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(71) Applicant (for all designated States except US): E.I. DUPONT DE NEMOURS AND COMPANY [US/US]; 1007 MARKET STREET, WILMINGTON, Delaware 19898 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): KENDIG, Terrance, D. [US/US]; 1 Revelstone Drive, Newark, Delaware 19711 (US). KANE, James, P., Jr. [US/US]; 1604 Desmond Road, Wilmington, Delaware 19805 (US).

(74) Agent: SHAY, Lucas, K.; E. I. DU PONT DE NEMOURS AND COMPANY, LEGAL PATENT RECORDS CENTER, 4417 Lancaster Pike, Wilmington, Delaware 19805 (US).

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(54) Title: MULTI-COMPARTMENT PACKAGE HAVING TEMPERATURE DEPENDENT FRANGIBLE SEALS

(57) Abstract: Disclosed is a multi-compartment package made from flexible polymeric material heat sealed at the peripheral edges for filling with products that are to be stored separately from each other and then combined after heating. Temperature dependent frangible seals between the sheets of polymeric packaging material form the compartments of the package. Also disclosed are films suitable for use in these packages. Also disclosed are convenience meals comprising these packages.

TITLE

MULTI-COMPARTMENT PACKAGE HAVING  
TEMPERATURE DEPENDENT FRANGIBLE SEALS

Field of the Invention

5 This invention relates to a multi-compartment flexible package, to a film therefor, and to a product such as convenience meal comprising the package.

Background of the Invention

10 It is often desirable to have products packaged together, yet separated, for later mixing. Such packaging is advantageous where the several products have differing physical characteristics or are incompatible during storage and are to be mixed shortly before consumption.

15 An example is a package or pouch to contain multiple foodstuffs separated by one or more seals. The foodstuffs require mixing or combining either sometime during or at the end of the cooking cycle. Various ingredients cannot be mixed together prior to cooking generally because they are incompatible in storage, or because qualities (e.g. flavor and texture) desired in the final cooked product cannot be achieved if the two or more ingredients are combined during preparation, or while in storage, or prior to cooking. Accordingly, the two or more ingredients should only be combined during cooking (for example, in an oven) or after they have been cooked. Also, it is typically inconvenient or impractical to require the user to provide the second or other ingredient independently after or during the cooking of the first ingredient, or the product itself, since 20 the ingredients may not be readily available to the user, or it may not be practical or safe to interrupt the cooking cycle to add such additional ingredients. Examples of such packages are disclosed in US 4,596,713 and US 4,806,371.

30 Packages with separated compartments relying on significant pressure increases or expansion of the foodstuff (e.g. popcorn) to rupture the compartments thereby releasing the contents are known. It is desirable to develop packages that do not rely on expansion of vapors or

foodstuffs to break the film. The invention is directed to packages made of polymeric films comprising specific sealants, which soften and rupture under increased internal temperature and allow the contents of the compartments to release and combine. Increases in internal pressure 5 have only a secondary effect on seal rupture.

Therefore, a multiple compartment package needs to be constructed so that it contains and preserves the foodstuffs during distribution and storage until it is ready for use, yet allows for mixing of the foodstuffs after processing, such as by heating.

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### Summary of the Invention

The invention comprises a multilayer film that can be used for packaging and can comprise or be produced from at least one polymer layer and at least one sealant layer.

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The invention also comprises multi-compartment package comprising first sheet of polymer film, second sheet of polymer film and at least one temperature-dependent frangible seal.

The invention also comprises a multi-compartment package comprising first sheet of polymer film, second sheet of polymer film and at least one temperature-dependent frangible seal.

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### Detailed Description of the Invention

In an embodiment, package can comprise or produced from a polymeric film comprising or produced from at least one polymer layer and a sealant layer comprising a polymeric material. The polymer layer can comprise or be produced from at least one polymeric material selected 25 from the group consisting of polyethylene, polypropylene, polyamide, polyester, polyvinylidene chloride and ethylene/vinyl alcohol copolymer. The sealant layer can comprise or be produced from amorphous polyethylene terephthalate or ethylene/vinyl acetate copolymer. The sealant layer is capable of forming a seal with strength greater than 1,500 30 g/inch (590 g/cm) and a temperature dependent frangible seal.

The polymer layer that can be used to produce the packages can be in flexible sheet or film form. The multilayer polymer film or sheet can

involve at least three layers, including but not limited to, an outermost structural or abuse layer, an inner or outer barrier layer, and an innermost layer and optionally one or more adhesive or tie layers therebetween. Also, the innermost layer making contact with and compatible with the

5 intended contents of the package (it is also referred to a pouch in this application) is capable of forming both the lock up perimeter seals (i.e., seal strengths typically greater than 1,500 g/inch or 590 g/cm) and internal frangible seal(s). Internal frangible seals have a peel strength ranging from about 400 to about 2500 g/inch (157-984 g/cm) of width and

10 perimeter seals have a peel strength ranging from about 1500 to about 3500 g/inch (590-1378 g/cm) of width. Preferably, the difference in strength between an exterior seal and an internal frangible seal is at least 800 g/inch (315 g/cm). Most preferably the innermost layer is also heat-sealable.

