

Description

Title of Invention: BIAXIALY ORIENTED POLYETHYLENE FILM,
LAMINATED FILM, AND PACKAGING BODY

Technical Field

[0001]

The present invention relates to a biaxially oriented polyethylene film that is oriented in both the machine (MD) direction and the transverse (TD) direction, a laminated film using the polyethylene film, and a packaging body using the polyethylene film.

Background Art

[0002]

Generally, a laminated film formed of a plurality of resin films made of different resin materials is used for packaging materials to package products such as food and daily items. The laminated film of this type has good quality and performance as a film product by laminating films with various functions. Due to increased awareness of recent environmental issues, there is a demand that products be recycled in the industry of this type of laminated film.

[0003]

However, in the case of laminated films formed of a plurality of resins, even though the resins composing the

film are remelted during recycling, they become a mixture of incompatible resins; therefore, the quality of the recycled resources significantly decreases, rendering them unsuitable as recycled materials. For this, a laminated film formed of a plurality of films made of a monomaterial has been proposed.

[0004]

For monomaterial laminated films, polypropylene-based resins are generally used to achieve properties, such as rigidity and heat resistance; however, polyethylene-based laminated films have been attracting attention as monomaterial laminated films in recent years. As polyethylene-based laminated films, for example, a polyethylene-based laminated film including a polyethylene-based sealant film, which is excellent in heat-sealing capacities, and an oriented film made from the same polyethylene-based material as the sealant film as a substrate film is known (Patent Literature 1).

[0005]

However, conventional polyethylene-based laminated films, as described above, tend to be flexible and have a low melting point compared to laminated films made of polypropylene-based resin, and as a result, the film performance required for packaging bodies or the like may not be obtained. Therefore, examples of methods of achieving the film performance required for packaging bodies or the like in polyethylene-based laminated film

include using a high-density resin material as a constituent material of the film to obtain high rigidity, and modifying the film through resin blending. However, such polyethylene-based laminated films do not exhibit good stretchability in some cases, for example, when the films are biaxially oriented in the machine (MD) direction and the transverse (TD) direction, breakage can occur, making it impossible to form a film. Consequently, there is a need for stable film production even when a polyethylene-based resin is used as the main raw material to form a monomaterial film.

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent Laid-Open No. 2019-189333

Summary of Invention

Technical Problem

[0007]

The present invention has been made in consideration of the above problems, and provides a biaxially oriented polyethylene film obtained by stretching a film made of a polyethylene-based resin as the main raw material that can be stably stretched in biaxial directions, as well as a laminated film and a packaging body.

Solution to Problem

[0008]

That is, the first invention relates to a biaxially oriented polyethylene film including a substrate layer and a surface layer A disposed on one side of the substrate layer, and being biaxially oriented in a machine (MD) direction and a transversal direction (TD), in which the substrate layer is mainly formed of a polyethylene-based resin, and the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$.

[0009]

The second invention relates to a biaxially oriented polyethylene film consists of at least three layers including a substrate layer, a surface layer A disposed on one side of the substrate layer, and a surface layer B disposed on the other side of the substrate layer, and being biaxially oriented in a machine (MD) direction and a transversal direction (TD), in which the substrate layer is mainly formed of a polyethylene-based resin; the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$; and the relationship between the calculated MFR (MFRc) of the

substrate layer and the calculated MFR (MFRs2) of the surface layer B satisfies $0.3 < \text{MFRc}/\text{MFRs2} < 1.9$.

[0010]

The third invention relates to the biaxially oriented polyethylene film according to the first invention, in which an inorganic vapor-deposited layer is disposed on the surface layer A side.

[0011]

The fourth invention relates to the biaxially oriented polyethylene film according to the second invention, in which an inorganic vapor-deposited layer is disposed on at least one of the surface layer A and the surface layer B.

[0012]

The fifth invention relates to the biaxially oriented polyethylene film according to the first invention, in which the surface layer A is mainly formed of a polyethylene-based resin.

[0013]

The sixth invention relates to the biaxially oriented polyethylene film according to the second invention, in which the surface layer A and/or the surface layer B are/is mainly formed of a polyethylene-based resin.

[0014]

The seventh invention relates to a laminated film, including the biaxially oriented polyethylene film

according to the first or second invention and at least a sealant film made of a polyethylene-based resin laminated thereon.

[0015]

The eighth invention relates to a laminated film, including the biaxially oriented polyethylene film according to the third or fourth invention and at least a sealant film made of a polyethylene-based resin laminated thereon.

[0016]

The ninth invention relates to a packaging body, formed of the laminated film according to the seventh invention.

[0017]

The tenth invention relates to a packaging body, formed of the laminated film according to the eighth invention.

Advantageous Effects of Invention

[0018]

According to the biaxially oriented polyethylene film of the first invention, a biaxially oriented polyethylene film can be provided that includes a substrate layer and a surface layer A disposed on one side of the substrate layer, and is biaxially oriented in the machine (MD) direction and the transversal direction (TD), in which the substrate layer is mainly formed of a

polyethylene-based resin, and the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$, which suppresses the occurrence of breakage due to uneven stretching during stretching to enable a stable stretching process, with a good film-forming capability.

[0019]

According to the biaxially oriented polyethylene film of the second invention, a biaxially oriented polyethylene film can be provided that consists of at least three layers including a substrate layer, a surface layer A disposed on one side of the substrate layer, and a surface layer B disposed on the other side of the substrate layer, and is biaxially oriented in the machine (MD) direction and the transversal direction (TD), in which the substrate layer is mainly formed of a polyethylene-based resin; the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$; and the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs2) of the surface layer B satisfies $0.3 < \text{MFRc}/\text{MFRs2} < 1.9$, which suppresses the occurrence of breakage due to uneven stretching during stretching to enable a stable stretching process, with a good film-forming capability.

[0020]

According to the biaxially oriented polyethylene film of the third invention, an inorganic vapor-deposited layer is disposed on the surface layer A side, thereby imparting gas barrier properties to the biaxially oriented polyethylene film of the first invention.

[0021]

According to the biaxially oriented polyethylene film of the fourth invention, an inorganic vapor-deposited layer is disposed on at least one of the surface layer A and the surface layer B, thereby imparting gas barrier properties to the biaxially oriented polyethylene film of the second invention.

[0022]

According to the biaxially oriented polyethylene film of the fifth invention, the surface layer A is mainly formed of a polyethylene-based resin, thereby easily realizing the film of the first invention to be a film made of a monomaterial.

[0023]

According to the biaxially oriented polyethylene film of the sixth invention, the surface layer A and/or the surface layer B are/is mainly formed of a polyethylene-based resin, thereby easily realizing that the film of the second invention to be a film made of a monomaterial.

[0024]

According to the laminated film of the seventh invention, the laminated film includes the biaxially oriented polyethylene film of the first or second invention and at least a sealant film made of a polyethylene-based resin laminated thereon, making it a promising alternative to existing laminated films.

[0025]

According to the laminated film of the eighth invention, the laminated film includes the biaxially oriented polyethylene film of the third or fourth invention and at least a sealant film made of a polyethylene-based resin laminated thereon, making it a promising alternative to existing laminated films.

[0026]

According to the packaging body of the ninth invention, the packaging body is formed of the laminated film of the seventh invention, making it a promising alternative to existing packaging bodies.

[0027]

According to the packaging body of the tenth invention, the packaging body is formed of the laminated film of the eighth invention, making it a promising alternative to existing packaging bodies.

