

POLYETHYLENE MULTILAYERED FILM

The present invention relates to polyethylene multilayered films. More particularly, it is concerned with polyethylene multilayered films with regard to their low-temperature sealability, seal stability, stiffness, slip properties, anti-block properties, and high-speed filling performance, to be suitable as the sealant substrate for a variety of packaging films and multilayered films.

Among conventional polyethylene films used for packaging in various application areas are those which are made of high-pressure low-density polyethylene, high-density polyethylene, and linear low-density polyethylene based on ethylene- α -olefin copolymer. The last one is now attracting attention on account of its lower production cost than conventional high-pressure low-density polyethylene and superior properties such as sealability (not affected by foreign elements present in the seal area), hot-tack properties, tear strength, and impact strength. It is expected to be used as a sealant substrate for multilayered films and packaging film .

Although polyethylene films for packaging are required to have good handling properties for lamination, printing, bag-making, and high-speed filling performance, the above-mentioned film made of linear low-density ethylene- α -olefin copolymer alone does not necessarily meet these requirements. Thus there has been a demand for a film which is superior in low-temperature sealability, seal stability, stiffness, slip properties, and anti-blocking properties.

To meet this demand, there has been proposed a variety of compositions and films. However, none of them satisfies requirements for the above-mentioned properties.

For example, Japanese Patent Laid-open Nos. 34145/1982 and 55045/1985 and Japanese Patent Publication No. 10532/1987 disclose a resin composition composed of an ethylene- α -olefin copolymer and a low-crystalline ethylene copolymer having a density not higher than 0.905 g/cm^3 , and Japanese Patent Laid-open No. 109543/1984 discloses a resin composition incorporated with ethylene-vinyl acetate copolymer.

Japanese Patent Laid-open Nos. 59943/1982 and 36549/1985 disclose a resin composition composed of a high-density ethylene- α -olefin copolymer and a low-density ethylene- α -olefin copolymer. These compositions provide a

film which has improved heat-sealability but is rather poor in stiffness, anti-blocking properties, and slip properties..

Japanese Patent Laid-open No. 85946/1985 discloses a multilayered film formed by laminating films which are made of the same kind of low-density ethylene- α -olefin copolymer. This multilayered film has improved transparency, impact resistance, and tear strength but is not improved in heat-sealability. Japanese Patent Laid-open No. 160147/1983 discloses a multilayered film composed of an upper layer of ethylene- α -olefin copolymer having a density of 0.91-0.93 g/cm³, an intermediate layer of high-pressure low-density polyethylene, and a lower layer of ethylene- α -olefin copolymer having a density of 0.92-0.94 g/cm³. This multilayered film is poor in low-temperature sealability.

The problem addressed by the invention is accordingly the provision of a multilayered polyolefin film which is generally improved with regard to low-temperature sealability, seal stability, stiffness, slip properties, anti-block properties, handling properties, and high-speed filling performance.

In an effort to develop the polyethylene multilayered film having the above-mentioned superior characteristic properties, the present inventors carried out a series of

researches, which led to the finding that the above-mentioned problem may be solved by a multilayered film composed of two layers and an optional intermediate layer, the first layer being made of a specific composition composed of two kinds of ethylene- α -olefin copolymers in a specific ratio or a specific copolymer composed of ethylene units and α -olefin units, both having specific densities, the second layer being made of a specific ethylene- α -olefin copolymer, and the intermediate layer being made of a specific ethylene polymer.

Accordingly, the invention provides a polyethylene multilayered film comprising

- (A) a first layer made of
 - (i) an ethylene - C₄₋₂₀ α -olefin copolymer having a density of 0.890 - 0.910g/cm³, or
 - (ii) a composition of (a) 60-95% by weight of ethylene - C₄₋₂₀ α -olefin copolymer having a density of 0.891 - 0.925g/cm³ and (b) 40-5% by weight of low-crystalline ethylene - C₃₋₁₂ α -olefin copolymer having a density of 0.860 - 0.890g/cm³; and
- (B) a second layer made of an ethylene - C₃₋₂₀ α -olefin copolymer having a density of 0.915 - 0.960g/cm³.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 and 2 are sectional views of a polyethylene multilayered film pertaining to the present inven-

tion. In the figures, the reference numerals 1, 2, and 3 denote the layer A, the layer B, and the layer C, respectively.