15 The outermost or structural or abuse layer can comprise or made from oriented polyester (a preferred polyester is oriented polyethylene terephthalate PET) or oriented polypropylene or oriented polyamide (nylon) or both. This layer preferably is reverse-printable and unaffected by the sealing temperatures used to make the package and

20 compartments. The package can be sealed through the entire thickness of the multilayer structure. The thickness of this layer can be selected to control the stiffness of the pouch, and may range from about 10 to about 60  $\mu\text{m}$ , or about 10 to about 60  $\mu\text{m}$ , or about 50  $\mu\text{m}$ . The structure layers may be provided with graphic elements such as printing and embossing to

25 provide information for the consumer and/or a pleasing appearance to the package. The particular multi-layered film used may depend upon the end use of the package. A preferred material for the strength layers is a polyamide such as biaxially oriented nylon from about 0.5 mil (12.7  $\mu\text{m}$ ) to about 3 mils (76.2  $\mu\text{m}$ ) in thickness. For example, nylon used as an outer

30 layer is preferably from about 1 (25.4  $\mu\text{m}$ ) to 3 mils (76.2  $\mu\text{m}$ ) thick. Nylon used as an inner layer in combination with another layer is preferably from about 0.5 to 1.5 mils (12.7 to 38.1  $\mu\text{m}$ ) thick.

The structural layer can also include one or more barrier layers, depending on which atmospheric conditions (oxygen, humidity, light, and the like) that potentially can affect the product inside the pouch. Barrier layers can be for example, oriented PET, polyvinylidene chloride (PVDC), 5 ethylene vinyl alcohol (EVOH), nylon or biaxially oriented nylon, blends or composites of the same as well as related copolymers thereof. When the package is not intended for microwave heating, other barrier layers can also include metallized or silicon oxide-coated polymers. Barrier layer thickness may depend on the sensitivity of the product and the desired 10 shelf life. In some applications, the functions of structure and barrier layers may be combined in a single layer of a suitable resin. For example, nylon or PET are suitable for both structure and barrier functions.

The innermost layer of the package is the sealant. The sealant is selected to have minimum effect on taste or color of the contents, to be 15 unaffected by the product, and to withstand sealing conditions (such as liquid droplets, grease, dust, or the like). The sealant can be a resin that can be bonded to itself (sealed) at temperatures substantially below the melting temperature of the outermost layer so that the outermost layer's appearance is not affected by the sealing process and does not stick to 20 the jaws of the sealing bar. Sealant layers are typically from about 6 to about 100  $\mu\text{m}$  thick, preferably from about 6 to about 25  $\mu\text{m}$ . The sealant can form a compartment that ruptures once a particular temperature is reached, i.e. a temperature dependent frangible seal. To ensure 25 performance of the frangible seals, the characteristics of the sealant remains constant and does not undergo changes in properties from the time the package is formed, filled and optionally chilled (i.e. frozen or refrigerated) until it is reheated. Other sealants known to those of skill in the art could also be used.

Sealant can be applied across the entire web, preferably in the form 30 of a copolyester or an ethylene vinyl acetate (EVA) copolymer, preferably an amorphous copolyester such as amorphous PET.

An amorphous PET copolyester heat-sealant can be derived from at least the following components: from about 10 to about 60 mole%

terephthalic acid ("Monomer A"); from about 10 to about 60 mole % ethylene glycol ("Monomer B"); and from about 5 to about 60 mole % of a third monomer being a secondary di-acid ("Monomer C") and/or a secondary diol ("Monomer D"). Examples of Monomer C can include one or more succinic acid, adipic acid, azelaic acid, sebacic acid, 1,10-decanedicarboxylic acid, phthalic acid, isophthalic acid, dodecanedioic acid, and the like; preferred are such as azelaic, sebacic, and/or isophthalic acid. Examples of Monomer D can include one or more propylene glycol, methoxypolyalkylene glycol, neopentyl glycol, trimethylene glycol, tetramethylene glycol, hexamethylene glycol, diethylene glycol, and the like.

10 The strength of the seal can be manipulated by the temperature, dwell time and pressure of the heat seal bar, depending on the type and thickness of the sealant being applied. The width of the seal can be from about 0.1 (2.54 mm) to about 0.4 inches (1.02 mm) wide and external perimeter seals are preferably from about 0.5 (12.7 mm) to about 1 inch (25.4 mm), or greater, wide.

