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(54) Title: NYLON CONTAINING LID FOR FOOD PACKAGING

(57) Abstract: A food package comprising a sealed package including a container and peelable lid portions which are readily separable from each other. The container is cup shaped and has a top opening and a substantially flat peripheral rim around the opening. The lid comprises a composite film having a shape which conforms to the shape of the opening and is attached to the rim. The film has a nylon containing layer comprising a polyamide or a composite of a first polyamide layer, an ethylene vinyl alcohol layer and a second polyamide layer, and a metal foil layer attached to one side of the nylon containing layer. The resulting lid exhibits good stiffness, tear propagation resistance, puncture resistance and excellent flex crack strength at low temperatures.

# NYLON CONTAINING LID FOR FOOD PACKAGING

## BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention relates to a lidding material for food, non-food and medical packages. More particularly the invention pertains to a lidding material for sealing packages or containers wherein the lidding material has good stiffness, tear propagation resistance, puncture resistance, good flex crack strength at low temperatures and can be easily die cut.

### Description of the Related Art

It is well known in the art to provide plastic containers, for example, tubs, cups, jars and pails (hereinafter termed containers) which are useful for packaging, distributing and serving food, non-food and medical items. Frequently, such containers are provided with a lid material, which seals its opening and yet is easily peeled off for access to the container contents. Many lids are made of multiple layers of different plastics in order to achieve the desired barrier properties. Typically such are made of materials such as aluminum foil or are multi-layered laminates of a first plastic which serves as a water or solvent barrier, and a second plastic which serves as an oxygen or air barrier, or the laminate may be a metallized plastic i.e., metallized polyethylene terephthalate or metallized polypropylene. These barrier layers are usually held together with an adhesive or tie layer which facilitates the formation of the layers into a single sheet from which the lid is made. The

typical moisture or solvent barrier plastic is a type of polyolefin such as polypropylene or polyethylene and the typical oxygen barrier plastic is a polyvinyl alcohol, an ethylene vinyl alcohol copolymer, a polyvinylidene chloride, a nylon, a polyacrylonitrile or a polyester. The tie layer is usually made of the polyolefin onto which are grafted some polar monomers, typically containing an acid or anhydride moiety, like polypropylene with maleic anhydride grafted thereto. The lids are usually made from multilayer sheets which are die cut into a desired shape or heat sealed to a base cup stock then die cut as the final process of the packaging operation.

Processes for producing these laminates are well known. If two thermoplastics are compatible, they can be combined by coextrusion to form a composite structure or laminated by melting the surfaces of the layers in contact with one another and by applying pressure. If the two thermoplastics are not compatible, they can be made into a laminate by placing an adhesive layer between the incompatible layers. The lid should be made of a material, which affords at least the same barrier properties as the container. It has been a problem in the art to provide a bond between the lid and the container which is adequate for moisture and oxygen barrier properties and yet is easily removable by the consumer without tearing. The bond between the lid and the container should preferably afford a strong barrier to oxygen and water, yet should be weak enough to be readily removed when the user seeks access to the contents of the container without tearing the lid. Also, it is desired to have a lidding material that is resistant to puncturing and has good flex crack strength at low refrigeration or freezer temperatures.

One way of solving this problem is to use aluminum lids comprising aluminum foil in conjunction with thermoplastic materials, which are heat-

sealed to the container, and wherein the lid is provided with an easily opened flap. For example, the aluminum lid may be adhesively bonded to the container via a polymer that acts as an adhesive or which facilitates a heat-seal bond to the container. Such a bond must also be easily broken to allow access to the container contents.

Tear propagation of lidding frequently and commonly occurs with aluminum foil, metallized PET and metallized polypropylene. Premature tear propagation is undesirable to consumer use and satisfaction. It can also render the foodstuff unsuitable for consumption if breakage occurs prior to sale or consumer use.

Another important characteristic of laminates suitable for packaging materials is the ability to withstand the combination of heat and flexing to which it is often subjected during packaging processes and subsequent usage. However, many of the known laminates containing oxygen barrier layers are unsuitable for such procedures in which they are subjected to temperatures of from 80°C to approximately 130°C. As a result of their low softening points, known barrier laminates are unable to maintain their structural integrity. Additionally, most plastic film laminates are not structurally stiff enough to be formed into lids by die-cutting and do not lend themselves to current packaging processes. U.S. patents 5,055,355 and 5,547,765 teach laminates of polyamides and ethylene vinyl alcohol copolymers which have excellent oxygen and moisture barrier properties. While these films have properties especially useful in packaging applications for food pouches for subsequent heating or cooking by the consumer, they have not been known heretofore as parts of lidding materials.

