

DESCRIPTION

Title of the Invention: MULTILAYER FILM AND LIQUID AGENT
CONTAINER

5

Technical Field

[0001]

The present invention relates to a multilayer film and
a liquid agent container formed of the multilayer film.

10 Background Art

[0002]

In recent years, a medical solution bag formed of a
flexible plastic film has become the mainstream of a
container for containing a medical solution such as infusion.

15 This type of medical solution bag has an advantage of being
easy to handle and easy to discard. Since this type of
medical solution bag comes into direct contact with the
medical solution, a bag formed of a polyolefin such as
polyethylene or polypropylene, whose safety has been

20 established, is widely used.

[0003]

A film for forming a liquid agent container such as a
medical solution bag has been improved from various
viewpoints in the conventional art.

For example, a container for containing a liquid agent such as infusion is subjected to high-pressure steam sterilization in a high temperature state, and thus, heat resistance is required. For this reason, a medical laminate
5 film using polybutylene terephthalate in an outer layer has been proposed (Patent Literature 1).

[0004]

In addition, a multilayer film using a cyclic polyolefin as an intermediate layer has also been proposed
10 for the purpose of preventing air from entering a container from the outside through a film and moisture in the container from leaking to the outside through the film during long-term storage of a container formed of a film containing a liquid agent such as infusion, that is, for the purpose of improving
15 gas shielding properties and moisture shielding properties (Patent Literature 2).

[0005]

Furthermore, in order to provide a pharmaceutical heat-resistant container that is excellent in heat
20 resistance, transparency, and flexibility, a pharmaceutical container or a multilayer pharmaceutical container formed of an ethylene-based resin composition whose residual crystallinity at a sterilization temperature is specified has also been proposed (Patent Literatures 3 and 4).

Citation List

Patent Literature

[0006]

5 Patent Literature 1: WO 2012/8007 A

Patent Literature 2: JP 2002-301796 A

Patent Literature 3: JP 2008-253478 A

Patent Literature 4: JP 2013-81494 A

10 Summary of Invention

Technical Problem

[0007]

As a result of intensive studies, the present
inventors have found that when polybutylene terephthalate is
15 used in an outer layer of a multilayer film for forming a
liquid agent container, there is a problem that a component
derived from the polybutylene terephthalate permeates the
multilayer film and is eluted into a content liquid.

[0008]

20 In view of such problems in the conventional art, a
first object of the present invention is to provide a liquid
agent container formed of a multilayer film using
polybutylene terephthalate in one layer (for example, an
outer layer), in which it is controlled or prevented that a

component derived from the polybutylene terephthalate permeates the multilayer film and is eluted into a content liquid, and a multilayer film for forming such a liquid agent container.

5 [0009]

In addition, a second object of the present invention is to provide a liquid agent container that is excellent in heat resistance, transparency, and impact resistance, and a multilayer film for forming such a liquid agent container.

10

Solution to Problem

[0010]

The present invention relates to the following [1] to [9].

15 [1]

A multilayer film comprising at least:

a layer (1) comprising polybutylene terephthalate,
a layer (2) comprising a cyclic olefin-based polymer,
a flexible layer (3) comprising an ethylene-based

20 resin, and

a layer (4) comprising a polyolefin, which are laminated,

wherein the layer (1), the layer (2), and the layer (4) forming one surface of the multilayer film are laminated

in this order.

[0011]

[2]

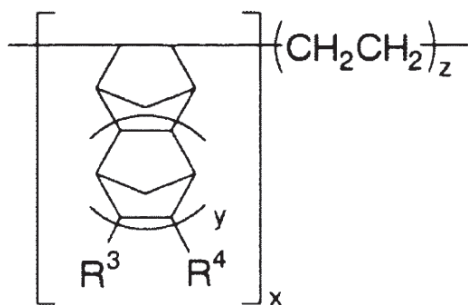
The multilayer film according to [1], wherein the
 5 cyclic olefin-based polymer has a glass transition
 temperature of 80 to 145°C.

[0012]

[3]

The multilayer film according to [1] or [2], wherein
 10 the cyclic olefin-based polymer has a structural unit
 represented by the following General Formula (2):

[0013]



... (2)

wherein in Formula (2), R^3 and R^4 are each independently a
 15 hydrogen atom or a hydrocarbon group having 1 to 5 carbon
 atoms, and may be bonded to each other to form a ring,

x is an integer of 1 or more, y is an integer of 0 or
 1 or more, and z is an integer of 1 or more.

[0014]

20

[4]

The multilayer film according to any one of [1] to [3], wherein in an endothermic curve obtained by differential scanning calorimetry of the ethylene-based resin, the following requirements [a], [b], and [c] are satisfied:

5 [a]: when $t = 107^{\circ}\text{C}$, $H_t = 55$ to 75% ,

 [b]: when $t = 121^{\circ}\text{C}$, $H_t = 65$ to 80% , and

 [c]: when $t = 127^{\circ}\text{C}$, $H_t = 70$ to 95% ,

wherein in [a], [b], and [c], H_t is the amount of melted component calculated by an equation: $H_t = ht/\Delta H_m$ by

10 determining the total heat of fusion (ΔH_m) and a heat of fusion (ht) observed from the melting start temperature to $t^{\circ}\text{C}$ from the endothermic curve observed at the second temperature increase by heating the ethylene-based resin from -20°C to 230°C at a temperature increasing rate of $10^{\circ}\text{C}/\text{min}$
15 in a nitrogen atmosphere and holding the ethylene-based resin at this temperature for 10 minutes, cooling the ethylene-based resin to 30°C at a temperature decreasing rate of $10^{\circ}\text{C}/\text{min}$ and holding the ethylene-based resin at this temperature for 1 minute, and then, heating the ethylene-based resin to 230°C at a temperature increasing rate of $10^{\circ}\text{C}/\text{min}$ by a differential scanning calorimeter.

[0015]

[5]

The multilayer film according to any one of [1] to

[4], wherein the ethylene-based resin has a melt flow rate (190°C, load: 2.16 kg) of 0.01 to 10 g/10 min.