Brief Description of Drawings

[0028]

[Figure 1] Figure 1 is a schematic cross-sectional view of a biaxially oriented polyethylene film according to an embodiment of the present invention.

[Figure 2] Figure 2 is a schematic cross-sectional view of a biaxially oriented polyethylene film according to another embodiment.

[Figure 3] Figure 3 is a schematic cross-sectional view of a laminated film using the biaxially oriented polyethylene film of Figure 2.

Description of Embodiments

[0029]

The biaxially oriented polyethylene film 10 according to an embodiment of the present invention, shown in Figure 1, is a laminated film including a substrate layer 20 and a surface layer A disposed on one side of the substrate layer 20, and being biaxially oriented in the machine (MD) direction and the transverse (TD) direction. The biaxially oriented polyethylene film 10 of the present invention can be used as a substrate film for a laminated film to be subjected to vapor deposition or the like. The laminated film can be suitably used for various packaging bodies (packaging bags) for, for example, food, cosmetics, drugs, daily necessities, parts and other products.

[0030]

The biaxially oriented polyethylene film of the present invention is formed of a monomaterial using a polyethylene-based resin as a constituent material. The monomaterial used herein means that the same kind of resin materials are used for the constituent materials of the entire film as the main raw material, and for example, the film may contain about 80% or more, and preferably about 90% or more of the main raw material as the constituent materials of the entire film. As such, the film made up of a monomaterial can also be suitably used as a recyclable material.

[0031]

The biaxially oriented polyethylene film of the present invention is a laminated film in which a polyethylene-based resin is the main raw material. The polyethylene-based resin to be used is appropriately selected from, for example, petroleum-derived, biomass-derived, materially-recycled, and/or chemically-recycled polyethylene-based resins, and examples thereof include an ethylene homopolymer or a random copolymer of ethylene and an α -olefin having 3 or more carbon atoms, such as propylene, 1-butene, 1-heptene, 1-hexene, or 1-octene. As the polyethylene-based resins, one or a mixture of two or more of the above can be used.

[0032]

The resin materials for the biaxially oriented polyethylene film of the present invention can be blended

with other olefin-based resins, olefin-based elastomers such as α -olefin copolymers as necessary, within a scope that does not impair the object of the present invention. Similarly, additives such as antioxidants, neutralizing agents, antistatic agents, antifogging agents, lubricants, nucleating agents, colorants, and antiblocking agents may also be blended as necessary.

[0033]

The substrate layer 20 is formed with a relatively thick layer thickness compared to other layers. The substrate layer 20 is mainly formed from a polyethylene-based resin, but any suitable resin materials can be used as the constituent material, as long as the conditions for using a monomaterial are met. The substrate layer 20 may be blended with additives such as a surfactant, as needed. For example, the addition of a surfactant can improve slip properties and/or antiblocking properties of the biaxially oriented polyethylene film 10.

[0034]

In addition, when the substrate layer 20 is subjected to a surface treatment on the surface of the substrate layer opposite the surface layer A described below to enhance the wetting tension of the surface as needed, printability and lamination suitability can be imparted. The wetting tension is preferably 36 mN/m or more; if the wetting tension is too low, it can cause poor printing or lamination, which is not favorable. The

wetting tension is measured by the determination of wetting tension in accordance with JIS K 6768 (1999). Examples of surface treatments include known surface treatment methods such as atmospheric pressure plasma treatment, flame treatment, and corona discharge treatment.

[0035]

The surface layer A corresponds to the outer layer on one side of the biaxially oriented polyethylene film 10, and its surface can be used as a surface to be processed when the film surface is subjected to surface treatment such as vapor deposition processing. The surface layer A can be made of any suitable resin materials that can be used for the film surface as the constituent material, as long as the conditions for using a monomaterial are met, but it is preferable to be mainly formed from a polyethylene-based resin. When the surface layer A is mainly formed from a polyethylene-based resin, the blending ratio of the polyethylene-based resin to the entire film increases, thereby easily realizing a film made of a monomaterial. To the surface layer A, antiblocking agents or the like can be added as needed.

[0036]

In addition, when the surface layer A is subjected to a surface treatment to enhance the wetting tension of the outer layer surface as needed, vapor deposition suitability, printability, and lamination suitability can

be imparted. The wetting tension is preferably 36 mN/m or more; if the wetting tension is too low, it can cause poor printing or lamination, which is not favorable. The wetting tension is measured by the determination of wetting tension in accordance with JIS K 6768 (1999). Examples of surface treatments include known surface treatment methods such as atmospheric pressure plasma treatment, flame treatment, and corona discharge treatment.

[0037]

The biaxially oriented polyethylene film 10 of the present invention can be obtained by a known film producing method, such as the T-die method and the inflation method. In particular, it is preferable to form a sheet shaped by the T-die method by stretching. Film forming by the T-die method has an advantage in achieving the high thickness accuracy required for a substrate film for printing or laminating a film.

[0038]

Further, the biaxially oriented polyethylene film 10 is a biaxially oriented film that has been biaxially oriented in the machine (MD) direction and the transverse (TD) direction of the film. As the biaxial orientation, either sequential biaxial stretching or simultaneous biaxial stretching can be favorably used. Film-forming of the biaxially oriented film generates resin orientation in both the machine (MD) direction and the

transverse (TD) direction, which enables improvement of thickness accuracy such as thinning, and mechanical properties such as strength, thereby achieving excellent mass production. The stretching ratio is approximately 2 to 8 times in the machine (MD) direction, and 4 to 12 times in the transverse (TD) direction.

[0039]

The thickness of the biaxially oriented polyethylene film 10 of the present invention is not particularly limited, and may be appropriately determined depending on the demand and/or applications, for example, 5 to 100 μm , and preferably 10 to 70 μm . Among these, the thickness of the substrate layer 20 is 4 to 99 μm , and preferably approximately 9 to 69 μm . Further, the thickness of the surface layer A is 0.3 to 5.0 μm , and preferably approximately 0.5 to 3.0 μm . If the surface layer A is too thin, there is a risk of poor appearance due to uneven film thickness, and if an antiblocking agent is added to the surface layer A, there is a risk of the agent falling off. If the surface layer A is too thick, there is a risk that the functionality cannot be imparted to the surface layer A because the conditions for using a monomaterial cannot be met. If the antiblocking agent is added to the surface layer A, its existing amount relatively increases, whereby there is a risk of a decrease in the sense of transparency.

[0040]

In the biaxially oriented polyethylene film 10 of the present invention, an inorganic vapor-deposited layer 30 is preferably disposed on the surface layer A side. The inorganic vapor-deposited layer 30 is a layer that prevents the permeability of gases such as water vapor and oxygen, and is provided on the surface layer A, thereby imparting gas barrier properties to the biaxially oriented polyethylene film 10. The inorganic vapor-deposited layer 30 is formed on the surface layer A directly or through an anchor coat layer by a known vapor-deposition method such as vacuum deposition, sputtering, or ion plating. Examples of materials that constitute the inorganic vapor-deposited layer 30 include inorganic materials, for example, known metals such as aluminum, gold, silver, copper, and chromium, oxides of these metals and other inorganic oxides, sulfides, and nitrides. The inorganic vapor-deposited layer 30 can be a single thin film layer made of any of these inorganic materials, or a composite layer or multi-layered layer made of one or two or more of these materials.

[0041]

In conventional laminated films made of polyethylene-based resins as the main raw material, when the films are subjected to biaxial extension treatment in the machine (MD) direction and the transverse (TD) direction during film formation, breakage may occur, making the film formation impossible in some cases.