It would be desirable to provide a lidding film which is puncture resistant, resists tear propagation, can be easily die cut and has high flex crack strength at low temperatures.

## SUMMARY OF THE INVENTION

The invention provides a peelable lid for a container, which container has a top opening and a substantially flat peripheral rim around the opening, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the nylon containing layer; the nylon containing layer comprising either (i) or (ii):

(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;

(ii) a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

The invention also provides a package comprising a container having a top opening and a substantially flat peripheral rim around the opening, and a peelable lid which conforms to the shape of the opening attached around the rim, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the nylon containing layer; the

nylon containing layer comprising either (i) or (ii):

(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;

(ii) a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

The invention further provides a process of producing a packaged product which comprises:

a) providing a container having enclosed side walls, a floor and an top opening defining a central cavity, which open top has a substantially flat peripheral rim,

b) filling the central cavity with a product; and

c) sealing the open top by attaching a peelable lid around a circumference of the rim, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the nylon containing layer; the nylon containing layer comprising either (i) or (ii):

(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;

(ii) a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a

combination thereof.

It is desirable that the lid and container entirely surround the contents in order to protect them and form a strong bond between them when the lid is sealed to the container. On the other hand, it is desirable that the lid be easily removable from the container by finger peeling without propagating tears. It is also desirable that the lid be made so that it may serve both as an oxygen barrier layer and a moisture barrier layer between the environment and the contents to reduce the risk of food spoilage or contamination of a medical product or device or leakage of a non-food substance. The present invention presents a solution to this need providing a puncture resistant lid with excellent barrier properties, which is resistant to tear propagation, can be easily die cut, has high flex crack strength at low temperatures, resists tear propagation and is receptive to being formed by coextrusion.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The peelable lid of the present invention comprises a film laminate comprising a nylon containing layer and a metal foil layer attached to one side of the nylon containing layer. It is suitable for use on a container which has a top opening and a substantially flat peripheral rim around the opening. The lid comprises a film having a shape which conforms to the shape of this container opening when attached to the rim. In the preferred embodiments of the present invention, the most preferred metal foil comprises aluminum. Other metals suitable for the purposes of the invention may be used instead of aluminum, but they are not preferred.

The nylon containing layer may comprise one of two general preferred embodiments. In one embodiment, the nylon containing layer preferably comprises a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof. In another embodiment, the nylon containing layer comprises a composite of two nylon layers separated by an ethylene vinyl alcohol copolymer layer.

Suitable polyamides may be aliphatic, aromatic or aliphatic/aromatic nylon homopolymer or copolymers. Polyamides suitable for use in the present invention include polyamides which are film forming. Preferred polyamides are long chain polymeric amides having recurring amide groups as part of the polymer backbone and preferably a relative formic acid viscosity (for nylon 6) of from about 40 to about 250 measured in 90 percent formic acid at a concentration of 9.2 weight percent. Non-limiting examples of such polyamides are:

a) those prepared by the polymerization of lactams, preferably poly (ε-caprolactam) (nylon 6);

b) those prepared by the condensation of a diamine with a dibasic acid, preferably the condensation of hexamethylene diamine with adipic acid (nylon 6,6) and the condensation of hexamethylene diamine with sebacic acid (nylon 6,10);

c) those prepared by self-condensation of amino acids, preferably self-condensation of 11-aminoundecanoic acid (nylon 11); and

d) those based on polymerized vegetable oil acids, or random, block, or graft interpolymers consisting of two or more of these polyamides.

Exemplary of such polyamides are poly(hexamethylene adipamide) (nylon 6,6), poly(hexamethylene sebacamide) (nylon 6, 10), poly(heptamethylene

pimelamide) (nylon 7,7), poly(octamethylene suberamide) (nylon 8,8), poly(nonamethylene azelamide) (nylon 9,9), poly(decamethylene azelamide) (nylon 10,9), poly(4-aminobutyric acid) (nylon 4), poly(6-aminohexanoic acid) (nylon 6, also known as poly(caprolactam)), poly(7-aminoheptanoic acid) (nylon 7), poly(8-aminoocatanoic acid)(nylon 8), poly(9-aminononanoic acid) (nylon 9), poly(10-aminodecanoic acid) (nylon 10), poly(11-aminoundecanoic acid) (nylon 11), poly(12-aminododecanoic acid) (nylon 12) and the like. Blends of two or more aliphatic polyamides may also be employed. Copolymers formed from recurring units of the above referenced aliphatic polyamides can be used in the fabrication of the polyamide layers. By way of illustration and not limitation, such aliphatic polyamide copolymers include caprolactam/hexamethylene adipamide copolymer (nylon 6/6,6), hexamethylene adipamide/caprolactam copolymer (nylon 6,6/6), trimethylene adipamide/hexamethylene azelaiamide copolymer (nylon trimethyl 6,2/6,2), hexamethylene adipamide/hexamethylene-azelaiamide/caprolactam copolymer (nylon 6,6/6,9/6) and the like. Preferred aliphatic polyamides for use in the practice of this invention are poly(caprolactam), poly(hexamethylene adipamide) and a copolymer of poly(caprolactam) and poly(hexamethylene adipamide), with poly(caprolactam) being the most preferred. Polyamides used in the practice of this invention may be obtained from commercial sources or prepared in accordance with known preparatory techniques. For example, polycaprolactam can be obtained from Honeywell International Inc.

