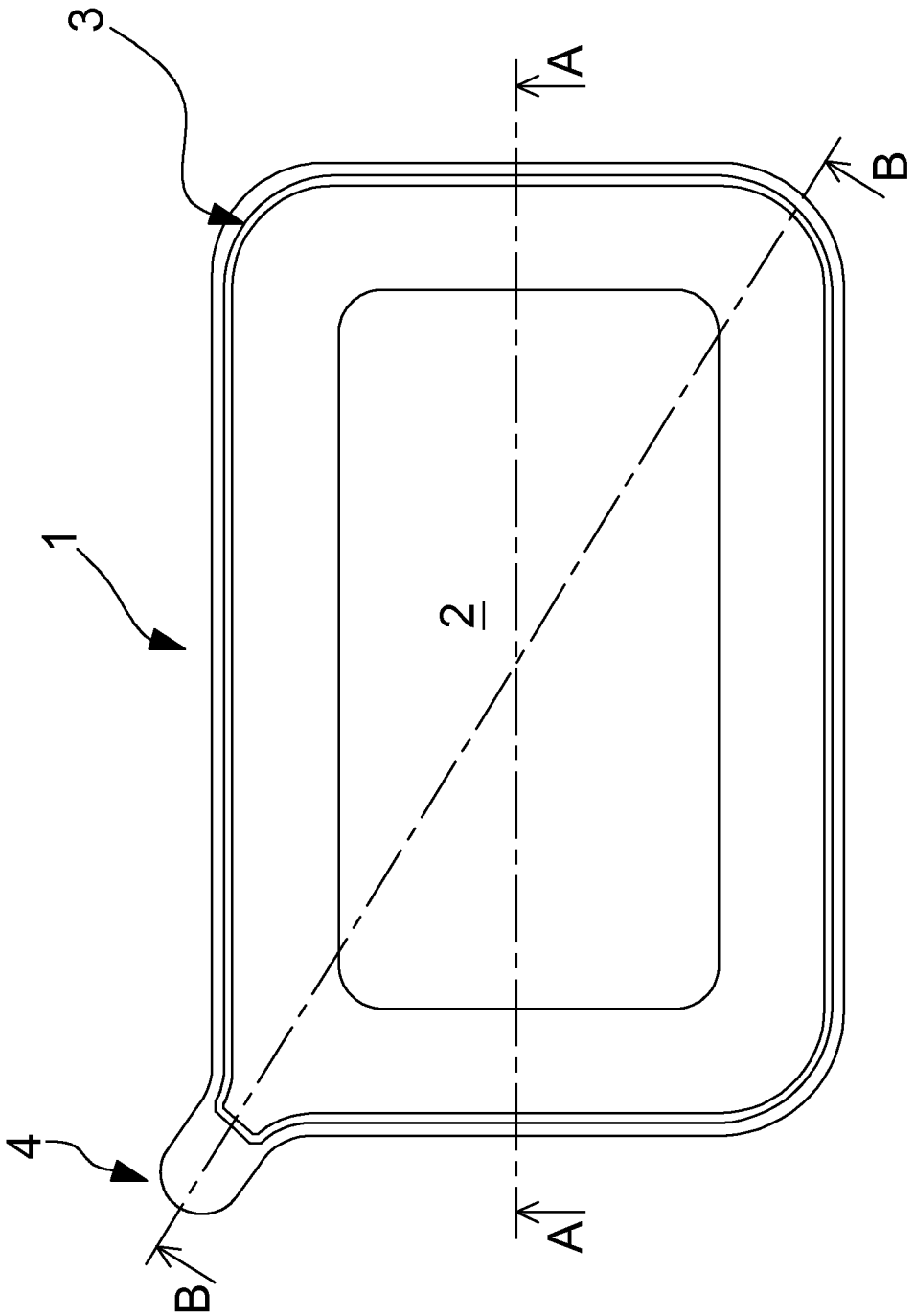


Figure 1

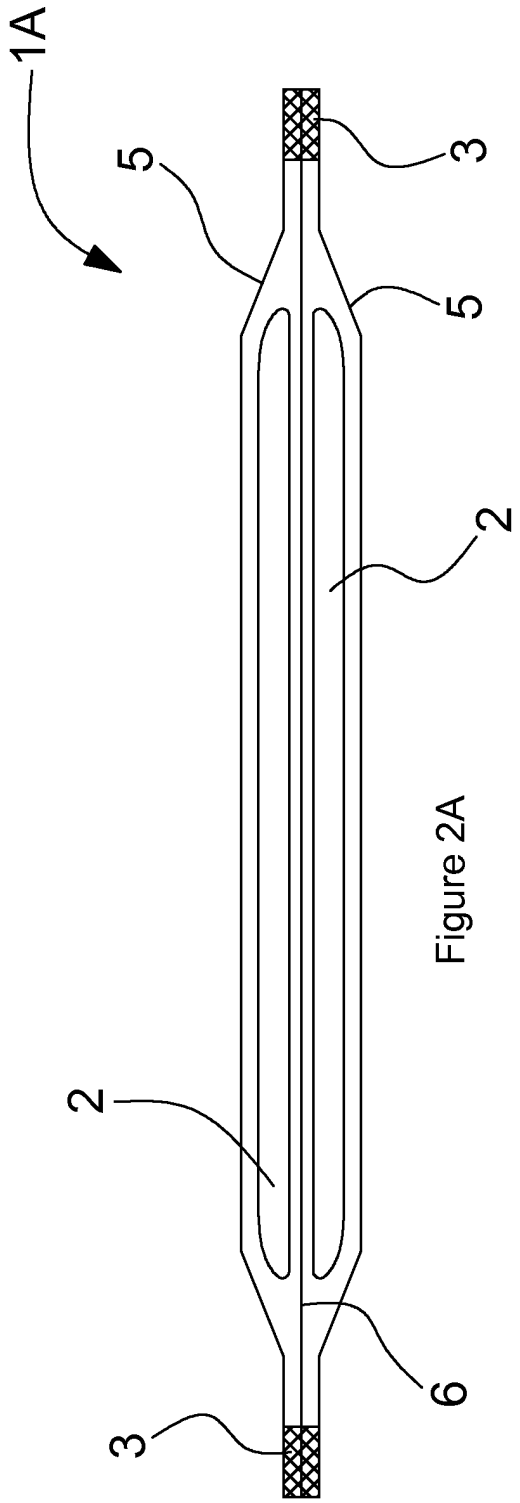