15 Choice of sealant and coating weight can affect the amount of product packaged, cooking time required and combinations of products in the package that are to be combined into a meal. For example, foodstuffs or sauces containing sugars typically heat at a faster rate than other foodstuffs. When these sugar-containing foodstuffs are combined with products that have a longer heating requirement, the correct sealant combination that can withstand the heating cycle and rupture at the correct 20 time is accordingly made. A thicker layer of sealant may have the same softening point as a thinner layer, but increase time to rupture depending on the contents. Variations in seal width can also be used to effect seal 25 rupture at desired times. At time of cooking, a thicker seal will soften and open at approximately the same temperature but with a longer time to 30 rupture than a lighter seal layer of the same type.

The polymer layer preferably comprises a layer of polyamide, a layer of amorphous PET copolymer, or both. The sealant layer preferably comprises a layer of amorphous PET copolymer.

The invention also includes a multi-compartment package, which can be suitable for filling with materials which are to be stored in isolation from each other, comprising or produced from two sheets of polymer film material positioned in overlying relationship and permanently heat-sealed

5 on the peripheral edges to form a package; and at least one temperature dependent frangible seal positioned at a predetermined location within the package to form separated compartments (of appropriate size depending upon the materials to be packaged) between the sheets of polymeric film.

10 The polymer film can be the same as disclosed above. The temperature-dependent frangible seal can be the same as the sealant or sealant layer disclosed above.

The invention also includes a multiple-compartment package, which can be suitable for filling with materials which are to be stored in isolation from each other, comprising or produced from (a) a first sheet of polymeric

15 film; (b) a second sheet of polymeric film superimposed on the first sheet of polymeric film wherein the first and second sheets of polymeric film are sealed to each other directly or indirectly through a third intervening polymeric film thus defining a sealed perimeter forming a pouch; wherein said pouch comprises at least one gusset; and (c) at least one

20 temperature dependent frangible seal internal to the perimeter of the pouch wherein the frangible seal divides the pouch into separated compartments. The polymer film and the temperature-dependent frangible seal can also be the same as those disclosed above.

The invention also provides the aforesaid packages further

25 comprising a foodstuff confined to one of said separated compartments and at least one other foodstuff confined to at least one other separated compartment.

The invention also includes a multiple-compartment package, which can be suitable for use in such packages comprising or produced from (a)

30 at least one layer comprising at least one polymeric material comprising or selected from the group consisting of polyethylene, polypropylene, polyamide, polyester, polyvinylidene chloride and ethylene/vinyl alcohol copolymer; (b) a sealant layer comprising a polymeric material selected

from the group consisting of amorphous polyethylene terephthalate or ethylene/vinyl acetate copolymer; wherein said sealant layer is capable of forming a seal with strength greater than 1,500 gram/inch and also capable of forming a temperature dependent frangible seal; and optionally

5 (c) at least one insulating layer.

The invention further includes a product such as a convenience meal comprising or produced from

(a) a multi-compartment package, comprising (1) two sheets of polymeric film material positioned in overlying relationship and

10 permanently heat sealed on the peripheral edges to form a package; and (2) at least one temperature dependent frangible seal positioned at a predetermined location within the package to form separated compartments between said sheets of polymeric film;

(b) a foodstuff contained in one of said compartments; and

15 (c) at least one other foodstuff or ingredient contained in at least one other of said compartments; wherein said temperature frangible seals are capable of releasing on heating thereby combining (b) and (c).

The multi-compartment package disclosed can include or be a pouch. The pouch can be constructed with permanent perimeter seals that contain foodstuffs and temperature-dependent frangible interior seals that provide for initial separation of the contents yet can be easily ruptured when desired. When exposed to heat in, for example, microwave oven, conventional oven, convection oven or boiling water, the frangible seals can rupture, allowing the contents to mix together while the perimeter seals remain intact. The package can then be opened and the foodstuffs can be consumed.

The interior frangible seal is designed to rupture when the product is heated to the softening point of the sealant (after the adjacent product reaches about 60 to about 100°C such as about 75-80°C), which causes

30 the seal to fail. The result is the combination of the previously separated products in the package.

A package or pouch can be fabricated from a single film structure. The package configuration can be with or without gussets. The package

can be made to stand up or lie flat during the cooking cycle. The packages of this invention can be made by, for example, forming a tube that can then be formed into a bag by heat-sealing across the bottom or folding a single sheet of polymeric material on itself and heat-sealing two 5 of the sides to form open-ended packages. Forming and heat-sealing the separate compartments of the pouch, filling the compartments and closing the compartments (by, for example, heat sealing) can be done in a single processing line if desired. Alternatively, the open-ended multi-compartment package itself can be made in one operation and fed from a 10 magazine for filling and closing the separate compartments in subsequent operations.

Another film for packages of this invention comprises a combination of polyamide and oriented PET as structural layers and amorphous PET copolymer as the sealant layer. Such combinations can be used in 15 microwave or conventional ovens. In some instances, it is convenient to heat-seal coat oriented PET with amorphous PET to provide a two-layer web for lamination to additional layers of polymeric material.