Exemplary of aliphatic/aromatic polyamides include poly (2,2,2-trimethyl hexamethylene terephthalamide), poly(m-xylylene adipamide) (MXD6), poly(p-xylylene adipamide), poly(hexamethylene terephthalamide), poly(dodecamethylene terephthalamide), and the like. Blends of two or more

aliphatic/aromatic polyamides can also be used. The most preferred aliphatic/aromatic polyamide is poly(m-xylylene adipamide). Aliphatic/aromatic polyamides can be prepared by known preparative techniques or can be obtained from commercial sources.

The number average molecular weight of the polyamide may widely vary. Usually, the aliphatic polyamide is of a "film-extrusion molecular weight", meaning an average molecular weight that is sufficiently high to form a free standing film but sufficiently low to allow melt processing of the blend into a film. Such number average molecular weights are well known to those of skill in the film forming art and are usually at least about 5,000 as determined by the formic acid viscosity method. In this method (ASTM D-789), a solution of 11 grams of aliphatic polyamide in 100 ml of 90% formic acid at 25 ° C. is used. In the preferred embodiments of the invention, the number average molecular weight of the aliphatic polyamide ranges between about 5,000 to about 100,000, and in the particularly preferred embodiments it ranges between about 10,000 to about 60,000. Most preferred are those in which the number average molecular weight of the aliphatic polyamide is from about 20,000 to about 40,000. Also suitable for use herein are polyamide interpolymers comprised of a polyamide and one or more comonomers. Non-limiting examples of such comonomers include acrylic or methacrylic acid and/or their derivatives, such as acrylonitrile, acrylamide, methyl, ethyl, propyl, butyl, 2-ethylhexyl, hexyl and tridecylesters of acrylic or methacrylic acid, vinyl esters such as vinyl acetate and vinyl propionate, vinyl aromatic compounds such as styrene, alpha-methyl styrene, and vinyl toluenes and vinyl ethers such as vinyl isobutyl ether.

It is further noted that the aforementioned polyamides containing various

terminal functionality are also suitable for use in the present invention. Preferred are polycaprolactams (nylon 6) containing a carboxyl group attached to one end and an acetamide group attached to the other end of the polymer chain, an amino group attached to both ends of the polymer chain and a carboxyl group attached to one end and an amino group attached to the other end of the polymer chain. Particularly preferred is a polycaprolactam having a carboxyl group attached to one end and an amino group attached to the other end of the polymer chain.

In another preferred embodiment, the nylon containing layer may comprise a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof. The ethylene vinyl alcohol copolymer layer preferably comprises an ethylene-vinyl alcohol copolymer ("EVOH") or a blend of a polyamide and an ethylene-vinyl alcohol copolymer. Copolymers of ethylene and vinyl alcohol suitable for use in the present invention can be prepared by the methods disclosed, for example, in U.S. patents 3,510,464; 3,560,461; 3,847,845; and 3,585,177.

The ethylene vinyl alcohol copolymer (EVOH) which is used for the nylon containing layer can be hydrolyzed ethylene vinyl acetate copolymer. The degree of hydrolysis can range from 85 to 99.5%. The ethylene vinyl alcohol copolymer preferably contains from 15 to 65 mol percent ethylene and more preferably 25 to 48 mol percent ethylene. Copolymers of lower than 15 mol percent ethylene tend to be difficult to extrude while those above 65 mol

percent ethylene have reduced oxygen barrier performance.

