DESCRIPTION

TITLE OF INVENTION: WINDING ROLL, AND BASE MATERIAL FILM SEPARATION METHOD

TECHNICAL FIELD

[0001]

The present invention relates to a winding roll and a base film separation method.

BACKGROUND ART

[0002]

In recent years, from the viewpoints of conservation of earth resources, environmental protection, and the like, movements aimed at constructing a recycling-oriented society have become active in various fields through efforts such as suppression of waste generation, reuse, and recycling.

For example, Patent Literature 1 discloses a method for removing a coating layer, the method including a step of cutting a laminated film including a base film and a coating layer into pieces, a step of separating the laminated film into the base film and the coating layer by immersing the cut laminated film in warm water in a stirring tank and performing stirring, a base film recovery step of recovering the separated base film, and a coating layer recovery step of recovering scraps of the separated coating layer, in which the coating layer includes an intermediate layer and a release agent layer, and the intermediate layer is disposed between the base film and the release agent layer.

CITATION LIST

PATENT LITERATURE

[0003]

Patent Literature 1: JP 2023-148863 A

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004]

In the removal method described in Patent Literature 1, separation of the coating layer from the laminated film is promoted by immersing the laminated film in warm water after cutting the laminated film into pieces.

The laminated film described in Patent Literature 1 is, for example, a laminated film after use in a production process for a multilayer ceramic capacitor (MLCC). The laminated film after use in the production process for an MLCC usually has a structure in which a ceramic green sheet further partially adheres to a release film including a base film and a release agent layer.

Since there are various structures of the laminated film in this manner, in a technique for separating the base film from the laminated film, development of a new separation method according to the structure of the laminated film has been demanded.

[0005]

An object of the invention is to provide a winding roll and a base film separation method each capable of easily separating a base film from a laminated film having a structure in which a ceramic green sheet adheres to a release film.

MEANS FOR SOLVING THE PROBLEM

[0006]

[1] A winding roll including a core and an elongated laminated film wound around an outer peripheral surface of the core, in which the laminated film includes a release film including a base film and a release agent layer, and a ceramic green sheet, the base film, the release agent layer, and the ceramic green sheet are disposed in this order, the ceramic green sheet has at least a first green sheet portion adhering to a first end side in a width direction of the laminated film and a second green sheet portion adhering to a second end side opposite to the first end side, the first green sheet portion and the second green sheet portion are each disposed to extend in a longitudinal direction of the laminated film, a recess located between the first green sheet portion and the second green sheet portion is formed on the release agent layer, the laminated film is wound around the core by traverse winding having a traverse width α, and when viewed in a cross section orthogonal to the longitudinal direction of the laminated film, the traverse width α is larger than a width β1 from an edge of the laminated film on the first end side to an inner edge of the first green

sheet portion, is larger than a width β2 from an edge of the laminated film on the second end side to an inner edge of the second green sheet portion, or is larger than the width β1 and larger than the width β2.

[2] The winding roll according to [1], in which the ceramic green sheet has a plurality of third green sheet portions adhering to the release agent layer in the width direction of the laminated film, one end in a longitudinal direction of each of the third green sheet portions is connected to the first green sheet portion, the other end in the longitudinal direction of each of the third green sheet portions is connected to the second green sheet portion, and a recess surrounded on four sides by the first green sheet portion, the second green sheet portion, and two of the third green sheet portions is formed on the release agent layer.

[3] The winding roll according to [2], in which, among a plurality of corners of the recess, at least one corner is in communication with the outside.

[4] The winding roll according to any one of [1] to [3] above, in which the laminated film further includes an intermediate layer disposed between the base film and the release agent layer.

[0007]

[5] A base film separation method including:

preparing the winding roll according to any one of [1] to [4]; treating the winding roll by immersing the winding roll in treatment water or by exposing the winding roll to steam; unwinding the laminated film from the winding roll after the treating the winding roll; and separating the base film from the unwound laminated film.

[6] The base film separation method according to [5] above, in which in the treating the winding roll, the treatment water used when the winding roll is immersed is water or an alkaline aqueous solution.

[7] The base film separation method according to [5] or [6] above, further including: after the separating the base film, winding the base film separated from the laminated film, in which a process from the unwinding the laminated film to the winding the base film is performed in a roll-to-roll manner.

[0008]

According to an aspect of the invention, it is possible to provide a winding roll and a base film separation method each capable of easily separating a base film from a laminated film having a structure in which a ceramic green sheet adheres to a release film.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a perspective view of a laminated film to be wound into a winding roll according to a first exemplary embodiment.

Fig. 2 is a cross-sectional view of the laminated film as viewed along line II-II in Fig. 1.

Fig. 3 is a cross-sectional view of a laminated film according to an exemplary embodiment.

Fig. 4 is a conceptual cross-sectional view of the winding roll according to the first exemplary embodiment.

Fig. 5 is an example of a hypothetical developed view of the laminated film in a state in which distortion when the laminated film is unwound from a core is maintained, according to the first exemplary embodiment.

Fig. 6 is a view illustrating a state in which the winding roll according to the first exemplary embodiment is immersed in treatment water.

Fig. 7 is a schematic view of a removal apparatus used in a separation step according to the first exemplary embodiment.

Fig. 8A is a view illustrating a state in which the winding roll according to the first exemplary embodiment is exposed to steam.

Fig. 8B is a view illustrating a state in which the winding roll according to the first exemplary embodiment is exposed to steam.

Fig. 8C is a view illustrating a state in which the winding roll according to the first exemplary embodiment is exposed to steam.

Fig. 9 is a schematic view of a removal apparatus used in a separation step according to an exemplary embodiment.

DESCRIPTION OF EMBODIMENTS

[0010]

In the present specification, ordinal expressions such as "first" and "second" are intended to distinguish configurations and do not indicate the order. In the present specification, an expression without an ordinal number, for example, an expression "green sheet portion" is a generic term for a first green sheet portion, a second green sheet portion, and a third green sheet portion, and is used to provide an explanation common to the green sheet portions to which the ordinal numbers "first", "second", and "third" are assigned.

[0011]

First exemplary embodiment

Winding roll

A first exemplary embodiment will be described with reference to the drawings.

An X-axis, a Y-axis, and a Z-axis in the first exemplary embodiment are orthogonal to one another; the X-axis and the Y-axis are axes in a predetermined plane, and the Z-axis is an axis orthogonal to the predetermined plane.

[0012]

A winding roll according to the first exemplary embodiment includes a core and an elongated laminated film wound around an outer peripheral surface of the core. First, the elongated laminated film will be described.

Fig. 1 is a perspective view of a laminated film 90 to be wound into a winding roll 1 according to the first exemplary embodiment. Fig. 2 is a cross-sectional view of the laminated film 90 as viewed along line II-II in Fig. 1.

The laminated film 90 includes a release film 95 including a base film 91 and a release agent layer 92, and a ceramic green sheet 93. The base film 91, the release agent layer 92, and the ceramic green sheet 93 are disposed in this order.

The ceramic green sheet 93 includes at least a first green sheet portion 931 adhering to a first end E1 side in a width direction (X-axis direction) of the laminated film 90, and a second green sheet portion 932 adhering to a second end E2 side opposite to the first end E1 side.

The first green sheet portion 931 and the second green sheet portion 932 are each disposed to extend in a longitudinal direction (Y-axis direction) of the laminated

film 90. A recess 94 located between the first green sheet portion 931 and the second green sheet portion 932 is formed on the release agent layer 92.

In the case of Fig. 1, the ceramic green sheet 93 further has a plurality of third green sheet portions 933 adhering to the release agent layer 92 in the width direction (X-axis direction) of the laminated film 90. One end in a longitudinal direction (X-axis direction) of each of the third green sheet portions 933 is connected to the first green sheet portion 931, and the other end in the longitudinal direction of each of the third green sheet portions 933 is connected to the second green sheet portion 932. Recesses 94 each surrounded on four sides by the first green sheet portion 931, the second green sheet portion 932, and two of the third green sheet portions 933 are formed on the release agent layer 92. Each of the recesses 94 has four corners 94A.

In the laminated film 90, the base film 91 and the release agent layer 92 may be in direct contact with each other or may not be in direct contact with each other. In the case of Figs. 1 and 2, the base film 91 and the release agent layer 92 are in direct contact with each other, and the release agent layer 92 and the green sheet portions 931, 932, and 933 are in direct contact with each other.

[0013]

The laminated film 90 is a laminated film which has been used for producing a ceramic green sheet and from which a part of the ceramic green sheet has been peeled off. The ceramic green sheet is used, for example, for production of a multilayer ceramic capacitor (MLCC).

In Fig. 1, the first green sheet portion 931, the second green sheet portion 932, and the third green sheet portions 933 are residues of the ceramic green sheet 93, and the recess 94 is a space formed by peeling off a part of the ceramic green sheet 93. The release agent layer 92 is exposed from the bottom of the recess 94.

