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Peelable Film and Method of Making a Peelable Film

This invention relates to a peelable film and to a method of making a peelable film.

5 In packaging there is a need for film which can securely package articles (such as food), and which at the same time is easy to open. Such packaging can be provided by using peelable films. It is an object of the present invention to provide an improved peelable film.

According to one aspect of the present invention there is provided a peelable
10 film comprising:

(A) a core layer comprising an olefin polymer

(B) a skin layer on at least one surface of the core layer, comprising:

(i) a blend of a butylene polymer with another olefin polymer; or

(ii) a polymer of butylene and at least one other olefin; and

15 (C) a coating layer on the skin layer.

Advantageously the core layer is an oriented olefin polymer, preferably a biaxially oriented olefin polymer.

The core layer may be cavitated as disclosed in our EP-A-0083495. The core layer may be as described in European Patent No. 258020, i.e., a voided core layer
20 comprising a matrix of a thermoplastic polymeric material in which is dispersed void initiating solid particles which are phase distinct from the thermoplastic polymeric material of the matrix and about which particles are located opacifying voids and a minor amount of a light absorbing pigment.

It is particularly preferred that the core layer is isotactic polypropylene, but the
25 core layer may instead be high density polyethylene.

When the skin layer is a blend it is preferably one of: a blend of polybutylene with polyethylene; a blend of polybutylene with polypropylene, a blend of polybutylene with a polypropylene copolymer; or a blend of polybutylene with a polypropylene terpolymer.

30 The polyethylene may comprise high density polyethylene, medium density polyethylene, low density polyethylene, linear low density polyethylene; or a copolymer of ethylene with polar monomers such as vinyl acetate or methyl acrylate.

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When the skin layer is a polymer of butylene and at least one other olefin, it preferably comprises a copolymer of butylene and propylene.

The coating layer is preferably a heat-sealable polymer. The heat-sealable polymer is preferably an acrylic polymer or polyvinylidene chloride.

5 Advantageously there is a primer for the coating provided between the skin layer and the coating layer. The primer improves the adhesion of the coating layer to the skin layer, but does not inhibit peelability. The nature of the primer will depend on the coating layer utilised: aqueous polyethyleneimine solution based primers may be used for acrylic coating layers while water-dispersed epoxy resin-based primers may be
10 used for vinylidene chloride polymer coating layers or acrylic coating layers. Polyethylene imine, or a blend of polyethylene imine and epoxy resin can also be used for acrylic based coating layers.

Thus the primers may comprise the reaction product of an epoxy resin and an acidified aminoethylated vinyl polymer. The contemplated epoxy resins are glycidyl
15 ethers of polyhydroxy compounds. Typical polyhydroxy compounds which may be used include bisphenol A, ring substituted bisphenol A, resorcinol, hydroquinone, phenol-formaldehyde novolac resins, aliphatic diols, such as ethylene glycol, propylene glycol, 1,4-butanediol, 1,6-hexanediol, glycerol, lower alkyl hydantoins or mixtures thereof.

The preferred epoxy resins of the present invention are those made by the
20 glycidation reaction between epichlorohydrin and bisphenol A. Epoxy resins of this type are commonly classified by their epoxy equivalent weight (EEW) which is defined as the weight of resin in grams which contains one gram equivalent of epoxy resins. Resins with an EEW ranging from 170 to 280 may be used in the present invention, but the preferred range is 180 to 210.

25 A variation in the composition of the epoxy resin component is one in which a hydantoin compound is substituted for the bisphenol A. For example, 1,1-dimethyl hydantoin may be employed in a lower molecular weight epoxy resin since resins based on this material are completely water soluble thereby eliminating the necessity for emulsification.

30 Although the specific structure of the epoxy resin is not critical to the primer employed in the present invention, important considerations in the selection of the epoxy resin revolve around its physical state. For example, it must be liquid and

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capable of being readily dispersed or dissolved with the second component or curing agent as described hereinbelow. If the epoxy resin is of low viscosity, it may be stirred directly into the second component, i.e., curing agent, however, it is preferred to employ the epoxy resin in an aqueous emulsion.