Figure 2A

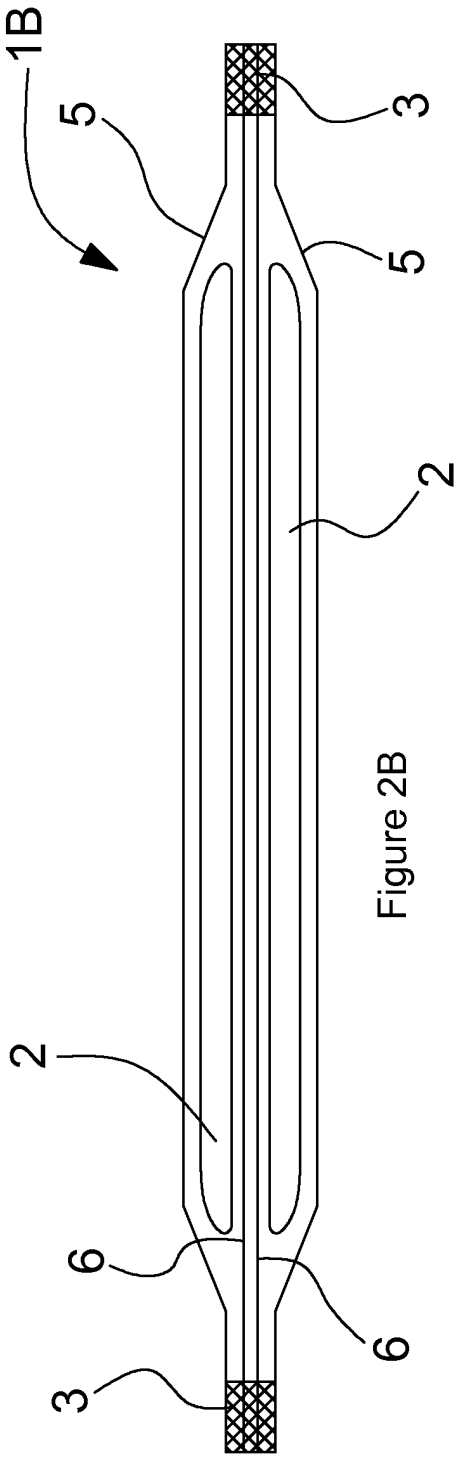
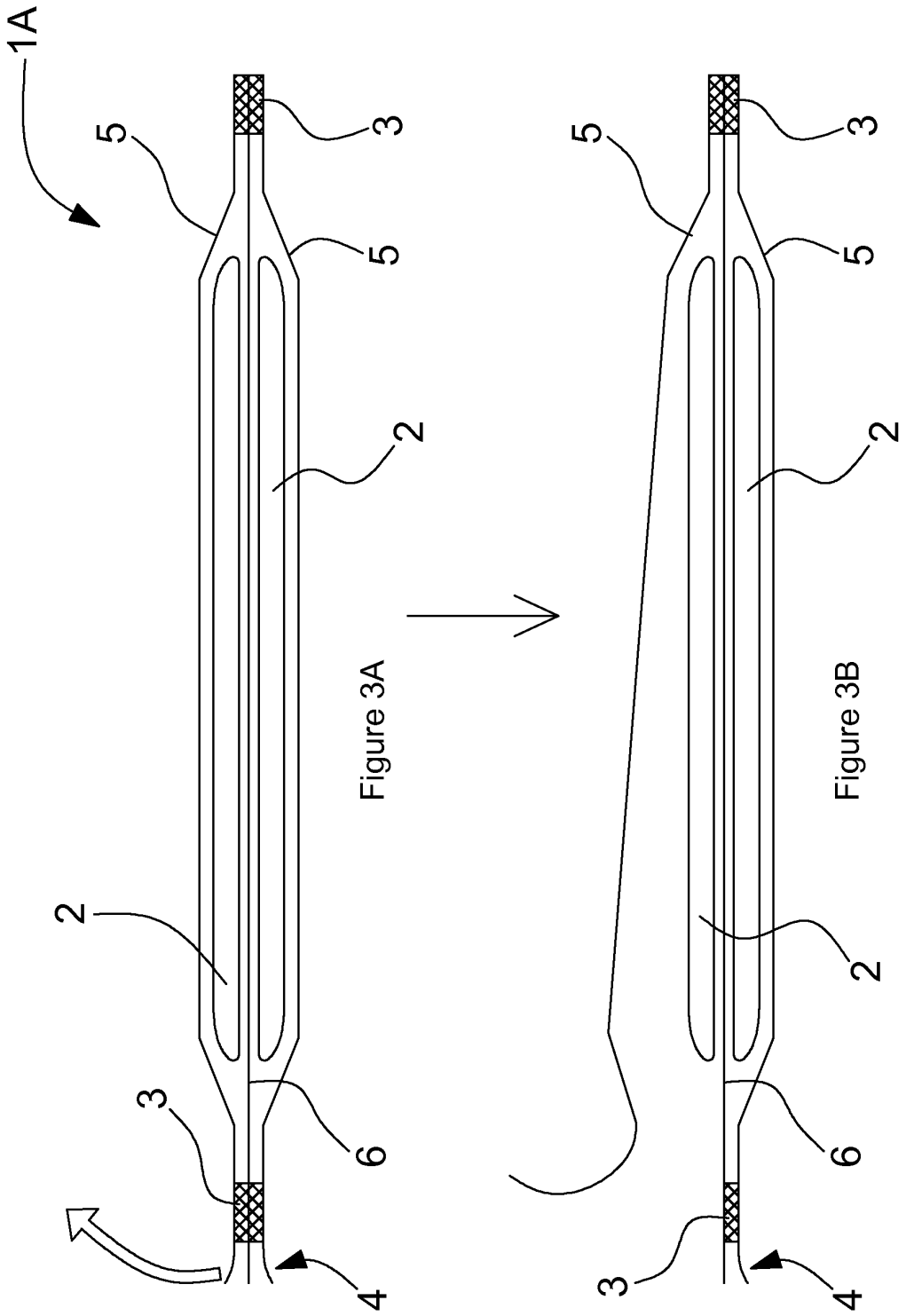


