

SYSTEM FOR CONTINUOUS MANUFACTURE OF OPTICAL DISPLAY PANELS,
AND METHOD FOR CONTINUOUS MANUFACTURE OF OPTICAL DISPLAY PANELS

TECHNICAL FIELD

[0001]

The invention relates to a system and a method for continuously manufacturing an optical display panel.

BACKGROUND ART

[0002]

A method for bonding an optical film to a liquid crystal cell includes peeling off an optical film from a carrier film by hooking a long multilayer optical film on a peeling member with the carrier film placed inside, wherein the long multilayer optical film is a laminate of the optical film and the carrier film with a pressure-sensitive adhesive therebetween; and bonding the peeled-off optical film to a liquid crystal cell (see, for example, Patent Documents 1 and 2).

[0003]

An apparatus for implementing this bonding method includes, in order from the upstream side, for example, upstream-side feed rolls for supplying the laminate of the optical film and the carrier film downstream; a dancer roll for

maintaining a tension on the carrier film; bonding rolls (a pair of bonding rolls) for bonding the optical film to the liquid crystal cell and feeding the liquid crystal cell after the bonding; and downstream-side feed rolls for feeding the carrier film downstream to a take-up roll. The dancer roll located between the upstream-side feed rolls and the peeling member plays a role as tension-controlling and accumulating means for ensuring the bonding accuracy.

[0004]

Patent Document 1 shows a manufacturing apparatus including a pair of feed pinch rolls 102a and 102b, a dancer roll 104, a tension controlling weight 106, take-up pinch rolls 9a and 9b, and a core 6. The feed pinch rolls 102a and 102b serve to feed a multilayer film 2 from a material roll 90. After held on the dancer roll (accumulator), the multilayer film is supplied from the dancer roll (accumulator) 104 by taking up the separate film 4 on the core 6. In this process, the multilayer film is not fed in the region upstream of the dancer roll.

[0005]

In the manufacturing apparatus shown in Patent Document 2, feed means 1, 4, 9, 11, and 16, take-up means 17, and tension control means 12 are moved together to peel off a non-defective sheet (acceptable sheet) and feed it to the position where it is to be bonded. In this case, the tension control means 12

is located at the forefront. The tension control means 12 is moved together with other feed means but does not function as an accumulator because it is located at the forefront when the non-defective sheet is bonded. In other words, the tension control means is provided only to take up slack in the carrier film when a defective sheet is discharged. Since the tension control means does not play a role as an accumulator, all feed rolls are moved synchronously at the same speed.

[0006]

Concerning the conventional movement of the dancer roll, Patent Document 3 shows a laminator having a feed movement controller (dancer roller) capable of feeding a multilayer material in such a way that the feed movement of the laminator is not linked to the feed movement of the unit for the later process when the feed movement of the multilayer material differs between the process in the laminator and the later process. The dancer roller 17 is rotatably and vertically-movably held in such a way that its weight is supported by the multilayer material F1. In other words, the vertically movable dancer is used as a speed controller.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0007]

Patent Document 1: JP-A-2004-338408

Patent Document 2: JP-A-2011-150328

Patent Document 3: JP-A-2010-036464

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008]

Unfortunately, in the bonding method shown in Patent Documents 1 and 2, air bubbles may form between the optical film and the liquid crystal cell at the initial stage of bonding the optical film to the liquid crystal cell.

[0009]

The invention has been accomplished in view of the problem, and it is an object of the invention to provide a system and a method for continuously manufacturing an optical display panel, in which the formation of air bubbles can be suppressed at the initial bonding stage.

MEANS FOR SOLVING THE PROBLEMS

[0010]

An aspect of the invention is directed to a system for continuously manufacturing an optical display panel, the system including:

a pair of first nip rolls configured to feed a multilayer optical film downstream, wherein the multilayer optical film comprises a pressure-sensitive adhesive-bearing optical film

and a long carrier film on which the optical film is placed with the pressure-sensitive adhesive interposed therebetween;

an accumulating unit having a dancer roll located downstream of the first nip rolls;

a peeling unit configured to peel off the optical film from the carrier film by inwardly folding back the carrier film;

a pair of second nip rolls configured to feed downstream the carrier film from which the optical film is peeled off by the peeling unit;

a take-up unit configured to take up the carrier film on a roll located downstream of the second nip rolls;

an optical cell feed unit configured to feed an optical cell;

a bonding unit configured to perform a process comprising bonding the optical film to the optical cell with the pressure-sensitive adhesive interposed therebetween to form an optical display panel while feeding the optical cell, wherein the optical film is peeled off by the peeling unit; and

a distortion cancelling unit configured to reduce, during the bonding of the optical film to the optical cell, distortion generated in the multilayer optical film by controlling an inertia force of the dancer roll.