[0016]

[6]

5 The multilayer film according to any one of [1] to [5], wherein the polyolefin satisfies the following requirements [d] and [e]:

 requirement [d]: the density is 0.900 to 0.960 kg/cm³,
and

10 requirement [e]: the melt flow rate (190°C, load: 2.16 kg) is 0.1 to 10 g/10 min.

[0017]

[7]

 The multilayer film according to any one of [1] to [6], wherein the polyolefin is a mixture of polyethylene and
15 polypropylene.

[0018]

[8]

 The multilayer film according to any one of [1] to [7], wherein the layer (1), the layer (3), the layer (2), the
20 layer (3), and the layer (4) are laminated in this order.

[0019]

[9]

A liquid agent container formed of the multilayer film

according to any one of [1] to [8] so that the layer (4) is formed as the innermost layer.

Advantageous Effects of Invention

5 [0020]

By using the multilayer film of the present invention, it is possible to produce a liquid agent container in which it is controlled or prevented that a component derived from polybutylene terephthalate permeates the multilayer film and
10 is eluted into a content liquid while polybutylene terephthalate is used in one layer (for example, an outer layer) of the multilayer film.

Furthermore, the liquid agent container formed of the multilayer film according to [4] is particularly excellent in
15 heat resistance, transparency, and impact resistance.

Description of Embodiments

[0021]

Hereinafter, the present invention will be more
20 specifically described.

[Multilayer Film]

The multilayer film according to the present invention includes at least:

a layer (1) including polybutylene terephthalate,

a layer (2) including a cyclic olefin-based polymer,
a flexible layer (3) including an ethylene-based
resin, and

a layer (4) including a polyolefin, which are
5 laminated,

wherein the layer (1), the layer (2), and the layer
(4) forming one surface of the multilayer film are laminated
in this order.

[0022]

10 (1) Layer Including Polybutylene Terephthalate:

The layer (1) is a layer including polybutylene
terephthalate.

As the polybutylene terephthalate, polybutylene
terephthalate known in the conventional art can be used.

15 Specific examples of a commercially available product include
"NOVADURAN (registered trademark)" manufactured by Mitsubishi
Engineering-Plastics Corporation.

[0023]

The melt volume flow rate (in accordance with ISO
20 1133, 250°C, load: 2.16 kg) of the polybutylene terephthalate
is preferably 1 to 30 cm³/10 min from the viewpoint of
formability of the film.

[0024]

The bending elastic modulus (in accordance with ISO

The layer (1) may contain a small amount of a component derived from polybutylene terephthalate or a component derived from, for example, 1,4-butanediol used in production of polybutylene terephthalate (for example, a compound represented by the following formula).

[0027]

The thickness of the layer (1) is preferably 1 μm or more from the viewpoint of stably forming the multilayer film, and is preferably 50 μm or less from the viewpoint of not lowering strength of the liquid agent container formed of

the multilayer film.

[0028]

(2) Layer Including Cyclic Olefin-Based Polymer:

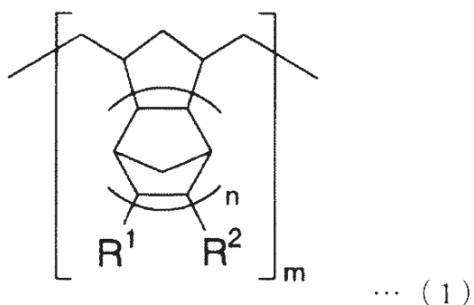
The layer (2) is a layer including a cyclic olefin-
5 based polymer.

As the cyclic olefin-based polymer, a cyclic olefin-
based polymer known in the conventional art can be used.

Specific examples thereof include a polymer having a
structural unit represented by the following General Formula

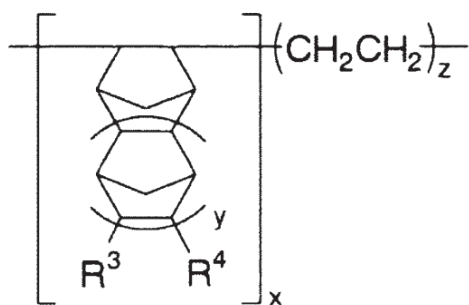
10 (1) and/or the following General Formula (2):

[0029]



wherein in Formula (1), R¹ and R² are each independently a
hydrogen atom or a hydrocarbon group having 1 to 10 carbon
15 atoms, and may be bonded to each other to form a ring, m is
an integer of 1 or more, and n is an integer of 0 or 1 or
more,

[0030]



... (2)

wherein in Formula (2), R^3 and R^4 are each independently a hydrogen atom or a hydrocarbon group having 1 to 5 carbon atoms, and may be bonded to each other to form a ring, x is an integer of 1 or more, y is an integer of 0 or 1 or more, and z is an integer of 1 or more.

[0031]

General Formula (2) represents that x number of structural units derived from a cyclic olefin and z number of structural units derived from ethylene are present in the polymer, and does not always represent a block copolymer composed of a block having x number of structural units derived from a cyclic olefin and a block having z number of structural units derived from ethylene.

[0032]

The polymer having a structural unit represented by General Formula (1) is a saturated polymer produced by hydrogenating a ring-opening polymer by a general hydrogenation method, the ring-opening polymer being obtained by polymerizing monomers selected from, for example,

norbornene and an alkyl and/or alkylidene substitution thereof (for example, 5-methyl-2-norbornene, 5,6-dimethyl-2-norbornene, 5-ethyl-2-norbornene, 5-butyl-2-norbornene, or 5-ethylidene-2-norbornene) (hereinafter, also referred to as a
 5 "norbornene-based monomer");

cyclopentadiene, 2,3-dihydrodicyclopentadiene, and an alkyl (for example, methyl, ethyl, propyl, and butyl) substitution thereof such as;

methanooctahydronaphthalene and an alkyl and/or
 10 alkylidene substitution thereof (for example, 6-methyl-1,4:5,8-dimethano-1,4,4a,5,6,7,8,8a-octahydronaphthalene, 6-ethyl-1,4:5,8-dimethano-1,4,4a,5,6,7,8,8a-octahydronaphthalene, or 6-ethylidene-1,4:5,8-dimethano-1,4,4a,5,6,7,8,8a-octahydronaphthalene); and

15 a trimer or tetramer of cyclopentadiene (for example, 4,9:5,8-dimethano-3a,4,4a,5,8,8a,9,9a-octahydro-1H-benzoindene, 5,8-methano-3a,4,4a,5,8,8a,9,9a-octahydro-1H-benzoindene, 5,8-methano-1,4,4a,4b,5,8,8a,9b-octahydro-1H-fluorene, or 4,11:5,10:6,9-trimethano-
 20 3a,4,4a,5,5a,6,9,9a,10,10a,11,11a-dodecahydro-1H-cyclopentanthracene)

by a known ring-opening polymerization method.