Figure 2B


1A
5
3
5
2
2
3
6
4
Figure 3A
5
3
5
2
2
6
3
4
Figure 3B

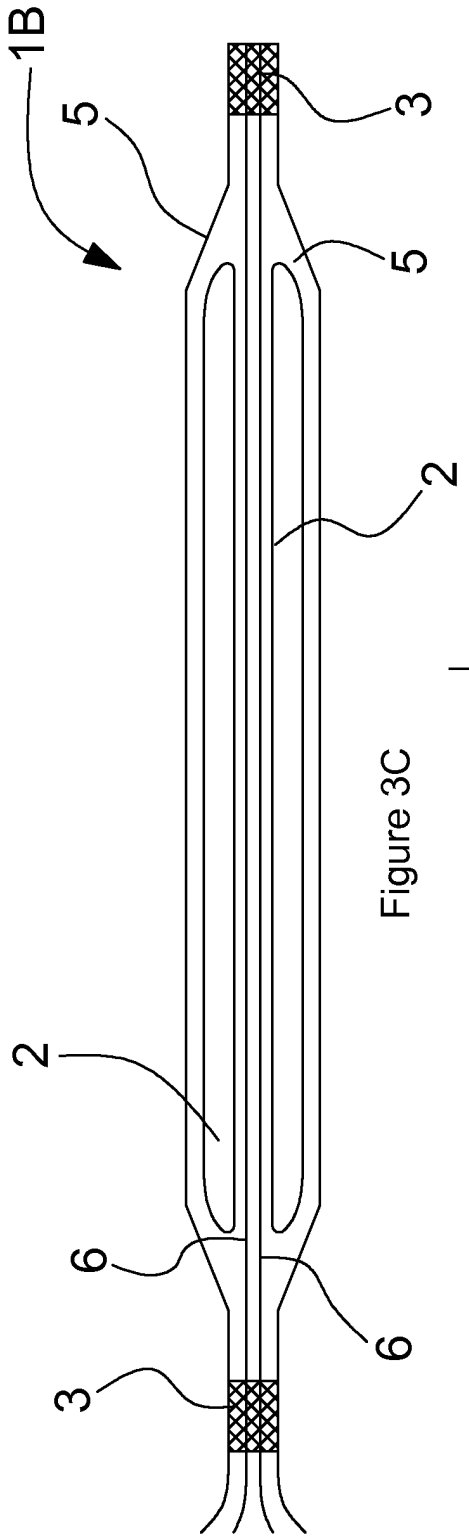


Figure 3C

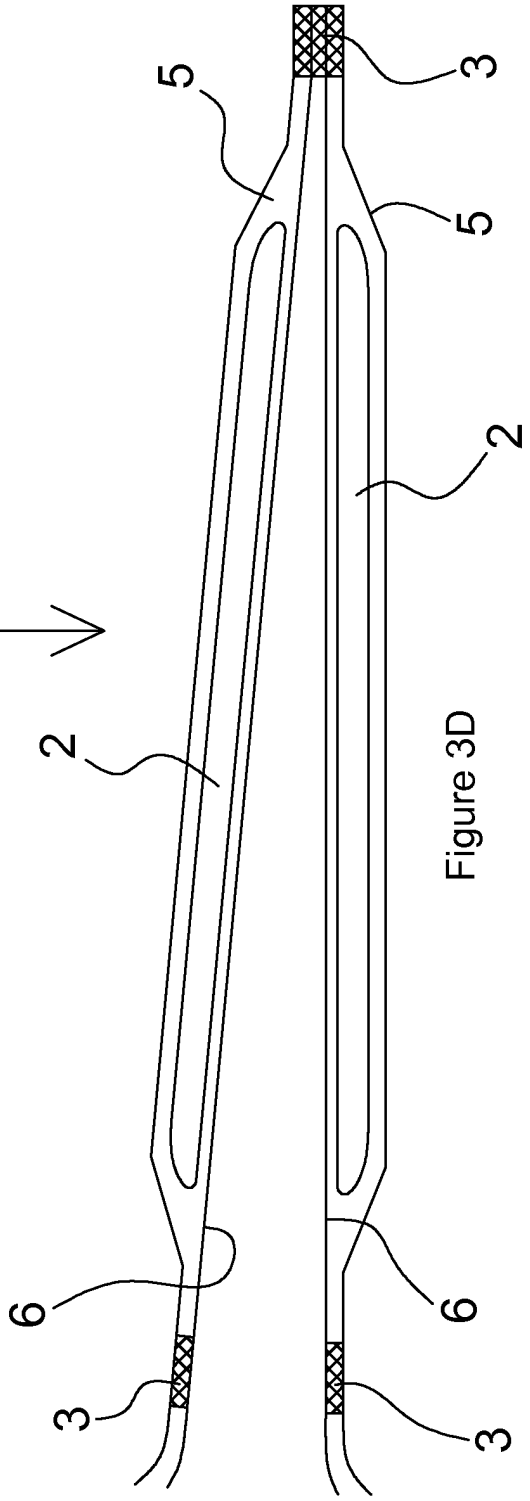


Figure 3D