DESCRIPTION OF PREFERRED FEATURES AND SPECIFIC EMBODIMENTS

In embodiments of the invention, the polyethylene multilayered film has a first layer (A) which is made of a specific composition or copolymer having a specific density.

The specific composition is composed of (a) a copolymer of ethylene and one or more than one α -olefin with 4-20 carbon atoms, preferably 4-12 carbon atoms, having a density of 0.891-0.925 g/cm³, preferably 0.895-0.920 g/cm³, and (b) a low-crystalline copolymer of ethylene and one or more than one α -olefin with 3-12 carbon atoms, preferably 4-10 carbon atoms, having a density of 0.860-0.890 g/cm³, preferably 0.870-0.890 g/cm³.

If the copolymer (a) has a density lower than 0.891 g/cm³, the resulting multilayered film has a low stiffness and a low heat-seal strength and is liable to blocking. If it has a density higher than 0.925 g/cm³, the resulting multilayered film tends to be poor in low-temperature sealability and impact strength.

The copolymer (a) should have a melt index of 1-50 g/10 min, preferably 2-30 g/10 min. With a melt index lower than 1 g/10 min, the copolymer has an excessively

high melt viscosity which has an adverse effect on the moldability of the first layer (A). With a melt index higher than 50 g/10 min, the copolymer has an excessively low melt viscosity which has an adverse effect on the moldability of the first layer (A), and the resulting multilayered film is poor in mechanical strength.

The copolymer (a) is obtained by polymerisation of ethylene and α -olefin as a comonomer. Examples of the α -olefin include butene-1, pentene-1, hexene-1, heptene-1, octene-1, nonene-1, decene-1, dodecene-1, tetradecene-1, octadecene-1, 4-methyl-pentene-1, 4-methyl-hexene-1, and 4,4-dimethyl-pentene-1. They may be used alone or in combination with one another. Preferable among them are those having 4-12 carbon atoms, particularly octene-1.

If the low-crystalline copolymer (b) has a density lower than 0.860 g/cm³, the resulting multilayered film has a low stiffness and a low heat-seal strength and is liable to blocking. If it has a density higher than 0.890 g/cm³, the resulting multilayered film tends to be poor in low-temperature sealability.

The low-crystalline copolymer (b) should have a degree of crystallinity not higher than 40% so that the resulting multilayered film has improved low-temperature sealability. In addition, it should have a melt index of 0.5-50 g/10 min, preferably 1-20 g/10 min. With a melt

index lower than 0.5 g/10 min, the resulting multilayered film does not have improved low-temperature sealability. With a melt index higher than 50 g/10 min, the resulting multilayered film is poor in anti-block properties and mechanical strength.

The copolymer (b) is obtained by polymerization of ethylene and α -olefin as a comonomer. Examples of the α -olefin include propylene, butene-1, pentene-1, hexene-1, heptene-1, octene-1, nonene-1, decene-1, dodecene-1, 4-methyl-pentene-1, 4-methyl-hexene-1, and 4,4-dimethyl-pentene-1. They may be used alone or in combination with one another. Preferable among them are those having 4-10 carbon atoms, particularly butene-1

According to the present invention, the components (a) and (b) should be mixed at a ratio of 60-95 wt% to 40-5 wt%, preferably 64-92 wt% to 36-8 wt%. Component (b) provides for an improvement in low-temperature sealability, and if less than 5 wt% is used this particular improvement is not significant. With more than 40 wt% of the component (b), the resulting multilayered film is liable to blocking and poor in mechanical strength.

Alternatively, the layer (A) may be made of a copolymer of ethylene and α -olefin

having 4-20 carbon atoms, preferably 4-12 carbon atoms, having a density of 0.890-0.910 g/cm³, preferably 0.895-0.910 g/cm³.

If the copolymer has a density lower than 0.890 g/cm³, the resulting multilayered film has a low stiffness and a low heat-seal strength and is liable to blocking. If it has a density higher than 0.910 g/cm³, the resulting multilayered film tends to be poor in low-temperature sealability and impact strength.

The copolymer should have a melt index of 1-50 g/10 min, preferably 2-30 g/10 min. With a melt index lower than 1 g/10 min, the copolymer has an excessively high melt viscosity which has an adverse effect on the moldability of the first layer (A). With a melt index higher than 50 g/10 min, the copolymer has an excessively low melt viscosity which has an adverse effect on the moldability of the first layer (A), and the resulting multilayered film is poor in mechanical strength.