[0033]

The polymer having a structural unit represented by

General Formula (2) is a polymer obtained by copolymerizing the norbornene-based monomer and ethylene by a known method and/or a hydrogenated product thereof, both of which are saturated polymers.

5 [0034]

Examples of the cyclic olefin-based polymer having a structural unit represented by General Formula (1) include "ZEONOR (registered trademark)" manufactured by ZEON CORPORATION as a commercially available product.

10 Examples of the cyclic olefin-based polymer having a structural unit represented by General Formula (2) include "APEL (registered trademark)" manufactured by Mitsui Chemicals, Inc. and "TOPAS (registered trademark)" manufactured by TOPAS ADVANCED POLYMERS GmbH as commercially
15 available products.

[0035]

From the viewpoint of preventing permeation of an eluate derived from polybutylene terephthalate constituting the layer (1), a cyclic olefin-based polymer having a
20 structural unit represented by General Formula (2) is particularly preferable.

[0036]

A glass transition temperature (T_g) of the cyclic olefin-based polymer measured by the following method is

preferably 80°C or higher and more preferably 100°C or higher from the viewpoint of preventing permeation of an eluate derived from polybutylene terephthalate constituting the layer (1), and is preferably 145°C or lower and more preferably 135°C or lower from the viewpoint of not decreasing the flexibility of the liquid agent container formed of the multilayer film.

[0037]

<Method for Measuring Glass Transition Temperature>

10 Using a differential scanning calorimeter, about 10 mg of a sample is heated from 30°C to 200°C at a temperature increasing rate of 50°C/min in a nitrogen atmosphere, and held at this temperature for 10 minutes. Furthermore, the sample is cooled to -100°C at a temperature decreasing rate
15 of 10°C/min, held at this temperature for 5 minutes, and then heated to 200°C at a temperature increasing rate of 10°C/min. At the second temperature increase, a DSC curve is bent due to a change in specific heat, and a baseline is sensed in a parallel movement manner. The temperature at the
20 intersection of the tangent line of the baseline on the lower temperature side than the bending temperature and the tangent line at the point where the inclination is maximized at the bent portion is defined as a glass transition temperature (Tg).

[0038]

The molecular weight of the cyclic olefin-based polymer measured by gel permeation analysis using toluene as a solvent is preferably 10,000 to 100,000 and more preferably 10,000 to 80,000.

The thickness of the layer (2) is preferably 5 μm or more from the viewpoint of stably forming the multilayer film, and is preferably 20 μm or less from the viewpoint of the transparency of the multilayer layer.

10 [0039]

The layer (2) may contain a resin other than the cyclic polyolefin in order to enhance weldability with an adjacent layer. Examples of such a resin include a polyolefin used in the layer (4) including a polyolefin described below.

[0040]

(3) Flexible Layer Including Ethylene-Based Resin:

The flexible layer (3) is a layer including an ethylene-based resin.

20 Examples of the ethylene-based resin include low-density polyethylene, linear low-density polyethylene, medium-density polyethylene, and high-density polyethylene. These ethylene-based resins may be used alone or in combination of two or more thereof.

[0041]

The ethylene-based resin is preferably a mixture of high-density polyethylene and linear low-density polyethylene from the viewpoint of heat resistance, transparency, and impact resistance. A value of (mass of high-density polyethylene)/(mass of linear low-density polyethylene) in the mixture is, for example, 95/5 to 5/95, and preferably 10/90 to 50/50. In addition, the high-density polyethylene in the mixture is preferably an ethylene homopolymer.

10 [0042]

Examples of the method for producing these ethylene-based resins include a slurry method, a solution method, and a gas phase method. When the ethylene-based resin is produced by these methods, examples of an olefin polymerization catalyst to be used include a magnesium chloride-supported titanium catalyst, a Phillips catalyst, and a metallocene catalyst.

15

[0043]

The density of the ethylene-based resin is preferably 955 to 900 kg/m³ and more preferably 930 to 905 kg/m³.

20

In addition, the melt flow rate (in accordance with ASTM D1238, 190°C, load: 2.16 kg) of the ethylene-based resin is preferably 0.01 to 10 g/10 min and more preferably 0.1 to 2 g/10 min.

[0044]

In an endothermic curve obtained by differential scanning calorimetry of the ethylene-based resin, the following requirements [a], [b], and [c] are preferably
5 satisfied.

[a]: when $t = 107^{\circ}\text{C}$, $H_t = 55$ to 75% .

[b]: when $t = 121^{\circ}\text{C}$, $H_t = 65$ to 80% .

[c]: when $t = 127^{\circ}\text{C}$, $H_t = 70$ to 95% .

In [a], [b], and [c], H_t is the amount of melted component
10 calculated by an equation: $H_t = ht/\Delta H_m$ by determining the total heat of fusion (ΔH_m) and a heat of fusion (ht) observed from the melting start temperature to $t^{\circ}\text{C}$ from the endothermic curve observed at the second temperature increase by heating the ethylene-based resin from -20°C to 230°C at a
15 temperature increasing rate of $10^{\circ}\text{C}/\text{min}$ in a nitrogen atmosphere and holding the ethylene-based resin at this temperature for 10 minutes, cooling the ethylene-based resin to 30°C at a temperature decreasing rate of $10^{\circ}\text{C}/\text{min}$ and holding the ethylene-based resin at this temperature for 1
20 minute, and then, heating the ethylene-based resin to 230°C at a temperature increasing rate of $10^{\circ}\text{C}/\text{min}$ by a differential scanning calorimeter.