Polyamide and PET (heat sealable) combinations can provide 20 directional tear properties in that a pre-notched package can be torn open in a straight line in either the machine direction or transverse directions. These tear properties allow for great flexibility in package configuration and design. Thus, the opening area to access the foodstuff after heating is not limited to a particular part (e.g. the top) of the pouch thereby allowing for locating a notch at the side of the desired area for opening. 25 For example, one could place the notch slightly above the "bottom" compartment of a pouch. After the frangible seal(s) rupture and all the previously separated products are combined into the single compartment remaining, the notch is used to propagate the directional tearing feature across the package side seals to open the pouch. This provides for 30 shortening of the pouch and the meal can be consumed directly from the bottom portion with the top being discarded; or the meal can be placed on a secondary dish if so desired.

Another embodiment of the invention employs forming a web of the packaging film with gussets to fabricate a stand-up pouch (SUP) by heat-sealing the built-in sealant. SUP pouches may be fabricated from two or three webs of film depending on design. Accordingly, a multiple-compartment package can comprise a first sheet of polymeric film; a second sheet of polymeric film superimposed on the first sheet of polymeric film wherein the first and second sheets of polymeric film are sealed to each other directly or indirectly through a third intervening polymeric film thus defining a sealed perimeter forming a pouch; wherein said pouch comprises at least one gusset; and at least one temperature dependent frangible seal internal to the perimeter of the pouch wherein the frangible seal divides the pouch into separated compartments.

Package structure combinations can be used in any format, including preformed pouches, such as stand-up pouches as described; formed in line just before filling by horizontal/ form/fill/seal (HFFS) processes or formed in line just before filling by vertical/ form/fill/seal (VFFS) processes. Filling and seal bar combinations must be configured to the pouch type required, including factors such as desired package size, configuration and contents.

Correct material combination can give puncture resistance and/or barrier properties as needed to protect the packaged products. For example, frozen vegetables or pasta become very sharp and hard and can easily puncture polyethylene terephthalate (PET) or paper when not combined with suitable puncture-resistant layers. This problem can become apparent during the handling and distribution cycle. These packages can also be made with barrier properties for modified atmosphere packaging (MAP) applications with extended shelf life in ambient temperatures, refrigerated temperatures or frozen, then refrigerated temperatures where required. Proper selection of the structure and/or barrier layers is especially important for protection and performance of the package when the consumer is ready to use it.

Vent areas can be made anywhere on the package simply by providing a slit in the package face in the area of the desired compartment

at the time of heating. Alternatively, a combination of materials including a non-venting sealant in combination with temperature dependent sealant materials (self-venting) in a three-layer laminate structure may provide the desired venting effect. Self-venting is a desirable safety feature to

5 minimize the occurrence of steam blast on opening the package. For example, sealant thickness and seal temperature can be designed to provide a vent (via rupture) once the foodstuff reaches 170 °F. Thus, the self-venting feature also serves as a temperature indicator to show that the food is heated to the proper temperature and is ready for consumption.

10 An example of a package disclosed, which uses heat to rupture the internal frangible seal and at the same time takes the food to the correct temperature where it can be safely consumed, is a package with pasta in one compartment and sauce in the other. The mass of the foodstuff packaged therein determine the length of time it takes to heat the foodstuff to the temperature required to soften and rupture the frangible seal while leaving the perimeter seal intact. This can be done in any pouch configuration. A one-web structure can be produced with a multitude of built-in functionality designed for any given application requiring mixing at elevated temperatures. The one-web structure provides the flexibility to

15 tailor to the need by incorporation of a variety of sealant materials, seal configurations and seal strengths.

20

Other materials combined with a heat-seal coated PET can be made for either use. Packages can be fabricated to cook raw or semi-cooked foodstuffs or to reheat previously cooked products.

25 Multilayer structures combining nylon and PET copolymers can be adhered using an adhesive such as a polyester urethane. The adhesive is applied as a solution. Applying a solvent-based adhesive to the base films can depend on the proper choice of solvent(s) (e.g., preferably tetrahydrofuran) for the adhesive so that drying can be achieved at about

30 76.7°C, reducing residual solvent levels. The solvent-based adhesive can be applied to one side (or two sides) of the base sheet by means of any of the many coating techniques known to those of skill in the art. For example, the film may be coated by roller (e.g. doctor roll) coating, spray

coating, gravure coating, or slot coating, preferably roller or gravure coating using a solution coating process.

In another embodiment, a film and packages prepared therefrom comprise at least one thermal insulating layer. This thermal insulating 5 layer may have a thermal resistance, as measured in units of insulation, or CLO, of 0.05 to 0.5. The CLO unit is defined as a unit of thermal resistance of a garment. The SI unit of thermal resistance is the square-meter kelvin per watt ( $m^2K/W$ ) (See "Textile Terms and Definitions", Tenth Edition, The Textile Institute, (1995), pp. 66, 350). Thus, the range of 10 thermal resistance in SI units of the thermal insulating layer of the present invention is 0.0077 to 0.077  $m^2K/W$ . Although CLO is defined in terms of a garment, this measurement can be used to describe the thermal resistance of any textile system, and is used herein to describe the thermal resistance of the thermal insulating layer of the present invention. CLO 15 values depend on the material used for the insulating layer and its thickness. CLO values of packaging films made without the thermal insulating layer are below the lower end of the range (0.05 CLO, or 0.0077  $m^2K/W$ ).