The copolymer is obtained by polymerization of ethylene and α -olefin as a comonomer. Examples of the α -olefin include those enumerated in the explanation for the copolymer (a) above. Preferable among them are those having 4-12 carbon atoms, particularly octene-1.

The second layer (B) should be made of a specific copolymer of ethylene and α - olefin with 3-20 carbon atoms, preferably 3-12 carbon atoms, having a density of 0.915-0.960 g/cm³, preferably 0.920-0.955 g/cm³.

If the copolymer has a density lower than 0.915 g/cm³, the resulting multilayered film has a low stiffness and is liable to blocking. If it has a density higher than 0.960 g/cm³, the resulting multilayered film tends to be poor in impact strength and clarity.

The copolymer should have a melt index of 0.5-30 g/10 min, preferably 1-20 g/10 min. With a melt index lower than 0.5 g/10 min, the copolymer has an excessively high melt viscosity which has an adverse effect on the moldability of the second layer (B). With a melt index higher than 30 g/10 min, the copolymer has an excessively low melt viscosity which has an adverse effect on the moldability of the second layer (B), and the resulting multilayered film is poor in mechanical strength.

The copolymer is obtained by polymerization of ethylene and α -olefin as a comonomer. Examples of the α -olefin include propylene, butene-1, pentene-1, hexene-1, heptene-1, octene-1, nonene-1, decene-1, dodecene-1, tetradecene-1, octadecene-1, 4-methyl-pentene-1, 4-methyl-hexene-1, and 4,4-dimethyl-pentene-1. They may be used alone or in

combination with one another. Preferable among them are those having 3-12 carbon atoms, particularly propylene, butene-1, and octene-1.

In different aspects of the invention, the multilayered film may be composed of the aforesaid first layer (A) and second layer (B), or may be composed of the first layer (A), the second layer (B), and an intermediate layer (C). The intermediate layer (C) is made of a high-pressure polyethylene or a copolymer of ethylene and α -olefin with 3-20 carbon atoms, preferably 4-10 carbon atoms, having a density of 0.900-0.940 g/cm³, preferably 0.910-0.935 g/cm³.

If the ethylene copolymer for the intermediate layer (C) has a density lower than 0.900 g/cm³, the intermediate layer (C) has a low stiffness and the resulting multilayered film tends to be less stiff. With a density higher than 0.940 g/cm³, the resulting multilayered film tends to be poor in mechanical strength, particularly impact strength.

This ethylene copolymer should have a melt index of 0.5-50 g/10 min, preferably 1-20 g/10 min. With a melt index lower than 0.5 g/10 min, the copolymer has an excessively high melt viscosity which has an adverse effect on the moldability. With a melt index higher than 50 g/10

min, the copolymer has an excessively low melt viscosity which has an adverse effect on the moldability and the resulting multilayered film is poor in mechanical strength.

The intermediate layer (C) may be made of the above-mentioned high-pressure polyethylene or ethylene- α -olefin copolymer or a mixture thereof. The α -olefin as a comonomer of the copolymer includes, for example, propylene, butene-1, pentene-1, hexene-1, heptene-1, octene-1, nonene-1, decene-1, dodecene-1, tetradecene-1, octadecene-1, 4-methyl-pentene-1, 4-methyl-hexene-1, and 4,4-dimethyl-pentene-1. They may be used alone or in combination with one another. Preferable among them are those having 4-10 carbon atoms, particularly butene-1 and octene-1.

The first layer (A) of the multilayered film of the present invention is made of an ethylene- α -olefin copolymer as mentioned above. This copolymer can be produced by polymerizing ethylene and an α -olefin in a proper ratio that gives a desired density, by the so-called medium- or low-pressure process. The polymerization may be performed by the aid of a chain transfer agent, whose kind and amount are properly selected according to the desired melt index. The polymerization may be accomplished by slurry polymerization, gas-phase polymerization, or solution polymerization.

The second layer (B) and the intermediate layer (C) of the multilayered film of the present invention are made of an ethylene- α -olefin copolymer as mentioned above. This copolymer may be made by the medium- or low-
5 pressure process that employs a transition metal catalyst or by the high-pressure process as mentioned above.