[0045]

When the ethylene-based resin satisfies the

requirements [a], [b], and [c], a liquid agent container formed of the multilayer film of the present invention does not cause deformation such as large wrinkles even when being sterilized under a high temperature condition of 121°C, has
5 sufficient heat resistance, has a high transmittance of 55% or more at a wavelength of 450 nm as measured by Ultraviolet-Visible absorption spectroscopy described in Transparency Test Method 1 of Japanese Pharmacopoeia (17th revision) after sterilization, further prevents leakage of a content solution
10 due to falling bag, and is excellent in impact resistance.
[0046]

The ethylene-based resin satisfying the requirements [a], [b], and [c] can be produced, for example, by appropriately adjusting, for example, a ratio of the high-
15 density polyethylene and the linear low-density polyethylene, and the density or the melting point of the linear low-density polyethylene, when producing a mixture of the high-density polyethylene and the linear low-density polyethylene described above.
20 [0047]

The thickness of the flexible layer (3) is preferably 5 μm or more from the viewpoint of stably forming the multilayer film, and is preferably 200 μm or less from the viewpoint of the transparency of the multilayer layer.

[0048]

(4) Layer Including Polyolefin:

The layer (4) is a layer including a polyolefin.

However, the layer (4) usually contains neither polybutylene
5 terephthalate nor a cyclic olefin-based polymer.

[0049]

As the polyolefin, a polyolefin used in the
conventional art in the innermost layer of the liquid agent
container formed of a multilayer film can be used.

10 Examples of the polyolefin include an ethylene-based
polymer and a propylene-based polymer.

[0050]

The polyolefin may be various polyolefins, for
example, a mixture of the ethylene-based polymer and the
15 propylene-based polymer.

The density (in accordance with ASTM D1505, 23°C) of
the polyolefin is, for example, 900 to 960 kg/m³, and
preferably 920 to 950 kg/m³ (requirement [d]).

[0051]

20 The melt flow rate (in accordance with ASTM D1238,
190°C, load: 2.16 kg) of the polyolefin is, for example, 0.1
to 10 g/10 min, and preferably 1 to 10 g/10 min (requirement
[e]).

[0052]

Examples of the ethylene-based polymer include HI-ZEX (registered trademark) 65150B and ULTZEX (registered trademark) 4020B (all manufactured by Prime Polymer Co., Ltd.) as commercially available products.

5 [0053]

Examples of the propylene-based polymer include Prime Polypro (registered trademark) J102WA (manufactured by Prime Polymer Co., Ltd.) as a commercially available product.

The ethylene-based polymer is a polymer whose main
10 structural unit is a structural unit derived from ethylene (hereinafter, referred to as an "ethylene unit"). Examples of the ethylene-based polymer include an ethylene homopolymer and an ethylene- α -olefin random copolymer having a small amount, for example, 10 mol% or less, and preferably 5 mol%
15 or less of structural unit(s) derived from α -olefin(s) having 3 to 20 carbon atoms.

[0054]

The melt flow rate (in accordance with ASTM D1238, 190°C, load: 2.16 kg) of the ethylene-based polymer is, for
20 example, 0.1 to 20 g/10 min, and preferably 1 to 10 g/10 min.

[0055]

The density (in accordance with ASTM D1505, 23°C) of the ethylene-based polymer is, for example, 900 to 960 kg/m³, and preferably 920 to 950 kg/m³.

The propylene-based polymer is a polymer whose main structural unit is a structural unit derived from propylene (hereinafter, referred to as a "propylene unit"). Examples of the propylene-based polymer include a propylene
5 homopolymer and a propylene- α -olefin random copolymer having a small amount, for example, 10 mol% or less, and preferably 5 mol% or less of structural unit(s) derived from α -olefin(s) having 2 or 4 to 20 carbon atoms.

[0056]

10 The melt flow rate (in accordance with ASTM D1238, 230°C, load: 2.16 kg) of the propylene-based polymer is, for example, 0.1 to 20 g/10 min, and preferably 1 to 10 g/10 min.

The thickness of the layer (4) is preferably 5 μm or more from the viewpoint of stably forming the multilayer
15 film, and is preferably 50 μm or less from the viewpoint of the transparency of the multilayer layer.

[0057]

(Multilayer Film)

In the multilayer film according to the present
20 invention, at least the layer (1), the layer (2), the flexible layer (3), and the layer (4) are laminated, and the layer (1), the layer (2), and the layer (4) forming one surface of the multilayer film are laminated in this order.

[0058]

By using the multilayer film of the present invention, it is possible to produce a liquid agent container in which it is controlled or prevented that a component derived from polybutylene terephthalate permeates the multilayer film and
5 is eluted into a content liquid while polybutylene terephthalate is used in one layer (for example, an outer layer) of the multilayer film. In addition, the multilayer film of the present invention is also particularly excellent in heat resistance, transparency, and impact resistance when
10 the flexible layer (3) satisfies the requirements [a], [b], and [c].

[0059]

Examples of the layer configuration of the multilayer film of the present invention include a configuration in
15 which the layer (1), the layer (2), the flexible layer (3), and the layer (4) are laminated in this order, and a configuration in which the layer (1), the flexible layer (3), the layer (2), the flexible layer (3), and the layer (4) are laminated in this order. Among these configurations, from
20 the viewpoint of improving the strength of the liquid agent container formed of the multilayer film according to the present invention, the configuration in which the layer (1), the flexible layer (3), the layer (2), the flexible layer (3), and the layer (4) are laminated in this order is

preferable.

[0060]

A film formed of a resin such as polyethylene terephthalate, polyethylene naphthalate, polyamide, polypropylene, polyethylene, or an ethylene-vinyl alcohol copolymer, a film obtained by vapor-depositing, for example, an inorganic oxide on the film formed of these resins, or a metal foil such as aluminum may be laminated on a surface of the multilayer film according to the present invention opposite to the layer (4) forming one surface of the multilayer film.

[0061]

An adhesive layer for enhancing adhesiveness between layers may be provided between adjacent layers. For example, the layer (1) and the flexible layer (3) may be adjacent to each other with the adhesive layer interposed therebetween. The adhesive layer may be a layer including an adhesive resin.

[0062]

The thickness of the multilayer film according to the present invention is appropriately set according to the application, for example, in a case of forming a liquid agent container formed of the multilayer film according to the present invention, according to the strength and flexibility

required for the liquid agent container, the thickness of the multilayer film is usually 100 to 300 μm , and preferably 100 to 200 μm .