[0014]

Next, the winding roll 1 according to the first exemplary embodiment will be described.

Fig. 4 is a conceptual cross-sectional view of the winding roll 1 as viewed in a cross section passing through a center line 80C of a core 80. The winding roll 1

includes the core 80 and the laminated film 90 wound around an outer peripheral surface of the core 80. A through hole 82 is formed in a central portion of the core 80.

In Fig. 4, the laminated film 90 is wound around the outer peripheral surface of the core 80 by traverse winding having a traverse width α.

Fig. 5 is an example of a hypothetical developed view of the laminated film 90 in a state in which distortion when the laminated film 90 is unwound from the core 80 is maintained.

[0015]

The winding roll 1 according to the first exemplary embodiment is a roll obtained by winding the laminated film 90 by traverse winding having a traverse width α.

A width of the winding roll 1, a width of the laminated film 90, and the traverse width α satisfy the relationship of the following numerical formula (Numerical Formula 1). In the case of Fig. 5, the shape of the laminated film 90 in the longitudinal direction is a sinusoidal shape (period P1).

Width of winding roll 1 = width of laminated film 90 + traverse width α… (Numerical Formula 1)

Winding in which the laminated film 90 is wound while being periodically moved in a width direction of the core 80 is referred to as traverse winding. In the present specification, a movement distance in the width direction in traverse winding is referred to as a "traverse width α". That is, the sum of the width of the laminated film 90 and the traverse width α is the value of the width of the winding roll 1 (see Figs. 4 and 5).

Dimensions of the laminated film 90 are, for example, such that the width (the distance from the first end E1 to the second end E2) is in a range from 100 mm to 1,000 mm and is preferably in a range from 200 mm to 600 mm. A length of the laminated film 90 in the winding roll 1 is, for example, in a range from 50 m to 30,000 m and is preferably in a range from 100 m to 10,000 m. The laminated film 90 may be formed by splicing together a plurality of laminated films so as to have a predetermined length.

[0016]

A width β1 from an edge of the laminated film 90 on the first end E1 side to an inner edge of the first green sheet portion 931, and a width β2 from an edge of the laminated film 90 on the second end E2 side to an inner edge of the second green sheet portion 932 are each, for example, in a range from 1 mm to 60 mm and preferably in a range from 2 mm to 30 mm. These widths may be the same dimension or may be different dimensions. An outer edge 931E of the first green sheet portion 931 may be located at the same position as the edge of the laminated film 90, or may be located at a position separated from the edge of the laminated film 90, as illustrated in, for example, Fig. 1. In a case where the outer edge 931E of the first green sheet portion 931 is located at a position separated from the edge of the laminated film 90, a distance D_1 between the edge of the laminated film 90 and the outer edge 931E of the first green sheet portion 931 is, for example, in a range from 1 mm to 30 mm and is preferably in a range from 3 mm to 10 mm. A distance D_2 between an outer edge 932E of the second green sheet portion 932 and the edge of the laminated film 90 is also the same as described above (see Figs. 1 and 2).

A width D_{11} of the first green sheet portion 931, a width D_{21} of the second green sheet portion 932, and a width D_{31} of each of the third green sheet portions 933 described later are, for example, each in a range from 1 mm to 30 mm and are each preferably in a range from 2 mm to 20 mm (see Figs. 1 and 2).

A width D_{94} of the recess 94 is, for example, in a range from 80 mm to 980 mm and is preferably in a range from 140 mm to 580 mm. In the case where the third green sheet portions 933 are provided, a length L_{94} of one recess 94 is, for example, in a range from 100 mm to 1,000 mm and is preferably in a range from 200 mm to 600 mm (see Fig. 1).

[0017]

The traverse width α (the value equal to twice an amplitude) in the winding roll 1 is preferably in a range from 3 mm to 100 mm, more preferably in a range from 10 mm to 50 mm. If the traverse width is excessively narrow, it becomes difficult to guide treatment water or steam into the recess 94, and if the traverse width is excessively wide, tensions of the respective parts in the winding roll 1 cannot be balanced, and winding becomes difficult.

A period of the traverse winding in the winding roll 1 is preferably in a range from 150 mm to 5,000 mm, more preferably in a range from 200 mm to 4,000 mm. In the case of Fig. 5, the period of the traverse winding in the winding roll 1 is P1.

In the case where the winding roll 1 includes the third green sheet portions 933, the period P1 of the traverse winding is preferably 1 to 10 times, and more preferably 2 to 4 times, the length L_{94} of the recess 94 of the laminated film 90.

A winding diameter of the winding roll 1 (a diameter of the winding roll 1 including the core 80) is, for example, in a range from 100 mm to 1,500 mm and is preferably in a range from 150 mm to 1,000 mm.

[0018]

In traverse winding having the traverse width α and the period P1 as illustrated in Figs. 4 and 5, one edge of the laminated film 90 in the longitudinal direction is wound with high tension and low tension alternating repeatedly, and the other edge is wound with low tension and high tension alternating repeatedly (in a manner opposite to that of the one edge). A portion wound with low tension becomes a loose winding and forms a gap between portions of the laminated film 90 that are adjacent to each other in the Z direction. When the winding roll 1 in this state is immersed in treatment water TW, the treatment water TW can be easily guided from the gap formed by the loose winding into the recesses 94.

[0019]

The laminated film 90 constituting the winding roll 1 may be wound around the core 80 with a side on which the ceramic green sheet 93 is disposed facing the core 80 (see Fig. 4), or may be wound around the core 80 with that side facing away from the core 80.

[0020]

In the winding roll 1 according to the present exemplary embodiment, among the plurality of corners 94A of each of the recesses 94, at least one corner 94A is preferably in communication with the outside. Whether the corner 94A is in communication with the outside can be confirmed, for example, by observing a wound state of the laminated film 90 in a cross section passing through the center line 80C of the core 80.

The corner 94A being in communication with the outside means a state in which, in the winding roll 1, the corner 94A is not sandwiched between the base film 91 and either the first green sheet portion 931 or the second green sheet portion 932, and flows of liquid and gas are not blocked. In this state, when the winding roll 1 is immersed in treatment water (TW in Fig. 4) or exposed to steam, the treatment water or steam is introduced into the recess 94 through the corner 94A from at least one of the first end E1 side or the second end E2 side of the laminated film 90.

For example, when the laminated film 90 illustrated in Fig. 1 is wound around the core 80 illustrated in Fig. 4 by traverse winding having a traverse width α, corners 94A in communication with the outside and corners not in communication with the outside are formed on each of the first end E1 side and the second end E2 side. Fig. 4 illustrates only the corners 94A in communication with the outside. In Fig. 4, the respective wound portions of the laminated film 90 each have, on the first end E1 side, a corner 94A in communication with the outside, and a gap is formed between each wound portion and the wound portion of the laminated film 90 immediately below it. A width of the gap (gap width 94B), as measured in the X-axis direction, is preferably 1 mm or more, and more preferably in a range from 2 mm to 100 mm.

[0021]

Second exemplary embodiment

Base film separation method

A base film separation method according to a second exemplary embodiment includes a preparation step of preparing the winding roll according to the first exemplary embodiment, a winding roll treatment step of treating the winding roll by immersing the winding roll in treatment water, a step of unwinding the laminated film from the winding roll after the winding roll treatment step, and a step of separating the base film from the unwound laminated film (hereinafter, also referred to as a separation step).

[0022]

Preparation step

The preparation step is a step of preparing the winding roll 1 according to the first exemplary embodiment. The winding roll 1 is a roll obtained by winding the laminated film 90 by traverse winding having a traverse width α.

Examples of a method for winding the laminated film 90 by traverse winding include a method in which the core 80 is fixed and a guide for winding a laminated film is periodically reciprocated to wind the laminated film 90 around the core 80, and a method in which a guide for winding a laminated film is fixed and the core 80 is periodically reciprocated to wind the laminated film 90. Accordingly, the laminated film 90 has a wave shape with a period and an amplitude (one-half of the traverse width), as illustrated in Fig. 5, which is a hypothetical developed view obtained by unwinding the laminated film 90 from the core 80 while retaining the positional relationship thereof in the wound state. The wave shape of the laminated film 90 in the winding roll 1 according to the present exemplary embodiment is preferably a sine wave, but may be a triangular wave or a rectangular wave.

[0023]

Winding roll treatment step

The winding roll treatment step is a step of treating the winding roll by immersing the winding roll in treatment water.

In the winding roll treatment step, the treatment water used when the winding roll is immersed is preferably water or an alkaline aqueous solution.

In the second exemplary embodiment, a container in which the winding roll 1 is immersed in the treatment water may be referred to as an immersion container.

In the winding roll treatment step, in a case where water is used as the treatment water, the immersion container is, for example, a water tank. In a case where an alkaline aqueous solution is used as the treatment water, the immersion container is, for example, an alkali treatment tank. In a case where superheated water is used as the treatment water, the immersion container is a pressure vessel.