Optionally the EVOH layer may comprise a blend of EVOH and a polyamide. In this case the EVOH component in the blend has an ethylene content of from about 27 mole percent to about 48 mole percent, preferably from about 27 mole percent to about 44 mole percent, and most preferably from about 32 mole percent to about 38 mole percent. The EVOH component further has a density ranging from about 1.12 g/cm$^3$ to about 1.20 g/cm$^3$, and a melting temperature ranging from about 142 ° C. to about 191° C. EVOH can be prepared by known preparative techniques or can be obtained from commercial sources. Suitable copolymers are described, for example, in U.S. patents 4,252,169 and 3,595,740. Blends may comprise from about 50% to 95%, preferably 65% to 85% of the polyamide and from about 5% to 50%, preferably 15% to 35% of EVOH. As used herein, all percentages are by weight. Blends may be formed by mechanically blending the polyamide and EVOH in a drum tumbler at room temperature for about 30 minutes. Alternatively, blends may be formed by melt blending technologies or any other mixing process that forms an intimate physical mix of the polymers. This also includes mixing resulting from blending extrusion and final pelletization of the extruded blend

In addition to the above described nylon containing layer and metal foil layer, the films may include one or more optional outer layers. Illustrative of such additional optional layers are polymeric layers formed of homopolymers and copolymers formed from polyvinyl alcohol, ethylene vinyl alcohol copolymer and blends thereof. Additional layers may also include adhesive tie layers to tie various layers together. Non-limiting examples of other optional polymeric layers and adhesive or tie layers which can be used in the film laminate of the

present invention are disclosed in U.S. Pat. Nos. 5,055,355; 3,510,464; 3,560,461; 3,847,845; 5,032,656; 3,585,177; 3,595,740; 4,284,674; 4,058,647; and 4,254,169.

The nylon film of this invention can be formed by any conventional technique for forming films, including extrusion. The nylon/EVOH/nylon composite may be formed either by coextrusion or lamination of the individual layers with or without an intermediate adhesive layer. In the most preferred method, the composite is formed by coextrusion. For example, the material for the individual layers, are fed into infeed hoppers of the extruders of like number, each extruder handling the material for one or more of the layers. The melted and plasticated streams from the individual extruders are fed into a single manifold co-extrusion die. While in the die, the layers are juxtaposed and combined, then emerge from the die as a single multiple layer film of polymeric material. After exiting the die, the film is cast onto a first controlled temperature casting roll, passes around the first roll, and then onto a second controlled temperature roll, which is normally cooler than the first roll. The controlled temperature rolls largely control the rate of cooling of the film after it exits the die. In another method, the film forming apparatus may be one which is referred to in the art as a "blown film" apparatus and includes a multi-manifold circular die head for bubble blown film through which the plasticized film composition is forced and formed into a film "bubble" which may ultimately be collapsed and formed into a film. Processes of coextrusion to form film and sheet laminates are generally known.

Alternatively the individual layers of the composite may first be formed into sheets and then laminated together under heat and pressure with or without intermediate adhesive layers. Any suitable adhesive may be employed. Such

adhesives include polyurethanes, epoxies, polyesters, acrylics, anhydride modified polyolefin and blends thereof. Modified polyolefin compositions have at least one functional moiety selected from the group consisting of unsaturated polycarboxylic acids and anhydrides thereof. Such unsaturated carboxylic acid and anhydrides include maleic acid and anhydride, fumaric acid and anhydride, crotonic acid and anhydride, citraconic acid and anhydride, itaconic acid an anhydride and the like. In another embodiment of the invention, the nylon containing layer may be extrusion laminated with the metal foil layer.

Typically, the nylon containing layer may be attached to the metal foil by laminating. Laminating is done by positioning the nylon containing and metal foil layers on one another with or without an intermediate adhesive under conditions of sufficient heat and pressure to cause the layers to combine. Typically the composite or nylon layer, adhesive, and metal foil are positioned on one another, and the combination is passed through the nip of a pair of heated laminating rollers by techniques well known in the art. Lamination heating may be done at temperatures ranging from about 120°C to about 175°C, preferably from about 150°C to about 175°C, at pressures ranging from about 5 psig (0.034 MPa) to about 100 psig (0.69 MPa), for from about 5 seconds to about 5 minutes, preferably from about 30 seconds to about 1 minute.

The films of this invention may be of any thickness desired. Preferably, the metal foil layer has a thickness of from about 8 μm to about 100 μm, more preferably from about 25 μm to about 65 μm and most preferably from about 30 μm to about 45 μm. Preferably, the nylon containing layer has a thickness of from about 3 μm to about 250 μm, more preferably from about 3 μm to

about 10 μm. When a nylon/EVOH/nylon composite is employed, each of these individual layers may have a thickness of from about 3 μm to about 250 μm, more preferably from about 3 μm to about 10 μm. While such thicknesses are preferred as providing a readily flexible film, it is to be understood that other film thicknesses may be produced to satisfy a particular need and yet fall within the scope of the present invention.