[0063]

5 (Method for Producing Multilayer Film)

The multilayer film according to the present invention can be produced by a conventionally known method except that the materials described above are used as the materials of the respective layers, for example, a water-cooled or air-cooled co-extrusion inflation method, a co-extrusion T-die method, a dry lamination method, or an extrusion lamination method. Among these methods, a water-cooled co-extrusion inflation method and a co-extrusion T-die method are preferable from the viewpoint of transparency and hygiene.

15 [0064]

[Liquid Agent Container]

The liquid agent container of the present invention is formed of the multilayer film of the present invention described above so that the layer (4) is formed as the innermost layer, that is, so that the layer (4) is a surface to be contacted with contents.

[0065]

According to the liquid agent container of the present invention, while polybutylene terephthalate is used in one

layer (for example, the outer layer) of the multilayer film forming the liquid agent container, it is controlled or prevented that the component derived from polybutylene terephthalate permeates the multilayer film and is eluted
5 into the content liquid. In addition, the liquid agent container of the present invention is also particularly excellent in heat resistance, transparency, and impact resistance when the flexible layer (3) satisfies the requirements [a], [b], and [c].

10 [0066]

The liquid agent container of the present invention can be produced by superposing the layers (4) of two multilayer films of the present invention on each other and performing thermocompression bonding on peripheral edges
15 thereof.

In addition, for example, the multilayer film of the present invention can also be formed by forming the multilayer film of the present invention into a bag shape by an inflation method so that the layer (4) is formed as a
20 surface in contact with the contents, and performing thermocompression bonding on peripheral edges of the obtained bag-shaped multilayer film of the present invention.

[0067]

As conditions for the thermocompression bonding, for

example, the temperature is preferably 130 to 200°C, and more preferably 150 to 180°C, the pressure is preferably 0.1 to 0.8 MPa, and more preferably 0.15 to 0.5 MPa, and the pressurization time is preferably 1 to 5 seconds, and more preferably 1.5 to 3 seconds.

[0068]

The liquid agent container of the present invention may be provided with a cylindrical member as a member for allowing a liquid agent such as a medical solution contained inside the liquid agent container to flow out to the outside of the liquid agent container or allowing the medical solution to flow from the outside of the liquid agent container to the inside of the liquid agent container.

[0069]

Furthermore, the liquid agent container of the present invention may be a multi-chamber container in which an easily-peelable seal portion is formed and the seal is peeled off at the time of use to mix the contents.

As the method in a case of sterilizing the liquid agent container of the present invention, a method performed in the conventional art can be applied, and examples thereof include a method including putting a medical solution and other contents in the liquid agent container, sealing the liquid agent container, and then sterilizing the liquid agent

container.

[0070]

Examples of a sterilization treatment method include known heat sterilization methods such as high-pressure steam
5 sterilization and hot water shower sterilization.

The sterilization treatment temperature in the heat sterilization treatment is generally about 105 to 110°C. The sterilization treatment temperature may be set to 118 to 121°C in accordance with the type, usage, and use environment
10 of the medical solution. When the flexible layer (3) satisfies the requirements [a], [b], and [c] described above, the liquid agent container of the present invention is particularly excellent in heat resistance, and does not undergo deformation such as large wrinkles even when
15 sterilized at 121°C.

Examples

[0071]

Hereinafter, the present invention will be described
20 in more detail based on Examples, but the present invention is not limited to these Examples.

<Method for Measuring Resin Physical Properties>

Physical properties of resins used in Examples, for example, were measured by the following methods.

[0072]

[Melt Flow Rate (MFR)]

The melt flow rate was measured in accordance with
ASTM D1238E at a load of 2.16 kg. The measurement
5 temperature was 190°C or 230°C.

[0073]

[Density]

The density was measured at 23°C according to ASTM
D1505.

10 [0074]

[Melting Point (T_m) and Amount of Melted Component
(H_t)]

Using a differential scanning calorimeter (DSC-7,
manufactured by PerkinElmer Co., Ltd.), about 5 mg of a
15 sample was packed in an aluminum pan, heated from -20°C to
230°C at a temperature increasing rate of 10°C/min in a
nitrogen atmosphere, and held at this temperature for 10
minutes. Next, the sample was cooled to 30°C at a
temperature decreasing rate of 10°C/min, held at this
20 temperature for 1 minute, and then heated to 230°C at a
temperature increasing rate of 10°C/min.

[0075]

Furthermore, in an endothermic curve observed at the
second temperature increase described above, the total heat

of fusion (ΔH_m) and the heat of fusion (h_t) observed from the melting start temperature to $t^\circ\text{C}$ were measured, and the amount of melted component (H_t) was calculated by the following equation.

5
$$H_t = h_t / \Delta H_m$$

[0076]

<Resin Used>

In Examples and the like, the following resins (1) to (4-5) were used as raw materials for the respective layers of the multilayer film. Representative physical properties or
10 trade names are shown.

(1) Polybutylene Terephthalate

Resin (1-1): NOVADURAN (registered trademark) 5505S
(manufactured by Mitsubishi Chemical Corporation)

15 (2) Cyclic Olefin-Based Polymer

Resin (2-1): APEL (registered trademark) 6011T (glass transition temperature: 105°C , manufactured by Mitsui Chemicals, Inc.)

Resin (2-2): TOPAS (registered trademark) 5013S-4
20 (glass transition temperature: 134°C , manufactured by TOPAS ADVANCED POLYMERS GmbH)

(3) Ethylene-Based Resin Composition

Resin (3-1): Ethylene-based resin composition prepared by mixing 20 parts by mass of high-density polyethylene

(ethylene homopolymer) and 80 parts by mass of an ethylene- α -olefin copolymer (linear low-density polyethylene) so that:

the density was 912 kg/m³,

the melt flow rate (190°C, load: 2.16 kg) was 0.5 g/10

5 min, and

the amount of melted component (Ht) was 71% when t = 107°C, 79% when t = 121°C, and 95% when t = 127°C.