Moreover, the high pressure polyethylene for the intermediate layer (C) may be made by the radical polymerisation of ethylene under a high pressure.

10 The multilayered film of the present invention is composed of two or three layers whose thicknesses are preferably as follows: The first layer (A) and the second layer (B) should have thicknesses whose ratio is in the range of 2:98 to 50:50, preferably 3:97 to 40:60. Where
15 the three layers (A), (B) and (C) are present, the ratio of the thickness of film (C) to the total thickness of the layers (A) and (B) is preferably from 96:4 to 20:80. In particular, the thickness ratios for (A):(C):(B) may be in the range of 2:96:2 to 40:20:40, preferably 3:94:3
20 to 30:40:30, if the first layer (A) and the second layer (B) have the same thickness. The multilayered film should have a total thickness of 10-300 μm , preferably 20-200 μm , and most desirably 30-150 μm .

The multilayered films presently described may be
25 produced by any process, such as tubular film process and T-die film process, which are in common use for the production of conventional multilayered film. These

processes may be carried out at a resin temperature of 200 to 300°C. The processes may employ an adequate cooling system for the emergent film. The tubular film process may employ an air cooling system and the T-die film process may employ a chill roll system. In the case of chill roll system, cooling should be carried out such that the second layer (B) comes into contact with the chill roll.

The cooling temperature is usually in the range of 20-80°C, preferably 30-70°C. With a cooling temperature lower than 20°C, the resulting multilayered film has a low stiffness and is poor in handling properties. With a cooling temperature higher than 80°C, the resulting multilayered film is poor in film-forming properties and film appearance.

The multilayered film of the present invention may contain, in any one layer or all the layers, a variety of additives which are commonly used for polyethylene film, according to need. The additives include an antioxidant, light stabilizer, heat stabilizer, anti-blocking agent, slip agent, catalyst deactivator (chlorine absorber), anti-fogging agent, and anti-static agent.

Among the antioxidants may be mentioned phenol-based ones and phosphorus-based ones. They should preferably be used in combination. Examples of the phenol-based anti-

oxidants include 2,6-di-*t*-butyl-4-methylphenol, tris-(3,5-di-*t*-butyl-4-hydroxybenzyl)isocyanurate ("Irganox 3114" made by Ciba-Geigy Corp.), 2,2'-methylenebis(4-ethyl-6-*t*-butylphenyl), *n*-octadecyl-3-(3',5'-di-*t*-butyl-4'-hydroxyphenyl)propionate ("Irganox 1076" made by Ciba-Geigy Corp.), 4,4'-thiobis(3-methyl-6-*t*-butylphenol), tetrakis[methylene-3-(3',5'-di-*t*-butyl-4'-hydroxyphenyl)-propionate]methane ("Irganox 1010" made by Ciba-Geigy Corp.), 4,4'-butylidenebis(3-methyl-6-*t*-butylphenol), 2,2'-methylenebis(4-ethyl-6-*t*-butylphenol), *N,N'*-hexamethylenebis(3,5-di-*t*-butyl-4-hydroxyhydrocinnamide) ("Irganox 1098" made by Ciba-Geigy Corp.), triethylene-glycolbis[3-(3'-*t*-butyl-5'-methyl-4-hydroxyphenyl)-propionate], and a mixture of bis(ethyl 3,5-di-*t*-butyl-4-hydroxysulfonate) calcium and PE wax (1:1 by weight) ("Irganox 1425WL" made by Ciba-Geigy Corp.).

(N.B. "Irganox" is a registered trade mark of Ciba-Geigy).

Examples of the phosphorus-based antioxidants include distearyl pentaerythritol diphosphite ("Markpep-8" made by Adeka-Argus Corp.), tetrakis(2,4-di-*t*-butylphenyl), 4,4'-biphenylenediphosphite ("Sandostab P-EPQ" made by Sandoz Corp.), trisnonylphenylphosphite, tris(2,4-di-*t*-butylphenyl)phosphite ("Mark 2112" Adeka-Argus Corp.), di(2,4-di-*t*-butylphenyl)-pentaerythritol diphosphite

("Markpep-24G" made by Adeka-Argus Corp.), and bis(2,6-di-t-butyl-4-methylphenyl)pentaerythritol diphosphite ("Markpep-36" made by Adeka-Argus Corp.).