Therefore, the present inventors have conducted extensive studies and found that the relationship between the melt flow rate (MFR) of the constituent materials of the substrate layer and the MFR of the constituent materials of the surface layer affects the film-forming capability of the laminated films, thereby deriving a relationship between the substrate layer and the surface layer that can achieve good film-forming capability of the laminated film made of polyethylene-based resins as the main raw material. In other words, the biaxially oriented polyethylene film 10 of the present invention is characterized in that the relationship between the calculated MFR (MFRc) of the substrate layer 20 and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$.

[0042]

The calculated MFR (MFRc) of the substrate layer 20 is the MFR of one or more resin materials that constitute the substrate layer 20, and is calculated from the MFR and the blending ratio of each resin material. Similarly, the calculated MFR (MFRs1) of the surface layer A is the MFR of one or more resin materials that constitute the surface layer A. Note that the MFR of each resin material is a value measured in accordance with JIS K 7210 (2014) under the conditions of 190°C and 2.16 kg.

[0043]

MFRc/MFRs1 is an index indicating the relationship of the fluidity of the resin material that constitutes the substrate layer 20 and the resin material that constitutes the surface layer A, and can be used as an index that indicates the stretchability of a film. In the index, when the MFRc/MFRs1 value is 1.0, it can be considered that the fluidity of the resin material of the substrate layer 20 and that of the surface layer A are approximately equal. Also, a smaller MFRc/MFRs1 value indicates that the fluidity of the resin of the substrate layer 20 is lower than that of the surface layer A, while a larger MFRc/MFRs1 value indicates that the fluidity of the resin of the substrate layer 20 is higher than that of the surface layer A. If the MFRc/MFRs1 value is too small, uneven stretching in the transverse (TD) direction is likely to occur during stretching in the transverse (TD) direction, resulting in a risk of breakage. If the MFRc/MFRs1 value is too large, uneven stretching in the machine (MD) direction is likely to occur during stretching in the machine (MD) direction, resulting in a risk of breakage during stretching in the transverse (TD) direction.

[0044]

For this reason, in the laminated film made of a polyethylene-based resin as the main raw material, uneven stretching, which may cause breakage during stretching, is likely to occur in the machine (MD) direction or the

transverse (TD) direction when the fluidity (calculated MFR) of the substrate layer 20 and that of the surface layer A are largely different, resulting in a risk of not obtaining a good film-forming capability. It is preferable that the fluidity (calculated MFR) of the substrate layer 20 and that of the surface layer A are closer, and even if they differ, as long as the relationship is within a certain range, i.e., falls in $0.3 < \text{MFRc/MFRs1} < 1.9$, the occurrence of breakage due to uneven stretching is suppressed during stretching to enable a stable stretching process, with a good film-forming capability.

[0045]

Figure 2 shows a biaxially oriented polyethylene film 10A according to another embodiment of the present invention, which consists of at least three layers including a substrate layer 20, a surface layer A disposed on one side of the substrate layer 20, and a surface layer B disposed on the other side of the substrate layer 20, and is biaxially oriented in the machine (MD) direction and the transversal direction (TD). The biaxially oriented polyethylene film 10A of the present invention can be favorably used as a substrate film for a laminated film to be subjected to vapor deposition or the like, similarly to the biaxially oriented polyethylene film 10. Note that, in Figure 2,

the same reference numerals as in Figure 1 represent the same components, and their explanation will be omitted.

[0046]

The surface layer B is a surface layer on the opposite side to the surface layer A, and its surface can be used as a surface to be processed when the film surface is subjected to surface treatment such as vapor deposition processing. Therefore, both surfaces of the biaxially oriented polyethylene film 10A are to be processed, thereby enhancing convenience. Similarly to the surface layer A, the surface layer B can be made of any suitable resin materials that can be used for the film surface as the constituent material, as long as the conditions for using a monomaterial are met, and it is preferable to be mainly formed from a polyethylene-based resin from the viewpoint of using a monomaterial. To the surface layer B, antiblocking agents or the like can be added as needed. Further, the thickness of the surface layer B is 0.3 to 5.0 μm , and preferably approximately 0.5 to 3.0 μm . Note that the constituent materials of the surface layer A and surface layer B may be the same resin or different resins.

[0047]

In addition, similarly to the surface layer A, when the surface layer B is subjected to a surface treatment to enhance the wetting tension of the outer layer surface as needed, vapor deposition suitability, printability,

and lamination suitability can be imparted. The wetting tension is preferably 36 mN/m or more; if the wetting tension is too low, it can cause poor printing or lamination, which is not favorable. The wetting tension is measured by the determination of wetting tension in accordance with JIS K 6768 (1999). Examples of surface treatments include known surface treatment methods such as atmospheric pressure plasma treatment, frame treatment, and corona discharge treatment.

[0048]

In the biaxially oriented polyethylene film 10A, the inorganic vapor-deposited layer 30 is preferably disposed on at least one of the sides of the surface layer A and the surface layer B. In the illustrated example, the inorganic vapor-deposited layer 30 is deposited on the surface layer B side. When the inorganic vapor-deposited layer 30 is disposed on at least one of the sides of the biaxially oriented polyethylene film 10A, gas barrier properties can be imparted to the biaxially oriented polyethylene film 10A. Note that, although not shown, the inorganic vapor-deposited layer 30 may be disposed on the surface layer A side instead of the surface layer B side, or may be disposed on both the surface layer A side and the surface layer B side.

[0049]

The biaxially oriented polyethylene film 10A has a relationship between the substrate layer and the surface

layer that can obtain a good film-forming capability, in which the relationship between the calculated MFR (MFRc) of the substrate layer 20 and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc/MFRs1} < 1.9$, and the relationship between the calculated MFR (MFRc) of the substrate layer 20 and the calculated MFR (MFRs2) of the surface layer B satisfies $0.3 < \text{MFRc/MFRs2} < 1.9$.

[0050]

As described above, MFRc/MFRs1 indicates the relationship of the fluidity of the resin material that constitutes the substrate layer 20 and the resin material that constitutes the surface layer A, and can be used as an index that indicates the stretchability of a film. When the MFRc/MFRs1 value is 1.0, it can be considered that the fluidity of the resin material of the substrate layer 20 and that of the surface layer A are approximately equal. If the MFRc/MFRs1 value is too small, the fluidity of the resin of the substrate layer 20 becomes too low compared to that of the surface layer A, and uneven stretching in the transverse (TD) direction is likely to occur during stretching in the transverse (TD) direction, resulting in a risk of breakage. On the other hand, if the MFRc/MFRs1 value is too large, the fluidity of the resin of the substrate layer 20 becomes too high compared to that of the surface layer A, and uneven stretching in the machine (MD) direction is likely to occur during stretching in the machine (MD) direction,

resulting in a risk of breakage. It is preferable that the fluidity (calculated MFR) of the substrate layer 20 and that of the surface layer A are closer, and even if they differ, as long as the relationship is within a certain range, i.e., falls in $0.3 < \text{MFRc/MFRs1} < 1.9$, the occurrence of breakage due to uneven stretching is suppressed during stretching to enable a stable stretching process, with a good film-forming capability. [0051]

The calculated MFR (MFRs2) of the surface layer B is the MFR of one or more resin materials that constitute the surface layer B. MFRc/MFRs2 is an index indicating the relationship of the fluidity of the resin material that constitutes the substrate layer 20 and the resin material that constitutes the surface layer B, and can be used as an index that indicates the stretchability of a film. Similarly to MFRc/MFRs1 , a smaller MFRc/MFRs2 value indicates that the fluidity of the resin of the substrate layer 20 is lower than that of the surface layer B, while a larger MFRc/MFRs2 value indicates that the fluidity of the resin of the substrate layer 20 is higher than that of the surface layer B. If the MFRc/MFRs2 value is too small, uneven stretching in the transverse (TD) direction is likely to occur during stretching in the transverse (TD) direction, resulting in a risk of breakage. On the other hand, if the MFRc/MFRs2 value is too large, uneven stretching in the machine (MD)

direction is likely to occur during stretching in the machine (MD) direction, resulting in a risk of breakage. It is preferable that the fluidity (calculated MFR) of the substrate layer 20 and that of the surface layer A are closer, and even if they differ, as long as the relationship is within a certain range, i.e., falls in $0.3 < \text{MFRc/MFRs2} < 1.9$, the occurrence of breakage due to uneven stretching is suppressed during stretching to enable a stable stretching process, with a good film-forming capability.