(4) Polyolefins

Resin (4-1): Polyethylene (density: 937 kg/m³, MFR
10 (190°C, load: 2.16 kg): 2 g/10 min)

Resin (4-2): Polyethylene (density: 957 kg/m³, MFR
(190°C, load: 2.16 kg): 1 g/10 min)

Resin (4-3): Polyethylene (density: 959 kg/m³, MFR
(190°C, load: 2.16 kg): 15 g/10 min)

15 Resin (4-4): Polypropylene (MFR (230°C, load: 2.16
kg): 4 g/10 min)

Resin (4-5): Polyethylene (density: 900 kg/m³, MFR
(190°C, load: 2.16 kg): 0.4 g/10 min)

[0077]

20 <Production of Multilayer Film and Liquid Agent
Container>

[Examples 1 to 3]

(1. Production of Multilayer Film)

Multilayer films each having a configuration in which

a first layer, a second layer, a third layer, a fourth layer, and a fifth layer shown in Table 1 were laminated in this order were produced by five-layer co-extrusion water-cooling inflation forming.

5 [0078]

Table 1

		Example 1	Example 2	Example 3
First layer	Constituent material (mass%) Resin (1-1)	100	100	100
	Thickness	5 μm	5 μm	5 μm
Second layer	Constituent material (mass%) Resin (3-1)	100	100	100
	Thickness	50 μm	50 μm	50 μm
Third layer	Constituent material (mass%) Resin (2-1)	60	60	
	Resin (2-2)			60
	Resin (4-2)	40	40	26
	Resin (4-5)			14
	Thickness	10 μm	10 μm	10 μm
Fourth layer	Constituent material (mass%) Resin (3-1)	100	100	100
	Thickness	75 μm	65 μm	75 μm
Fifth layer	Constituent material (mass%) Resin (4-1)	34	34	34
	Resin (4-2)	34	34	34
	Resin (4-3)	17	17	17
	Resin (4-4)	15	15	15
	Thickness	10 μm	20 μm	10 μm

[0079]

(2. Production of Liquid Agent Container)

The obtained multilayer films were each cut into a size of 15 cm ×14 cm, two sheets were superposed with the fifth layers facing inward, and peripheral edges were heat-sealed with a width of 5 mm, thereby producing a liquid agent container.

[0080]

<Evaluation of Liquid Agent Container>

(1. Amount of Eluted Component)

150 mL of a liquid agent containing 15 g/L of soybean oil, 70 g/L of glucose, and further amino acid(s), electrolyte(s), and vitamin(s) was sealed in the liquid agent container produced in each of Examples or the like, and high-pressure steam sterilization was performed at 121°C. Thereafter, the sample was stored for 2 weeks under the condition of 60°C and 75%RH. After the storage, an eluate (shown in Table 3) from polybutylene terephthalate was confirmed by liquid chromatography (the conditions were as follows).

[0081]

Liquid Chromatography Measurement Conditions:

10 mL of an extract is accurately measured, 1 g of sodium chloride, 10 mL of acetonitrile, and 4 g of magnesium sulfate are added, the mixture is vigorously shaken for 1 minute, centrifugation is performed at 2,000 rotations per

minute for 5 minutes, and then an upper layer is fractionated into an eggplant-shaped flask. 10 mL of acetonitrile is added to the remaining lower layer, the mixture is vigorously shaken for 1 minute, centrifugation is performed at 2,000
5 rotations per minute for 5 minutes, an upper layer is combined with the previous upper layer, and then distillation is performed under reduced pressure at $40^{\circ}\text{C} \pm 10^{\circ}\text{C}$. A water/acetonitrile mixed solution (1:1) is added to the residue to make the solution exactly 10 mL, and this solution
10 is used as a sample solution. Separately, 10 mg of PBT-CD (see Tables 3 and 4) is accurately measured, and acetone is added to dissolve PBT-CD so as to make the solution exactly 100 mL. 10 mL of the solution is accurately measured, acetonitrile is added to make the solution exactly 100 mL,
15 and the solution is used as a standard stock solution. 5 mL of each standard stock solution is accurately weighed, and acetonitrile is added to make the solution exactly 50 mL. 4 mL of the solution is accurately measured, a 5 mM ammonium acetate buffer solution (pH 3.0) is added to make the
20 solution exactly 50 mL, and the solution is used as a standard solution. 100 μL of each of the standard solution and the sample solution is accurately measured, and a test is performed by liquid chromatography under the following conditions to measure peak areas A_t and A_s of the eluate in

each solution. The concentration ($\mu\text{g/L}$) of PBT-CD in the liquid agent is calculated by the following equation.

[0082]

Concentration ($\mu\text{g/L}$) of PBT-CD in Liquid Agent

5 $= (M/10) \times (A_t/A_s) \times 0.08 \times C \times 1,000$

M: Weighed amount (mg) of PBT-CD

As: Peak area of PBT-CD in standard solution

At: Peak area of PBT-CD in sample solution

C: Correction coefficient: 10/7

10 [0083]

Test Conditions:

Detector: Ultraviolet absorptiometer (measurement wavelength: 260 nm)

Column: A stainless steel tube having an inner
15 diameter of 4.6 mm and a length of 15 cm was filled with 5 μm of octadecylsilylated silica gel for liquid chromatography (ZORBAX SB-C18, 4.6 mmID $\times$ 150 mm, 5 μm , manufactured by Agilent Technologies, Inc.)

Column temperature: Constant temperature around 40°C

20 Mobile phase A: 5 mM ammonium acetate buffer solution (pH 3.0)

Mobile phase B: Acetonitrile

Feeding of mobile phase: Concentration gradient control by changing a mixing ratio of the mobile phase A and

the mobile phase B as follows:

[0084]

Table 2

Time after injection (min)	Mobile phase A (%)	Mobile phase B (%)
0	85	15
1	85	15
43	0	100
73	0	100
80	85	15
90	85	15

Flow rate: 1.5 mL/min

5 [0085]

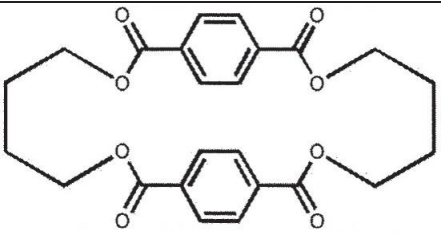
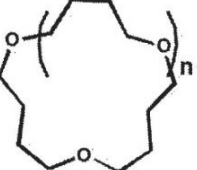
Table 3

Eluate name	TDI (Tolerable daily intake)
PBT-CD	75 (µg/L)
PBT-CE pentamer	75 (µg/L)
PBT-CE hexamer	75 (µg/L)
PBT-CE heptamer	75 (µg/L)
PBT-CE octamer	75 (µg/L)
PBT-CE nonamer	75 (µg/L)

* Description of Abbreviation

[0086]

Table 4

Eluate name	Structural formula
PBT-CD	
PBT-CE pentamer	 Each n is an integer of 3 to 7
PBT-CE hexamer	
PBT-CE heptamer	
PBT-CE octamer	
PBT-CE nonamer	

[0087]

The results are shown in Table 5.