[0024]

Treatment water

First, the case where water is used as the treatment water will be described.

The water used as the treatment water means liquid water for immersing the winding roll in the winding roll treatment step. In the present exemplary embodiment, the water used as the treatment water means ordinary water. Specifically, the water is preferably, for example, industrial water, and may be purified water or distilled water. The water may also be water obtained by reusing wastewater used in various

industrial production processes, and may be water obtained by reusing wastewater after use in carrying out the present exemplary embodiment. In the case where wastewater is reused, the wastewater may be subjected to regeneration treatment, as appropriate.

From the viewpoint of improving work efficiency, the water used as the treatment water may appropriately contain an additive that provides functionality, but preferably does not contain such an additive. Examples of the additive include surfactants and water-soluble organic solvents. In a case where the water used as the treatment water contains an additive, the concentration of an active ingredient of the additive in the treatment water is preferably 0.2 mass% or less, more preferably 0.1 mass% or less, relative to a total amount of the treatment water. Furthermore, preferably, the water used as the treatment water is not water to which an additive has been intentionally added.

Since wastewater may be handled by simple regeneration treatment, the water used as the treatment water may contain a basic substance and an acidic substance as additives; however, in such a case, the pH of the treatment water is preferably in a range from 5.8 to 8.6 so as to conform to the uniform effluent standards (other items) under the Water Pollution Control Act.

[0025]

In the second exemplary embodiment, the entirety of both surfaces of the laminated film can be wetted with the treatment water by immersing the winding roll in the treatment water. Thus, water permeability into the interface between the release agent layer and the base film can be increased, and consequently, the base film can be easily separated from the laminated film. Permeation of water into the interface between the release agent layer and the base film can also be performed in the form of a roll, because water is easily guided into the inside of the winding roll 1 (specifically, the recesses 94 of the laminated film 90) by subjecting the laminated film to traverse winding.

Since the release agent layer tends to have low affinity for water, the winding roll treatment step is preferably performed while applying ultrasonic vibration to the treatment water. This can promote guidance of water into the inside of the winding roll 1 and removal of air from the inside of the winding roll 1.

[0026]

In the winding roll treatment step, in a case where warm water is used as the treatment water, the winding roll treatment step may be a step of immersing the winding roll in warm water in a container, may be a step of putting warm water into a container containing the winding roll, or may be a step of, after placing water and the winding roll in a container, heating the water to a predetermined temperature. A known heater can be used for heating the water.

In the case where warm water is used as the treatment water, the temperature of the treatment water is preferably in a range from 80 degrees Celsius to 100 degrees Celsius, more preferably in a range from 90 degrees Celsius to 100 degrees Celsius.

In the winding roll treatment step, after the water temperature reaches a target temperature, the winding roll is held in the treatment water for a predetermined time at this temperature. In the present specification, a holding time of the winding roll in the treatment water from when the target temperature is reached is defined as an immersion time of the winding roll.

The immersion time of the winding roll is preferably 5 minutes or more, more preferably 30 minutes or more. The immersion time of the winding roll is preferably 10 days or less, more preferably 24 hours or less.

[0027]

The water used as the treatment water may be superheated water. The superheated water is liquid water at a temperature exceeding 100 degrees Celsius that has been heated under pressure. In a case where the superheated water is used as the treatment water, the winding roll treatment step is a step of placing the winding roll and water in a pressure vessel, heating the contained water, and pressurizing the inside of the pressure vessel to a pressure higher than 1 atmosphere. As the water to be placed in the pressure vessel, water having the same water quality as the "ordinary water" described in the winding roll treatment step of the second exemplary embodiment can be used. Therefore, in the winding roll treatment step, the superheated water used as the treatment water is obtained by heating the "ordinary water" under pressure.

In the winding roll treatment step, the pressure in the pressure vessel and the temperature of the heated water (superheated water) are each determined according to the Boyle-Charles' law, and are preferably within the following ranges.

The pressure in the pressure vessel is preferably 1.2 atmospheres or more, more preferably 1.4 atmospheres or more, from the viewpoint of facilitating infiltration of the superheated water into the interface between the base film and the release agent layer. The pressure in the pressure vessel is preferably 9.9 atmospheres or less, more preferably 4.7 atmospheres or less, from the viewpoint of suppressing melting of a resin component contained in the release film. The pressure in the pressure vessel is adjusted by a pressure control valve or the like.

The temperature of the superheated water is preferably 105 degrees Celsius or higher, more preferably 110 degrees Celsius or higher, from the viewpoint of facilitating infiltration of the superheated water into the interface between the base film and the release agent layer. The temperature of the superheated water is preferably 180 degrees Celsius or lower, more preferably 150 degrees Celsius or lower, from the viewpoint of suppressing melting of a resin component contained in the release film.

In the winding roll treatment step, a holding time of the winding roll in the superheated water from when the water temperature reaches a target temperature (the immersion time of the winding roll) is, for example, preferably 5 minutes or more, more preferably 10 minutes or more. The immersion time of the winding roll in the superheated water is preferably 60 minutes or less, more preferably 40 minutes or less.

[0028]

Next, the case where an alkaline aqueous solution is used as the treatment water will be described.

Examples of the alkaline aqueous solution include one or two or more aqueous solutions selected from an aqueous sodium hypochlorite solution, an aqueous sodium hydroxide solution, and an aqueous potassium hydroxide solution. The alkaline aqueous solution is preferably an aqueous sodium hydroxide solution or an aqueous potassium hydroxide solution, more preferably an aqueous potassium hydroxide solution.

The alkaline aqueous solution may further contain an auxiliary agent. Examples of the auxiliary agent include surfactants, water-soluble inorganic compounds, water-soluble organic compounds, and water-soluble solvents. Specific examples of the auxiliary agent include nonionic surfactants, water-soluble inorganic salts, water-soluble organic salts, water-soluble polymers, polysaccharides, alcohols, glycols, and water-soluble organic solvents. Examples of the glycols include ethylene glycol, diethylene glycol, and propylene glycol. Examples of the water-soluble organic solvents include dimethylformamide (DMF), dimethyl sulfoxide (DMSO), and ethers of ethylene glycol (various cellosolves). These auxiliary agents may be used alone or in combination of two or more thereof.

[0029]

The temperature of the alkaline aqueous solution is preferably 5 degrees Celsius or higher, more preferably 20 degrees Celsius or higher. The temperature of the alkaline aqueous solution is preferably 100 degrees Celsius or lower, more preferably 80 degrees Celsius or lower.

[0030]

In the winding roll treatment step, the concentration of the alkaline aqueous solution when the winding roll 1 is immersed in the alkaline aqueous solution is preferably 0.5 mass% or more, more preferably 1.0 mass% or more, and still more preferably 3.0 mass% or more. The concentration of the alkaline aqueous solution is preferably 60 mass% or less, more preferably 55 mass% or less, still more preferably 50 mass% or less, still further more preferably 47 mass% or less, and yet still further more preferably 45 mass% or less. In a case where the alkaline aqueous solution contains an auxiliary agent, the concentration of the alkaline aqueous solution means a total concentration of alkaline components in the alkaline aqueous solution.

[0031]

In the winding roll treatment step, the immersion time of the winding roll 1 in the alkaline aqueous solution is preferably 5 minutes or more, more preferably 30 minutes or more. The immersion time of the winding roll 1 in the alkaline aqueous solution is preferably 10 days or less, more preferably 24 hours or less.

In the winding roll treatment step, by increasing the immersion time of the winding roll 1, the temperature or concentration condition for the alkaline aqueous solution can be made milder.

After the winding roll treatment step is performed, the alkaline aqueous solution used as the treatment water is subjected to neutralization treatment so that the alkaline aqueous solution can be discarded.

[0032]

Form of winding roll

In the winding roll treatment step, the winding roll 1 may be immersed in the treatment water as it is, or may be immersed in the treatment water in a state in which the winding roll 1 is contained in a holding container. Alternatively, the winding roll 1 may be immersed in the treatment water in a state of being fixed using a jig (for example, a clip or the like). Examples of the holding container include containers having a plurality of holes (such as a basket, a strainer, and a container formed of a metal mesh).

[0033]

The winding roll treatment step will be described with reference to Specific Examples 1 and 2. The winding roll treatment step is not limited to Specific Examples 1 and 2.

[0034]

Specific Example 1

The winding roll treatment step according to Specific Example 1 is performed using an immersion container 20 illustrated in Fig. 6.

Fig. 6 illustrates a state in which the winding roll 1 is immersed in treatment water TW as it is (winding roll treatment step). The laminated film 90 is wound around the core 80 by traverse winding having a traverse width α.

In the case of Fig. 6, the treatment water TW is contained in the immersion container 20. The treatment water TW may be water, warm water, or an alkaline aqueous solution.

