AUSTRALIA

Patents Act 1990 **660184**

PATENT REQUEST: STANDARD PATENT

~~I/~~We, being the person(s) identified below as the Applicant(s), request the grant of a patent to the person(s) identified below as the Nominated Person(s), for an invention described in the accompanying standard complete specification.

Full application details follow.

Applicant(s): UBE REXENE CORPORATION and UBE INDUSTRIES, LTD

Address: 3-11, Higashishinagawa 2-chome, Shinagawa-ku, Tokyo, 140 Japan and 12-32, Nishihonmachi 1-chome, Ube-shi, Yamaguchi-ken, 755 Japan respectively

Nominated Person(s): UBE REXENE CORPORATION and UBE INDUSTRIES, LTD

Address: 3-11, Higashishinagawa 2-chome, Shinagawa-ku, Tokyo, 140 Japan and 12-32, Nishihonmachi 1-chome, Ube-shi, Yamaguchi-ken, 755 Japan respectively

Title: POLYOLEFIN ~~RESIN~~ COMPOSITION

Name(s) of actual inventor(s): Iwao Tsurutani
Takahumi Manabe
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~~ASSOCIATED PROVISIONAL APPLICATION(S) DETAILS~~

~~Application No(s).:~~
~~Application date(s):~~

BASIC CONVENTION APPLICATION(S) DETAILS

Application No(s).: 3-223459

Country(ies) & Code(s): Japan (JP)

Date(s) of Application(s): 8 August 1991

~~DIVISIONAL APPLICATION DETAILS~~

~~Original application number:~~

Drawing number recommended to accompany abstract: Fig. 1

Date: 7th August 1992

M 038478 070892

AUSTRALIAN PATENT OFFICE

Signed: ....
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NOTICE OF ENTITLEMENT

[APPLICANT]

I/We, UBE REXENE CORPORATION and UBE INDUSTRIES, LTD

of 3-11, Higashishinagawa 2-chome, Shinagawa-ku, Tokyo, 140 Japan and 12-32, Nishihonmachi 1-chome, Ube-shi, Yamaguchi-ken, 755 Japan respectively

being the Applicant(s) in respect of ☐ the accompanying application
☒ Application No. 20,928/92

state the following:

1. I am/We are the Nominated Person(s) to whom I/we request the patent to be granted.

2. [INVENTORS]

(a) ☐ I am/We are the inventor(s) of the invention and I am/we are entitled to the grant of a patent under Section 15(1)(a) of the Patents Act.

(b) ☒ [Name(s) of Inventor(s):] Iwao Tsurutani, Takahumi Manage and Ikuo Emoto of C/- Ube Rexene Corporation, 3-11, Higashishinagawa 2-chome, Shinagawa-ku, Tokyo, 140 Japan and C/- Sakai Laboratory, Ube Industries Ltd, 3-1, Chikkoshinmachi, Sakai-shi, Osaka-fu, 592 Japan respectively.

is/are the inventor(s) of the invention and the Nominated Person(s) is/are entitled to the grant of a patent by virtue of the following facts:

☐ The inventor(s) made the invention in the course of employment by the Nominated Person(s) and the Nominated Person(s) would, on the grant of a patent for the invention, be entitled to be assignee(s) of the patent.

☒ The Nominated Person(s) is/are the assignee(s) of the inventor(s) in respect of the invention.

☐ [Other situation entitling Nominated Person(s) to the patent:]

3. [PRIORITY CLAIM]

(a) ☒ [Convention applications] The basic application(s) identified in the Patent Request was/were the first application(s) made in a Convention country in respect of the invention the subject of this application. Priority is claimed under Part 2 of Chapter 8 of the Patents Act from the basic application(s) identified in the Patent Request, and I am/we are the Applicant(s) is/are entitled to claim such priority since:

☒ ~~I am~~/we are/~~the Applicant(s) is/are~~ the basic applicant(s) in respect of the basic application(s).

☐ I am/we are/the Applicant(s) is/are the assignee(s) of rights from applicant(s) in respect of the basic application(s), these rights including the right to file patent application(s) in Australia claiming the priority of the basic application(s).

(b) ☐ [Divisional applications] Priority is claimed under Section 39 of the Patents Act from the original application identified in the Patent Request, and I am/we are/the Applicant(s) is/are entitled to claim such priority since:

☐ I am/we are/the Applicant(s) is/are the applicant(s) in respect of the original application.