Each layer of the multilayer film structure may contain additives which are conventionally used in such films. Examples of such additives are pigments, dyes, slip additives, fillers, nucleating agents, plasticizers, lubricants, antiblocking agents, stabilizers and inhibitors of oxidation, thermal stabilizers and ultraviolet light stabilizers. Such may be present in an amount of about 10% or less based on the weight of the layer.

The nylon films of this invention is preferably stretched or oriented in any direction using methods known to those of skill in the art. In such a stretching operation, the film may be stretched in either the direction coincident with the direction of movement of the film being withdrawn from the casting roll, also referred to in the an as the "machine direction", i.e. the direction which is perpendicular to the machine direction, and referred to in the art as the "transverse direction" where the resulting film is "uniaxially" oriented; or the machine direction as well as in the transverse direction, where the resulting film is "biaxially" oriented. Typically for use in the present invention, the oriented film formed from the composition of the invention are preferably produced at draw ratios of from about 1.5:1 to about 10:1, and preferably at a draw ratio of from about 1.5:1 to about 4:1. The term "draw ratio" as used herein indicates the increase of dimension in the direction of the draw. Therefore, a film having a draw ratio of 2:1 has its length doubled during the

drawing process. Generally, the film is drawn by passing it over a series of preheating and heating rolls. The heated film moves through a set of nip rolls downstream at a faster rate than the film entering the nip rolls at an upstream location. The change of rate is compensated for by stretching in the film.

Typical process and range of conditions for monoaxially oriented polyamide films are disclosed, for example, in U.S. Pat. No. 4,362,385. The film laminate of the present invention can be biaxially oriented using blown tube apparatus, or a tenter frame apparatus, and can either be sequentially or simultaneously oriented biaxially. The film laminate of the present invention can also be embossed after orientation.

One noteworthy characteristic of the lidding films of this invention is that they exhibit excellent gas barrier properties, particularly oxygen barrier properties, at 90% relative humidity (RH). Oxygen barrier resistance may be measured using the procedure of ASTM D-3985. In general, using the aforesaid method, the films of this invention have an oxygen transmission rate ($O_2$ TR) at 90% relative humidity equal to or less than about 0.5 $cm^3/100\ in^2$ (645 $cm^2$)/24 hrs/Atm or less at 23°C. Preferably the lid film has a oxygen transmission rate less than or equal to that of the container stock. The superior oxygen barrier properties of the lidding of this invention makes them especially useful in food lid applications. Preferably the lid film has a moisture vapor transmission rate equivalent to either the container stock or the shelf life requirements of the food stuff. This rate typically ranges from about 0.05cc/100 $in.^2$ (645 $cm^2$) /24 hrs at 70°F (21°C), 50% relative humidity to about 20cc/100 $in.^2$ (645 $cm^2$)/24 hrs. at 70°F (21°C), 50% relative humidity or more preferably from about 1 cc to about 16cc/100 $in.^2$ (645 $cm^2$) /24 hrs at 70°F (21°C), 50% relative humidity.

In order to produce a food container lid, a sheet of the film is cut, preferably die cut to the desired size and shape. Preferably the lid has a pull tab in order to ease finger peeling removal. The lid should have that amount of thickness and stiffness to allow easy peel off of the container to which it is attached without tearing. The film may be die cut either before or after applying a sealing layer to the film. In the preferred embodiment of the invention it is cut after applying a sealing layer to the film.

The invention further comprises a food package comprising a cup shaped container having enclosed side walls, a floor and a top opening defining a central cavity, which top opening has a substantially flat peripheral rim, and the above described peelable lid which conforms to the shape of the opening attached around the rim. The container may comprise a material such as cardboard, paperboard, boardstock, a plastic and combinations thereof. Preferred plastics for the container include any one of several thermosetting or thermoplastic resins any of which are capable of sealing to the lidding material. Examples of materials include acrylonitrile, an acrylic polymer, polyethylene terephthalate (PET), polyvinyl chloride, polycarbonate, copolymers of "PET", polystyrene and polypropylene.

The lid can be heat sealed such as by means of a heat sealable material, adhesive or lacquer placed at least around a peripheral edge of the lid for attaching to the rim of a container. Usually the heat sealable material or adhesive is attached to the entire surface lidding film such as by coating, laminating a layer of the material, or other technique such as by coextruding a layer of a heat sealable material or adhesive onto a surface of the nylon containing layer or the metal foil layer. Suitable adhesives for this purpose

include a thermoplastic hot melt adhesive, such as a layer of a petroleum wax-ethylene vinyl acetate or any suitable polyolefin copolymer composition which serves as an heat activated adhesive or sealant material when subsequently subjected to heat and pressure by the packer. Useful food grade heat seal materials include JVHS Universal Heat Seal Coating, a modified acrylic available from Watson Rhenania of Philadelphia, Pa. Others include SC804 vinyl lacquer adhesive coating and 9806 series paraffin wax hot melt adhesive, both available from H.B. Fuller of St. Paul Minnesota. These materials are preferably applied to the nylon containing layer, optionally by a suitable intermediate primer. A laminatable heat seal layer may be a polyethylene sheet film. Typically, after the container has been filled, the lid is pressed against the container rim as heat and pressure are applied to provide a peelable seal therebetween.