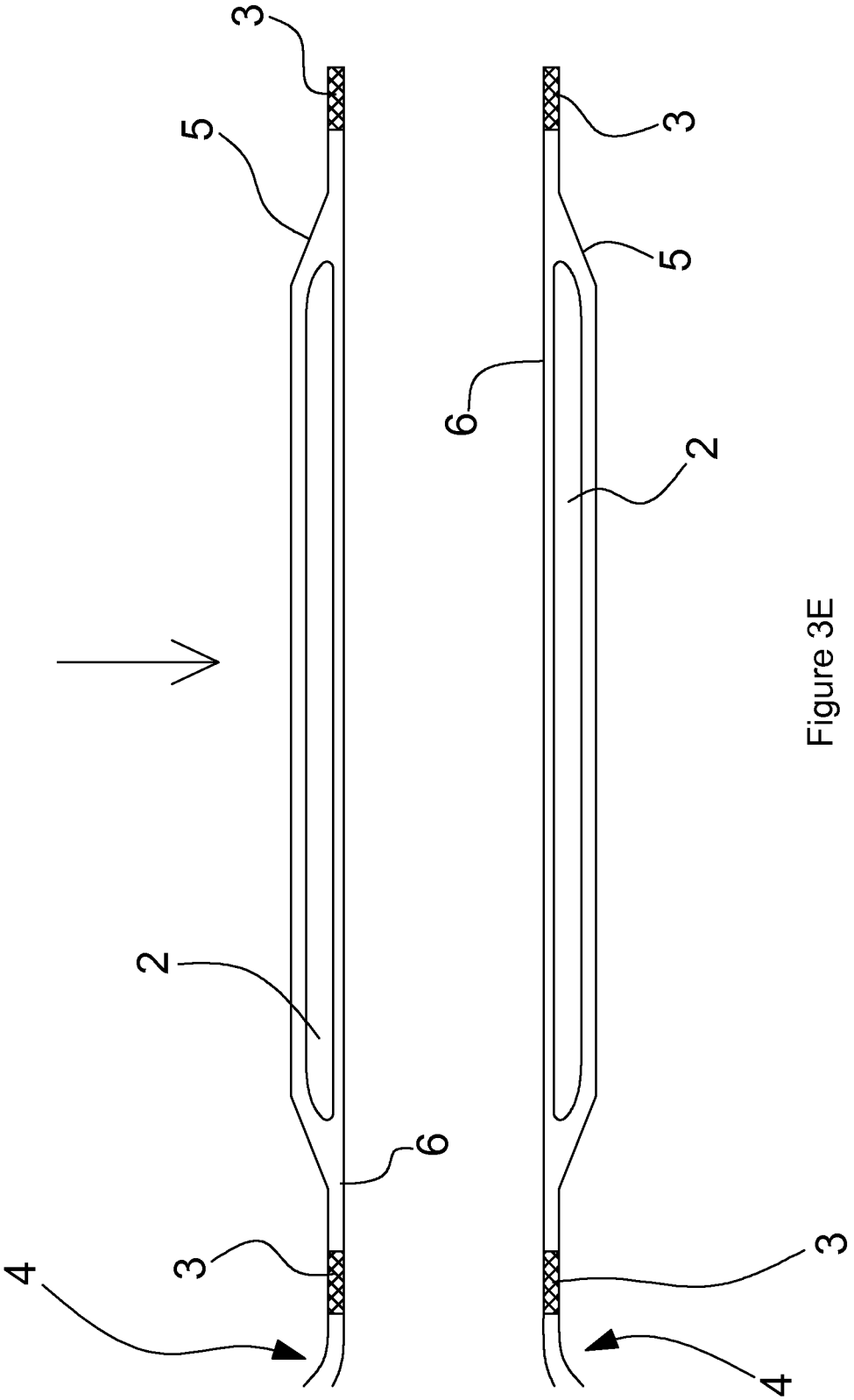


Figure 3E

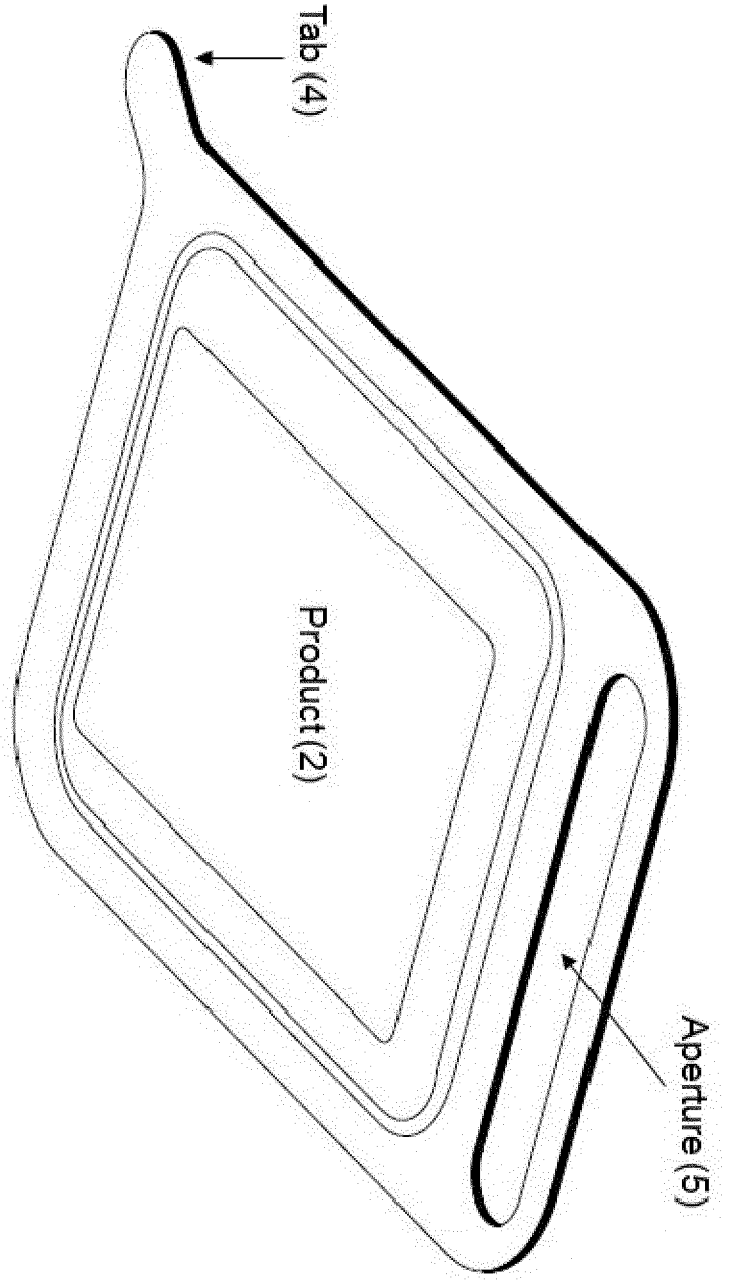


Figure 4

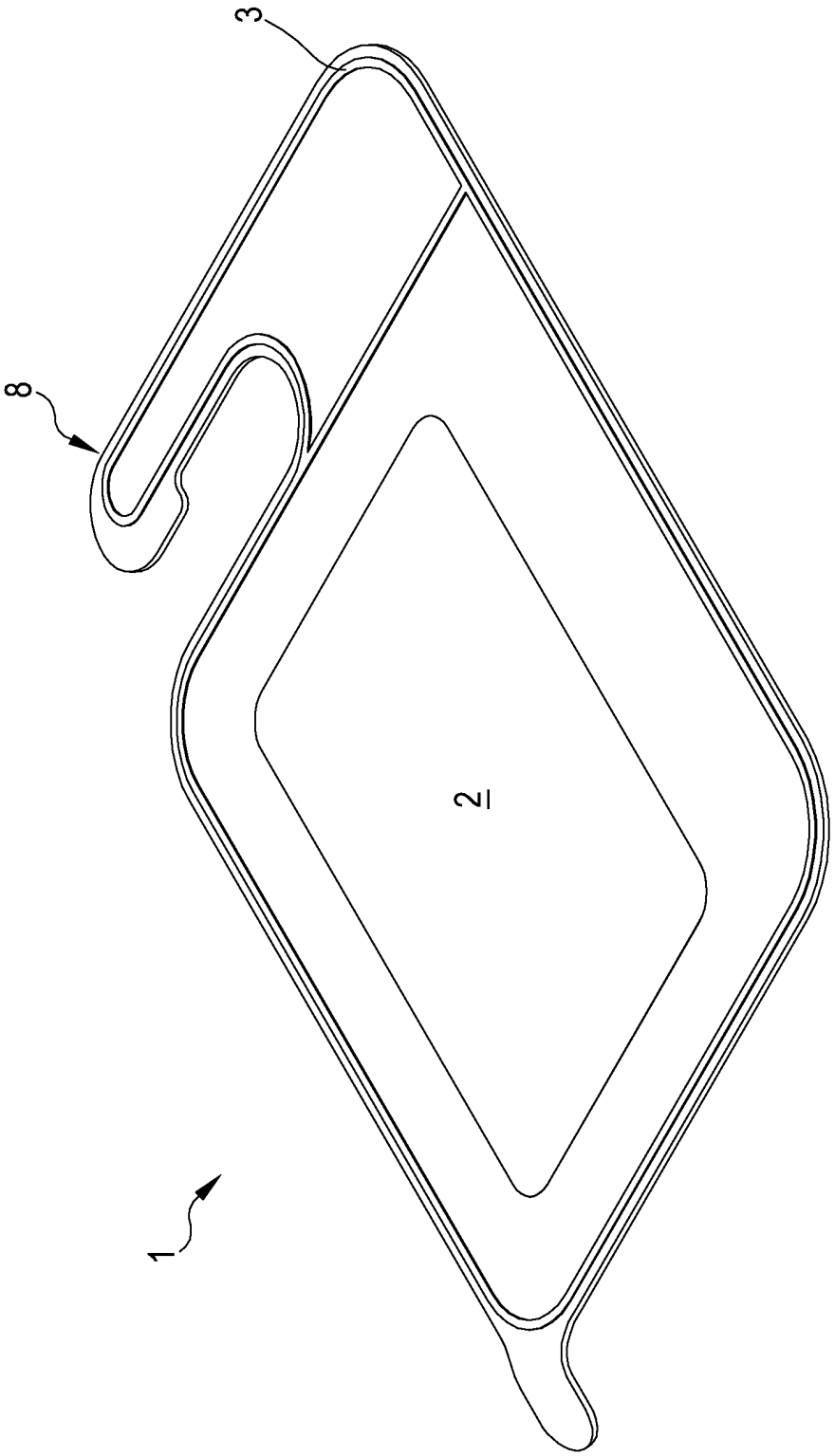


Figure 5