☐ I am/we are/the Applicant(s) is/are entitled under an assignment or agreement or by operation of law to request the patent to be granted to me/us/the Applicant(s) and claiming priority from the original application.

(c) ☐ [Complete application after Provisional application] Priority is claimed under Section 38 of the Patents Act from the Provisional application(s) identified in the Patent Request, and I am/we are/the Applicant(s) is/are entitled to claim such priority since:

☐ I am/we are/the Applicant(s) is/are the applicant(s) in respect of the Provisional application(s).

☐ I am/we are/the Applicant(s) is/are entitled under an assignment or agreement or by operation of law to request the patent to be granted to me/us/the Applicant(s) and claiming priority from the Provisional application(s).

Date: 18 June 1993

Signature:

(Michael J Grant - Attorney of the Applicants)

(12) PATENT ABRIDGMENT (11) Document No. AU-B-20928/92
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 660184

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POLYOLEFIN COMPOSITION

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(56) Prior Art Documents
US 4186240
US 4211852
US 4395519

(57)

The boiling-n-heptane insoluble content was measured by the method of Soxhlet extraction, using 2 g of cubes with each side measuring between 3 and 5 mm.

In the present invention, Shore D hardness Hs (23°C) and tensile modulus (80°C) were measured in accordance with the following methods.

Shore D hardness Hs (23°C)

A resin composition was subjected to press molding consisting of 2 minutes of preheating, 1 minute of pressing (temperature = 180°C, pressure = 100 kg/cm^2) and 3 minutes of cooling, to obtain a sheet of 2 mm in thickness.

.../2

Claim

1. A resin composition comprising:

(a) 20 - 80% by weight of an amorphous polyolefin having a propylene and/or butene-1 component content of 50% by weight or more, and a boiling n-heptane insoluble content of 10% by weight or less, and

(b) 80 - 20% by weight of a crystalline polypropylene, wherein the Shore D hardness Hs (23°C) and the common logarithm y of the tensile modulus (80°C) satisfy the following formulas (1) and (2):

$$10 \leq Hs\ (23^{\circ}\ C) \leq 55 \qquad (1)$$

$$y \geq 0.04163Hs\ (23^{\circ}\ C) + 0.8665 \qquad (2)$$

AUSTRALIA

Patents Act 1990

COMPLETE SPECIFICATION
FOR A STANDARD PATENT
ORIGINAL

Applicant(s): UBE REXENE CORPORATION and UBE INDUSTRIES, LTD

Actual Inventor(s): Iwao Tsurutani
Takahumi Manabe
Ikuo Emoto

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26 Ellingworth Parade
Box Hill Victoria 3128
Australia

Title: POLYOLEFIN ~~RESIN~~ COMPOSITION

Associated Provisional Applications: No(s).:

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

AUSTRALIAN PATENT OFFICE

Title of the Invention

Polyolefin ~~Resin~~ Composition

Background of the Invention and Related Art Statement

The present invention relates to a novel resin composition. More particularly, the present invention relates to a novel soft polypropylene resin composition having flexibility at normal temperature and a sufficient mechanical strength at high temperatures.

In recent years, soft vinyl chloride resins containing a plasticizer have been widely used as a soft resin for sheets or films. Soft vinyl chloride resins, however, may give rise to social problems such as (1) toxicity problem caused by bleed-out of plasticizer or monomer used therein and (2) acid rain derived from hydrogen chloride generated by burning thereof.

Meanwhile, as a soft resin comparable to the soft vinyl chloride resins, there are resins using ethylene as a main ~~Main~~ component, such as ethylene/vinyl acetate copolymer, ethylene/ethyl acrylate copolymer, ionomer, linear low-density polyethylene, ultralow-density polyethylene, ethylene/propylene copolymer and the like. These ethylene- based soft resins, however, are not balanced in flexibility and mechanical strength. That is, resins having sufficient flexibility at normal temperature tend to have a low mechanical strength at about 80° C, while resins having an excellent mechanical strength at about 80° C have low flexibility at normal temperature.