5 [0088]

Table 5 Amount of eluate (unit: $\mu\text{g/L}$)

Eluate name	Example 1	Example 2	Example 3
PBT-CD	0	0	0
PBT-CE pentamer	0	0	0
PBT-CE hexamer	0	0	0
PBT-CE heptamer	0	0	0
PBT-CE octamer	0	0	0
PBT-CE nonamer	0	0	0

"0" represents that the amount of eluate is less than $0.1 \mu\text{g/L}$.

In all of Examples 1 to 3, elution of the eluate derived from polybutylene terephthalate into the liquid agent was prevented.

10

[0089]

(2. Heat Resistance, Transparency, and Impact

Resistance)

Heat resistance:

The multilayer film obtained in each of Examples was cut into a size of 20 cm × 28 cm, two sheets were superposed with the fifth layers facing inward, and peripheral edges were heat-sealed with a width of 5 mm, thereby producing a liquid agent container. 1,000 mL of distilled water was sealed in the obtained liquid agent container and treated by high-pressure steam sterilization at 121°C for 15 minutes, the presence or absence and degree of occurrence of wrinkles were visually observed at four corners of the liquid agent container, and then heat resistance was evaluated according to the following criteria based on the observation results.

AA: No wrinkles are observed

BB: No remarkable wrinkles are observed (slight wrinkles are observed)

CC: Remarkable wrinkles are observed

[0090]

Transparency:

1,000 mL of distilled water was sealed in a liquid agent container prepared in the same manner as in the heat resistance test, a high-pressure steam sterilization treatment was performed at 121°C for 15 minutes, the multilayer film in a portion in contact with the solvent was

cut off from the liquid agent container to prepare a sample piece, a light transmittance (%) in water at 450 nm was measured for the sample piece using an ultraviolet-visible spectrophotometer, and transparency was evaluated according to the following criteria based on the measurement results.

AA: The light transmittance in water is 70% or more

BB: The light transmittance in water is 65% or more and less than 70%

CC: The light transmittance in water is less than 65%

10 [0091]

Impact Resistance:

1,000 mL of distilled water was sealed in a liquid agent container prepared in the same manner as in the heat resistance test, a high-pressure steam sterilization treatment was performed at 121°C for 15 minutes, and then the liquid agent container was stored under a temperature condition of 0°C for 48 hours or longer. Thereafter, the liquid agent container was set on a flat workbench, and an iron plate (width 30 cm and length 32 cm) having a weight of 6.4 kg was horizontally dropped from a height of 50 cm above the liquid agent container, and impact resistance was evaluated according to the following criteria.

BB: No bag breakage occurred.

CC: Bag breakage occurred.

[0092]

The results are shown in Table 6.

Table 6

	Example 1	Example 2	Example 3
Heat resistance	AA	AA	BB
Transparency	AA	BB	AA
Impact resistance	BB	BB	BB

[0093]

5 <Production of Multilayer Film and Liquid Agent
Container>

[Example 4 and Comparative Example 1]

(1. Production of Multilayer Film)

A multilayer film having a configuration in which a
10 first layer, a second layer, a third layer, a fourth layer,
and a fifth layer shown in Table 7 were laminated in this
order was produced by five-layer co-extrusion water-cooling
inflation forming (Example 4). In addition, a multilayer
film having a configuration in which a first layer, a second
15 layer, and a fifth layer were laminated in this order was
produced by three-layer co-extrusion water-cooling inflation
forming (Comparative Example 1).

[0094]

Table 7

		Example 4	Comparative Example 1
First layer	Constituent material (mass%) Resin (1-1)	100	100
	Thickness	5 μm	5 μm
Second layer	Constituent material (mass%) Resin (3-1)	100	100
	Thickness	45 μm	135 μm
Third layer	Constituent material (mass%) Resin (2-1)	60	
	Resin (4-2)	22	
	Resin (4-5)	18	
	Thickness	10 μm	
Fourth layer	Constituent material (mass%) Resin (3-1)	100	
	Thickness	80 μm	
Fifth layer	Constituent material (mass%) Resin (4-1)	43	43
	Resin (4-2)	27	
	Resin (4-3)	15	
	Resin (4-4)	15	
	Thickness	10 μm	10 μm

[0095]

(2. Production of Liquid Agent Container)

5 The obtained multilayer film was cut into a size of 15 cm $\times$ 14 cm, two sheets were superposed with the sixth layers facing inward, and peripheral edges were heat-sealed with a width of 5 mm, thereby producing a liquid agent container.