[0052]

In the case of the laminated film with at least three layers containing the substrate layer 20, the surface layer A, and the surface layer B, when either the relationship of the calculated MFR between the substrate layer 20 and the surface layer A ($0.3 < \text{MFRc/MFRs1} < 1.9$) or the relationship of the calculated MFR between the substrate layer 20 and the surface layer B ($0.3 < \text{MFRc/MFRs2} < 1.9$) does not satisfy the conditions, it may be difficult to obtain a good film-forming capability. In the biaxially oriented polyethylene film 10A of the present invention, both the relationship of the calculated MFR between the substrate layer 20 and the surface layer A ($0.3 < \text{MFRc/MFRs1} < 1.9$) and the relationship of the calculated MFR between the substrate layer 20 and the surface layer B ($0.3 < \text{MFRc/MFRs2} < 1.9$) satisfy the conditions, which can suppress the occurrence

of breakage due to uneven stretching during stretching to obtain a good film-forming capability.

[0053]

Figure 3 shows a laminated film 50 using the biaxially oriented polyethylene film of the present invention. The laminated film 50 shown in the Figure is an example in which the biaxially oriented polyethylene film 10A with at least three layers having the surface layers A and B is used as a substrate film, and a sealant film 60 is laminated thereon through the inorganic vapor-deposited layer 30 disposed on the surface layer B side of the biaxially oriented polyethylene film 10A. The substrate film of the laminated film 50 is not limited to the illustrated biaxially oriented polyethylene film 10, and the biaxially oriented polyethylene film according to the present invention, such as the biaxially oriented polyethylene film 10 shown in Figure 1, can be appropriately used. Further, the sealant film 60 to be laminated to the substrate film is not limited to the example shown, and can be appropriately provided, such as laminated on the surface layer A side.

[0054]

The sealant film 60 is a heat sealable film made from a polyethylene resin. The polyethylene resin to be used for the sealant film 60 is selected singly or in combination as appropriate from, for example, linear low-density polyethylene resin (LLDPE), high-density

polyethylene (HDPE), and low-density polyethylene (LDPE). When the main raw material of the sealant film 60 is a polyethylene resin of the same kind as the biaxially oriented polyethylene film 10A, which serves as the substrate film, the laminated film 50 can be regarded as a monomaterial. Accordingly, the laminated film 50 is easily recycled.

[0055]

The laminated film 50 may have other polyethylene films or other functional layers, such as printed layers, and/or adhesive layers, on the surface layer A side or the surface layer B side, as needed. The other polyethylene films are films to be laminated to improve the functions of the laminated film 50, such as the rigidity. The polyethylene films are formed from the same type of polyethylene-based resin as the biaxially oriented polyethylene film 10A, which serves as the substrate film, and therefore, a monomaterial formation is achieved, making it easy to recycle. Also, the other polyethylene films can be appropriately selected from cast film, uniaxially oriented, or biaxially oriented films depending on the purpose, and from the viewpoint of the rigidity of the laminated film 50, uniaxially oriented films or biaxially oriented films are preferably selected.

[0056]

The printed layer is a layer that forms any desired printed patterns such as letters, numerals, pictures, and diagrams to add design or aesthetic sense, and to display various information such as contents, best before dates, manufacturers and distributors, and others. The printed layer is formed using a known processing method such as screen printing, flexographic printing, offset printing, and gravure printing, and includes appropriate printing conditions, such as full-page printing (solid printing) and partial printing.

[0057]

The adhesive layer is a layer used to adhere layers to each other, and a known method can be used, such as dry lamination, non-solvent lamination, and melt extrusion lamination. As adhesives to be used in the adhesive layer, known adhesives are preferably used such as polyurethane adhesives, polyester-polyurethane adhesives, and polyether-polyurethane adhesives.

[0058]

In the laminated film 50, the order in which the inorganic vapor-deposited layer 30, the printed layer, the adhesive layer, and other polyethylene films are stacked can be appropriately set, as long as their functionalities are not impaired. For example, the stacking order can be such that the printed layer is disposed on the surface layer A side of the biaxially oriented polyethylene film 10A followed by the inorganic

vapor-deposited layer 30. As such, various functionalities can be imparted to the laminated film 50 according to the application, and the laminated film 50 can be a promising alternative to existing laminate films.

[0059]

The present invention can also provide a packaging body using the laminated films. The packaging body is made of a monomaterial laminated film, and therefore, it is easily recycled and a promising alternative to existing packaging bodies.

Examples

[0060]

[Fabrication of Biaxially Oriented Polyethylene Film]

Biaxially oriented polyethylene films consisting of two layers with a surface layer A and a substrate layer, or three layers with a surface layer A, substrate layer, and a surface layer B of Trial Production Example 1 to 24 were prepared by blending each material described below at predetermined ratios (weight %) according to the following procedure. First, the materials were each fed into an extrusion device, melted, kneaded, and formed into a sheet shape using a T-die method to conduct two-layer co-extrusion of the surface layer A and the substrate layer, or three-layer co-extrusion of the

surface layer A, the substrate layer, and the surface layer B, so that the thickness after the biaxial orientation was 20 μm . At that time, the layer thickness (layer ratio) of each layer to the total thickness was adjusted to surface layer A:substrate layer = 1:19 in the case of two layers, and surface layer A:substrate layer:surface layer B = 1:18:1 in the case of three layers. Next, the co-extruded sheet-shaped product was stretched 5 times in the machine (MD) direction by roll-to-roll stretching and 8 times in the transverse (TD) direction by tenter stretching, and then the surface of the surface layer A was subjected to corona treatment to obtain a biaxially oriented film. The materials used in each layer of Trial Production Examples 1 to 24 are shown in Tables 1 to 4 below. Note that the stretching conditions were as follows: the roll stretching temperature in the machine (MD) direction was 115°C, the preheat temperature in the transverse (TD) direction was 143 to 145°C, and the stretching temperature was 122°C.

[0061]

The following resins were used as the constituent materials of the surface layer A, the substrate layer, and the surface layer B. The melt flow rate (MFR) of each material was a value measured in accordance with JIS K 7210 (2014) under the conditions of 190°C and 2.16 kg. Also, the density of the additives was taken as the density of the base resin.