It was attempted to allow a polypropylene resin inherently having an excellent mechanical strength to have flexibility by copolymerizing propylene with ethylene to obtain a propylene/ethylene copolymer having a lower melting point, a sufficient mechanical strength and flexibility. In this approach, however, the ethylene content is at best 5-6% by weight under the present technique; hence, it is difficult to obtain a polypropylene having flexibility comparable to that of soft vinyl chloride resins.

In view of the above situation, an object of the present invention is to provide a soft resin composition other than soft vinyl chloride resins, in particular, a resin composition having excellent flexibility and mechanical strength over a temperature range from normal temperature to high temperatures.

Other object of the present invention is to provide a resin composition which has a low cost and which can be suitably used in various applications, for example, as a packaging film or sheet, a building material sheet in the construction field, a carpet backing in the automobile and construction fields, an insulator for cable, a fiber, and a base material for tape.

Summary of the Invention

According to the present invention, there is provided a resin composition comprising:

A resin composition comprising:

(a) 20 - 80% by weight of an amorphous polyolefin having a propylene and/or butene-1 component content of 50% by weight or more, and a boiling n-heptane insoluble content of 10% by weight or less, and

(b) 80 - 20% by weight of a crystalline polypropylene, wherein the Shore D hardness Hs (23°C) and the common logarithm y of the tensile modulus (80°C) satisfy the following formulas (1) and (2):

$$10 \leq \mathrm{Hs}\ (23^\circ\mathrm{C}) \leq 55 \qquad (1)$$

$$y \geq 0.04163\mathrm{Hs}\ (23^\circ\mathrm{C}) + 0.8665 \qquad (2)$$

Brief Description of the Drawing

Fig. 1 is a graph showing the relations between Shore D hardness Hs (23°C) and tensile modulus (80°C), of the resin compositions of Examples and Comparative Examples.

Detailed Description of the Invention

The amorphous polyolefin used as the component (a) in the present invention can be any olefin polymer having a propylene and/or butene-1 component content of 50% by weight or more. It can be, for example, an amorphous polypropylene or a propylene/other α-olefin copolymer.

When the propylene and/or butene-1 component content in the amorphous polyolefin is less than 50% by weight, the amorphous polyolefin has low compatibility with the crystalline polypropylene [the component (b)], which is not preferable.

It is preferable that the amorphous polyolefin of the present invention has a heat of crystallisation ~~crystal~~ within a certain limitation. To be more precise, when the amorphous polyolefin is a propylene/butene-1 copolymer, a heat of crystal fusion is desired to be less than 10 Joule/g, and when the amorphous polyolefin is a propylene/ethylene copolymer, a heat of crystal fusion is desired to be 20 Joule/g or less. In case that the heat of crystal fusion is beyond its limitation, the amorphous polyolefin has low flexibility.

Incidentally, the heat of crystal fusion was measured as follows.

The heat of crystal fusion was measured in accordance with the straight line extended to the side of lower temperatures from a curved line of specific heat obtained by differential scanning calorimetry under a condition of perfect fusion of polymer. The measurement was proceeded by the use of DSC-50 produced by Shimadzu Corporation, about 10 mg of the sample, and Indium as a caloric standard under nitrogen atmosphere with the following heating program:

In the first place, the sample was heated up to 2[illegible] °C with temperature increase of 50°C per minute. After leaving the sample at 210°C for five minutes, it was cooled down to -42°C with temperature decrease of 10°C per minute. After leaving the sample at -42°C for five minutes, the measurement was proceeded from the temperature range of -40°C to 200°C with temperature increase of 20°C per minute.

The amorphous polyolefin [the component (a)] of the present invention desirably has a boiling-n-heptane insoluble content (i.e. a boiling-n-heptane insoluble content when subjected to Soxhlet extraction) of 10% by weight or less. When the boiling-n-heptane insoluble content is high, the proportion of the amorphous portion in the amorphous polyolefin is small, making it impossible to obtain a resin composition having desired sufficient flexibility. The amorphous polyolefin [the component (a)] desirably has a number-average molecular weight of 1,000-200,000, preferably 1,500-100,000.

The boiling-n-heptane insoluble content was measured by the method of Soxhlet extraction, using 2 g of cubes with each side measuring between 3 and 5 mm.

In the present invention, it is possible to use one or more amorphous polyolefins.

As the amorphous polypropylene, there may be used an atactic polypropylene which is produced as a by-product in producing a crystalline polypropylene. Alternatively, the amorphous polypropylene may be produced as such from a raw material. The propylene/other α-olefin copolymer can be produced as an intended product, from raw materials containing propylene in a desired proportion.