[0011]

These features make it possible to suppress the formation of air bubbles at the initial bonding stage.

[0012]

Hereinafter, the mechanism of the invention will be described. As a result of intensive studies, the inventors have found that changes in distortion in the multilayer optical film (elongation and contraction of the multilayer optical film in a longitudinal direction), caused by the inertia force of a dancer roll, have a significant influence and then fluctuations in the speed of the multilayer optical film, caused by the changes in distortion, have a significant influence.

[0013]

At the initial drive stage (the initial stage where the multilayer optical film, which has been stopped, starts to be fed (transported)), the multilayer optical film is accelerated by feed rolls on the upstream side and/or the downstream side. Upon the acceleration, the feed velocity is transmitted by the rotational drag of each guide roll on which the multilayer optical film is wrapped, and the multilayer optical film is distorted. The velocity is transmitted to the dancer roll, at which only when a force greater than the gravity of the dancer roll and the tension controlling weight (or the resistance of the hydraulic or pneumatic mechanism) is applied, the dancer roll is vertically accelerated. For example, when the dancer roll is accelerated upward, the inertia force acts downward, so that the multilayer optical film is further distorted. The distorted multilayer optical film is then accelerated upward so as to reduce the distortion. At the initial drive stage,

the time period from the generation of the distortion to the reduction of the distortion is as short as about 0.1 to 0.5 seconds. In addition, during this period (the distortion-reducing action), the rate of upward acceleration of the tension controlling weight decreases as the drive of downstream-side feed rolls reaches a constant speed, so that an upward inertia force occurs, which enhances fluctuations in the film speed along with the reduction of distortion in the film. Therefore, (large) fluctuations in the speed would be caused by the effect of the distortion in the multilayer optical film, which is caused by the inertia force of the dancer roll. Thus, the distortion in the multilayer optical film should be reduced taking into account this mechanism, in other words, the dancer roll should be controlled in such a way that the inertia force of the dancer roll is kept low, so that fluctuations in the speed of the multilayer optical film can be reduced and the formation of air bubbles can be suppressed at the initial bonding stage.

[0014]

In one of embodiment of the invention, the distortion cancelling unit includes an inertia force control unit configured to perform control in such a way that a force applied per 100 mm width of the carrier film due to the inertia force of the dancer roll becomes 1.8 N or less during the bonding of the optical film to the optical cell.

[0015]

In one of embodiment of the invention, the inertia force control unit is configured to detect an acceleration when the dancer roll is moving and then to suppress the movement of the dancer roll.

[0016]

In one of embodiment of the invention, the dancer roll is configured to automatically move in such a way as to maintain a tension on the multilayer optical film, and

the distortion cancelling unit include a dancer roll position-limiting control unit configured to control the dancer roll in such a way that the dancer roll stays at a certain position during the bonding of the optical film to the optical cell.

[0017]

In this embodiment, the dancer roll position-limiting control unit is configured to control the dancer roll in such a way that the first nip rolls for feeding the multilayer optical film and the bonding unit move synchronously at the same speed.

[0018]

In this embodiment, the dancer roll position-limiting control unit is configured to control the dancer roll in such a way that the first nip rolls and the bonding unit move synchronously at the same speed and the first nip rolls, the bonding unit, and the second nip rolls move synchronously.

[0019]

In this embodiment, the dancer roll position-limiting control unit is configured to control the dancer roll in such a way that the first nip rolls and the bonding unit move synchronously at the same speed and the first nip rolls, the bonding unit, and the second nip rolls move at the same speed.

[0020]

In this embodiment, the dancer roll position-limiting control unit may be configured to control the dancer roll by allowing all the first nip rolls, the bonding unit, and the second nip rolls to move synchronously at the same speed.

[0021]

In one of embodiment of the invention, the dancer roll forms an accumulating part with a tension controlling weight.

[0022]

The accumulating unit (accumulator) may be, for example, a liquid-operated (hydraulic) accumulating unit, a gas-operated accumulating unit, a spring-type accumulating unit, a bladder-type accumulating unit, a diaphragm-type accumulating unit, or a piston-type accumulating unit. However, since the above problem (the generation of distortion) is more likely to occur in an accumulating unit with a tension controlling weight than in other mechanisms, the invention is more effective in a manufacturing system with a tension controlling weight-type dancer roll.