By immersing the winding roll 1 in the treatment water TW as it is, the treatment water TW enters the recesses 94 in the laminated film 90 through the corners 94A (communication portions with the outside) formed on at least one of the

first end E1 side or the second end E2 side of the laminated film 90. This facilitates infiltration of the treatment water TW into the interface between the base film 91 and the release agent layer 92, and therefore, in the subsequent separation step, the base film 91 can be easily separated from the laminated film 90.

[0035]

Specific Example 2

The winding roll treatment step according to Specific Example 2 is performed using a pressure vessel (not illustrated). In this case, superheated water is used as the treatment water. A known pressure vessel can be used as the pressure vessel.

In the case of Specific Example 2, the winding roll treatment step is performed, for example, as follows.

The winding roll 1 and water are placed in the pressure vessel. The contained water is heated, and the inside of the pressure vessel is pressurized to a pressure higher than 1 atmosphere. After the pressure in the pressure vessel has reached a pressure such that the water temperature reaches a target temperature, the state at this temperature is maintained for a predetermined time (winding roll treatment step). Subsequently, the pressure inside the pressure vessel is returned to normal pressure, and after a pressure lid is opened, the winding roll 1 is taken out from the treatment water.

[0036]

Unwinding step

The unwinding step is performed by unwinding the laminated film 90 from the winding roll 1 after the winding roll treatment step.

In the unwinding step, preferably, a surface of the unwound laminated film 90 is not dried. That is, the unwinding step is preferably performed while a wet state of the winding roll 1 is maintained. As a result, the base film 91 can be efficiently separated from the laminated film 90.

[0037]

Separation step

The separation step is a step of separating the base film 91 from the unwound laminated film 90.

The separation step is preferably performed while the unwound laminated film 90 is passed through washing water. As a result, the release agent layer with the green sheet can be washed away so that the release agent layer 92 and the ceramic green sheet 93 that are separated from the laminated film 90 do not adhere to the base film 91 again.

As the washing water used in the separation step, water having the same water quality as the "ordinary water" described in the winding roll treatment step of the second exemplary embodiment can be used. The washing water may contain an additive necessary for washing.

The temperature of the washing water is not particularly limited, and may be room temperature or a temperature of warm water, but is preferably room temperature from the viewpoint of improving energy efficiency. In a case where warm water is used as the washing water, the temperature of the washing water is, for example, preferably 40 degrees Celsius or higher, more preferably 60 degrees Celsius or higher. The temperature of the washing water is preferably lower than 100 degrees Celsius, more preferably 98 degrees Celsius or lower.

In a case where the washing water is warm water, even if weakening of bonding at the interface between the base film and the release agent layer or an intermediate layer described later is insufficient in the winding roll treatment step, the bonding at the interface can be weakened in the separation step, thereby facilitating separation of the ceramic green sheet and the release agent layer.

[0038]

The separation method according to the present exemplary embodiment preferably further includes, after the separation step, a step of winding the base film 91 separated from the laminated film 90, and a process from the unwinding step to the winding step is preferably performed in a roll-to-roll manner.

The separation step is preferably a step of scraping off the ceramic green sheet and the release agent layer from the base film 91 while the laminated film 90 unwound from the winding roll 1 is passed through washing water.

Examples of a scraping-off unit include a blade and a wire brush. Known members can be used respectively as the blade and the wire brush. The number and

arrangement positions of the scraping-off units are not particularly limited. Alternatively, another scraping-off unit may be a high-pressure water stream.

Hereinafter, a container used in the separation step may be referred to as a washing container. The washing container is, for example, a water tank.

In the separation step, the laminated film unwound from the winding roll 1 is preferably passed through the washing water contained in the washing container while being wrapped around guide rollers.

Since the separation method according to the present exemplary embodiment is intended to prevent the separated ceramic green sheet and release agent layer from adhering to the base film 91 again, the intended purpose can be achieved in a short passage time. The passage time in the washing water is usually in a range from 0.01 seconds to 10 minutes, and is preferably in a range from 0.1 seconds to 5 minutes.

The immersion container used in the winding roll treatment step and the washing container used in the separation step may be the same as or different from each other.

[0039]

In the case where washing water is used in the separation step, the separation step is preferably a step of sinking the base film 91 separated from the laminated film 90 in water and floating the separated ceramic green sheet or release agent layer on the water. After the separation step, the base film 91 separated from the ceramic green sheet and the release agent layer is taken out from the washing water and recovered.

[0040]

The separation step will be described with reference to Specific Example 3. The separation step is not limited to Specific Example 3.

Specific Example 3

The separation step according to Specific Example 3 is performed using a removal apparatus 100 illustrated in Fig. 7.

The removal apparatus 100 illustrated in Fig. 7 includes an unwinding unit 10, a separation unit 30, a winding unit 40, and a plurality of guide rollers GR1, GR2, and GR3. The unwinding unit 10 is a unit configured to unwind the laminated film 90

from the winding roll 1, and includes a support member 10A that rotatably supports the core 80 of the winding roll 1. In the winding roll 1, the laminated film 90 is wound around the core 80 by traverse winding having a traverse width α (see Fig. 4).

The separation unit 30 includes the guide roller GR2 and a wire brush 34 (an example of the scraping-off unit) configured to scrape off the ceramic green sheet and the release agent layer from the base film 91. In the case of Fig. 7, the separation unit 30 includes a washing container 32. Washing water W2 is contained in the washing container 32.

The wire brush 34 is provided so as to face the guide roller GR2, and is provided so as to come into contact with a surface of the laminated film 90 on the ceramic green sheet side.

The winding unit 40 is a unit configured to wind the base film 91, after the ceramic green sheet and the release agent layer are separated, into a roll shape. The winding unit 40 includes a support member 40A that rotatably supports the wound roll-shaped base film 91. The winding shape of the base film 91 may be traverse winding in which the base film 91 is wound while maintaining the shape of the winding roll 1, or may be normal winding in which an adjustment for eliminating the traverse width α is performed.

[0041]

For example, after the winding roll treatment step is performed by the method of Specific Example 1 or Specific Example 2, the laminated film 90 can be unwound from the winding roll 1 by attaching the core 80 of the winding roll 1 to the support member 10A of the unwinding unit 10.

The laminated film 90 unwound from the winding roll 1 by the unwinding unit 10 is wrapped around the guide roller GR1 and then passes through the washing water W2 in the washing container 32. Subsequently, when the laminated film 90 is wrapped around the guide roller GR2 provided in the washing water W2, the ceramic green sheet and the release agent layer are scraped off from the base film 91 by the wire brush 34 provided so as to face the guide roller GR2 (separation step, scraping-off step).

After the separation step, the base film 91 is taken out from the washing container 32 and isolated from the ceramic green sheet and the release agent layer

separated in the washing water W2. The base film 91 is then wrapped around the guide roller GR3 and is wound around a core 6A by the winding unit 40 and recovered.

[0042]

Third exemplary embodiment

Base film separation method

Compared with the separation method according to the second exemplary embodiment, a separation method according to a third exemplary embodiment is the same as the separation method according to the second exemplary embodiment except that the winding roll treatment step is changed to a method of exposing the winding roll to steam.

The base film separation method according to the third exemplary embodiment includes a step of preparing the winding roll according to the first exemplary embodiment, a winding roll treatment step of treating the winding roll by exposing the winding roll to steam, a step of unwinding the laminated film from the winding roll after the winding roll treatment step, and a step of separating the base film from the unwound laminated film.

Hereinafter, differences from the second exemplary embodiment will be mainly described, and a description of similar points will be omitted or simplified by, for example, assigning the same reference signs.

[0043]

Winding roll treatment step

The winding roll treatment step is a step of treating the winding roll by exposing the winding roll to steam. The winding roll treatment step is preferably performed by exposing the winding roll to steam in a container (preferably a pressure vessel).

In the third exemplary embodiment, a container in which the winding roll 1 is exposed to steam may be referred to as a steam chamber.

The steam chamber preferably has a structure capable of supplying steam into the steam chamber or a structure capable of generating steam in the steam chamber, in a state in which the winding roll 1 is contained therein. Examples of the steam chamber include a chamber with a lid and a pressure vessel.

[0044]

In the third exemplary embodiment, the steam to be placed in the steam chamber is preferably either steam generated outside the steam chamber and then introduced into the steam chamber, or steam generated from water introduced into the steam chamber (hereinafter, also referred to as steam source water).

In one exemplary embodiment, the winding roll 1 and steam are placed in a pressure vessel serving as the steam chamber.

As the steam source water to be placed in the steam chamber, water having the same water quality as the "ordinary water" described in the winding roll treatment step of the second exemplary embodiment can be used. The steam source water changes state from liquid to gas (steam) by being heated.

Examples of means for placing steam in the steam chamber include (1) means for introducing steam generated outside into the steam chamber, and (2) means for introducing steam source water into the steam chamber and heating the steam source water to generate steam in the steam chamber.