[0062]

[Resin Material]

- PE1: polyethylene-based resin (manufactured by The Dow Chemical Company; "TF80"), MFR: 1.7 g/10 min, density: 0.926 g/cm³

- PE2: polyethylene-based resin (manufactured by Prime Polymer Co. Ltd.; "SP4020"), MFR: 1.7 g/10 min, density: 0.937 g/cm³

- PE3: polyethylene-based resin (manufactured by Ube-Maruzen Polyethylene Co., Ltd.; "4040F"), MFR: 4.2 g/10 min, density: 0.937 g/cm³

- PE4: polyethylene-based resin (manufactured by Mitsui Chemicals Inc.; "A-4085S"), MFR: 3.6 g/10 min, density: 0.885 g/cm³

- PE5: polyethylene-based resin (manufactured by Ube-Maruzen Polyethylene Co., Ltd.; "021GT"), MFR: 6.8 g/10 min, density: 0.919 g/cm³

- PE6: polyethylene-based resin (manufactured by Ube-Maruzen Polyethylene Co., Ltd.; "031GLD"), MFR: 9.1 g/10 min, density: 0.913 g/cm³

- PE7: polyethylene-based resin (manufactured by Mitsui Chemicals Inc.; "A-20085S"), MFR: 18.5 g/10 min, density: 0.885 g/cm³

- PE8: polyethylene-based resin (manufactured by Mitsui Chemicals Inc.; "A-20090S"), MFR: 18.2 g/10 min, density: 0.893 g/cm³

[0063]

[Additive]

- AB1: 5 wt% concentration of an antiblocking agent masterbatch obtained by compounding 5 wt% of an antiblocking agent (manufactured by Fuji Silysia Chemical Ltd.; "SYLYSIA 430") and 95 wt% of a base resin (polyethylene-based resin: manufactured by The Dow Chemical Company; "TF80"), MFR: 1.6 g/10 min, density: 0.926 g/cm³

- AS1: 10 wt% concentration of an antistatic agent masterbatch obtained by compounding 10 wt% of a mixed material obtained by mixing a surfactant 1 (manufactured by TOHO Chemical Industry Co., Ltd.; "SA-20B") and a surfactant 2 (manufactured by TOHO Chemical Industry Co., Ltd.; "MG-100VP") at a weight ratio of 1:2, and 90 wt% of a base resin (polyethylene-based resin: manufactured by The Dow Chemical Company; "TF80"), MFR: 2.9 g/10 min, density: 0.926 g/cm³

[0064]

[Trial Production Example 1]

Trial Production Example 1 was a three-layered film, and its composition was as follows: the surface layer A was made of 94 wt% of PE1 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive, the substrate layer was made of 80.0 wt% of PE3 and 20.0% of PE4 as the polyethylene-based resin, and the surface layer B was made of 94.0 wt% of PE1 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive.

[0065]

[Trial Production Example 2]

The composition of Trial Production Example 2 was the same as that of Trial Production Example 1, except that the substrate layer was made of 40.0 wt% of PE2, 40.0 wt% of PE3, and 20.0% of PE8 as the polyethylene-based resin.

[0066]

[Trial Production Example 3]

The composition of Trial Production Example 3 was the same as that of Trial Production Example 1, except that the substrate layer was made of 20.0 wt% of PE2, 60.0 wt% of PE3, and 20.0% of PE4 as the polyethylene-based resin.

[0067]

[Trial Production Example 4]

The composition of Trial Production Example 4 was the same as that of Trial Production Example 3, except that PE2 was changed to 26.0 wt% and PE3 to 54.0 wt% as the substrate layer made of polyethylene-based resin.

[0068]

[Trial Production Example 5]

The composition of Trial Production Example 5 was the same as that of Trial Production Example 3, except that PE2 was changed to 33.0 wt% and PE3 to 47.0 wt% as the substrate layer made of polyethylene-based resin.

[0069]

[Trial Production Example 6]

The composition of Trial Production Example 6 was the same as that of Trial Production Example 3, except that PE2 was changed to 40.0 wt% and PE3 to 40.0 wt% as the substrate layer made of polyethylene-based resin.

[0070]

[Trial Production Example 7]

Trial Production Example 7 was a three-layered film, and its composition was as follows: the surface layer A was made of 37.6 wt% of PE2, 37.6 wt% of PE3, and 18.8 wt% of PE7 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive, the substrate layer was made of 40.0 wt% of PE2, 40.0 wt% of PE3 and 20.0% of PE7 as the polyethylene-based resin, and the surface layer B was made of 37.6 wt% of PE2, 37.6 wt% of PE3, and 18.8 wt% of PE7 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive.

[0071]

[Trial Production Example 8]

The composition of Trial Production Example 8 was the same as that of Trial Production Example 7, except that PE7 was changed to PE8 in the surface layer A, PE7 was changed to PE8 in the substrate layer, and PE7 was changed to PE8 in the surface layer B.

[0072]

[Trial Production Example 9]

The composition of Trial Production Example 9 was the same as that of Trial Production Example 1, except that the substrate layer was made of 100.0 wt% of PE1 as the polyethylene-based resin.

[0073]

[Trial Production Example 10]

The composition of Trial Production Example 10 was the same as that of Trial Production Example 9, except that the polyethylene-based resin in the surface layer A was changed to 84.0 wt% of PE1 and 10.0 wt% of PE4, the substrate layer was changed to 97.0 wt% of PE1 as the polyethylene-based resin and 3.0 wt% of AS1 as the additive, and the polyethylene-based resin in the surface layer B was changed to 84.0 wt% of PE1 and 10.0 wt% of PE4.

[0074]

[Trial Production Example 11]

The composition of Trial Production Example 11 was the same as that of Trial Production Example 10, except that PE1 was changed to 64.0 wt% and PE4 to 30.0 wt% in the surface layer A, and PE1 was changed to 64.0 wt% and PE4 to 30.0 wt% in the surface layer B.

[0075]

[Trial Production Example 12]

The composition of Trial Production Example 12 was the same as that of Trial Production Example 10, except that PE1 was changed to 49.0 wt% and PE4 to 45.0 wt% in

the surface layer A, and PE1 was changed to 49.0 wt% and PE4 to 45.0 wt% in the surface layer B.

[0076]

[Trial Production Example 13]

The composition of Trial Production Example 13 was the same as that of Trial Production Example 10, except that PE1 was changed to 34.0 wt% and PE4 to 60.0 wt% in the surface layer A, and PE1 was changed to 34.0 wt% and PE4 to 60.0 wt% in the surface layer B.

[0077]

[Trial Production Example 14]

The composition of Trial Production Example 14 was the same as that of Trial Production Example 9, except that the polyethylene-based resin in the surface layer A was changed to 37.6 wt% of PE2, 37.6 wt% of PE3, 9.4 wt% of PE4, and 9.4 wt% of PE7, and the polyethylene-based resin in the surface layer B was changed to 37.6 wt% of PE2, 37.6 wt% of PE3, 9.4 wt% of PE4, and 9.4 wt% of PE7.

[0078]

[Trial Production Example 15]

The composition of Trial Production Example 15 was the same as that of Trial Production Example 14, except that the polyethylene-based resin in the surface layer A was changed to 37.0 wt% of PE2, 37.0 wt% of PE3, and 20.0 wt% of PE7, and the polyethylene-based resin in the surface layer B was changed to 37.0 wt% of PE2, 37.0 wt% of PE3, and 20.0 wt% of PE7.

[0079]

[Trial Production Example 16]

The composition of Trial Production Example 16 was the same as that of Trial Production Example 9, except that PE1 was changed to PE5 in the surface layer A, and PE1 was changed to PE5 in the surface layer B.