[0023]

In one of embodiment of the invention, the dancer roll is configured to move when the dancer roll is controlled so as to maintain a tension on the multilayer optical film, and

the distortion cancelling unit is configured to control the dancer roll in such a way that during the bonding of the optical film to the optical cell, the dancer roll is shifted based on results of detecting, in advance, distortion generated in the multilayer optical film.

[0024]

According to this feature, the dancer roll may be allowed to move freely so that it can act to maintain a tension on the multilayer optical film. Additionally, based on data on the amount of distortion detected in advance, the distortion cancelling unit may allow the dancer roll to move in such a way that distortion is cancelled out.

[0025]

In one of embodiment of the invention, the optical film has a thickness of 200 μm or less.

[0026]

When a thinner optical film is used, the formation of air bubbles caused by fluctuations in the distortion can be more significant during the bonding, for which the invention can be more effective.

[0027]

In one of embodiment of the invention, the optical film includes a polarizing film.

[0028]

An aspect of the other invention is directed to a method for continuously manufacturing an optical display panel, the method including:

a first feed step including feeding a multilayer optical film downstream with a pair of first nip rolls, wherein the multilayer optical film includes a pressure-sensitive adhesive-bearing optical film and a long carrier film on which the optical film is placed with the pressure-sensitive adhesive interposed therebetween;

a step including performing accumulation with a dancer roll located downstream of the first nip rolls;

a peeling step including peeling off the optical film from the carrier film by inwardly folding back the carrier film;

a second feed step including feeding the carrier film downstream with a pair of second nip rolls after the optical film is peeled off from the carrier film in the peeling step;

a take-up step including taking up the carrier film on a roll located downstream of the second nip rolls;

an optical cell feed step including feeding an optical cell;

a bonding step including bonding the optical film to the optical cell with the pressure-sensitive adhesive interposed

therebetween to form an optical display panel while feeding the optical cell, wherein the optical film is peeled off in the peeling step; and

a distortion cancelling step including reducing, during the bonding of the optical film to the optical cell, distortion generated in the multilayer optical film by controlling an inertia force of the dancer roll.

[0029]

These features make it possible to suppress the formation of air bubbles at the initial bonding stage.

[0030]

In one of embodiment of the invention, the distortion cancelling step includes an inertia force control step comprising performing control in such a way that a force applied per 100 mm width of the carrier film due to the inertia force of the dancer roll becomes 1.8 N or less during the bonding of the optical film to the optical cell.

[0031]

In one of embodiment of the invention, the inertia force control step includes detecting an acceleration when the dancer roll is moving and then suppressing the movement of the dancer roll.

[0032]

In one of embodiment of the invention, the dancer roll is configured to automatically move in such a way as to maintain a tension on the multilayer optical film, and

the distortion cancelling step includes a dancer roll position-limiting control step including controlling the dancer roll in such a way that the dancer roll stays at a certain position during the bonding of the optical film to the optical cell.

[0033]

In this embodiment, the dancer roll position-limiting control step includes controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed.

[0034]

In this embodiment, the dancer roll position-limiting control step includes controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed, feeding the multilayer optical film by first nip rolls, bonding the optical film to the optical cell by the bonding step, and feeding the carrier film by the second nip rolls are performed synchronously.

[0035]

In this embodiment, the dancer roll position-limiting control step includes controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and

bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed, feeding the multilayer optical film by first nip rolls, bonding the optical film to the optical cell by the bonding step, and feeding the carrier film by the second nip rolls are performed at the same speed.

[0036]

In this embodiment, the dancer roll position-limiting control step may include controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls, feeding the carrier film by the second nip rolls, and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed.

[0037]

In one of embodiment of the invention, the dancer roll forms an accumulating part with a tension controlling weight.

[0038]

In one of embodiment of the invention, the dancer roll is configured to move when the dancer roll is controlled so as to maintain a tension on the multilayer optical film, and

the distortion cancelling step includes controlling the dancer roll in such a way that during the bonding of the optical film to the optical cell, the dancer roll is shifted based on results of detecting, in advance, distortion generated in the multilayer optical film.

[0039]

In the distortion cancelling step according to this embodiment, the control method for shifting the dancer roll in response to the resulting distortion may be, for example, as follows. During the bonding of the optical film to the optical cell (the bonding period), the accumulating unit is brought into operation with the dancer roll loaded with its weight, in which the amount of distortion generated in the multilayer optical film is detected. Subsequently, based on the detected amount of distortion, the dancer roll is controlled in such a way that the distortion can be cancelled out. Specifically, for example, the dancer roll is shifted based on data on fluctuations over time in the amount of distortion, which are detected in advance during test production, so that elongation and contraction of the multilayer optical film can be cancelled out.