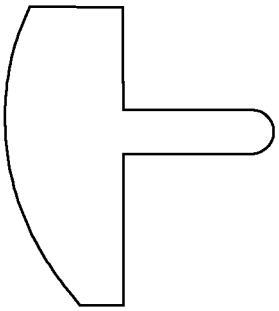


Figure 6B

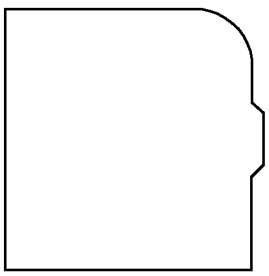


Figure 6A

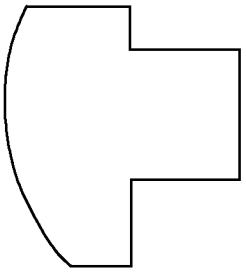


Figure 6D

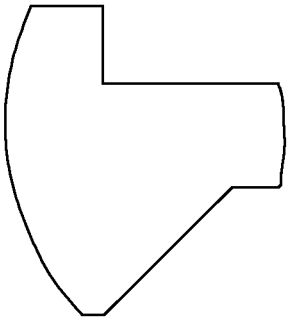


Figure 6C

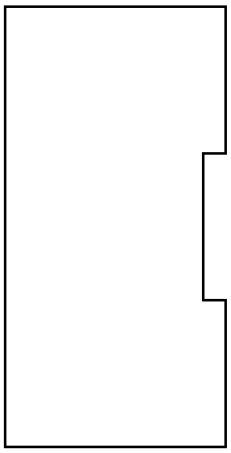


Figure 6E

Figure 7B

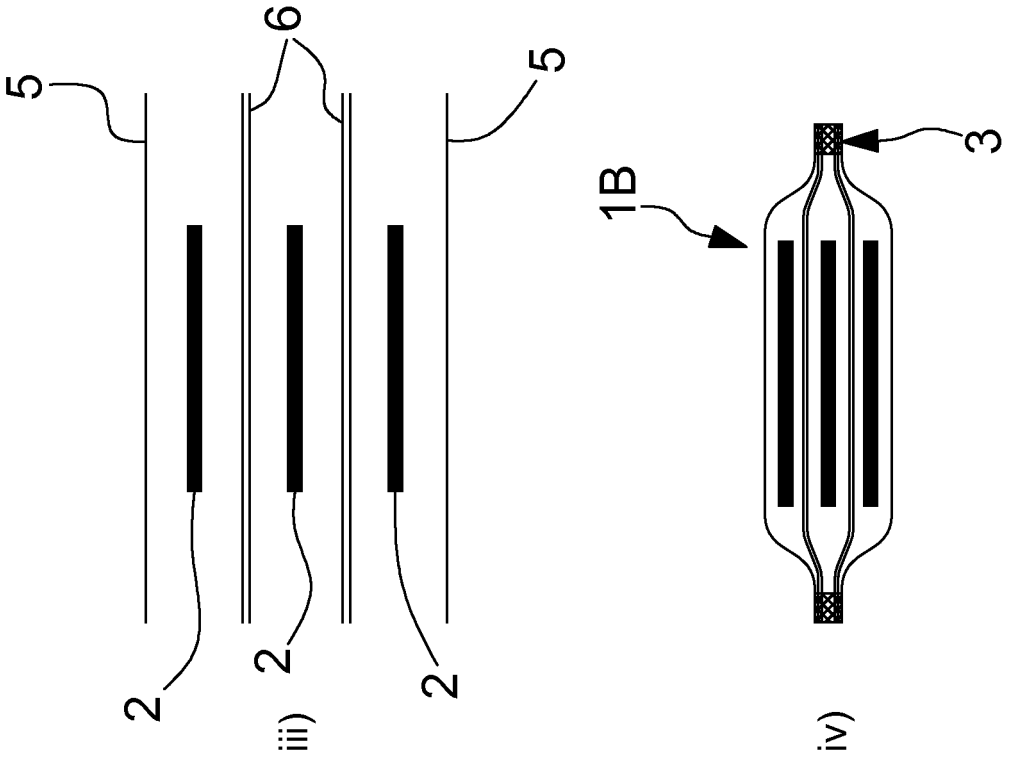


Figure 7A

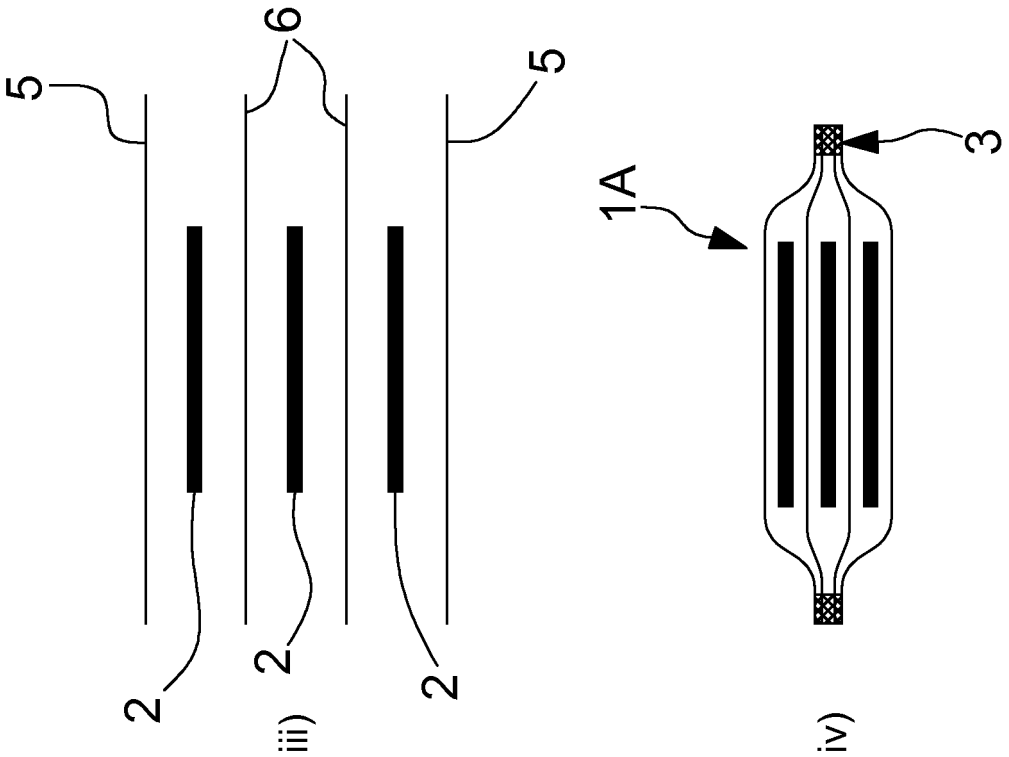