In use, the cup shaped container as described above is filled through its central cavity with a product such as a food through the open top. The top is then closed by sealing the open top by attaching the peelable lid around a circumference of the rim. While it is contemplated that the container will hold a food product, it could just as well hold a pharmaceutical composition, an electronic component or a medical device. While it is contemplated that the lid may be peelable from the container, it is also within the contemplation of the invention that the lid be welded to the container so that it is essentially non-peelable.

The following non-limiting examples serve to illustrate the invention.

EXAMPLE 1

A laminate is made from poly(ε-caprolactam) (nylon 6) and aluminum foil. The nylon-6 polymer has a relative formic acid viscosity of 73 measured in 90% formic acid and a 9.2% concentration by weight. The polymer is extruded through a 3.5 inch (8.89 cm) diameter Davis Standard Extruder and operates with a screw speed of 44 rpm, a motor drive 42 amps, a barrel pressure of 900 psig (6.29 x $10^3$ kPa), the melt temperature of the nylon at 501 °F (260 °C), and an extruder output of 60 pounds (27.27 kg) per hour.

The extrudate from the extruder is put through a feed block. The extruded film is then cast on a roll followed by a cooling roll at and an additional roll at 200 °F (93 °C). The film is then biaxially oriented at a stretch ratio of 3x in each of the machine and longitudinal directions.

The film is then laminated to a layer of aluminum foil by an intermediate adhesive. Next, it is die cut to a circular shape having a pull tab. The outer perimeter of the circular portion of the lid, on the surface opposite the aluminum foil, is applied with layer of a petroleum wax-ethylene vinyl acetate copolymer thermoplastic hot melt adhesive. The adhesive on the lid is applied to the flat rim of a thermoformable plastic cup, subjected to heat and pressure, and cooled to provide a peelable seal.

EXAMPLE 2

A co-extruded laminate is made from nylon 6/ethylene vinyl alcohol/nylon-6. The nylon polymer has a relative formic acid viscosity of 73 measured in 90% formic acid and a 9.2% concentration by weight. The ethylene vinyl alcohol is Grade LC-F produced by Kuraray of Japan. The ethylene vinyl alcohol is in

pellet form and has a melt index of 1.5 g per 10 minutes as measured on the ASTM Test No. 1238 at a load of 2160 g at 190 ° C. The ethylene vinyl alcohol copolymer contains 67 mol percent vinyl alcohol and has a glass transition temperature of 69°C. The ethylene vinyl alcohol copolymer (EVOH) and the nylon-6 layers are co-extruded to form a nylon-6/EVOH/nylon-6 co-extruded film laminate. The nylon-6 layers are extruded through a 3.5 inch (8.89 cm) diameter Davis Standard Extruder. The extruder is operated with a screw speed of 44 rpm, a motor drive 42 amps, a barrel pressure of 900 psig (6.29 x $10^3$ kPa), the melt temperature of the nylon at 501 °F (260 °C), and an extruder output of 60 pounds (27.27 kg) per hour.

The ethylene vinyl alcohol copolymer is extruded through a 2 inch (5.08 cm) diameter Wellex Extruder. The operating conditions of the extruder includes a screw speed of 30 rpm, a motor drive amperage of 8 amps, a melt temperature of 461 ° F (238 °C), and an extruder output of 16 pounds (7.26 kg) per hour.

The extrudate from the extruders is put through a feed block coextrusion adapter manufactured by the Johnson Plastic Corporation. The coextruded film is then cast on a roll followed by a cooling roll and an additional roll. The total extrusion output is 76 pounds (34.5 kg) per hour. The film has a thickness of 2.5 mils (63.5 microns). The film is then biaxially oriented at a stretch ratio of 3x in each of the machine and longitudinal directions.

The film is then laminated to a layer of aluminum foil by an intermediate adhesive. Next it is die cut to a circular shape having a pull tab. The outer perimeter of the circular portion of the lid, on the surface opposite the aluminum foil, is applied with layer of a petroleum wax-ethylene vinyl acetate copolymer thermoplastic hot melt adhesive. The adhesive on the lid is applied

to the flat rim of a thermoformable plastic cup, subjected to heat and pressure, and cooled to provide a peelable seal.