The insulated packaging material has enough loft, i.e., is thick 20 enough (greater than 0.0075 inch (0.0190 cm)) to provide adequate insulation when used, for example, as an insulated pouch, but is thin enough to be flexible. The insulated packaging material of the present invention is printable, thereby enhancing its use as a packaging material.

The insulated packaging material of the present invention can 25 comprise a thermal insulating layer having a thermal resistance disclosed above and laminated to a face material, wherein the insulated packaging material has a thickness in the range of 0.0075 inch (0.0190 cm) and 0.07 inch (0.1778 cm). In an embodiment, the insulating packaging material or film comprises a thermal insulating layer, such as a fiberfill batt, having a 30 thermal insulating value in the range of 0.05 to 0.5 CLO that has been laminated to at least one, more preferably two, face materials that serve as structure and/or abuse layers. The insulating packaging film has a thickness of at least 0.0075 inch (0.0190 cm).

The thermal insulating layer comprises an organic thermoplastic fiber based material comprising polyester, polyethylene or polypropylene. In a preferred embodiment, the thermal insulating layer is a fiberfill batt that can comprise or be produced from polyester. A fiberfill batt sold as

5 THERMOLITE® Active Original by E. I. du Pont de Nemours and Company (DuPont), Wilmington, Delaware can be used. The fiberfill batt used can have an areal weight in the range of 10 gm/m<sup>2</sup> to 200 gm/m<sup>2</sup>, and a bulk density of less than 0.3 gm/cm<sup>3</sup>. Alternatively, the thermal insulating layer may comprise melt blown fibers, such as melt blown polyolefins, sold as

10 THINSULATE®, by 3M.

Many other variations of insulating material for the thermal insulating layer can be used with the present invention. For instance, the thermal insulating layer may comprise a foam. The foam may be polyurethane or polypropylene, or any other foam composition as known in the art. The thermal insulating layer may be alternatively made of an inorganic thermoplastic fiber based material comprising glass wool, borosilicate glass or rockwool.

Alternatively, the thermal insulating layer may comprise a knit fabric, made, for example from a tetrachannel or scalloped oval fiber, sold 20 under the trademark COOLMAX® by DuPont. The thermal insulating layer may also be a woven or fleece material. The insulating layer could also comprise some sort of nonwoven textile, such as felt, or a highloft nonwoven or needled nonwoven fabric.

A preferred film comprising at least one insulating layer comprises 25 at least one layer of polyester (e.g. oriented PET) as a structural layer and a layer of amorphous polyethylene terephthalate copolymer as the sealant.

During the manufacture of the polymeric film or sheet to be used in making the package, co-extrudable adhesives are optionally used between functional layers to adhere the layers to each other and to provide 30 structural integrity. The films may be coextruded or laminated and may be adhered together with a coextruded tie layer such as ethylene/vinyl acetate copolymer, an ionomer, anhydride-grafted ethylene/vinyl acetate copolymer, low density polyethylene or linear low density polyethylene.

Alternatively, lamination of the functional layers may be accomplished by incorporating between the layers an adhesive designed to withstand elevated temperatures. A typical film-to-film bond from lamination is made by adhering the films together with a thin layer of polyurethane coating on 5 an adhesive laminator. Extrusion lamination or extrusion coating with an adhesive coextrusion tie layer resin at the bond interface can also accomplish this lamination. The multi-layered films are typically from 0.75 mils to 5.0 mils thick, preferably about 1.5 to about 3.0 mils thick.

Also, to provide additional thickness (if desired by the consumer for 10 a particular application), bulk layers of polyolefin or chopped remnants of the multilayer film trimmed during pouch fabrication can be incorporated within the multilayer structure. It is contemplated that the sheet of polymeric film (i.e., the so-called "web stock") may be produced using any combinations of the processes generally known in the art, such as 15 monolayer or multilayer casting, blowing film, extrusion lamination, and adhesive lamination and combinations thereof. Processing aids as generally known in the art, including by way of example but not limited thereto; slip agents (such as amide waxes), antiblocking agents (such as silica), and antioxidants (such as hindered phenols), may be incorporated 20 in the web stock to facilitate either manufacture of the film or pouch formation. Pouches can be formed from web stock by either cutting and heat sealing separate pieces of web stock or by a combination of folding and heat sealing with cutting. As described herein, pouches are formed from two film sheets. The two film sheets may be two individual sheets of 25 film. A single web of film may be folded onto itself to provide two overlying sheets, or a tube of film may be formed such that two overlying portions of the tube provide the equivalent of two sheets of film. The heat sealed perimeter of the pouch according to the instant invention can be achieved by superimposing the first and second sheets of polymeric film and then 30 heat sealing each directly to the other or heat sealing them indirectly through the use of an intervening third polymeric film, again as generally known and practiced in the art. The frangible seals can be installed either during or after pouch formation. Pouch making equipment such as that

made by Totani Corporation, Kyoto, Japan or Klockner Barlett Co., Gordonsville, VA can be used.