The light stabilizers may be those which are derived from salicylate, benzophenone, triazole, oxalanilide, or hindered amine. The anti-blocking agent may be, for example, natural silica, synthetic silica, zeolite, amorphous silica, or diatomaceous earth, the last one being preferable. The slip agent may be, for example, stearyl- amide, palmitylamide, oleamide, or erucamide. The catalyst deactivator may be, for example, calcium stearate, zinc stearate, magnesium stearate, or hydrotalcite.

In the case where the multilayered film of the present invention undergoes lamination or printing, it is advantageous to perform surface treatment on the second layer (B) by corona discharge or the like. The corona discharge treatment should be carried out with an electric power not less than $20 \text{ W/m}^2/\text{min}$, preferably not less than $25 \text{ W/m}^2/\text{min}$. The surface treatment should be carried out such that the surface of the second layer (B) has a wetting index not lower than 30 dyne/cm , preferably not lower than 35 dyne/cm , and most desirably not lower than 38 dyne/cm .

The polyethylene multilayered films generally have a construction as shown in Fig. 1 or Fig. 2, which

are sectional views. Shown in Fig. 1 is that of double-layer structure which is composed of the first layer (A) 1 and the second layer (B) 2. Shown in Fig. 2 is that of triple-layer structure which is composed of the first layer (A) 1, the second layer (B) 2, and the intermediate layer (C) 3. These films should be used in such a manner that the first layer (A) 1 is sealed.

It has been found that the polyethylene multilayer films described are generally superior in low-temperature sealability, seal stability, stiffness, slip properties, anti-block properties, handling properties, and high-speed filling performance. They may be suitable for e.g. packaging film and laminate sealant substrate.

The invention will be described in more detail with reference to the following examples, which are not intended to restrict the scope of the invention.

In the examples, the film samples are tested for physical properties in the following manner.

(1) Seal temperature (Idemitsu Method)

Two pieces of film samples are sealed together, with the first layer (A) facing each other, under 2 kg/cm^2 for 1 sec at varied temperatures. The seal temperature that gives a seal strength of 300 g/25 mm was measured using a heat gradation tester made by Toyo Seiki Co., Ltd.

(2) Film impact (Idemitsu Method)

Measured with a film impact tester made by Toyo Seiki Co., Ltd., with the full range being 30 kg·cm and the striking head being 1 inch.

(3) Dart impact

Measured according to ASTM D-1709A, with the height being 66 cm and the temperature being -20°C.

(4) Elmendorf tear strength and tensile modulus

Measured according to JIS Z-1702.

(5) Film running performance

Unwinding, wandering, and blocking.

Rated according to the following criteria.

1: Excellent, 2: Good, 3: Fair, 4: Poor

The film samples were prepared from the raw material resins shown in Table 1.

Table 1

Resin	Producer	Trade name	α -olefin	Density (g/cm ³)	Melt Index (g/10 min)	Additive	(wt%)
L-LDPE-1	Idemitsu Petrochemical	Moretick 0258C	C8	0.930	2	Diatomite, erucamide	0.50 0.04
L-LDPE-2	Idemitsu Petrochemical	Moretick 1018C	C8	0.905	9	Diatomite, erucamide	0.80 0.08
L-LDPE-3	Idemitsu Petrochemical	Moretick 0238C	C8	0.920	2	Diatomite, erucamide	0.20 0.08
L-LDPE-4	Idemitsu Petrochemical	Idemitsu Polyethylene-L 0254	C4	0.935	4	Diatomite, erucamide	0.85 0.04
L-LDPE-5	Idemitsu Petrochemical	Idemitsu Polyethylene-L 0234	C4	0.920	2	Diatomite, erucamide	0.50 0.08
HDPE	Idemitsu Petrochemical	Idemitsu Polyethylene 440M	C3	0.954	0.9	Diatomite, erucamide	0.20 0.04
LDPE	Toso	Petrothene 219	-	0.925	3	Diatomite, erucamide	0.80 0.08
EBC			C4	0.88	4	-	-

- Note
1. EBC : Ethylene-butene-1 copolymer, melting point: 70°C, Mooney viscosity ML₁₊₁ (100°C): 18
 2. The additives were added through a masterbatch of L-LDPE-1.
 3. Diatomite: anti-blocking agent
 4. Erucamide: slip agent