Figure 8A

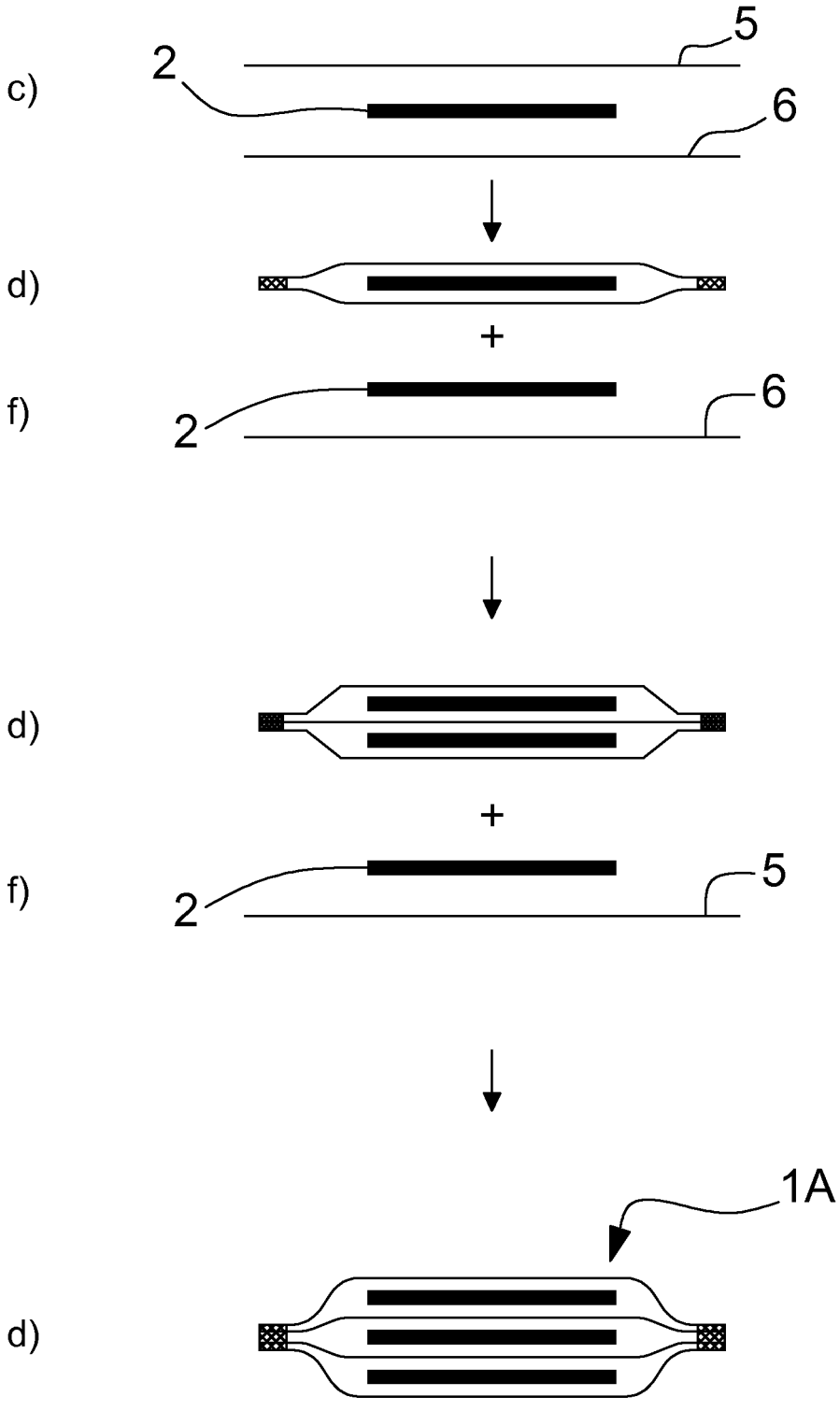


Figure 8B

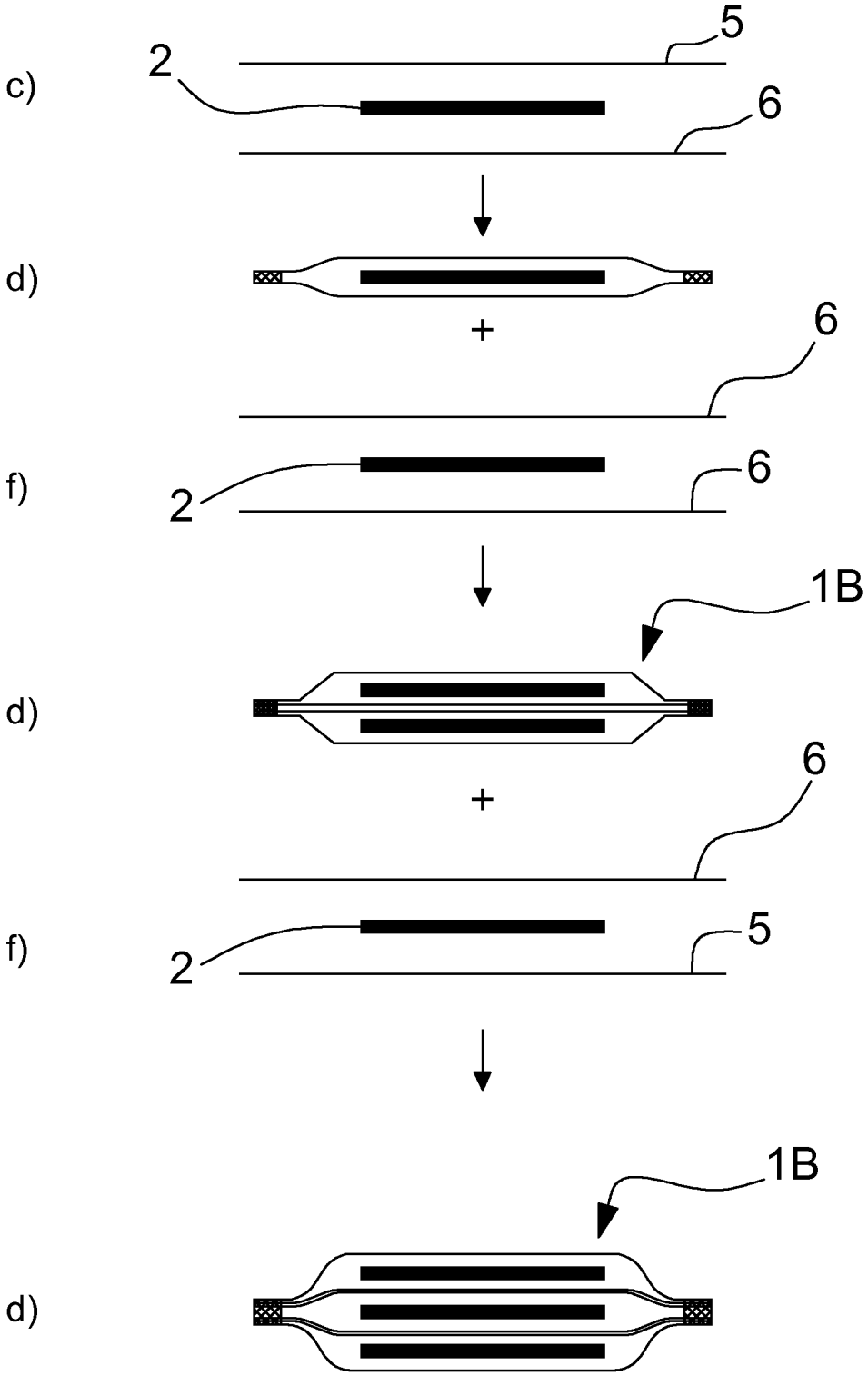


Figure 9A

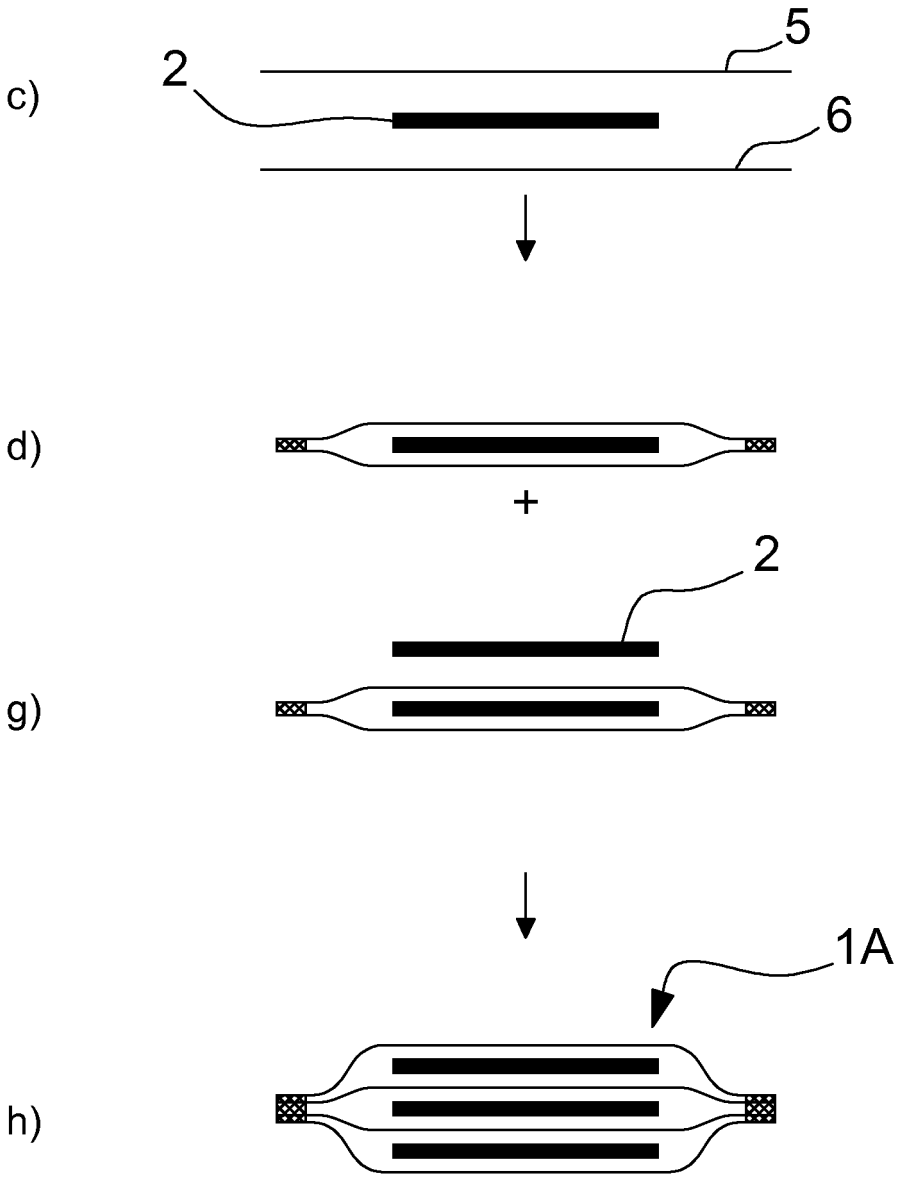