5 The second component in the epoxy primer compositions of the present invention is an amino modified acrylic polymer which is water soluble. This polymer is a curing agent for the epoxy compound. The preferred material is described in US-A-3,719,629 and may be generically described as an acidified aminoethylate interpolymer having pendant aminoalkylate groups. This material is produced by
10 polymerizing acrylate, methacrylate, styrene or other suitable monomers with sufficient methacrylic or acrylic acid to give a $-\text{COOH}$ content of 7.5 to 12.5%. Solvent polymerization techniques are preferred. The polymer is then reacted with ethyleneimine monomer and acidified with hydrochloric acid to render the polymer water soluble.

15 The primer may also comprise a poly(ethylene imine). The imine primer provides an overall adhesively active surface for thorough and secure bonding with the subsequent applied heat seal composition. It has been found that an effective coating solution concentration of the poly(ethylene imine) applied from either aqueous or organic solvent media, such as ethanol, is a solution comprising 0.1-0.6% by weight of
20 the poly(ethylene-imine). A commercially available material of this type is known as Polymin M, a product of BASF-Wyandotte Corp.

 The surface of the skin layer which receives the coating layer can be subjected to a surface modifying treatment by corona discharge, flame or oxidising chemicals. Preferably the surface is treated by flame or corona to a surface activity of at least 36
25 dynes/cm (36 mN/m), preferably to approximately 40 dynes/cm (40mN/m).

 The polybutylene is preferably present in the skin layer in an amount from 5 to 50 wt%, more preferably 10 to 30 wt%. When the skin layer is a polymer of butylene with at least one other olefin, then the butylene content of the polymer is preferably present in the skin layer in an amount from 5 to 50 wt%, more preferably 10 to 30
30 wt%.

 The polypropylene copolymer is suitably a copolymer of ethylene and propylene or of butylene and propylene. Particularly preferred copolymers are ethylene-propylene

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copolymers containing from 1 to 30 wt%, preferably from 2 to 7 wt%, more preferably 3 to 5 wt%, ethylene and having a melt flow rate at 230°C ranging from 2 to 15, more preferably 3 to 8, a crystalline melting point in the range 125 to 150°C, a number average molecular weight range from 25000 to 100000, and a density from 0.89 to 0.90.

5 Preferred copolymers of butylene and propylene contain up to 30 wt% butylene.

The polypropylene terpolymer is suitably a terpolymer of ethylene, propylene, and butylene containing from 1 to 10, and preferably from 2 to 6, wt% ethylene, from 80 to 97, and preferably from 88 to 95, wt% propylene, and from 1 to 20, and preferably from 2 to 15, wt% butene-1.

10 In one embodiment the skin and coating layers are provided on both surfaces of the core layer.

According to another aspect of the present invention there is provided a method of making a peelable film comprising coextruding a core layer comprising an olefin polymer with a skin layer comprising either: (i) a blend of a butylene polymer with
15 another olefin polymer; or (ii) a polymer of butylene and at least one other olefin; and coating said skin layer with a coating layer comprising a heat-sealable polymer.

The core layer is preferably coextruded with the skin layer and then is desirably biaxially oriented. The polymers can be brought to the molten state and coextruded from a conventional extruder through a flat sheet die, the melt streams being combined
20 in an adaptor prior to being extruded from the die. After leaving the die orifice, the multi-layer film structure is chilled and the quenched sheet is then preferably reheated and stretched, e.g., 4 to 6 times in the machine direction at approximately 250°F (121°C) and subsequently, for example, 8 to 10 times in the transverse direction at approximately 320°F (160°C).

25 The peelable film according to the invention is advantageously used in packaging for articles, such as food, imparting a good appearance (low haze and high gloss), high aroma barrier, and excellent surface properties such as low coefficient of friction and good printabilities.

The peelable film according to the present invention has superior peelability to
30 peelable film in the prior art. In particular the film peels between the coating layer and the skin layer, or within the coating itself, rather than within the skin layer, or between the core layer and the skin layer.

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Examples

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Comparative Example 1

A film (A) was produced by extruding a core layer with a skin layer. After
5 extrusion the film was biaxially oriented. One side of the film (A) was corona treated
after biaxial orientation. The core layer comprised Fina polypropylene and was free of
additives. The skin layer comprised a blend of 70 wt% polypropylene terpolymer and
30 wt% polybutylene. The polypropylene terpolymer was Chisso 7510, which is a
terpolymer containing 95.4 wt% polypropylene, 1.9 wt% ethylene and 2.7 wt% butylene.
10 The polybutylene was PB8240, which is available from Shell.