An example multi-compartment package in the form of a generally flat rectangular pouch-like shape is formed of two juxtaposed sheets of thin, flexible, impervious polymeric material as described above. Particular embodiments of the present invention include those wherein the multi-compartment package has two or three compartments. A pouch can be formed by heat-sealing the peripheral edges of the juxtaposed polymer sheets, leaving openings for subsequent filling. A plurality of frangible seals formed between film layers by heat-sealing the layers together in predetermined locations within the pouch divides the pouch into separate compartments. The frangible seal(s) may be placed at any suitable location within the pouch and their positions will depend on such factors as the relative amounts of materials to be packaged and/or the mode of forming and filling the package. The compartments may be filled with foodstuffs and/or other ingredients through the above-mentioned openings in the perimeter seal. After filling each compartment, the openings of the package are heat sealed to permanently enclose each compartment and store the products separately from each other. Alternatively, the foodstuffs may be placed on a bottom sheet in locations suitable to be separated by internal seals and a second top sheet placed over the foodstuffs such that the perimeters of the top and bottom sheets are juxtaposed. The perimeter seal is formed by heat sealing at an appropriate temperature, pressure and time duration to form a lock-down seal. The internal frangible seals are formed by heat sealing at an appropriate temperature, pressure and time duration to separate the foodstuffs.

Functional structures can be produced in extrusion laminated or coextruded structures. Blown film versions are also possible depending on the demand and functionality required by the application.

A convenience meal is a foodstuff wherein at least some of the means for preparing and consuming (i.e. eating) the foodstuff are supplied with the foodstuff (for example, the consumer does not need to supply serving dishes and/or utensils in order to consume the meal).

Examples of convenience meals comprise combinations such as pasta and sauce, macaroni and cheese, meat and vegetables and the like, packaged to allow for easy preparation and consumption. Also an example of such a convenience meal is a combination of sauce, rice, 5 chicken and vegetables in a three-compartment pouch. Additional examples of convenience meals include packages wherein a foodstuff is packaged together with another ingredient (e.g. a dry or dehydrated foodstuff is packaged together with a liquid such that the dry foodstuff and liquid are combined upon heating). A further example of such a 10 convenience meal is a two-compartment package of dry oatmeal and water.

The following Examples are to be construed as illustrative, and not limiting the scope, of the invention.

#### Examples

##### 15 Example 1

This example illustrates an adhesive lamination of nylon and polyester incorporating a polyester urethane adhesive designed to withstand elevated temperatures. The nylon outer layer provides toughness for puncture resistance and heat resistance to the film and also 20 serves as an oxygen barrier and a possible print carrier. The amorphous polyester seal layer provides a temperature resistant perimeter seal, designed not to rupture by making a wider one-inch heat seal at a higher temperature. The same seal layer provides for frangible seals designed to rupture between compartments. In microwave applications the amorphous 25 polyester sealant is efficient for an internal frangible seal if heat-sealed at a lower temperature using a 0.25" seal bar.

#### Structural Components

Outer Structure Layer: nylon 6; 2 mil (50.8 µm) thickness available under the tradename Dartek® B601 from DuPont of Canada/Liqui-Box.

30 Lamination Adhesive: solvent-based polyester urethane adhesive available under the tradename Adcote 503A/Catalyst F from the Morton division of Rohm and Haas.

Seal Layer: biaxially oriented polyester (OPET) coated with an amorphous PET copolymer (APET) heat seal layer; 0.5 mil (12.7  $\mu$ m) available under the tradename Mylar<sup>®</sup> OL13 from DuPont Teijin Films.

The structural components were combined as described below to 5 prepare a multilayer film consisting of these layers (from outermost to innermost): nylon/adhesive/OPET/APET.

All surfaces in contact with the adhesive were corona treated to 48 dynes prior to lamination. Adhesive was first applied by rotogravure process to the nylon structure layer and dried at 170 °F (76.7°C). The 10 polyester heat seal layer was brought into the lamination as the secondary web. Both the nylon structure web and the secondary polyester web were 24 inches (61 cm) wide and were laminated using a 23.5-inch (60 cm) back up roll for adhesive lay down optimization. The non-sealable side of the polyester was laminated to the structure layer using a hot nip process 15 at a dynamic temperature of 170°F (76.7°C), leaving the heat-sealable APET surface exposed to air upon unwinding. The heat seal layer was kept away from the hot nip. The amorphous coated side of the polyester provided the high temperature seal where required for the perimeter seal and the frangible seal. The laminated nylon/polyester film then became 20 the primary web for finishing the laminate into rollstock for fabrication into package stock.