[0040]

Another example of the control method may be as follows. During the bonding of the optical film to the optical cell (the bonding period), the accumulating unit is brought into operation with the dancer roll loaded with its weight, in which the movement of the dancer roll (the position of the dancer roll, the acceleration and velocity of the dancer roll, and the like during the bonding period) is recorded. The dancer roll may be so controlled that it moves in the same way as recorded. In other words, for example, the movement of the dancer roll loaded

with its weight may be recorded in advance during test production, and the same movement may be reproduced during actual production.

[0041]

In one of embodiment of the invention, the optical film has a thickness of 200 μm or less.

[0042]

In one of embodiment of the invention, the optical film includes a polarizing film.

[0043]

In the invention, the optical cell may be a VA- or IPS-mode liquid crystal cell or an organic electroluminescent (EL) cell.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044]

Fig. 1 is a schematic diagram of a system according to Embodiment 1 for continuously manufacturing an optical display panel;

Fig. 2A is a graph showing the relationship between the displacement of a dancer roll, the film speed, and the infeed speed in an example;

Fig. 2B is an enlarged graph of Fig. 2A showing the relationship between the displacement of a dancer roll, the film speed, and the infeed speed at the initial drive stage;

Fig. 3A is a graph showing the relationship between the

displacement of a dancer roll, the film speed, and the infeed speed in a comparative example; and

Fig. 3B is an enlarged graph of Fig. 3A showing the relationship between the displacement of a dancer roll, the film speed, and the infeed speed at the initial drive stage.

MODE FOR CARRYING OUT THE INVENTION

[0045]

As shown in Fig. 1, an optical film roll 1 is a roll of a long multilayer optical film having a width corresponding to the length of a pair of opposite sides of an optical cell and including a pressure-sensitive adhesive-bearing long optical film and a long carrier film placed on the optical film with the pressure-sensitive adhesive interposed therebetween. In another mode of the long multilayer optical film, the long optical film wound into a roll has a plurality of score lines each formed in the transverse direction of the long optical film.

[0046]

(Optical film)

An example of the optical film is a polarizing film. For example, the main part of the polarizing film includes a polarizer (generally about 1 to about 80 μm in thickness) and a polarizer protecting film or films (generally about 1 to about 500 μm in thickness) formed on one or both sides of the polarizer

with or without an adhesive. The polarizer generally has an absorption axis in the stretched direction. A polarizing film including a long polarizer having an absorption axis in the longitudinal direction is also called an "MD polarizing film," and a polarizing film including a long polarizer having an absorption axis in the transverse direction is also called a "TD polarizing film." The main part of the film may further include an additional film such as a retardation film such as a $\lambda/4$ plate or a $\lambda/2$ plate (generally 10 to 200 μm in thickness), a viewing angle compensation film, a brightness enhancement film, or a surface protective film. For example, the multilayer optical film may have a thickness in the range of 10 μm to 500 μm .

[0047]

Alternatively, the optical film may be, for example, a linearly polarized light separating film or a multilayer reflective polarizing film having reflection and transmission axes.

[0048]

The pressure-sensitive adhesive may be of any type such as an acrylic pressure-sensitive adhesive, a silicone pressure-sensitive adhesive, or a urethane pressure-sensitive adhesive. The thickness of the pressure-sensitive adhesive layer is preferably, for example, in the range of 10 μm to 50 μm . The peel strength between the pressure-sensitive adhesive

and the carrier film is typically, but not limited to, 0.15 (N/50 mm sample width). The peel strength can be measured according to JIS Z 0237.

[0049]

(Carrier film)

The carrier film to be used may be a conventionally known film such as a plastic film (e.g., a polyethylene terephthalate film or a polyolefin film). If necessary, the carrier film may also be an appropriate film coated with an appropriate release agent such as a silicone, long-chain alkyl, fluorine, or molybdenum sulfide release agent according to conventional techniques. In general, the carrier film is also called a release film (separator film).