Examples of the means (1) above include a known steam generator (for example, a boiler or the like) and a steam inlet path for introducing steam generated by the steam generator into the steam chamber. For the means (2) above, for example, steam source water to be introduced into the steam chamber and a known heating unit (for example, a heater or the like) for heating the steam source water are used.

[0045]

Examples of the method for exposing the winding roll 1 to steam include a method of putting the winding roll 1 in a steam chamber filled with steam, a method of supplying steam into a steam chamber in a state in which the winding roll 1 is contained in the steam chamber, and a method of placing the winding roll 1 and steam source water in a steam chamber and then heating the steam source water.

[0046]

In the winding roll treatment step, the pressure in the steam chamber and the temperature in the steam chamber are preferably within the following ranges.

In the winding roll treatment step, the pressure in the steam chamber is preferably 1.2 atmospheres or more, more preferably 1.4 atmospheres or more. The

pressure in the steam chamber is preferably 9.9 atmospheres or less, more preferably 4.7 atmospheres or less.

In the winding roll treatment step, the temperature in the steam chamber is preferably 105 degrees Celsius or higher, more preferably 110 degrees Celsius or higher. The temperature in the steam chamber is preferably 180 degrees Celsius or lower, more preferably 150 degrees Celsius or lower.

[0047]

In the winding roll treatment step, the exposure time of the winding roll 1 to steam is, for example, in a range from 5 minutes to 60 minutes and is preferably in a range from 10 minutes to 40 minutes.

[0048]

Form of winding roll 1

The form of the winding roll 1 in the winding roll treatment step of the third exemplary embodiment is preferably the same as the form of the winding roll 1 described in the second exemplary embodiment.

The winding roll treatment step of the third exemplary embodiment is performed without immersing the winding roll 1 in liquid water.

[0049]

The winding roll treatment step of the third exemplary embodiment will be described with reference to Specific Examples 4 to 6. The winding roll treatment step of the third exemplary embodiment is not limited to Specific Examples 4 to 6.

[0050]

Specific Example 4

The winding roll treatment step according to Specific Example 4 is performed using a steam chamber 60 illustrated in Fig. 8A.

Fig. 8A illustrates a state in which the winding roll 1 is contained in the steam chamber 60 as it is. In the winding roll 1, the laminated film 90 is wound around the core 80 by traverse winding having a traverse width α.

The steam chamber 60 includes a chamber body 62 and a lid 61. At upper portions of the lid 61, a steam inlet path 63 for introducing steam V1 and a pressure relief pipe 64 are formed. A pressure relief valve 73 for controlling the pressure in the

steam chamber 60 is disposed in the pressure relief pipe 64. The lid 61 has an edge 601 along an outer periphery thereof.

[0051]

The winding roll treatment step according to Specific Example 4 is performed, for example, as follows.

First, the winding roll 1 is placed in the steam chamber 60. Steam V1 generated by a steam generator (not illustrated) is introduced from the steam inlet path 63 into the steam chamber 60.

The winding roll 1 is exposed to the steam V1 introduced from the steam inlet path 63 into the steam chamber 60.

In Specific Example 4, when the winding roll 1 is exposed to the steam V1, the steam V1 enters the recesses 94 in the laminated film 90 through the corners 94A (communication portions with the outside) formed on at least one of the first end E1 side or the second end E2 side of the laminated film 90. As a result, for the same reason as in Specific Example 1, the base film 91 can be easily separated from the laminated film 90 in the separation step.

[0052]

Specific Example 5

The winding roll treatment step according to Specific Example 5 is performed using a pressure vessel 400 (an example of the steam chamber) illustrated in Fig. 8B.

Fig. 8B illustrates a state in which the winding roll 1 is contained in the pressure vessel 400 while being held in a basket 407 (an example of the holding container). Wheels 407A are provided at bottom portions of the basket 407.

The pressure vessel 400 includes an outer housing 402, a pressure vessel body 401 installed in the outer housing 402, and a lid 403 that hermetically seals the pressure vessel body 401 and the outer housing 402.

A steam supply pipe 404 and a steam discharge pipe 405 are provided at upper portions of the pressure vessel 400, and the steam supply pipe 404 is connected to a boiler 420. Steam control valves 404A and 405A are disposed in the steam supply pipe 404 and the steam discharge pipe 405, respectively.

A drain pipe 406 is provided at a bottom portion of the pressure vessel 400. The drain pipe 406 is configured such that water W3 introduced into the pressure vessel body 401 is discharged from a drain outlet 406B. A drain control valve 406A is disposed in the drain pipe 406.

A heater 411 for heating the water W3 introduced into the pressure vessel body 401 is also disposed on a bottom portion of the pressure vessel 400. The position where the heater 411 is disposed is not limited to that in Fig. 8B. For example, the heater 411 may be disposed inside the outer housing 402 and outside the pressure vessel body 401.

The pressure vessel body 401 includes, at a bottom portion thereof, a water stop wall 410 and a reservoir 409 for storing the water W3, and includes a support platform 408 at a position higher than the reservoir 409. The basket 407 holding the winding roll 1 is disposed on the support platform 408.

The support platform 408 has a plurality of openings 408A and is configured such that steam generated from the water W3 in the reservoir 409 diffuses into the pressure vessel body 401 through the openings 408A.

[0053]

The winding roll treatment step according to Specific Example 5 is performed, for example, as follows.

In Specific Example 5, a description will be given of a case where, as the steam used in the winding roll treatment step, only steam generated from the water W3 (steam source water) introduced into the pressure vessel 400 (in the case of Fig. 8B, the reservoir 409) is used.

First, the winding roll 1 held in the basket 407 and the water W3 are placed in the reservoir 409 of the pressure vessel body 401. The water W3 is heated by the heater 411 to generate steam V3. The generated steam V3 diffuses through the openings 408A of the support platform 408 into the pressure vessel body 401.

As a result, the inside of the pressure vessel body 401 is filled with the steam V3, and the winding roll 1 is exposed to the steam V3.

In Specific Example 5, when the winding roll 1 is exposed to the steam V3, the steam V2 enters the recesses 94 in the laminated film 90 through the corners 94A (communication portions with the outside) formed on at least one of the first end

E1 side or the second end E2 side of the laminated film 90. As a result, for the same reason as in Specific Example 1, the base film 91 can be easily separated from the laminated film 90 in the separation step.

[0054]

Specific Example 6

In Specific Example 6, a description will be given of a case where, as the steam used in the winding roll treatment step, only steam generated outside the pressure vessel 400 (in the case of Fig. 8B, steam V2 generated by the boiler 420) is used. Fig. 8B illustrates a state in which the water W3 capable of generating steam has been introduced into the reservoir 409 of the pressure vessel body 401; however, in the case of Specific Example 6, the water W3 may not be introduced.

First, the winding roll 1 held in the basket 407 is placed in the pressure vessel body 401. The steam V2 generated by the boiler 420 is introduced from a steam inlet 404B of the steam supply pipe 404 into the pressure vessel body 401, and the winding roll 1 is exposed to the steam V2.

[0055]

Specific Example 7

The winding roll treatment step according to Specific Example 7 is performed using a pressure vessel 60A illustrated in Fig. 8C, instead of the pressure vessel 400 used in Specific Example 5.

Fig. 8C illustrates a state in which the winding roll 1 is contained in the pressure vessel 60A together with water W1 (steam source water).

In the pressure vessel 60A, a support platform 66 having a height greater than a depth of the water W1 is installed, and the winding roll 1 is disposed on the support platform 66.

The pressure vessel 60A includes a pressure vessel body 62A and a pressure lid 61A. The pressure lid 61A has an edge 601A along an outer periphery thereof. A pressure controller 70 is disposed at an upper portion of the pressure lid 61A. The pressure controller 70 controls the pressure inside the pressure vessel 60A to a first pressure higher than 1 atmosphere. As the pressure controller 70, for example, a pressure-regulating valve (for example, a safety valve), a pressure-regulating valve (for example, a relief valve), a pressure control valve used in an

ordinary pressure cooker (for example, a weight type or a spring type), or the like can be used.

In the case of Fig. 8C, the pressure controller 70 includes a relief valve 71 and a pressure sensor 72. The relief valve 71 controls an opening area of a steam outlet 71A formed in the pressure lid 61A to adjust the pressure inside the pressure vessel 60A to a predetermined pressure. The control of the opening area of the steam outlet 71A is performed by a control unit of a computer according to a pressure value acquired by the pressure sensor 72. The control of the pressure inside the pressure vessel 60A is not limited thereto.

A heater 68 for heating the water W1 is disposed at a lower portion of the pressure vessel body 62A.

[0056]

The winding roll treatment step according to Specific Example 7 is performed, for example, as follows.

First, the winding roll 1 is placed on the support platform 66 installed in the pressure vessel 60A, and the water W1 is placed at the bottom of the pressure vessel 60A. When the water W1 in the pressure vessel 60A is heated by the heater 68 and the inside of the pressure vessel 60A is pressurized to a pressure higher than 1 atmosphere, steam is generated in the pressure vessel 60A, and the inside of the pressure vessel 60A is filled with the steam. The winding roll 1 disposed on the support platform 66 is exposed to the steam (not illustrated) without being immersed in the water W1.