When the amorphous polyolefin [the component (a)] is produced as an intended product, it can be obtained by, for example, polymerizing raw material monomers using (a) a titanium catalyst supported on magnesium chloride and (b) triethylaluminum, in the presence or absence of hydrogen. Use of an amorphous polyolefin produced as an intended product is preferable in view of its stable supply and stable quality. As the amorphous polyolefin [the component (a)], there may be used a commercial product if there is an appropriate commercial product.

Specific examples of the amorphous polyolefin [the component (a)] include those containing propylene as a main component and having properties mentioned above, such as polypropylene, propylene/ethylene copolymer, propylene/butene-1 copolymer, propylene/butene-1/ethylene terpolymer, propylene/hexene-1/octene-1 terpolymer, propylene/hexene-1/4-methylpentene-1 terpolymer and the like.

The propylene/ethylene copolymer used as the amorphous polyolefin, desirably contains an ethylene component in an amount of 0-30% by weight, preferably 1-20% by weight. When the amount of the ethylene component is larger than 30% by weight, the resulting resin composition is too soft, has high surface tackiness, and is inconvenient to handle. The propylene/butene-1 copolymer used as polypropylene is preferably an α-olefin of 2-8 carbon atoms, such as ethylene, butene-1, pentene-1, hexene-1, heptene-1, octene-1 or the like. Of these, ethylene or butene-1 is particularly preferable.

As the crystalline polypropylene [the component (b)] of the present invention, there are preferably mentioned a propylene homopolymer; a propylene/ethylene random or block copolymer having an ethylene component content of 1-30% by weight, preferably 2-25% by weight; a propylene/butene-1 random or block copolymer having a butene-1 component content of 1-20% by weight. Of these, a propylene/butene-1 copolymer is particularly preferable in view of the applications (film, sheet, etc.) of the present resin composition.

The crystalline polypropylene [the component (b)] can be used singly or in combination of two or more of (co)polymers.

In the present invention, the component (a) and/or the component (b) may be used in modified forms (form). That is, the component (a) or (b) may be used after being modified with an unsaturated carboxylic acid (e.g. acrylic acid, methacrylic acid, ethacrylic acid, maleic acid, fumaric acid, itaconic acid) and/or its derivative (e.g. ester, acid anhydride, metal salt). Of the modification products, preferable is a product modified with maleic anhydride or itaconic anhydride, and more preferable is a product modified with maleic anhydride.

The production of the present resin composition comprising the components (a) and (b) is not critical and can be carried out by a method ordinarily used in the production of conventional polypropylene composition, wherein melt kneading is conducted with heating, using, for example, a kneader (e.g. kneader, Banbury mixer, rolls) or a single-screw or twin-screw extruder.

The present resin composition may contain, as necessary, various additives, reinforcing agents and fillers, such as heat stabilizer, antioxidant, light stabilizer, antistatic agent, lubricant, nucleating agent, flame retardant, pigment or dye, glass fiber, carbon fiber, calcium carbonate, calcium sulfate, barium sulfate, magnesium hydroxide, mica, talc, clay and the like.

The present resin composition may further contain, as necessary, other thermoplastic resins, elastomers, rubbers, etc. It is possible that these resins, elastomers, rubbers, etc. be compounded so as to form a ~~crossliked~~ crosslinked structure.

The resin composition of the present invention can be obtained by compounding the component (a) and the component (b) so that the content of the component (a) becomes 20-80% by weight, preferably 25-75% by weight. When the content of the component (a) is less than 20% by weight, the resulting resin composition has a Shore hardness Hs (23°C) of more than 60 and has insufficient flexibility. When the content of the component (a) is more than 80% by weight, the resin composition has a Shore hardness Hs (23°C) or less than 8, is too soft at normal temperature, has a tensile modulus (80°C) of less than 30 kg/cm^2, and is unable to keep its own shape and mechanical strength satisfactorily.