[0050]

(Liquid crystal cell and liquid crystal display panel)

The optical cell may be, for example, a liquid crystal cell or an organic EL cell. The liquid crystal cell includes a pair of opposed substrates (a first substrate Pa (viewer side) and a second substrate Pb (back side)) and a liquid crystal layer sealed between the substrates. The liquid crystal cell to be used may be of any type. To achieve high contrast, it is preferable to use a vertical alignment (VA) mode liquid crystal cell or an in-plane switching (IPS) mode liquid crystal cell. The liquid crystal display panel includes the liquid crystal cell, a polarizing film or films bonded to one or both sides

of the liquid crystal cell, and optionally a driving circuit incorporated therein.

[0051]

(Organic EL cell and organic EL display panel)

The organic EL cell includes a pair of electrodes and an electroluminescent layer sandwiched between the electrodes. The organic EL cell to be used may be of any type, such as a top emission type, a bottom emission type, or a double emission type. The organic EL display panel includes the organic EL cell, a polarizing film or films bonded to one or both sides of the organic EL cell, and optionally a driving circuit incorporated therein.

[0052]

<Embodiment 1>

Fig. 1 is a schematic diagram of a system for continuously manufacturing an optical display panel. Hereinafter, the system according to this embodiment for continuously manufacturing an optical display panel will be specifically described with reference to Fig. 1.

[0053]

This embodiment will be described with reference to an example where the optical cell and the optical display panel are a rectangular liquid crystal cell and a rectangular liquid crystal display panel, respectively. The optical film roll used is as shown in Fig. 1. Specifically, the optical film roll

1 used is a roll of a long multilayer optical film 10 having a width corresponding to the length of the long side of a liquid crystal cell P and including a carrier film 12 and a laminate of a long polarizing film 11 (corresponding to the optical film) disposed on the carrier film 12 and having an absorption axis in the longitudinal direction. In this embodiment, the long polarizing film 11 has a long film main part 11a and a pressure-sensitive adhesive 11b.

[0054]

As shown in Fig. 1, the system according to this embodiment for continuously manufacturing a liquid crystal display panel includes a series of feed units X configured to feed the liquid crystal cell P and the liquid crystal display panel LD, an optical film supply unit 101, and a bonding unit 81.

[0055]

(Optical cell feed unit)

The feed unit X is configured to feed the liquid crystal cell P and the liquid crystal display panel LD. The feed unit X includes a plurality of feed rollers X1, a suction plate, and other components.

[0056]

(Optical film supply unit)

The optical film supply unit 101 is configured to perform a process including unwinding the long multilayer optical film

10, which has a width corresponding to the long side of the liquid crystal cell P, from the optical film roll 1; cutting the long polarizing film 11 in the transverse direction at intervals corresponding to the short side of the liquid crystal cell P to form a polarizing film 111; and supplying the resulting polarizing film 111 to the bonding unit 81. In this embodiment, the optical film supply unit 101 includes an unwinding unit 1a, a cutting unit 21, an infeed roll unit 31, an accumulating unit 41, a peeling unit 51, an outfeed roll unit 61, a take-up unit 71, and a plurality of feed roller units 101a, 101b, and 101c.

[0057]

The unwinding unit 1a has an unwinding shaft, on which the optical film roll 1 is mounted, and is configured to unwind the long multilayer optical film 10 from the optical film roll 1.

[0058]

The cutting unit 21 includes cutting means 21a and suction means 21b and is configured to half cut the long multilayer optical film 10 in the transverse direction at intervals corresponding to the short side of the liquid crystal cell P (namely, to cut the long polarizing film 11 in the transverse direction without cutting the carrier film 12). In this embodiment, the cutting unit 21 is configured to perform a process including cutting the long polarizing film 11 (the main film part 11a and the pressure-sensitive adhesive 11b) in the

transverse direction using the cutting means 21a while fixing the long multilayer optical film 10 by sucking it from the carrier film 12 side with the suction means 21b, so that a polarizing film 111 of a size corresponding to that of the liquid crystal cell P is formed on the carrier film 12. The cutting means 21a may be a cutter, a laser, or a combination thereof.

[0059]

The infeed roll unit 31 includes a pair of opposed first nip rolls 31a and 31b configured to nip the multilayer optical film 10 therebetween and to feed it downstream to the accumulating unit 41. At least one of the pair of nip rolls 31a and 31b includes a driving roller. The infeed roll unit 31 may have two or more pairs of opposed rolls. The driving roller is a mechanism configured to rotate with a motor (not shown).

[0060]

The accumulating unit 41 is located downstream of the infeed roll unit 31 and includes a tension control weight 41a and a dancer roll 41b. The accumulating unit 41 has the function of maintaining a tension on the long multilayer optical film 10.