EXAMPLE 3

A three layer co-extruded structure is made from two nylon 6 layers, sandwiching an interior layer formed of a blend of 75 weight percent poly(m-xylylene adipamide) (MXD6) and 25 weight percent of EVOH. The MXD6 and EVOH are preblended in a drum tumbler at room temperature for approximately 30 minutes.

The nylon 6 has a relative formic acid viscosity of 73 and a melt index of 0.7 g per 10 minutes at a load of 325 kg. at 275 ° C. (condition K). The MXD6, which is produced by Mitsubishi Gas Chemical Company of Japan, is in pellet form and has a melt index of 4.0 g per 10 minutes as measured per the ASTM Test No. D1238 at a load of 325 kg at 275 ° C (condition K). The EVOH, which is produced by Nippon Gohsei Company, Ltd. of Japan under the tradename Soarnol DC 3203, has an ethylene content of 32 molecular percent, a density of 1.19 g/cm$^3$ and a melting temperature of 183 ° C (US5547765).

The MXD6/EVOH blend layer and the two layers of nylon 6 are co-extruded to form a three layer co-extruded composite such that the blend layer is in between the two layers of nylon 6. The nylon 6 layers are extruded through a 31/2 inch (88.9 mm) diameter Davis Standard Extruder which operates with a screw speed of 25 to 30 rpm, a motor drive amperage of 25 amps, a barrel pressure of 1000 psig (6.99 x 10$^3$ kPa), a melt temperature of the nylon at 490 °F (254 °C.), and an extruder output of 120 pounds per hour (54.43 kg/hr).

The MXD6/EVOH blend layer is extruded through a 2 inch (50.8 mm)

diameter Wellex extruder. The operating conditions of the extruder include a screw speed of 100 rpm, a motor drive amperage of 10 to 15 amps, a melt temperature of 513 °F (267 °C), and an extruder output of 60 pounds per hour (27.22 kg/hr).

The extrudate from the two extruders is fed through a feed block coextrusion adapter manufactured by the Johnson Plastic Corporation. The coextruded composite is then cast on a roll. The total extrusion output is 180 pounds per hour (81.65 kg/hr). The film has an average gauge of 1.082 mils (27.5 microns). The film is then biaxially oriented at a stretch ratio of 3x in each of the machine and longitudinal directions.

The three layer co-extruded film is then laminated to an aluminum foil and a sealant, a petroleum wax-ethylene vinyl acetate copolymer thermoplastic hot melt adhesive, is coextruded onto the nylon containing layer of the film opposite the aluminum foil. Next the film is die cut to a circular shape having a pull tab. A polypropylene cup is filled with yogurt and the film is then subjected to heat and pressure, and cooled to provide a peelable seal on the container.

## EXAMPLE 4

Example 3 is repeated except a film of a thermoplastic hot melt adhesive is laminated onto the nylon containing layer prior to die cutting.

It can be seen that the present invention provides excellent lidding material for food containers. While the present invention has been particularly shown and described with reference to preferred embodiments, it will be readily

appreciated by those of ordinary skill in the art that various changes and modifications may be made without departing from the spirit and scope of the invention. It is intended that the claims be to interpreted to cover the disclosed embodiment, those alternatives which have been discussed above and all equivalents thereto.

What is claimed is:

1. A peelable lid for a container, which container has a top opening and a substantially flat peripheral rim around the opening, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the nylon containing layer; the nylon containing layer comprising either (i) or (ii):

(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;

(ii) a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

2. The lid of claim 1 wherein the nylon containing layer comprises a polyamide homopolymer, a polyamide copolymer or a combination thereof.

3. The lid of claim 1 wherein the nylon containing layer comprises a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

4. The lid of claim 1 wherein the nylon containing layer comprises poly

(caprolactam), poly(hexamethylene adipamide) or a combination thereof.

5. The lid of claim 1 wherein the ethylene vinyl alcohol copolymer has from about 15 to about 65 mol percent ethylene and a degree of hydrolysis of from about 85 to about 99.5%.

6. The lid of claim 1 wherein the metal foil layer comprises aluminum.

7. The lid of claim 1 further comprising an adhesive layer between the nylon containing and metal foil layers.

8. The lid of claim 1 wherein the nylon containing layer is biaxially oriented.

9. The lid of claim 1 wherein the nylon containing layer is biaxially oriented at a draw ratio of from about 1.5:1 to about 10:1 in each orthogonal direction.