In compounding the component (a) and the component (b) to obtain the present resin composition, it is preferable to control the shore D hardness Hs (23°C) and the common logarithm of the tensile modulus (80°C) to satisfy the following formulas (1) and (2) because the resulting resin composition has higher flexibility at normal temperature, shows no reduction in mechanical strength at about 80°C, and is well balanced in flexibility and mechanical strength.

$$10 \leq Hs\ (23^\circ\ C) \leq 55 \qquad (1)$$

$$y \geq 0.04163Hs\ (23^\circ\ C) + 0.8665 \qquad (2)$$

In the present invention, Shore D hardness Hs (23°C) and tensile modulus (80°C) were measured in accordance with the following methods.

Shore D hardness Hs (23°C)

A resin composition was subjected to press molding consisting of 2 minutes of preheating, 1 minute of pressing (temperature = 180°C, pressure = 100 kg/cm^2) and 3 minutes of cooling, to obtain a sheet of 2 mm in thickness.

The sheet was kept in a constant-temperature room of 23° C and piled in 6 layers (6 sheets), after which a hardness meter was pressed upon the uppermost layer and, after 5 seconds, the hardness of the sheet was measured.

Tensile modulus (80° C)

The sheet obtained in the same manner as above was subjected to punching using a JIS No. 2 type dumbbell, to obtain a test piece.

The test piece having a sectional area of S cm^2 was subjected to a tensile test (crosshead speed = 50 mm/min, distance between chucks = 5 cm, chart speed = 50 cm/min) in a constant-temperature chamber to measure a tensile load X kg when 2% distortion occurred, while reading the displacement of the distance between chucks on the chart. The tensile modulus (80° C) of the test piece was calculated from the S and X obtained, using the following formula (3).

$$\text{Tensile modulus (80° C) (kg/cm}^2\text{)} = [X/S]/[2/100] = 100X/2S \qquad (3)$$

As mentioned above, the resin composition of the present invention has excellent flexibility at normal temperature and a high mechanical strength at about 80° C, and can be used alone as a resin for film, sheet, bottle, pipe, fibrous material, porous film and other general molded articles, all of which have heretofore been made of a soft polymer. The molding of the present resin composition into the above articles can be conducted by an ordinary molding method such as extraction, injection molding, blow molding, press molding, stretching or the like. A film, a sheet and a blown bottle made of a single layer of the present resin composition can be used in various aplications.

The resin composition of the present invention can also be used as a composite material with other polymer or the like, such as laminate with leather or polyvinyl chloride, laminate with polypropylene, polyethylene, nylon, polyester or the like, laminate with woven cloth or unwoven cloth, or other laminate. Examples of the laminates are a crystalline polypropylene/the present resin composition, a crystalline polypropylene/the present resin composition/a crystalline polypropylene and a crystalline polypropylene/the present resin composition/a polyethylene; and such laminates can reduce the surface tackiness of the present resin composition or can improve the surface hardness of the present resin composition. Said laminates can further have thereon a layer of good-gas-barrier resin [e.g. Eval (trade name) manufactured by KURARAY Co., Ltd.] to impart selective gas permeability, whereby a multi-layered film, a multi-layered sheet or a multi-layered bottle can be obtained.

The present resin composition can also be used as a foamed material. The molded articles obtained from the present resin composition can be subjected to known surface treatments such as coating, vapor deposition and the like.

The present invention is hereinafter described in detail by way of Examples. However, the present invention is by no means restricted by the Examples.

In the Examples, melting point was measured by using a differential scanning calorimeter, under the conditions of temperature elevation rate = 10 °C/min and helium flow rate = 100 ml/min.

Examples 1-4

As the amorphous polyolefin [the component (a)], there was used REXTAC RT 2780 (trade name) which was a propylene/butene-1 copolymer manufactured by U.S. Rexene Co., having a propylene/butene-1 weight ratio of 65/35, a number- average molecular weight Mn of 6,500, a heat of crystal fusion of 7.2 Joule/g and a n-heptane insoluble of 5% by weight. As the crystalline polypropylene [the component (b)], there was used POLYPROPYLENE RF 355B (trade name) which was a polypropylene manufactured by Ube Industries, Ltd., having an MFR of 2.7 and an ethylene content of 4% by weight. The two components were melt-mixed in component ratios shown in Table 1, in a stainless steel beaker heated at 180° C, to obtain resin compositions.

The resin compositions were measured for Shore D hardness Hs (23° C), tensile modulus (80° C) and melting point by the methods mentioned above. The results are shown in Table 1.