Similar laminated film structures were prepared using 1.25 mil (31.8  $\mu$ m)-thick nylon 6 film using similar procedures. The thickness of individual layers and the overall thickness of the laminate will be dictated 25 by the material combinations and requirements for a specific package construction.

#### Example 2

A three-compartment pouch was formed using the film of Example 1. Two portions of film stock were overlaid so that the respective heat seal 30 layers (APET) of the film stock were facing and in contact. The overall dimensions of the pouch were 10.5 inches x 14 inches (26.7 cm x 35.7 cm). Internal frangible seals divided the pouch into three compartments: two compartments each about 4 inches x about 6 inches and a third

compartment about 6 inches x about 8 inches (15.2 cm x 20.3 cm). The frangible seals were made using a Vertrod Impulse heat sealer to provide 0.125-inch (0.32 cm) seal width at 200°F (93.3°C) with one-second dwell and no pressure control. One small compartment was filled with 75 g of sauce, the second small compartment was filled with 185 g of white rice and the larger compartment was filled with 114 g of sliced chicken and 185 g of mixed vegetables. Perimeter seals were made using a Sentinel heat sealer to provide one-inch seal width at 350°F (176.7°C) with 1.5-second dwell and 30 psi pressure. A notch was made in the perimeter seal adjacent to the rice compartment, approximately one inch from the frangible seal dividing the rice and chicken/vegetable compartments. This notch provided a guide for directional tear for opening the package after heating.

The filled and sealed pouch was then frozen.

15 Example 3

This example illustrates heating packages of Example 2 such that the temperature dependent frangible seals release, allowing the previously separated contents to be mixed. Samples of the package of Example 2 were individually laid flat on the rotating carousel of a standard household microwave oven and heated at full power (800 watts) to reheat the foodstuffs therein.

Test 1: The frozen package was not vented. After 4 minutes and 43 seconds of heating, the frangible seals were ruptured. The seals forming sauce compartment broke first, since the sugars in the sauce provide for faster heating relative to the rice and chicken. After 7 minutes and 20 seconds, a portion of the perimeter seal ruptured, providing a vent for steam release. This venting also serves as a temperature gauge, providing an indicator for when the package contents reach at least 170°F (76.7°C).

30 The pouch was turned to an upright orientation, allowing the sauce and rice components to drop onto the chicken and vegetables. The pouch was opened by peeling horizontally across the notch for a straight and uniform directional tear. The temperature of the food was 175°F (79.4°C).

Test 2: The frozen package was vented prior to heating by cutting a small slit in the upper face of the package. After 5 minutes of heating, the frangible seals were ruptured. The sequence of seal rupture was the same as described in Test 1. After 7 minutes of heating, the pouch was 5 opened as described in Test 1. The temperature of the food was 175°F (79.4°C).

#### Example 4

This example illustrates a multilayer adhesive lamination incorporating an insulating layer. The insulating layer allowed the package 10 to be used as a serving container following heating by retaining heat in the interior of the package while remaining relatively cool to the touch.

#### Structural Components

Outer Structure Layer: 50 gauge biaxially OPET coated with an ethylene vinyl acetate (EVA) copolymer heat seal layer; 0.5 mil (12.7µm); 15 available under the tradename Mylar® RL33 from DuPont Teijin Films.

Insulating Layer: A fiberfill batt of the type sold by DuPont under the trademark THERMOLITE® Active Original was used as the thermal insulating layer. The fiberfill batt had an areal weight of 100 g/m<sup>2</sup> at a specified thickness of 0.25 inch (0.63 cm), or a bulk density of 0.013 20 g/cm<sup>3</sup>. This batt was reduced in thickness, via needling and calendering, to about 0.030 inch (.0012 cm).

Inner Structure Layer: 50 gauge biaxially oriented OPET coated with an EVA copolymer heat seal layer; 0.5 mil (12.7 µm).

Lamination Adhesive: polyester urethane available under the 25 tradename Adcote 503A/Catalyst F from the Morton division of Rohm and Haas, Philadelphia, Pennsylvania.

Seal Layer: biaxially OPET coated with an amorphous APET heat seal layer; 0.5 mil (12.7 µm) available under the tradename Mylar® OL13.

The structural components are combined as described below to 30 prepare a multilayer film consisting of the following layers (from outermost to innermost): OPET/EVA/insulated layer/EVA/OPET/adhesive/OPET/APET.

Using a laminating machine, the inner and outer structure layers were placed on opposite faces of the insulating batt such that the EVA heat seal layers were in contact with the batt and pressed together by heated nip rolls.

5 All surfaces to be in contact with the solvent-based adhesive were corona treated to 48 dynes prior to lamination. Adhesive was first applied by rotogravure process to the structural laminate and dried at 170°F (76.7°C). The polyester heat seal layer was brought into the lamination as the secondary web. Both the structural web and the secondary polyester  
10 web were 24 inches (61 cm) wide and were laminated using a 23.5-inch (60cm) back up roll for adhesive lay down optimization. The non-sealable side of the polyester was laminated to the structural laminate using a hot nip process at a dynamic temperature of 170°F (76.7°C), leaving the heat-sealable APET surface exposed to air upon unwinding.