Examples 1 to 6 and 11, and

Comparative Examples 1 to 3, 5 to 8 and 9

A 40- μ m thick two-layered film was prepared by coextrusion from the resins shown Table 2. The first layer (A) was formed by a 50-mm extruder, and the second layer (B), by a 60-mm extruder. The two extrudates were combined in a multimanifold T-die (800 mm wide) at 250°C. The emergent multilayered film was cooled by a chill roll (at 40°C), with the second layer (B) in contact with the chill roll. The ratio of the thickness of the first layer (A) to the thickness of the second layer (B) is 1:6. The second layer (B) underwent corona discharge treatment with a power of 28 W/m²/min. The characteristic properties of the multilayered film are shown in Table 2.

Examples 7 to 10, and 12 to 15, and

Comparative Examples 4, and 10

A 40- μ m thick three-layered film was prepared by coextrusion from the resins shown Table 2. The first layer (A) was formed by a 50-mm extruder, the second layer (B), by a 60-mm extruder, and the intermediate layer (C), by a 50-mm extruder. The three extrudates were combined in a multimanifold T-die (800 mm wide) at 250°C. The emergent multilayered film was cooled by a chill roll (at 40°C), with the second layer (B) in contact with the chill roll. The ratio of the thickness of the first layer (A),

the thickness of the intermediate layer (C), and the thickness of the second layer (B) is 1:5:1. The second layer (B) underwent corona discharge treatment with a power of 28 W/m²/min. The characteristic properties of the multilayered film are shown in Table 2.

Table 2

Example	Layer (B)	Layer (C)	Layer (A) (wt%)		Heat seal temperature (°C)	Impact strength (kg·cm/cm)	Dart impact (g)	Tear strength MD/TD (kg/cm ²)	Tensile modulus MD/TD (kg/cm ²)	Film running performance
1	L-LDPE-1	-	L-LDPE-2 (90)	EBC (10)	95	2000	100	40/150	4200/4300	Good
2	L-LDPE-1	-	L-LDPE-2 (80)	EBC (20)	93	2000	110	50/150	4000/4600	Good
3	L-LDPE-1	-	L-LDPE-2 (70)	EBC (30)	89	2500	120	60/140	4000/4600	Good
4	L-LDPE-1	-	L-LDPE-3 (80)	EBC (20)	98	2000	115	55/150	4300/4900	Excellent
5	L-LDPE-1	-	L-LDPE-3 (70)	EBC (30)	96	2000	125	60/150	4200/4800	Excellent
6	L-LDPE-4	-	L-LDPE-2 (70)	EBC (30)	89	1500	100	20/150	4200/4800	Good
7	L-LDPE-1	L-LDPE-3	L-LDPE-2 (80)	EBC (20)	93	4500	180	100/150	2000/2000	Good
8	L-LDPE-1	L-LDPE-3	L-LDPE-3 (70)	EBC (30)	96	4300	180	160/150	2000/2000	Good
9	L-LDPE-1	L-LDPE-5	L-LDPE-2 (70)	EBC (30)	89	3500	120	80/160	2000/2000	Good
10	HDPE	L-LDPE-3	L-LDPE-3 (70)	EBC (30)	97	4300	160	80/160	3000/3500	Excellent
(1)	L-LDPE-1	-	L-LDPE-3 (97)	EBC (3)	105	2000	110	40/150	4200/4800	Excellent
(2)	L-LDPE-1	-	L-LDPE-4 (70)	EBC (30)	113	2000	100	35/160	4500/5200	Good

Table 2 (Cont'd)