[0080]

[Trial Production Example 17]

The composition of Trial Production Example 17 was the same as that of Trial Production Example 9, except that PE1 was changed to PE6 in the surface layer A, and PE1 was changed to PE6 in the surface layer B.

[0081]

[Trial Production Example 18]

The composition of Trial Production Example 18 was the same as that of Trial Production Example 16, except that PE5 was changed to PE1 in the surface layer B.

[0082]

[Trial Production Example 19]

The composition of Trial Production Example 19 was the same as that of Trial Production Example 18, except that PE5 was changed to PE6 in the surface layer A.

[0083]

[Trial Production Example 20]

The composition of Trial Production Example 20 was the same as that of Trial Production Example 4, except that the polyethylene-based resin in the surface layer B

was changed to 20.0 wt% of PE2, 55.2 wt% of PE3, and 18.8 wt% of PE4.

[0084]

[Trial Production Example 21]

The composition of Trial Production Example 21 was the same as that of Trial Production Example 3, except that the polyethylene-based resin in the surface layer B was changed to 14.0 wt% of PE2, 61.2 wt% of PE3, and 18.8 wt% of PE4.

[0085]

[Trial Production Example 22]

The composition of Trial Production Example 22 was the same as that of Trial Production Example 11, except that the polyethylene-based resin in the substrate layer was changed to 87.0 wt% of PE1 and 10.0 wt% of PE4, and the polyethylene-based resin in the surface layer B was changed to 94.0 wt% of PE1.

[0086]

[Trial Production Example 23]

Trial Production Example 23 was a two-layered film, and its composition was as follows: the surface layer A was made of 94 wt% of PE1 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive, and the substrate layer was made of 100.0 wt% of PE1 as the polyethylene-based resin.

[0087]

[Trial Production Example 24]

Trial Production Example 24 was a two-layered film, and its composition was as follows: the surface layer A was made of 54 wt% of PE1 and 40.0 wt% of PE4 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive, and the substrate layer was made of 94.0 wt% of PE1 as the polyethylene-based resin and 6.0 wt% of AB1 as the additive.

[0088]

[Table 1]

		Trial Production Example 1	Trial Production Example 2	Trial Production Example 3	Trial Production Example 4	Trial Production Example 5	Trial Production Example 6
Surface layer A	PE1	94.0	94.0	94.0	94.0	94.0	94.0
	PE2						
	PE3						
	PE4						
	PE5						
	PE6						
	PE7						
	PE8						
	AB1	6.0	6.0	6.0	6.0	6.0	6.0
Substrate layer	PE1						
	PE2		40.0	20.0	26.0	33.0	40.0
	PE3	80.0	40.0	60.0	54.0	47.0	40.0
	PE4	20.0		20.0	20.0	20.0	20.0
	PE7						
	PE8		20.0				
	AB1						
	AS1						
Surface Layer B	PE1	94.0	94.0	94.0	94.0	94.0	94.0
	PE2						
	PE3						
	PE4						
	PE5						
	PE6						
	PE7						
	PE8						
	AB1	6.0	6.0	6.0	6.0	6.0	6.0

[0089]

[Table 2]

		Trial Production Example 7	Trial Production Example 8	Trial Production Example 9	Trial Production Example 10	Trial Production Example 11	Trial Production Example 12
Surface Layer A	PE1			94.0	84.0	64.0	49.0
	PE2	37.6	37.6				
	PE3	37.6	37.6				
	PE4				10.0	30.0	45.0
	PE5						
	PE6						
	PE7	18.8					
	PE8		18.8				
	AB1	6.0	6.0	6.0	6.0	6.0	6.0
Substrate layer	PE1			100.0	97.0	97.0	97.0
	PE2	40.0	40.0				
	PE3	40.0	40.0				
	PE4						
	PE7	20.0					
	PE8		20.0				
	AB1						
	AS1				3.0	3.0	3.0
Surface Layer B	PE1			94.0	84.0	64.0	49.0
	PE2	37.6	37.6				
	PE3	37.6	37.6				
	PE4				10.0	30.0	45.0
	PE5						
	PE6						
	PE7	18.8					
	PE8		18.8				
	AB1	6.0	6.0	6.0	6.0	6.0	6.0

[0090]

[Table 3]

		Trial Production Example 13	Trial Production Example 14	Trial Production Example 15	Trial Production Example 16	Trial Production Example 17	Trial Production Example 18
Surface Layer A	PE1	34.0					
	PE2		37.6	37.0			
	PE3		37.6	37.0			
	PE4	60.0	9.4				
	PE5				94.0		94.0
	PE6					94.0	
	PE7		9.4	20.0			
	PE8						
	AB1	6.0	6.0	6.0	6.0	6.0	6.0
Substrate layer	PE1	97.0	100.0	100.0	100.0	100.0	100.0
	PE2						
	PE3						
	PE4						
	PE7						
	PE8						
	AB1						
	AS1	3.0					
Surface Layer B	PE1	34.0					94.0
	PE2		37.6	37.0			
	PE3		37.6	37.0			
	PE4	60.0	9.4				
	PE5				94.0		
	PE6					94.0	
	PE7		9.4	20.0			
	PE8						
	AB1	6.0	6.0	6.0	6.0	6.0	6.0

[0091]

[Table 4]

		Trial Production Example 19	Trial Production Example 20	Trial Production Example 21	Trial Production Example 22	Trial Production Example 23	Trial Production Example 24
Surface Layer A	PE1		94.0	94.0	64.0	94.0	54.0
	PE2						
	PE3						
	PE4				30.0		40.0
	PE5						
	PE6	94.0					
	PE7						
	PE8						
	AB1	6.0	6.0	6.0	6.0	6.0	6.0
Substrate layer	PE1	100.0			87.0	100.0	94.0
	PE2		26.0	20.0			
	PE3		54.0	60.0			
	PE4		20.0	20.0	10.0		
	PE7						
	PE8						
	AB1						6.0
	AS1				3.0		
Surface Layer B	PE1	94.0			94.0		
	PE2		20.0	14.0			
	PE3		55.2	61.2			
	PE4		18.8	18.8			
	PE5						
	PE6						
	PE7						
	PE8						
	AB1	6.0	6.0	6.0	6.0		

[0092]

[Calculated Density]

The calculated density (g/cm³) of the polyethylene films of Trial Production Examples 1 to 22 was calculated for each of the surface layer A, the substrate layer, and the surface layer B. The calculated density (g/cm³) of the polyethylene films of Trial Production Examples 23 and 24 was calculated for the surface layer A and the substrate layer. The calculated density was calculated

by the following Expression (i) based on the density and blending ratio of each constituent material used in the target layers.

[0093]

[Expression 1]

$$1/P = \sum_{k=1}^n wk/\rho_k \quad \dots(i)$$

[0094]

Symbols in Expression (i) are as follows.

P: calculated density of the target layer (g/cm³)

n: total number of resins that constitute the target layer

wk: blending ratio of resin k that constitutes the target layer

pk: density of resin k that constitutes the target layer (g/cm³)

[0095]

[Calculated MFR]

The calculated MFR (g/10 min) of the polyethylene films of Trial Production Examples 1 to 22 was calculated for each of the surface layer A, the substrate layer, and the surface layer B. Also, the calculated MFRs (g/10 min) of the polyethylene films of Trial Production Examples 23 and 24 were calculated for the surface layer A and the substrate layer. The calculated MFRs were calculated by the following Expression (ii) based on the

MFR and blending ratio of each constituent material used in the target layers. The calculated MFRs of the surface layer A, the substrate layer, and the surface layer B were denoted by MFRs1, MFRc, and MFRs2, respectively. In addition, the relationship between the calculated MFRs of the substrate layer and the surface layer A was denoted by MFRc/MFRs1, and the relationship between the calculated MFRs of the substrate layer and the surface layer B was denoted by MFRc/MFRs2.