Table 1

	Example			
	1	2	3	4
Component ratio (% by weight)				
Component (a): RT2780	80	60	40	20
Component (b): RF355B	20	40	60	80
Properties				
Melting point (°C)	138	138	138	138
Hs (23°C)	16	28	42	53
Tensile modulus (80°C) (kg/cm²)	45	164	520	1355
Function				
y	1.6532	2.2148	2.7160	3.1319
0.04163Hs + 0.8665	1.5326	2.0321	2.6150	3.0729

Examples 5-8

Resin compositions were obtained in the same manner as in Example 1 except that as the component (a), there was used REXTAC RT2585 (trade name) which was a propylene/ethylene copolymer manufactured by U.S. Rexene Co., having a propylene/ethylene weight ratio of 85/15, a number-average molecular weight Mn of 7,100, a heat of crystal fusion of 4.7 Joule/g and a n-heptane insoluble of 0.7% by weight and, as the component (b), there was used FM801 (trade name) which was a polypropylene manufactured by Union Polymer K.K., having an MFR of 9 and an ethylene content of 5.7% by weight and that the two components were used in ratios shown in Table 2.

The resin compositions were measured for Shore D hardness Hs (23°C), tensile modulus (80°C) and melting point in the same manners as in Example 1. The results are shown in Table 2.

Table 2

	Example			
	5	6	7	8
Component ratio (% by weight)				
Component (a): RT2585	80	60	40	20
Component (b): FM801	20	40	60	80
Properties				
Melting point (°C)	132	132	132	132
Hs (23°C)	13	24	33	47
Tensile modulus (80°C) (kg/cm^2)	46	176	451	1083
Function				
y	1.6628	2.2455	2.6542	3.0346
0.04163Hs + 0.8665	1.4077	1.8656	2.2403	2.8231

Examples 9-12

Resin compositions were obtained in the same manner as in Example 1 except that REXTAC RT2780 used in Example 1 was used as the component (a) and FM801 used in Example 5 was used as the component (b) and that the two components were used in ratios shown in Table 3.

The resin compositions were measured for Shore D hardness Hs (23°C), tensile modulus (80°C) and melting point in the same manners as in Example 1. The results are shown in Table 3.

Table 3

	Example			
	9	10	11	12
Component ratio (% by weight)				
Component (a): RT2780	80	60	40	20
Component (b): FM801	20	40	60	80
Properties				
Melting point (°C)	132	132	132	132
Hs (23°C)	12	29	41	50
Tensile modulus (80°C) (kg/cm^2)	40	145	439	1127
Function				
y	1.6021	2.1614	2.6425	3.0519
0.04163Hs + 0.8665	1.3661	2.0738	2.5733	2.9480

Comparative Example 1

A sheet of 2 mm in thickness was prepared from POLYPROPYLENE RF 355B [used in Example 1 as the component (B)] alone, in the same manner as in the test piece preparation mentioned above with respect to the test methods for Shore D hardness (23° C) and tensile modulus (80° C).

Using the sheet, Shore D hardness Hs (23° C), tensile modulus (80° C) and melting point were measured in the same manners as in Example 1. The results are shown in Table 4.

Comparative Examples 2-3

Resin compositions were obtained in the same manner as in Example 1 except that the component (a)/component (b) ratios were as shown in Table 4.

The resin compositions were measured for Shore D hardness Hs (23° C), tensile modulus (80° C) and melting point in the same manners as in Example 1. The results are shown in Table 4.

Comparative Example 4

A sheet of 2 mm in thickness was prepared from FM801 [used in Example 5 as the component (B)] alone, in the same manner as in the test piece preparation mentioned above with respect to the test methods for Shore D hardness (23° C) and tensile modulus (80° C).

Using the sheet, Shore D hardness Hs (23°C), tensile modulus (80°C) and melting point were measured in the same manners as in Example 1. The results are shown in Table 4.

Table 4

	Comparative Example			
	1	2	3	4
Component ratio (% by weight)				
Component (a)	-	RT2780	RT2780	-
		10	90	
Component (b)	RF355B	RF355B	RF355B	FM801
	100	90	10	100
Properties				
Melting point (°C)	138	138	138	132
Hs (23°C)	62	58	8	60
Tensile modulus (80°C) (kg/cm^2)	2500	2000	24	1938
Function				
y	3.3979	3.3010	1.3802	3.2874
0.04163Hs + 0.8665	3.4476	3.2810	1.8656	3.3643

Comparative Examples 5-10

Sheets of 2 mm in thickness were prepared using only one of the following resins, in the same manner as in Comparative Example 1.