In Specific Example 7, when the winding roll 1 is exposed to the steam, the steam enters the recesses 94 in the laminated film 90 through the corners 94A (communication portions with the outside) formed on at least one of the first end E1 side or the second end E2 side of the laminated film 90. As a result, for the same reason as in Specific Example 1, the base film 91 can be easily separated from the laminated film 90 in the separation step.

[0057]

Unwinding step and separation step

The unwinding step and the separation step according to the third exemplary embodiment can be performed in the same manner as the unwinding step and the separation step described in the second exemplary embodiment.

[0058]

Modifications of exemplary embodiments

In the first exemplary embodiment, an example in which the laminated film 90 is wound into the winding roll 1 has been described; however, instead of the laminated film 90, a laminated film 90B illustrated in Fig. 3 may be wound.

Fig. 3 is a cross-sectional view of the laminated film 90B according to an exemplary embodiment.

Compared with the laminated film 90 illustrated in Fig. 2, the laminated film 90B further includes an intermediate layer 921 disposed between the base film 91 and the release agent layer 92. Except for this point, the laminated film 90B has the same configuration as the laminated film 90 illustrated in Fig. 2.

In the laminated film 90B, the base film 91, the intermediate layer 921, the release agent layer 92, and the ceramic green sheet 93 are disposed in this order. A release film 95A includes the base film 91, the intermediate layer 921, and the release agent layer 92.

In Fig. 3, a indicates a base-film-side surface of the intermediate layer 921, and b indicates a release-agent-layer-side surface of the intermediate layer 921. d indicates a ceramic-green-sheet-side surface of the release agent layer 92, and c indicates an intermediate-layer-side surface of the release agent layer 92.

In the laminated film 90B, the base film 91 and the intermediate layer 921 are preferably in direct contact with each other. In the case of Fig. 3, the base film 91 and the intermediate layer 921 are in direct contact with each other, and the intermediate layer 921 and the release agent layer 92 are in direct contact with each other. The release agent layer 92 and the green sheet portions 931, 932, and 933 are also in direct contact with each other.

[0059]

In Specific Example 3, a case where the separation step is performed using the removal apparatus 100 illustrated in Fig. 7 has been described; however, the

separation step may be performed using a removal apparatus 100A illustrated in Fig. 9 instead of the removal apparatus 100.

Compared with the removal apparatus 100 illustrated in Fig. 7, the removal apparatus 100A illustrated in Fig. 9 has the same configuration as the removal apparatus 100 except that the removal apparatus 100A includes a circulation unit 300. The circulation unit 300 is a unit configured to filter washing water W2 through a filter 35 and then return the washing water W2 to a washing container 32.

The circulation unit 300 includes a drain outlet 32A provided in the washing container 32, the filter 35 for filtering the washing water W2, a reservoir 36 for storing the washing water W2 after filtration, an input port 38 provided in an opening of the washing container 32, and a circulation path 37 connecting a bottom drain outlet 36A of the reservoir 36 and the input port 38.

In the case of Fig. 9, a release agent layer with a green sheet, the release agent layer being separated from the laminated film 90, is discharged from the drain outlet 32A of the washing container 32 together with the washing water W2 and is filtered by the filter 35. The washing water W2 filtered by the filter 35 is stored in the reservoir 36, and then discharged from the bottom drain outlet 36A of the reservoir 36, flows through the circulation path 37, and is again supplied from the input port 38 into the washing container 32.

[0060]

In the removal apparatuses described in Figs. 7 and 9, a foreign matter removal unit may be provided at any position between a downstream side of the washing container 32 (a position where the base film 91 is taken out from the washing water W2 after the separation step) and the winding unit 40. The foreign matter removal unit is a unit configured to remove foreign matter adhering to the base film 91. The foreign matter includes, for example, the ceramic green sheet and the release agent layer remaining on the base film 91, and water droplets adhering to the base film 91. Examples of the foreign matter removal unit include, but are not particularly limited to, an air knife and a dryer.

In the removal apparatuses described in Figs. 7 and 9, the number of the guide rollers is not particularly limited.

[0061]

The configuration of the laminated film used in the above exemplary embodiments will be described.

Laminated film

The laminated film used in the above exemplary embodiments includes a release film including a base film and a release agent layer, and a ceramic green sheet.

In the base film separation method according to the above exemplary embodiments, the base film is separated from the laminated film. That is, the laminated film is separated into the base film and a layer other than the base film.

Hereinafter, the "layer other than the base film" may be collectively referred to as a coating layer.

For example, when the laminated film is formed of the base film, the release agent layer, and the ceramic green sheet, the release agent layer and the ceramic green sheet correspond to the coating layer (the layer other than the base film).

The release agent layer may be a single layer, or may be a multilayer formed of two or more release agent layers of the same type or different types. The ceramic green sheet may be disposed on at least a part of the release agent layer, or may be disposed over an entire surface of the release agent layer.

The coating layer may include a layer other than the release agent layer and the ceramic green sheet.

For example, the coating layer may include an intermediate layer, the release agent layer, and the ceramic green sheet, and the intermediate layer may be disposed between the base film and the release agent layer. The intermediate layer may be a single layer, or may be a multilayer formed of two or more intermediate layers of the same type or different types.

In one mode of the laminated film, the base film, the release agent layer, and the ceramic green sheet may be directly laminated in this order. In one mode of the laminated film, the base film, the intermediate layer, the release agent layer, and the ceramic green sheet may be directly laminated in this order.

[0062]

Base film

As the base film, a resin film formed from a resin component intended to be recovered is used. As the resin film, a polyester film such as a polyethylene terephthalate film, polybutylene terephthalate, or polyethylene naphthalate; a polyolefin film such as a polyethylene film or a polypropylene film; a polyimide film; a polyamide film; a polycarbonate film; a polyacetate film; an ethylene-vinyl acetate copolymer (EVA) film; an ethylene-(meth)acrylic acid copolymer film; an ethylene-(meth)acrylic acid ester copolymer film; a cycloolefin polymer film; a polyurethane film; a polyphenylene sulfide film; cellophane; or the like can be used. Among these, a polyester film is preferred from the viewpoints of heat resistance and strength. In the present specification, a principal constituent component or a main component means that a proportion thereof in the total mass of a material is 50 mass% or more.

As the polyester film, from the viewpoint of ease of recovery and recycling of the resin, a polyester film containing, as a principal constituent component, any one of polyethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate is preferred. The resin film may contain known fillers, colorants, antistatic agents, antioxidants, organic lubricants, catalysts, and the like. The resin film may be transparent or may be, for example, colored as desired. At least one surface of the base film may be subjected in advance to a surface treatment such as sputtering, corona discharge, flame treatment, ultraviolet irradiation, electron beam irradiation, or etching treatment, e.g., oxidation, as necessary.

[0063]

The thickness of the base film is not particularly limited, but is preferably in a range from 10 μm to 500 μm, more preferably in a range from 15 μm to 300 μm, and still more preferably in a range from 20 μm to 200 μm from the viewpoints of strength, rigidity, and the like.

[0064]

Release agent layer

The release agent layer is preferably a layer formed from a release agent composition. The release agent composition used for forming the release agent layer is not particularly limited as long as the release agent composition has releasability, and for example, a release agent composition containing, as a main component, a silicone compound; a fluorine compound; a long-chain alkyl-group-containing

compound; a thermoplastic resin material such as an olefin resin or a diene resin; or the like can be used. It is also preferable to use a release agent composition containing, as a main component, an energy-ray-curable resin or a thermosetting resin. These release agent compositions may be used alone or in combination of two or more thereof.

[0065]

In a release agent composition containing, as a main component, a silicone compound, examples of the silicone compound include silicone compounds having an organopolysiloxane as a basic skeleton. Examples of the silicone compound also include thermosetting silicone compounds such as an addition-reaction type or a condensation-reaction type; and energy-ray-curable silicone compounds such as an ultraviolet-curable type or an electron-beam-curable type.

[0066]

In a release agent composition containing, as a main component, a fluorine compound, examples of the fluorine compound include fluorosilicone compounds, fluoroboron compounds, and poly(perfluoroalkylene ether) chain-containing compounds.

[0067]

In a release agent composition containing, as a main component, a long-chain-alkyl-group-containing compound, examples of the long-chain-alkyl-group-containing compound include polyvinyl carbamates obtained by reacting a polyvinyl alcohol-based polymer with a long-chain alkyl isocyanate, alkylurea derivatives obtained by reacting polyethyleneimine with a long-chain alkyl isocyanate, and copolymers of long-chain alkyl (meth)acrylates. Furthermore, a long-chain-alkyl-modified alkyd resin obtained by using a long-chain fatty acid as a modifier for an alkyd resin obtained by a condensation reaction between a polyhydric alcohol and a polybasic acid may be used.