Comparative Example 2

A film (B) was produced by extruding a core layer with a skin layer. After
extrusion the film was biaxially oriented. One side of the film (A) was corona treated
15 after biaxial orientation. The core layer comprised Fina polypropylene and was free of
additives. The skin layer comprised a blend of 60 wt% LLDPE (linear low density
polyethylene), 30 wt% polybutylene and 10 wt% polypropylene terpolymer. The
polypropylene terpolymer and the polybutylene were the same as in example 1. The
LLDPE was Dow 4201.

20

Example 1(a)

The film (A) of comparative example 1 was used to produce a film (C). The skin
layer of film (A) was subjected to corona treatment, and then primed with a
polyethyleneimine primer. An acrylic coating was then applied to the primed skin layer.
25 The acrylic coating was as described in EP-A-0237213 and was composed of about 4%
methacrylic acid, 54% methyl methacrylate and 42% methyl acrylate.

Example 1(b)

The film (A) of comparative example 1 was used to produce a film (D). The skin
30 layer of film (A) was subjected to corona treatment, and then primed with an epoxy
resin primer. The primer was made by the glycidation reaction between epichlorohydrin
and bisphenol A, and an amino modified acrylic polymer as a hardener. A

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polyvinylidene chloride coating was then applied to the primed skin layer.

Example 2(a)

The film (B) of comparative example 2 was used to produce a film (E). The skin
5 layer of film (B) was subjected to corona treatment, and then primed with a
polyethyleneimine primer. An acrylic coating was then applied to the primed skin layer.
The acrylic coating was the same as in Example 1(a).

Example 2(b)

10 The film (B) of comparative example 2 was used to produce a film (F). The skin
layer of film (B) was subjected to corona treatment, and then primed with an epoxy
resin primer. The epoxy resin primer was the same as in Example 1(b). A
polyvinylidene chloride coating was then applied to the primed skin layer.

15 Two sets of heat-sealed samples of films (A) to (F) were produced, one set using
the LPS (Low Pressure Sealing) apparatus and the other set using the Otto Bruger
apparatus. For films (A) and (B), the skin layer was heat-sealed to another film; for
films (C) to (F), the coating layer was heat-sealed to another film.

20 With the LPS apparatus the sealing time was 0.2s, the sealing pressure was 35
gcm⁻², and only one sealing jaw was heated. With the Otto Bruger apparatus the sealing
time was 0.2s, the sealing pressure was 2.5 bars, and both sealing jaws were heated.
Each sealing operation was carried out at a variety of sealing temperatures.

Test strips of 25mm width were cut from each of the sealed samples: the force
required to separate the test strips was determined with a tensile tester and reported
25 in Tables 1 and 2 as a function of sealing temperature.

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TABLE 1: Sealing on Otto Bruger Apparatus

(Pressure: 2.5 Bars; Dwell Time: 0.2s)

	<u>Film</u>	<u>100°C</u>	<u>110°C</u>	<u>120°C</u>	<u>130°C</u>	<u>140°C</u>	<u>150°C</u>
5							
	A	45	70	125	205*	220*	345*
	B	10	35	150	165	265**	480*
	C	110	170	240	440	430	510
	D	90	160	210	290	310	390
10	E	90	140	190	290	280	400
	F	100	170	210	310	370	410

TABLE 2: Sealing on LPS Apparatus(Pressure: 35 gcm⁻²; Dwell Time: 0.2s)

	<u>Film</u>	<u>100°C</u>	<u>110°C</u>	<u>120°C</u>	<u>130°C</u>	<u>140°C</u>	<u>150°C</u>
15							
	A	0	25	305	420*	395*	455**
	B	0	0	75	445**	520**	500**
20	C	110	170	240	440	430	510
	D	90	160	210	290	310	390
	E	0	0	0	130	220	300
	F	0	0	0	180	230	250

25 * Skin delamination occurred

** Film tearing occurred

The seal strengths of films (A) and (B) increased as a function of the sealing temperature until the seal failed by tearing or skin delamination. Tearing occurred when the bond between the sealable surface of the two sealed films is greater than the tear strength of the film. Skin delamination occurred when the bond between the sealable surfaces of the two sealed films is greater than the bond between the skin layer

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and the core layer.