Example	Layer (B)	Layer (C)	Layer (A) (wt%)		Heat seal temperature (°C)	Impact strength (kg·cm/cm)	Dart impact (g)	Tear strength MD/TD (kg/cm ²)	Tensile modulus MD/TD (kg/cm ²)	Film running performance
11	L-LDPE-1	-	L-LDPE-2 (100)	-	98	2000	110	40/160	4300/4100	Excellent
12	L-LDPE-1	L-LDPE-3	L-LDPE-2 (100)	-	97	4300	160	100/150	2000/2000	Good
13	L-LDPE-4	L-LDPE-3	L-LDPE-2 (100)	-	97	4000	150	80/150	2000/2000	Good
14	HDPE	L-LDPE-3	L-LDPE-2 (100)	-	97	4000	150	80/150	2000/2000	Good
15	L-LDPE-1	L-LDPE-5	L-LDPE-2 (100)	-	97	3500	120	20/170	2000/2000	Good
(3)	L-LDPE-1	-	L-LDPE-3 (100)	-	107	2000	100	40/160	4500/4200	Excellent
(4)	L-LDPE-1	L-LDPE-5	L-LDPE-3 (100)	-	107	3500	100	20/170	2000/2000	Excellent
(5)	L-LDPE-1	-	L-LDPE-5 (100)	-	107	2200	80	20/170	4300/4100	Excellent
(6)	L-LDPE-1	-	L-LDPE-1 (100)	-	123	1900	100	30/160	4700/5600	Excellent
(7)	L-LDPE-3	-	L-LDPE-3 (100)	-	107	4300	160	100/150	2000/2000	Good
(8)	L-LDPE-1	-	L-LDPE-3 (50)	EBC (50)	90	1900	120	45/130	4000/4500	Poor
(9)	L-LDPE-2	-	L-LDPE-2 (100)	-	97	4000	100	80/140	1200/1300	Poor
(10)	L-LDPE-2	HDPE	L-LDPE-2 (100)	-	97	1500	60	20/160	5500/6500	Fair

Remarks: Parenthesized example Nos. indicate Comparative Examples.

CLAIMS:

1. A polyethylene multilayered film comprising
 - (A) a first layer made of
 - 5 (i) an ethylene - C₄₋₂₀ α -olefin copolymer having a density of 0.890 - 0.910g/cm³, or
 - (ii) a composition of (a) 60-95% by weight of ethylene - C₄₋₂₀ α -olefin copolymer having a density of 0.891 - 0.925g/cm³ and (b) 40-5% by weight of
 - 10 low-crystalline ethylene - C₃₋₁₂ α -olefin copolymer having a density of 0.860 - 0.890g/cm³;
 - and
 - (B) a second layer made of an ethylene - C₃₋₂₀ α -olefin copolymer having a density of 0.915 - 0.960g/cm³.
- 15 2. A polyethylene multilayered film according to claim 1, which further comprises an intermediate layer (C) interposed between said first layer (A) and said second layer-(B), said intermediate layer (C) being made of high-pressure polyethylene and/or an ethylene-C₃₋₂₀ α -
- 20 olefin copolymer having a density of 0.900-0.940 g/cm³.
3. A polyethylene multilayered film according to claim 1 or claim 2, wherein the first layer (A) is made of a composition composed of a copolymer (a) having a melt index of 1 to 50 g/10 min and a low-crystalline copolymer
- 25 (b) having a melt index of 0.5 to 50 g/10 min.
4. A polyethylene multilayered film according to any



one of claims 1, 2 and 3 wherein said first layer (A) is made of a composition composed of a copolymer (a) containing ethylene units and octene-1 units and a low-crystalline copolymer (b) containing ethylene units and butene-1 units.

- 5 5. A polyethylene multilayered film as claimed in claim 1 or 2, wherein said first layer (A) is made of a copolymer containing ethylene units and octene-1 units and having a melt index of 1-50 g/10 min.
- 10 6. A film according to any one of the preceding claims, wherein said second layer (B) is made of a copolymer containing ethylene units and propylene units, butene-1 units, or octene-1 units and having a melt index of 0.5-30 g/10 min.
- 15 7. A polyethylene film according to claim 2 or any claim depending thereon, wherein said intermediate layer (c) is made of a copolymer containing ethylene units and butene-1 units or octene-1 units and having a melt index of 0.5-50 g/10 min.
- 20 8. A film according to any one of the preceding claims, wherein the ratio of the thickness of said first layer (A) to the thickness of said second layer (B) is in the range of 2:98 to 50:50.
- 25 9. A polyethylene multilayered film according to claim 2 or any claim depending thereon, wherein the ratio of the thickness of the intermediate film (C) to the total



thickness of the two films (A) and (B) is from 96:4 to 20:80.

10. A polyethylene multilayered film according to claim 9, wherein layers (A) and (B) have the same thickness so
5 that the thickness ratio for layers (A):(C):(B) is from 2:96:2 to 40:20:40.

11. A polyethylene multilayered film substantially as
any herein described with reference to the Examples (but
not the Comparative Examples) and to the accompanying
10 drawings.