[0068]

The release agent composition containing, as a main component, an energy-ray-curable resin is preferably, for example, a release agent composition containing an energy-ray-curable compound having a reactive functional group selected from a (meth)acryloyl group, an alkenyl group, and a maleimide group, and a

polyorganosiloxane. In the release agent layer formed by this release agent composition, since the energy-ray-curable compound and the polyorganosiloxane, which differ from each other in molecular structure, polarity, and molecular weight, are used, a component derived from the polyorganosiloxane is segregated near the outer surface of the release agent layer before curing, and the segregation is then fixed by curing with energy rays. As a result, releasability of the release agent layer can be improved. The release agent composition containing, as a main component, an energy-ray-curable resin may further contain a photopolymerization initiator.

[0069]

Examples of the release agent composition containing, as a main component, a thermosetting resin include a release agent composition containing, as a main component, a melamine resin, and a release agent composition containing, as a main component, an epoxy resin. Examples of the release agent composition containing, as a main component, a melamine resin include a composition containing a melamine resin serving as a base resin, an acid catalyst for thermally curing the melamine resin, and a polyorganosiloxane for imparting releasability to the release agent layer. Examples of the release agent composition containing, as a main component, an epoxy resin include a composition containing an epoxy resin serving as a base resin, an acid or basic thermosetting catalyst for thermally curing the epoxy resin, and a polyorganosiloxane for imparting releasability to the release agent layer. Before curing, a component derived from the polyorganosiloxane is segregated near the outer surface of the release agent layer, and the segregation is then fixed by curing. As a result, releasability of the release agent layer can be improved.

[0070]

The release agent layer may contain, in addition to the above-described resin components, other additives. Examples of the other additives include anti-aging agents, light stabilizers, flame retardants, conductive agents, antistatic agents, and plasticizers.

[0071]

The thickness of the release agent layer can be selected as appropriate and is not particularly limited, but is, for example, preferably in a range from 0.02 μm to 5

μm, more preferably in a range from 0.03 μm to 2 μm, and still more preferably in a range from 0.05 μm to 1.5 μm.

[0072]

Intermediate layer

Examples of the intermediate layer include a water-soluble intermediate layer, an alkali-degradable intermediate layer, and a layer that exhibits hydrophilicity and water insolubility.

[0073]

Water-soluble intermediate layer

In a case where the intermediate layer is a water-soluble intermediate layer, examples of a water-soluble resin contained in the intermediate layer include water-soluble polyvinyl alcohol resins, water-soluble acrylic resins, water-soluble polyester resins, water-soluble polyester urethane resins, water-soluble ethylene ionomer resins, water-soluble polyvinyl pyrrolidone resins, water-soluble poly-N-vinylacetamide resins, water-soluble polyamide resins, water-soluble ethylene-vinyl alcohol resins, and water-soluble starch.

The content of the water-soluble resin in the intermediate layer is preferably in a range from 30 mass% to 90 mass%, more preferably in a range from 40 mass% to 80 mass%, relative to the total mass of the intermediate layer. The upper limit of the content of the water-soluble resin in the intermediate layer is 100 mass%.

[0074]

Alkali-degradable intermediate layer

In a case where the intermediate layer is an alkali-degradable intermediate layer, examples of an alkali-degradable resin contained in the intermediate layer include phenolic resins, polyacrylic acid, polyamide resins, polyester resins, and polylactic acid.

The content of the alkali-degradable resin in the intermediate layer is preferably in a range from 30 mass% to 90 mass%, more preferably in a range from 40 mass% to 80 mass%, relative to the total mass of the intermediate layer. The upper limit of the content of the water-soluble resin in the intermediate layer is 100 mass%.

[0075]

Layer that exhibits hydrophilicity and water insolubility

In a case where the intermediate layer is a layer that exhibits hydrophilicity and water insolubility, the intermediate layer is preferably a layer formed using a silane-based compound that exhibits polycondensability upon hydrolysis, from the viewpoint of more easily separating the coating layer from the base-film-side surface of the intermediate layer.

[0076]

Hereinafter, whether the intermediate layer 921 is hydrophilic and whether the intermediate layer 921 is water-insoluble will be described in order by taking the laminated film 90B illustrated in Fig. 3 as an example.

In the present specification, whether the intermediate layer 921 is "hydrophilic" is determined such that, when a contact angle of water on the base-film-side surface of the intermediate layer 921 is 55 degrees or less, the intermediate layer 921 is determined to be hydrophilic.

In the case of the laminated film 90B illustrated in Fig. 3, when the contact angle of water on the base-film-side surface of the intermediate layer 921 (reference sign a in Fig. 3) is 55 degrees or less, the intermediate layer 921 is hydrophilic.

From the viewpoint of promoting separability of the base film 91, the contact angle is preferably 50 degrees or less, more preferably 45 degrees or less. The contact angle is a value obtained by separating the base film 91 from the laminated film 90B, that is, by bringing the intermediate layer 921 into contact with water to cause peeling at the interface between the intermediate layer 921 and the base film 91, and then measuring a contact angle of water on a surface of the intermediate layer 921 that had been in contact with the base film 91 (a peeled surface). Purified water is used as the water to be brought into contact with the intermediate layer in the measurement of the contact angle of water.

[0077]

Specifically, the intermediate layer 921 is separated from the base film 91 and the contact angle of water on the base-film-side surface of the intermediate layer 921 is measured by the following method. The obtained value is taken as the contact angle of water on the base-film-side surface of the intermediate layer 921.

An adhesive tape having a width of 50 mm (product name: "Polyester adhesive tape No. 31B", manufactured by Nitto Denko Corporation) is attached to a surface of a release agent layer of a laminated film, and the laminated film is then cut to a size of 50 mm × 50 mm to prepare a test piece.

Subsequently, a 500 mL glass beaker is filled with 300 mL of purified water at 90 degrees Celsius serving as treatment water, and the entire test piece is immersed in the purified water and left to stand for three hours. Subsequently, it is confirmed that the test piece has been separated into the base film and a laminate in which the release agent layer and the intermediate layer are integrally supported on the adhesive tape, and the adhesive tape supporting the release agent layer and the intermediate layer is taken out from the purified water and dried at room temperature for 24 hours. Subsequently, a contact angle is measured for the surface of the intermediate layer supported on the adhesive tape (the surface of the intermediate layer that had been in contact with the surface of the base film). The contact angle is measured using a contact angle meter (product name: "DM-701", manufactured by Kyowa Interface Science Co., Ltd.) by a sessile drop method in accordance with JIS R3257:1999. Distilled water is used for a liquid droplet.

[0078]

In the present specification, whether the intermediate layer 921 is "water-insoluble" is determined such that, when a difference between a contact angle of water on a surface of the release agent layer (reference sign d in Fig. 3) measured by the following method and a contact angle of water on the base-film-side surface of the intermediate layer 921 (reference sign a in Fig. 3) is 30 degrees or more, the intermediate layer 921 is determined to be water-insoluble. The difference between the contact angles is preferably 40 degrees or more, more preferably 50 degrees or more. When the value of this difference is small, this means that a component constituting the intermediate layer 921 has dissolved into water, and the measured surface is the release agent layer 92 that is partially exposed.

The contact angle of water on the surface of the release agent layer is not particularly limited, but is usually 80 degrees or more, preferably 85 degrees or more, and more preferably 90 degrees or more. The upper limit of the contact angle of water

on the surface of the release agent layer is usually 150 degrees, preferably 140 degrees, and more preferably 130 degrees.

The contact angle of water on the surface of the release agent layer is measured using a contact angle meter (product name: "DM-701", manufactured by Kyowa Interface Science Co., Ltd.) by the sessile drop method in accordance with JIS R3257:1999. Distilled water is used for a liquid droplet.

[0079]

In the case where the intermediate layer is a layer that exhibits hydrophilicity and water insolubility, the silane-based compound is preferably a tetraalkoxysilane. More preferable specific examples of the tetraalkoxysilane include tetramethoxysilane, tetraethoxysilane, tetrapropoxysilane, and tetrabutoxysilane. Among these, from the viewpoints of ease of availability and reactivity of a hydrolysis reaction, at least one of tetramethoxysilane or tetraethoxysilane, or a mixture of tetramethoxysilane and tetraethoxysilane is preferred.

As a hydrolytic polycondensate of the silane-based compound, a commercially available product can also be used.

[0080]

The laminated film used in each exemplary embodiment is preferably a laminated film after use for a specific application. For example, a laminated film whose coating layer includes an intermediate layer, a release agent layer, and a ceramic green sheet and which is for use in a specific application (during actual use) may have a configuration in which a water-insoluble resin component is incorporated into the intermediate layer together with the silane-based compound in order to improve adhesion between the base film and the coating layer (the intermediate layer, the release agent layer, and the ceramic green sheet) during use. The intermediate layer may have a configuration obtained by applying and curing a composition blended with a water-insoluble resin component.