15 Example 5

A package of this invention was prepared from the film of Example 4 by overlaying two portions of the film so that their respective seal layers were facing and in contact and forming a flat pouch 7.0 inches (17.8 cm) in length and 5.5 inches (14 cm) in width. Perimeter seals were formed by  
20 applying 0.5 inch (1.27 cm)-wide metal heat seal bars to both faces of the package at 350°F (176.7°C) at 40 psi for four seconds. An internal frangible seal that divided the package into two compartments was formed by applying 0.125 inch (0.32 cm)-wide metal heat seal bars to both faces of the package at 200°F (93.3°C) at 40 psi for 1.25 seconds. One  
25 compartment, 4.25 inches x 3.0 inches (10.9 cm x 7.62 cm), was filled with 1.5 ounces dry oatmeal and the other compartment, 5.25 inches x 2.75 inches (13.3 cm x 7 cm), was filled with 70 ml of water. The openings of the compartments were sealed in a perimeter seal as described above to provide a self-contained convenience meal comprising oatmeal and water  
30 in a package suitable for heating in a microwave oven for consumption.

Example 6

This example illustrates heating the package of Example 5 to rupture the temperature-dependent frangible seals, allowing the previously separated contents to be mixed.

5 The package was placed on the rotating carousel of a standard household microwave oven and heated at full power (800 watts) for 40 to 50 seconds. The internal frangible seal released, allowing the dry oatmeal and heated water to combine. Kneading the package for about twenty seconds provided complete mixing of the oatmeal and water.

CLAIMS

1. A multilayer film comprising or produced from at least one polymer layer, at least one sealant layer, and optionally at least one insulating layer; wherein the polymer layer comprises or is produced from  
5 polyethylene, polypropylene, polyamide, polyester, polyvinylidene chloride, ethylene/vinyl alcohol copolymer, or combinations of two or more thereof, preferably from polyamide; the sealant layer comprises or is produced from amorphous polyethylene terephthalate copolymer, ethylene/vinyl acetate copolymer, or combination thereof, preferably from amorphous  
10 polyethylene terephthalate copolymer; and the sealant layer is a temperature-dependent frangible seal capable of forming a seal with strength greater than 1,500 g/inch.
2. The film of claim 1 wherein the polymer layer further comprises a layer comprising or produced from oriented polyethylene terephthalate.
- 15 3. The film of claim 1 or 2 wherein the film comprises the insulating layer which has a thermal resistant value of least 0.05 CLO (or 0.0077 m<sup>2</sup>K/W) and at least 0.0075 inch (0.0190 cm) thick.
4. A multi-compartment package comprising first sheet of polymer film, second sheet of polymer film and at least one temperature-dependent  
20 frangible seal wherein the film is as recited in claim 1, 2, or 3 and the seal is the sealant layer recited in claim 1, 2, or 3.
5. The package of claim 4 wherein the first sheet and second sheet are positioned in overlying relationship and permanently heat-sealed on the peripheral edges of the sheets to form a package; and the seal is  
25 positioned at a predetermined location within the package to form separated compartments between the first sheet and second sheet.
6. The package of claim 4 wherein the second sheet is superimposed on the first sheet; the first sheet and the second sheet are sealed to each other directly or indirectly through a third intervening polymer film thereby  
30 defining a sealed perimeter forming a pouch; the pouch comprises at least one gusset; and the seal divides the pouch into separated compartments.

7. The package of claim 4, 5, or 6 further comprising a foodstuff confined to one of the compartments and at least one other foodstuff confined to at least one other compartment.
8. A convenience meal comprising a package as recited in claim 4, 5, 5 6, or 7; a foodstuff or ingredient contained in one of the compartments; and at least one other foodstuff or ingredient contained in at least one other of the compartments; wherein the at least one temperature frangible seals are rupture on heating.
9. The convenience meal of claim 25 comprising dry oatmeal and 10 water.

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US2004/034445

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B65D81/32 B32B27/36

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B65D B32B A61J B61D

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/124258 A1 (BENIM THOMAS E ET AL) 3 July 2003 (2003-07-03) paragraph '0047! paragraph '0034!; figure 1a paragraph '0035!; figure 1b paragraph '0050!; figure 8 paragraph '0057!; claims 1,4,6,11,13; example 1 -----	1-8
X	GB 1 437 046 A (TOYO BOSEKI KK; TOYOBO CO LTD) 26 May 1976 (1976-05-26) example 1 -----	1,2
A	EP 0 648 601 A (WOLFF WALSRODE AG) 19 April 1995 (1995-04-19) examples 1,2 ----- -/-	1,2

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
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\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl  
Fax: (+31-70) 340-3016

Authorized officer

Stabel, A

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US2004/034445

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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