[0096]

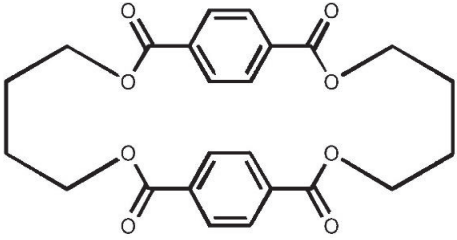
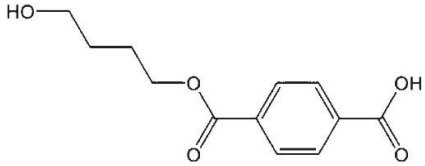
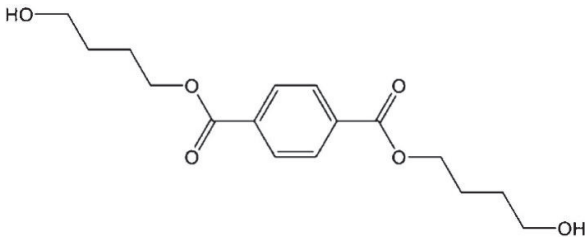
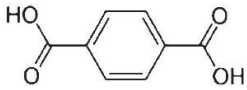
10 <Evaluation of Liquid Agent Container>

(Amount of Eluted Component)

In the liquid agent container produced in each of Examples and the like, 150 mL of each of (1) water, (2) a liquid agent (pH 8.5 buffer solution) whose pH was set to 8.5
5 obtained by weighing 1.33 g of ammonium chloride, dissolving it in 1,000 mL of water and adding ammonia water (28%) dropwise little by little, or (3) a liquid agent (pH 3.5 buffer solution) whose pH was set to 3.5 obtained by weighing 1.58 g of ammonium formate, dissolving it in 1,000 mL of
10 water and adding formic acid was sealed, and high-pressure steam sterilization was performed at 121°C. Thereafter, the sample was stored for 2 weeks under the condition of 60°C and 75%RH. After the storage, an eluate (shown in Table 8) from polybutylene terephthalate was confirmed by liquid
15 chromatography (the conditions were the same as in Examples 1 to 3).

[0097]

Table 8

Eluate name	Structural formula
PBT-CD	
PBT-1	
PBT-2	
Terephthalic acid	

[0098]

The results are shown in Table 9.

[0099]

5 Table 9 Amount of eluate (unit: $\mu\text{g/L}$)

Eluate name	Example 4			Comparative Example 1		
	Water	pH 8.5 buffer solution	pH 3.5 buffer solution	Water	pH 8.5 buffer solution	pH 3.5 buffer solution
PBT-CD	0	0	0	64.0	110.9	349.8
PBT-1	0	0	0	72.9	58.5	13.3
PBT-2	0	0	0	238.9	246.0	182.8
Terephthalic acid	0	0	0	0	0	156.6

"0" represents that the amount of eluate is less than 0.1 $\mu\text{g/L}$.

[0100]

Compared to Comparative Example 1, in Example 4, elution of the eluate derived from polybutylene terephthalate into the liquid agent was prevented.

CLAIMS

[Claim 1]

A multilayer film comprising at least:

5 a layer (1) comprising polybutylene terephthalate,
a layer (2) comprising a cyclic olefin-based polymer,
a flexible layer (3) comprising an ethylene-based
resin, and

10 a layer (4) comprising a polyolefin, which are
laminated,

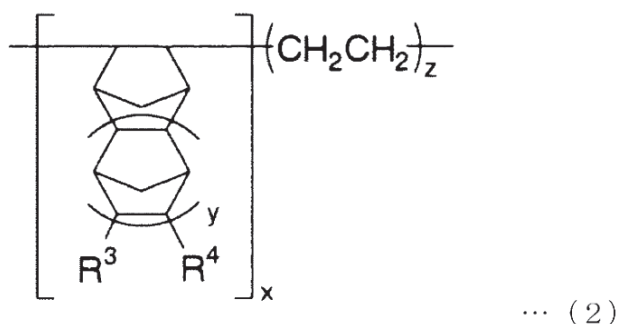
wherein the layer (1), the layer (2), and the layer (4)
forming one surface of the multilayer film are laminated in
this order.

[Claim 2]

15 The multilayer film according to claim 1, wherein the
cyclic olefin-based polymer has a glass transition
temperature of 80 to 145°C.

[Claim 3]

20 The multilayer film according to claim 1 or 2, wherein
the cyclic olefin-based polymer has a structural unit
represented by the following General Formula (2):



wherein in Formula (2), R^3 and R^4 are each independently a hydrogen atom or a hydrocarbon group having 1 to 5 carbon atoms, and may be bonded to each other to form a ring,

5 x is an integer of 1 or more, y is an integer of 0 or 1 or more, and z is an integer of 1 or more.

[Claim 4]

The multilayer film according to any one of claims 1 to 3, wherein in an endothermic curve obtained by
 10 differential scanning calorimetry of the ethylene-based resin, the following requirements [a], [b], and [c] are satisfied:

[a]: when $t = 107^\circ\text{C}$, $H_t = 55$ to 75% ,

[b]: when $t = 121^\circ\text{C}$, $H_t = 65$ to 80% , and

15 [c]: when $t = 127^\circ\text{C}$, $H_t = 70$ to 95% ,

wherein in [a], [b], and [c], H_t is the amount of melted component calculated by an equation: $H_t = ht/\Delta H_m$ by determining the total heat of fusion (ΔH_m) and a heat of fusion (ht) observed from the melting start temperature to
 20 $t^\circ\text{C}$ from the endothermic curve observed at the second

temperature increase by heating the ethylene-based resin from -20°C to 230°C at a temperature increasing rate of 10°C/min in a nitrogen atmosphere and holding the ethylene-based resin at this temperature for 10 minutes, cooling the ethylene-based resin to 30°C at a temperature decreasing rate of 10°C/min and holding the ethylene-based resin at this temperature for 1 minute, and then, heating the ethylene-based resin to 230°C at a temperature increasing rate of 10°C/min by a differential scanning calorimeter.

10 [Claim 5]

The multilayer film according to any one of claims 1 to 4, wherein the ethylene-based resin has a melt flow rate (190°C, load: 2.16 kg) of 0.01 to 10 g/10 min.

[Claim 6]

15 The multilayer film according to any one of claims 1 to 5, wherein the polyolefin satisfies the following requirements [d] and [e]:

requirement [d]: the density is 0.900 to 0.960 kg/cm³,
and

20 requirement [e]: the melt flow rate (190°C, load: 2.16 kg) is 0.1 to 10 g/10 min.

[Claim 7]

The multilayer film according to any one of claims 1 to 6, wherein the polyolefin is a mixture of polyethylene and

polypropylene.

[Claim 8]

The multilayer film according to any one of claims 1
to 7, wherein the layer (1), the layer (3), the layer (2),
5 the layer (3), and the layer (4) are laminated in this order.

[Claim 9]

A liquid agent container formed of the multilayer film
according to any one of claims 1 to 8 so that the layer (4)
is formed as the innermost layer.