Examples of the water-insoluble resin component include energy-ray-curable resins, epoxy resins, and melamine resins. The water-insoluble resin component can preferably ensure water insolubility even after being cured.

[0081]

The "water-insoluble resin component" is preferably an energy-ray-curable resin, and examples thereof include polyfunctional (meth)acrylates such as dipentaerythritol tri(meth)acrylate, dipentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, pentaerythritol tri(meth)acrylate, and pentaerythritol tetra(meth)acrylate.

In a case where the intermediate layer contains a resin that exhibits hydrophilicity and water insolubility (preferably, the above silane-based compound), the content of the resin that exhibits hydrophilicity and water insolubility is preferably in a range from 30 mass% to 90 mass%, more preferably in a range from 40 mass% to 80 mass%, relative to the total mass of the intermediate layer. The upper limit of the content of the resin that exhibits hydrophilicity and water insolubility in the intermediate layer is 100 mass%.

In a case where the intermediate layer contains a resin that exhibits hydrophilicity and water insolubility (preferably, the above silane-based compound) and the "water-insoluble resin component", the content of the resin that exhibits hydrophilicity and water insolubility is preferably in a range from 30 mass% to 90 mass%, more preferably in a range from 40 mass% to 80 mass%, relative to the total mass of the intermediate layer. The content of the "water-insoluble resin component" is preferably in a range from 10 mass% to 70 mass%, more preferably in a range from 20 mass% to 60 mass%, relative to the total mass of the intermediate layer. The upper limit of the total content of the resin that exhibits hydrophilicity and water insolubility and the "water-insoluble resin component" in the intermediate layer is 100 mass%.

[0082]

In a case where an energy-ray-curable resin is incorporated into the intermediate layer, the intermediate layer preferably further contains a photopolymerization initiator. The photopolymerization initiator is preferably, for example, 2-methyl-1[4-(methylthio)phenyl]-2-morpholinopropan-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butanone-1, or 2-(dimethylamino)-2-[(4-methylphenyl)methyl]-1-[4-(4-morpholinyl)phenyl]-1-butanone.

In a case where the intermediate layer contains a photopolymerization initiator, the content of the photopolymerization initiator is preferably 20 parts by mass

or less, more preferably 10 mass% or less, based on 100 parts by mass of the "water-insoluble resin component".

[0083]

From the viewpoint of facilitating infiltration of moisture when the intermediate layer comes into contact with water, the thickness of the intermediate layer is preferably in a range from 0.01 μm to 1 μm, more preferably in a range from 0.03 μm to 0.5 μm, and still more preferably in a range from 0.05 μm to 0.3 μm.

[0084]

Ceramic green sheet

The ceramic green sheet is obtained by applying a ceramic slurry to a surface of the release agent layer opposite to the base film and then drying the ceramic slurry. The application can be performed by, for example, a slot die coating method, a doctor blade method, or the like.

The ceramic slurry contains a ceramic powder, a binder component, a solvent, and the like.

Examples of the ceramic powder include dielectric powders such as barium titanate, titanium oxide, alumina, zirconia, zinc oxide, aluminum silicate, and silicon nitride.

Examples of the binder component include butyral resins and acrylic resins. Examples of the solvent include organic solvents and aqueous solvents.

[0085]

In the laminated film used in each of the above-described exemplary embodiments, the ceramic green sheet does not adhere over the entire surface of the release agent layer. Therefore, coating-layer scraps with the ceramic green sheet after the separation step either have the ceramic green sheet partially remaining and adhering to the surface of the release agent layer or have no ceramic green sheet adhering thereto. Accordingly, properties of the coating-layer scraps with the ceramic green sheet are substantially the same as those of coating-layer scraps to which no ceramic green sheet adheres.

In a case where the laminated film used in each of the above-described exemplary embodiments has an intermediate layer that is hydrophilic and water-insoluble, the separated coating-layer scraps with the ceramic green sheet have a

release agent layer surface and a hydrophilic intermediate layer surface. When the scraps having this configuration are immersed in water, the scraps are stabilized, due to surface tension, with the release agent layer surface facing air and the intermediate layer surface facing water. That is, the scraps having this configuration are more likely to be present at the interface between water and air than in the water. It is considered that, since the coating-layer scraps with the ceramic green sheet are extremely thin films, the buoyant force due to surface tension prevails even if the density of the scraps is somewhat high, and further, since the intermediate layer is water-insoluble, the scraps can continue to float on the surface of the water.

[0086]

The laminated film used in each exemplary embodiment is generally used for the purpose of protecting surfaces of other functional sheets and various parts used for specific applications during production, transport, storage, and the like of the functional sheets and the parts. After the laminated film actually serves to protect these parts and the like, the laminated film is often peeled off from the surfaces and discarded. Accordingly, since use of the laminated film enables the laminated film to be easily separated into the coating layer with the ceramic green sheet and the base film, this use of the laminated film is highly contributive to resource conservation and environmental protection.

EXPLANATION OF CODES

[0087]

1: winding roll, 10: unwinding unit, 10A: support member, 20: immersion container, 30: separation unit, 32: washing container, 32A: drain outlet, 34: wire brush, 35: filter, 36: reservoir, 36A: bottom drain outlet, 37: circulation path, 38: input port, 40: winding unit, 40A: support member, 60: steam chamber, 60A: pressure vessel, 61: lid, 61A: pressure lid, 62: chamber body, 62A: pressure vessel body, 63: steam inlet path, 64: pressure relief pipe, 66: support platform, 68: heater, 70: pressure controller, 71: relief valve, 71A: steam outlet, 72: pressure sensor, 73: pressure relief valve, 80: core, 82: through hole, 90, 90A, 90B: laminated film, 91: base film, 92: release agent layer, 93: ceramic green sheet, 94: recess, 94A: corner, 94B: gap width, 95, 95A: release film, 100, 100A: removal apparatus, 300: circulation unit, 400: pressure vessel, 401: pressure vessel body, 402: outer housing, 403: lid, 404: steam

supply pipe, 404A, 405A: steam control valve, 404B: steam inlet, 405: steam discharge pipe, 406: drain pipe, 406A: drain control valve, 406B: drain outlet, 407: basket, 407A: wheel, 408: support platform, 408A: opening, 409: reservoir, 410: water stop wall, 411: heater, 420: boiler, 601, 601A: edge, 921: intermediate layer, 931, 932, 933: green sheet portion.

CLAIMS

[Claim 1]

A winding roll comprising a core and an elongated laminated film wound around an outer peripheral surface of the core,

wherein the laminated film includes a release film including a base film and a release agent layer, and a ceramic green sheet,

the base film, the release agent layer, and the ceramic green sheet are disposed in this order,

the ceramic green sheet has at least a first green sheet portion adhering to a first end side in a width direction of the laminated film and a second green sheet portion adhering to a second end side opposite to the first end side,

the first green sheet portion and the second green sheet portion are each disposed to extend in a longitudinal direction of the laminated film,

a recess located between the first green sheet portion and the second green sheet portion is formed on the release agent layer,

the laminated film is wound around the core by traverse winding having a traverse width α, and

when viewed in a cross section orthogonal to the longitudinal direction of the laminated film,

the traverse width α is larger than a width β1 from an edge of the laminated film on the first end side to an inner edge of the first green sheet portion,

is larger than a width β2 from an edge of the laminated film on the second end side to an inner edge of the second green sheet portion, or

is larger than the width β1 and larger than the width β2.

[Claim 2]

The winding roll according to claim 1,

wherein the ceramic green sheet has a plurality of third green sheet portions adhering to the release agent layer in the width direction of the laminated film,

one end in a longitudinal direction of each of the third green sheet portions is connected to the first green sheet portion,

the other end in the longitudinal direction of each of the third green sheet portions is connected to the second green sheet portion, and

a recess surrounded on four sides by the first green sheet portion, the second green sheet portion, and two of the third green sheet portions is formed on the release agent layer.

[Claim 3]

The winding roll according to claim 2,

wherein, among a plurality of corners of the recess, at least one corner is in communication with the outside.

[Claim 4]

The winding roll according to any one of claims 1 to 3,

wherein the laminated film further includes an intermediate layer disposed between the base film and the release agent layer.

[Claim 5]

A base film separation method comprising:

preparing the winding roll according to claim 1;

treating the winding roll by immersing the winding roll in treatment water or by exposing the winding roll to steam;

unwinding the laminated film from the winding roll after the treating the winding roll; and

separating the base film from the unwound laminated film.

[Claim 6]

The base film separation method according to claim 5,

wherein in the treating the winding roll, the treatment water used when the winding roll is immersed is water or an alkaline aqueous solution.

[Claim 7]

The base film separation method according to claim 5 or 6, further comprising:

after the separating the base film, winding the base film separated from the laminated film,

wherein a process from the unwinding the laminated film to the winding the base film is performed in a roll-to-roll manner.