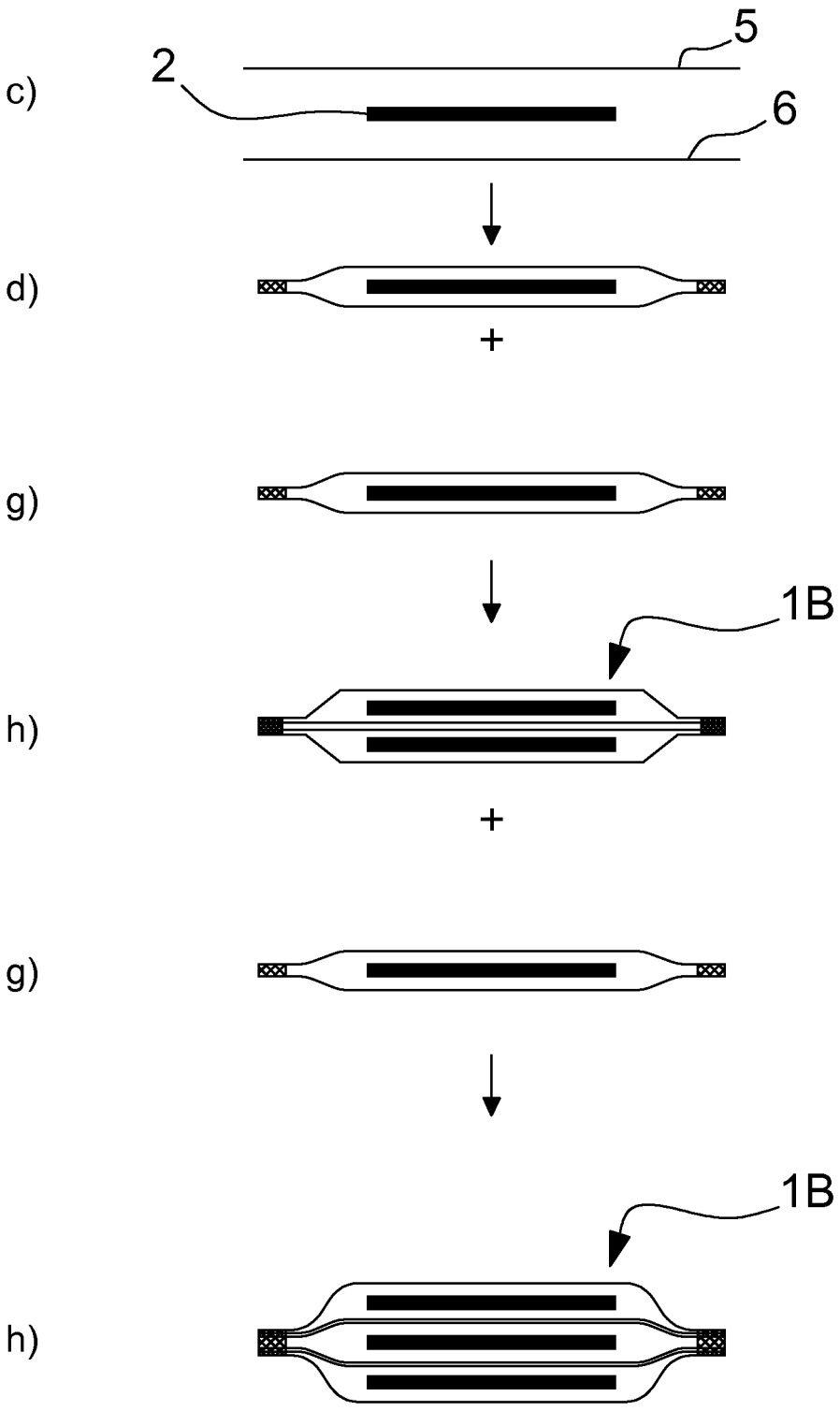


Figure 9B



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Application Number
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