The seal strengths of films (C) to (F) increased as a function of the sealing temperature, but without skin tearing or delamination. For general packaging applications where easy opening is required, the objective is to get a film which gives acceptable seal strengths (ie above 300g/25mm) at as low a temperature as possible. At the same time the film should not have seals that are destroyed by tearing or skin delamination when the samples are opened after sealing at high temperature. It is clear that films (C) to (F) meet these criteria, whereas films (A) and (B) do not.

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CLAIMS

1. A peelable film comprising:
 - (A) a core layer comprising an olefin polymer;
 - (B) a skin layer on at least one surface of the core layer, comprising:
 - (i) a blend of a butylene polymer with another olefin polymer; or
 - (ii) a polymer of butylene and at least one other olefin; and
 - (C) a coating layer on the skin layer.
2. A peelable film according to claim 1, wherein the core layer is an oriented olefin polymer.
3. A peelable film according to claim 2, wherein said core layer is a biaxially oriented olefin polymer.
4. A peelable film according to claim 1, 2 or 3, wherein said core layer is cavitated.
5. A peelable film according to claim 1, 2 or 3, wherein said core layer comprises isotactic polypropylene.
6. A peelable film according to claim 1, 2 or 3, wherein said core layer comprises high density polyethylene.
7. A peelable film according to any preceding claim, wherein the skin layer comprises one of: a blend of polybutylene with polyethylene; a blend of polybutylene with polypropylene; a blend of polybutylene with a polypropylene copolymer; or a blend of polybutylene with a polypropylene terpolymer.
8. A peelable film according to claim 7, wherein the polypropylene copolymer is a copolymer of ethylene and propylene or of butylene and propylene.



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9. A peelable film according to claim 7, wherein the polypropylene terpolymer is a terpolymer of ethylene, propylene, and butylene.
10. A peelable film according to claim 7, 8, or 9 wherein the polyethylene comprises
5 high density polyethylene, medium density polyethylene, low density polyethylene, linear low density polyethylene; or a copolymer of ethylene with a polar monomer.
11. A peelable film according to any of claims 1 to 6, wherein the skin layer comprises a copolymer of propylene and butylene.
- 10 12. A peelable film according to any preceding claim, wherein there is a primer for the coating provided between the skin layer and the coating layer.
13. A peelable film according to claim 12, wherein the primer is based on an
15 aqueous polyethyleneimine solution, or is based upon a water-dispersed epoxy resin.
14. A peelable film according to any preceding claim wherein the coating layer comprises a heat-sealable polymer.
- 20 15. A peelable⁴ film according to claim 15, wherein the heat-sealable polymer comprises an acrylic polymer or polyvinylidene chloride.
16. A peelable film according to any preceding claim, wherein the skin and coating layers are provided on both surfaces of the core layer.
- 25 17. A peelable film according to any preceding claim, wherein when the skin layer is a blend, the polybutylene is present in the skin layer in an amount from 5 to 50 wt%.
18. A peelable film according to any preceding claim, wherein when the skin layer
30 is a blend, the polybutylene is present in the skin layer in an amount from 10 to 30 wt%.



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19. A peelable film according to any of claims 1 to 15, wherein when the skin layer is a polymer of butylene and at least one other olefin, the butylene content of the polymer is from 5 to 50 wt%.
- 5 20. A peelable film according to any of claims 1 to 15, wherein when the skin layer is a polymer of butylene and at least one other olefin, the butylene content of the polymer is from 10 to 30 wt%.
- 10 21. A method of making a peelable film comprising coextruding a core layer comprising an olefin polymer with a skin layer comprising either: (i) a blend of a butylene polymer with another olefin polymer; or (ii) a polymer of butylene and at least one other olefin; and coating said skin layer with a coating layer comprising a heat-sealable polymer.
- 15 22. A method according to claim 21, wherein said core layer is oriented by stretching in at least one direction.
- 20 23. A method according to claim 22, wherein said core layer is biaxially oriented by stretching in a longitudinal and a transverse direction.
24. A method according to claim 21, 22 or 23, wherein the skin layer is provided with a primer before the coating layer is coated thereon.
- 25 25. A method according to claim 24, wherein the skin layer is subjected to a surface modifying treatment prior before the primer is provided.
26. The use of peelable film according to any of claims 1 to 19 in packaging for articles.