Z517 (trade name), a very low-density polyethylene manufactured by Ube Industries, Ltd., of MI = 2.0 g/10 min and density = 0.906 g/cm³ (Comparative Example 5)

640UF (trade name), a high-density polyethylene manufactured by Idemitsu Petrochemical K.K., of MI = 0.05 g/10 min and density = 0.955 g/cm³ (Comparative Example 6)

FA120N (trade name), linear low-density polyethylene manufactured by Ube Industries, Ltd., of MI = 1.0 g/10 min and density = 0.920 g/cm³ (Comparative Example 7)

L719 (trade name), a low-density polyethylene manufactured by Ube Industries, Ltd., of MI = 7.5 g/10 min and density = 0.918 g/cm³ (Comparative Example 8)

V315 (trade name), an ethylene/vinyl acetate copolymer manufactured by Ube Industries, Ltd., of MI = 17 g/10 min and vinyl acetate content = 15% by weight (Comparative Example 9)

J109 (trade name), a homopolypropylene manufactured by Ube Industries, Ltd., of MFR = 9 g/10 min (Comparative Example 10)

Using the sheets, Shore D hardness Hs (23°C), tensile modulus (80°C) and melting point were measured in the same manners as in Example 1. The results are shown in Table 5.

Table 5

	Comparative Example					
	5	6	7	8	9	10
Resin component	Z517	640UF	FA120N	L719	V315	J109
Properties						
Melting point (°C)	114	130	123	109	90	167
Hs (23°C)	36	59	49	46	34	70
Tensile modulus(80°C) (kg/cm²)	177	2282	663	188	152	6065
Function						
y	2.2480	3.3583	2.8215	2.2742	2.1818	3.7828
0.04163Hs + 0.8665	2.3652	3.3227	2.8614	2.7815	2.2819	3.7806

As is clear from the above Examples, the resin compositions of the present invention have flexibility at normal temperature and a tensile modulus of 30 kg/cm² or more at 80°C.

Based on the above Examples and Comparative Examples, the relation of (a) Shore D hardness (23°C) and (b) tensile modulus (80°C) is shown in Fig. 1 by taking the abscissa for (a) and the ordinate (expressed in logarithm) for (b). It is appreciated from Fig. 1 that the resin compositions of the present invention satisfy the formulas (1) and (2) shown above and are well balanced in flexibility and mechanical strength.

Incidentally, in each of Tables 1-5 are shown the common logarithm of tensile modulus (80°C) and the right side [0.04163Hs (23°C) + 0.8665] of the above formula (2) corresponding to the straight line Z in Fig. 1.

The claims defining the invention are as follows:

1. A resin composition comprising:

(a) 20 - 80% by weight of an amorphous polyolefin having a propylene and/or butene-1 component content of 50% by weight or more, and a boiling n-heptane insoluble content of 10% by weight or less, and

(b) 80 - 20% by weight of a crystalline polypropylene, wherein the Shore D hardness Hs (23°C) and the common logarithm y of the tensile modulus (80°C) satisfy the following formulas (1) and (2):

$$10 \leq Hs\ (23^{\circ}C) \leq 55 \qquad (1)$$

$$y \geq 0.04163Hs\ (23^{\circ}C) + 0.8665 \qquad (2)$$

2. A resin composition according to Claim 1, wherein the amorphous polyolefin is a propylene/ethylene copolymer having a maximum ethylene component content of 30% by weight.

3. A resin composition according to Claim 1, wherein the amorphous polyolefin is a propylene/butene-1 copolymer having a butene-1 component content of 1-50% by weight.

4. A resin composition according to Claim 1, wherein the amorphous polyolefin is a propylene/butene-1/ethylene terpolymer.

5. A resin composition according to Claim 1, wherein the amorphous polyolefin is a propylene/ethylene copolymer having a heat of crystal fusion of 20 Joule/g or less.

6. A resin composition according to Claim 1, wherein the amorphous polyolefin is a propylene/butene-1 copolymer having a heat of crystal fusion of less than 10 Joule/g.

7. A resin composition according to claim 1 substantially as hereinbefore described with reference to any one or more of the drawings or examples.

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