[0096]

[Expression 2]

$$\log(MFRx) = \sum_{k=1}^n wk \cdot \log(MFRk) \quad \dots (i \quad i)$$

[0097]

Symbols in Expression (ii) are as follows. Note that the logarithm in Expression (ii) is a common logarithm.

MFRx: calculated MFR of the target layer (g/10 min)

n: total number of resins that constitute the target layer

wk: blending ratio of resin k that constitutes the target layer

MFRk: MFR of resin k that constitutes the target layer (g/10 min)

[0098]

[Evaluation]

The polyethylene films of Trial Production in Examples 1 to 24 were assessed as "Poor" when breakage occurred from the stretching treatment (film formation failed), and "Good" when a biaxially oriented film was properly formed by the stretching treatment (film formation succeeded). The assessments of the film formation are shown in Tables 5 to 8 below, together with the calculated density and calculated MFR of each layer for Trial Production Examples 1 to 24.

[0099]

[Table 5]

		Trial Production Example 1	Trial Production Example 2	Trial Production Example 3	Trial Production Example 4	Trial Production Example 5	Trial Production Example 6
Calculated density (g/cm ³)	Surface Layer A	0.9260	0.9260	0.9260	0.9260	0.9260	0.9260
	Substrate layer	0.9261	0.9279	0.9261	0.9261	0.9261	0.9261
	Surface Layer B	0.9260	0.9260	0.9260	0.9260	0.9260	0.9260
Calculated MFR (g/10 min)	MFRs1	1.7	1.7	1.7	1.7	1.7	1.7
	MFRc	4.1	3.9	3.4	3.2	3.0	2.8
	MFRs2	1.7	1.7	1.7	1.7	1.7	1.7
MFRc/MFRs1		2.4	2.3	2.0	1.9	1.8	1.6
MFRc/MFRs2		2.4	2.3	2.0	1.9	1.8	1.6
Film formation		Poor	Poor	Poor	Poor	Good	Good

[0100]

[Table 6]

		Trial Production Example 7	Trial Production Example 8	Trial Production Example 9	Trial Production Example 10	Trial Production Example 11	Trial Production Example 12
Calculated density (g/cm ³)	Surface Layer A	0.9261	0.9277	0.9260	0.9217	0.9133	0.9071
	Substrate layer	0.9261	0.9279	0.9260	0.9260	0.9260	0.9260
	Surface Layer B	0.9261	0.9277	0.9260	0.9217	0.9133	0.9071
Calculated MFR (g/10 min)	MFRs1	3.7	3.7	1.7	1.8	2.1	2.4
	MFRc	3.9	3.9	1.7	1.7	1.7	1.7
	MFRs2	3.7	3.7	1.7	1.8	2.1	2.4
MFRc/MFRs1		1.1	1.1	1.0	0.9	0.8	0.7
MFRc/MFRs2		1.1	1.1	1.0	0.9	0.8	0.7
Film formation		Good	Good	Good	Good	Good	Good

[0101]

[Table 7]

		Trial Production Example 13	Trial Production Example 14	Trial Production Example 15	Trial Production Example 16	Trial Production Example 17	Trial Production Example 18
Calculated density (g/cm ³)	Surface Layer A	0.9010	0.9261	0.9255	0.9194	0.9138	0.9194
	Substrate layer	0.9260	0.9260	0.9260	0.9260	0.9260	0.9260
	Surface Layer B	0.9010	0.9261	0.9255	0.9194	0.9138	0.9260
Calculated MFR (g/10min)	MFRs1	2.7	3.2	3.8	6.2	8.2	6.2
	MFRc	1.7	1.7	1.7	1.7	1.7	1.7
	MFRs2	2.7	3.2	3.8	6.2	8.2	1.7
MFRc/MFRs1		0.6	0.5	0.4	0.3	0.2	0.3
MFRc/MFRs2		0.6	0.5	0.4	0.3	0.2	1.0
Film formation		Good	Good	Good	Poor	Poor	Poor

[0102]

[Table 8]

		Trial Production Example 19	Trial Production Example 20	Trial Production Example 21	Trial Production Example 22	Trial Production Example 23	Trial Production Example 24
Calculated density (g/cm ³)	Surface Layer A	0.9138	0.9260	0.9260	0.9133	0.9260	0.9092
	Substrate layer	0.9260	0.9261	0.9261	0.9217	0.9260	0.9260
	Surface Layer B	0.9260	0.9261	0.9261	0.9260	–	–
Calculated MFR (g/10 min)	MFRs1	8.2	1.7	1.7	2.1	1.7	2.3
	MFRc	1.7	3.2	3.4	1.9	1.7	1.7
	MFRs2	1.7	3.2	3.4	1.7	–	–
MFRc/MFRs1		0.2	1.9	2.0	0.9	1.0	0.7
MFRc/MFRs2		1.0	1.0	1.0	1.1	–	–
Film formation		Poor	Poor	Poor	Good	Good	Good

[0103]

[Results and Discussion]

As can be seen from Tables 5 to 8, when the polyethylene films of Trial Production Examples 1 to 24 were subjected to the stretching treatment, breakage occurred in Trial Production Examples 1 to 4 and 16 to 21, resulting in failure of film formation; whereas biaxially oriented polyethylene films were properly formed in Trial Production Examples 5 to 15 and 22 to 24. In particular, in Trial Production Examples 1 to 4, 20, and 21, breakage occurred from the stretching treatment in the transverse (TD) direction due to uneven stretching generated during stretching in the machine (MD) direction, and in Trial Production Examples 16 to 19, breakage occurred from the stretching treatment in the transverse (TD) direction due to uneven stretching in the transverse (TD) direction.

[0104]

Here, an investigation was conducted on Trial Production Examples 1 to 17, which were three-layered films with the surface layers A and B of the same composition, focusing on the physical properties (calculated density and calculated MFR) of the constituent materials, by comparing Trial Production Examples 5 to 15, in which the film formation was properly succeeded, with Trial Production Examples 1 to 4, 16, and 17, in which breakage occurred from the stretching treatment in the transverse (TD) direction.

[0105]

First, looking at the calculated density of Trial Production Examples 1 to 17, for example, the calculated density of each layer was almost the same in Trial Production Examples 4 to 6, and no difference in calculated density was observed between Trial Production Examples 3 and 4, in which the film formation failed, and Trial Production Examples 5 and 6, in which the film formation was succeeded. Further, looking at the assessment results for the calculated density and film formation in other Trial Production Examples 1, 2, and 7 to 17, no relationship between the calculated density and the film formation could be found.

[0106]

On the other hand, looking at the calculated MFRs of Trial Production Examples 1 to 17, the film formation

failed when the MFRc/MFRs1 values that indicate the relationship between the calculated MFRs of the substrate layer and the surface layer A and the MFRc/MFRs2 values that indicate the relationship between the calculated MFRs of the substrate layer and the surface layer B were 1.9 or more (Trial Production Examples 1 to 4), and 0.3 or less (Trial Production Examples 16 and 17), respectively. In particular, when the MFRc/MFRs1 values or the MFRc/MFRs2 values are 1.9 or more (Trial Production Examples 1 to 4), breakage occurred during stretching in the transverse (TD) direction due to uneven stretching in the machine (MD) direction generated during stretching in the machine (MD) direction, and when they are 0.3 or less (Trial Production Examples 16 and 17), breakage occurred during stretching in the transverse (TD) direction due to uneven stretching in the transverse (TD) direction.