10. The lid of claim 1 wherein the composite layers are coextruded.

11. The lid of claim 1 wherein the composite layers are attached by lamination.

12. The lid of claim 1 wherein the nylon containing layer and metal foil layer are attached by lamination.

13. The lid of claim 1 wherein the film further comprises a pull tab.

14. The lid of claim 1 wherein the nylon containing layer has a thickness of from about 3 μm to about 250 μm.

15. The lid of claim 1 wherein the metal foil layer has a thickness of from about 8 μm to about 100 μm.

16. The lid of claim 1 wherein the film has an oxygen transmission rate at 90% relative humidity of about 0.5 $cm^3/100\ in^2/24$ hrs/Atm or less at 23°C.

17. The lid of claim 1 wherein the film has a moisture vapor transmission rate of from about 0.05 cc to about 20cc/100 $in.^2$ /24 hrs. at 70°F and 50% relative humidity.

18. The lid of claim 1 further comprising a heat sealable material on a surface of the film for attaching the lid to the rim of a container.

19. The lid of claim 1 further comprising an adhesive on a surface of the film for attaching to the rim of a container.

20. The lid of claim 1 further comprising a heat sealable material coextruded with the nylon containing layer, which heat sealable material is positioned on a surface of the nylon containing layer opposite to the metal foil layer.

21. A package comprising a container having a top opening and a substantially flat peripheral rim around the opening, and a peelable lid which conforms to the shape of the opening attached around the rim, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the nylon containing layer; the a nylon containing layer comprising either (i) or (ii):

(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;

(ii) a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of a ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

22. The package of claim 21 wherein the container comprises a material selected from the group consisting of cardboard, paperboard, boardstock, a plastic and combinations thereof.

23. The package of claim 21 wherein the nylon containing layer comprises poly(caprolactam), poly(hexamethylene adipamide) or a combination thereof.

24. The package of claim 21 wherein the ethylene vinyl alcohol copolymer has from about 15 to about 65 mol percent ethylene and a degree of hydrolysis of from about 85 to about 99.5%.

25. The package of claim 21 wherein the metal foil layer comprises aluminum.

26. The package of claim 21 further comprising an adhesive layer between the a nylon containing and metal foil layers.

27. The package of claim 21 wherein the nylon containing layer is biaxially oriented.

28. The package of claim 21 wherein the lid is attached to the rim of the container by means of a heat sealable material around a peripheral edge of the lid.

29. The package of claim 21 wherein the lid is attached to the rim of the container by means of an adhesive around a peripheral edge of the lid.

30. A process of producing a packaged product which comprises:
a) providing a container having enclosed side walls, a floor and an top opening defining a central cavity, which open top has a substantially flat peripheral rim,
b) filling the central cavity with a product; and
c) sealing the open top by attaching a peelable lid around a circumference of the rim, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the a nylon containing layer; the a nylon containing layer comprising either (i) or (ii):
(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;
(ii) a composite comprising a first layer of a polyamide homopolymer, a polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

31. The process of claim 30 wherein the nylon containing and metal foil

layers are attached by lamination.

32. The process of claim 30 wherein the nylon containing and metal foil layers are attached by lamination via an intermediate adhesive layer.

33. The process of claim 30 wherein the composite layers are coextruded.

34. The process of claim 30 wherein the composite layers are attached by lamination.

35. The process of claim 30 wherein the product is a food.

36. The package of claim 30 wherein the product is a pharmaceutical composition, an electronic component or a medical device.

37. A process of producing a packaged product which comprises:
a) providing a container having enclosed side walls, a floor and an top opening defining a central cavity, which open top has a substantially flat peripheral rim,
b) filling the central cavity with a product; and
c) sealing the open top by attaching a lid around a circumference of the rim, which lid comprises a film having a shape which conforms to the shape of the opening when attached to the rim, the film having a nylon containing layer, and a metal foil layer attached to one side of the a nylon containing layer; the a nylon containing layer comprising either (i) or (ii):
(i) a layer comprising a polyamide homopolymer, a polyamide copolymer or a combination thereof;
(ii) a composite comprising a first layer of a polyamide homopolymer, a

polyamide copolymer, or a combination thereof, which first layer is attached to one side of an ethylene vinyl alcohol copolymer layer, which ethylene vinyl alcohol copolymer layer is attached on another side thereof to a second layer comprising a polyamide homopolymer, a polyamide copolymer, or a combination thereof.

# INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/US 02/05791

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B32B27/34 B32B15/08 B65D77/20

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 B32B B65D

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] 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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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 5 July 2002 | 29/07/2002 |

| Name and mailing address of the ISA | Authorized officer |
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| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040, Tx. 31 651 epo nl,<br>Fax: (+31–70) 340–3016 | Kanetakis, I |

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