[0107]

The MFRc/MFRs1 values or the MFRc/MFRs2 values being large indicates a state where the MFR of the substrate layer is higher than that of the surface layer A and the surface layer B, in other words, a state where the fluidity of the resin in the substrate layer is higher than that of the surface layer A and the surface layer B. In Trial Production Examples 1 to 4, in which breakage occurred during stretching in the transverse (TD) direction, it is considered that the MFR (fluidity) of

the substrate layer was excessively higher than that of the surface layer A and the surface layer B, and in turn, breakage occurred because uneven stretching was likely to be generated in the machine (MD) direction during stretching in the machine (MD) direction.

[0108]

Further, the MFRc/MFRs1 values or the MFRc/MFRs2 values being small indicates a state where the MFR of the substrate layer is lower than that of the surface layer A and the surface layer B, in other words, a state where the fluidity of the resin in the substrate layer is lower than that of the surface layer A and the surface layer B. In Trial Production Examples 16 and 17, in which breakage occurred during stretching in the transverse (TD) direction, it is considered that the MFR (fluidity) of the substrate layer was excessively lower than that of the surface layer A and the surface layer B, and in turn, breakage occurred because uneven stretching was likely to be generated in the transverse (TD) direction.

[0109]

Contrary to this, in Trial Production Examples 5 to 15, in which the film formation was successful, the MFRc/MFRs1 values and the MFRc/MFRs2 values all fell in a certain range. This indicates a state in which the fluidity of the substrate layer and that of the surface layer A and/or the surface layer B are relatively close. Therefore, it can be considered that when the MFR

(fluidity) of the substrate layer and that of the surface layer A and/or the surface layer B are close to some extent, a stable stretching process is possible, and film formation can be properly performed. It is considered from each Trial Production Example that the favorable relationship between the MFR (fluidity) of the surface layer and that of the surface layer A and/or the surface layer B is $0.3 < \text{MFRc/MFRs1} < 1.9$ for the substrate layer (MFRc) and the surface layer A (MFRs1), and $0.3 < \text{MFRc/MFRs2} < 1.9$ for the substrate layer (MFRc) and the surface layer B (MFRs2).

[0110]

Next, another investigation was conducted on Trial Production Examples 18 to 22, which were three-layered films with the surface layers A and B of the different compositions. In Trial Production Examples 18 to 21, which breakage occurred, the relation value (MFRc/MFRs2) of the substrate and the surface layer B fell in the above range, whereas the relation value (MFRc/MFRs1) of the substrate and the surface layer A fell out of the above range. Contrary to this, in Trial Production Example 22, in which the film formation was properly succeeded, the relation values (MFRc/MFRs1 and MFRc/MFRs2) all fell in the above range. Accordingly, it is considered that, even though the compositions of the surface layers A and B are different, the relationship (MFRc/MFRs1 and MFRc/MFRs2) of the MFRs of the substrate

layer and each surface layer satisfies the above conditions, resulting in successful proper film formation; on the other hand, if one of the relationships does not satisfy the above conditions, proper film formation becomes difficult.

[0111]

As described above, it has been shown that a polyethylene film consisting of at least three layers of a substrate layer, a surface layer A, and a surface layer satisfies the relationship between the substrate layer and the surface layer A of $0.3 < \text{MFRc/MFRs1} < 1.9$, and the relationship between the substrate layer and the surface layer B of $0.3 < \text{MFRc/MFRs2} < 1.9$, and therefore, film formation can be stably performed. Accordingly, it can be said that the MFRc/MFRs1 , which indicates the relationship between the calculated MFR of the substrate and that of the surface layer A, and the MFRc/MFRs2 , which indicates the relationship between the calculated MFR of the substrate and that of the surface layer B are useful as indexes that indicate the stretchability (film-forming capability) of a polyethylene film.

[0112]

Note that, in Trial Production Examples 23 and 24, which are two-layered films of the substrate layer and the surface layer A, the relationship of the MFRs fell within the range of $0.3 < \text{MFRc/MFRs1} < 1.9$, and the film formation was properly performed. Therefore, it can be

considered that a polyethylene film consisting of two layers, a substrate layer and a surface layer A, can be stably formed into a film by satisfying the relationship between the substrate layer and the surface layer A of $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$.

Industrial Applicability

[0113]

As described above, the biaxially oriented polyethylene film of the present invention exhibits good stretchability when the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$ in a two-layered laminated film made mainly from a polyethylene-based resin to form a monomaterial film. Further, a laminated film with at least three layers exhibits good stretchability when the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$, and the relationship between the calculated MFR (MFRc) of the substrate layer and the calculated MFR (MFRs2) of the surface layer B satisfies $0.3 < \text{MFRc}/\text{MFRs2} < 1.9$. Accordingly, it is possible to provide a biaxially oriented polyethylene film made of a monomaterial more stably than before.

Reference Signs List

[0114]

10, 10A Biaxially oriented polyethylene film

20 Substrate layer

30 Inorganic vapor-deposited layer

50 Laminated film

60 Sealant film

A Surface layer

B Surface layer

Claims

[Claim 1]

A biaxially oriented polyethylene film comprising a substrate layer and a surface layer A disposed on one side of the substrate layer, and being biaxially oriented in a machine (MD) direction and a transversal direction (TD),

wherein the substrate layer is mainly formed of a polyethylene-based resin, and

the relationship between a calculated MFR (MFRc) of the substrate layer and a calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$.

[Claim 2]

A biaxially oriented polyethylene film consisting of at least three layers comprising a substrate layer, a surface layer A disposed on one side of the substrate layer, and a surface layer B disposed on the other side of the substrate layer, and being biaxially oriented in a machine (MD) direction and a transversal direction (TD),

wherein the substrate layer is mainly formed of a polyethylene-based resin;

the relationship between a calculated MFR (MFRc) of the substrate layer and a calculated MFR (MFRs1) of the surface layer A satisfies $0.3 < \text{MFRc}/\text{MFRs1} < 1.9$; and the relationship between the calculated MFR (MFRc) of the

substrate layer and a calculated MFR (MFRs2) of the surface layer B satisfies $0.3 < \text{MFRc}/\text{MFRs2} < 1.9$.

[Claim 3]

The biaxially oriented polyethylene film according to claim 1, wherein an inorganic vapor-deposited layer is disposed on the surface layer A side.

[Claim 4]

The biaxially oriented polyethylene film according to claim 2, wherein an inorganic vapor-deposited layer is disposed on at least one of the surface layer A and the surface layer B.

[Claim 5]

The biaxially oriented polyethylene film according to claim 1, wherein the surface layer A is mainly formed of a polyethylene-based resin.

[Claim 6]

The biaxially oriented polyethylene film according to claim 2, wherein the surface layer A and/or the surface layer B are/is mainly formed of a polyethylene-based resin.

[Claim 7]

A laminated film, comprising the biaxially oriented polyethylene film according to claim 1 or 2 and at least a sealant film made of a polyethylene-based resin laminated thereon.

[Claim 8]

A laminated film, comprising the biaxially oriented polyethylene film according to claim 3 or 4 and at least a sealant film made of a polyethylene-based resin laminated thereon.

[Claim 9]

A packaging body, formed of the laminated film according to claim 7.

[Claim 10]

A packaging body, formed of the laminated film according to claim 8.