[0061]

The peeling unit 51 is configured to peel off the polarizing film 111 from the carrier film 12 by folding back the long multilayer optical film 10 with the carrier film 12

inside. The peeling unit 51 may include a wedge-shaped member, rollers, and other components.

[0062]

The outfeed roll unit 61 includes a71 61a and 61b configured to feed the carrier film 12 downstream to the take-up unit 71 when the polarizing film 111 is peeled off from the carrier film 12 by the peeling unit 51. At least one of the pair of nip rolls 61a and 61b includes a driving roller. The outfeed roll unit 61 may have two or more pairs of opposed rolls. The driving roller is a mechanism configured to rotate with a motor (not shown).

[0063]

The take-up unit 71 is located downstream of the outfeed unit 61 and configured to take up the carrier film 12 on a take-up roll 71a when the polarizing film 111 is peeled off from the carrier film 12. The take-up unit 71 is a mechanism configured to rotate with a motor (not shown).

[0064]

(Bonding unit)

The bonding unit 81 is configured to perform a process including bonding the polarizing film 111 (peeled off by the peeling unit 51) to the upward-facing surface Pb of the liquid crystal cell P with the pressure-sensitive adhesive 11b interposed therebetween while feeding the liquid crystal cell P in a direction parallel to the short side of the liquid crystal

cell P, which has been fed by the feed units X, wherein the polarizing film 111 is supplied by the optical film supply unit 101, and bonding the polarizing film 111 is started from the long side of the liquid crystal cell P and performed along the direction in which the polarizing film 111 is supplied (or along the direction of the short side of the liquid crystal cell P). The bonding unit 81 includes a pair of bonding rollers 81a and 81b, in which at least one of the bonding rollers 81a and 81b includes a driving roller. The driving roller is a mechanism configured to rotate with a motor (not shown).

[0065]

(Distortion cancelling unit)

A distortion cancelling unit 91 functions to reduce distortion generated in the multilayer optical film 10 during the bonding of the polarizing film 111 to the liquid crystal cell P. Specifically, the distortion cancelling unit 91 includes an inertia force control unit 91a configured to perform control in such a way that the force applied per 100 mm width of the carrier film 12 due to the inertia force of the dancer roll 41b becomes 1.8 N or less during the bonding of the polarizing film 111 to the liquid crystal cell P. In a method for this control, for example, the inertia force control unit 91a is configured to detect the acceleration when the dancer roll 41b is moving and then to suppress the movement of the dancer roll 41b.

[0066]

<Other control methods>

In another method for the control, the dancer roll 41b is configured to automatically move in such a way as to maintain a tension on the multilayer optical film 10. Specifically, the distortion cancelling unit 91 includes a dancer roll position-limiting control unit 91b configured to control the dancer roll 41b in such a way that the dancer roll 41b stays at a certain position during the bonding of the polarizing film 111 to the liquid crystal cell P. More specifically, the dancer roll position-limiting control unit 91b is configured to allow the infeed roll unit 31 for feeding the multilayer film and the bonding unit 81 to move synchronously at the same speed so that the dancer roll 41b is allowed to stay at a certain position.

[0067]

In another method for the control, the dancer roll position-limiting control unit 91b is configured to control the dancer roll 41b not only by allowing the infeed roll unit 31 for feeding the multilayer film and the bonding unit 81 to move synchronously at the same speed but also by allowing the outfeed roll unit 61 to move synchronously. The dancer roll position-limiting control unit 91b is configured to control the timing of rotation of motors connected to the infeed roll unit 31, the outfeed roll unit 61, and the bonding unit 81, respectively, for their synchronization.

[0068]

In another method for the control, the dancer roll position-limiting control unit 91b is configured to control the dancer roll 41b not only by allowing the infeed roll unit 31 for feeding the multilayer film and the bonding unit 81 to move synchronously at the same speed but also by allowing the take-up unit 71 to move at the same speed. The dancer roll position-limiting control unit 91b is configured to control each of motors connected to the infeed roll unit 31, the outfeed roll unit 61, and the bonding unit 81, respectively, in such a way that the motors rotate at the same speed.

[0069]

In another method for the control, the dancer roll position-limiting control unit 91b is configured to control the dancer roll 41b by allowing the infeed roll unit 31 for feeding the multilayer optical film 10, the outfeed roll unit 61, and the bonding unit 81 to move synchronously at the same speed. The dancer roll position-limiting control unit 91b is configured to control the timing of rotation of motors connected to the infeed roll unit 31, the outfeed roll unit 61, and the bonding unit 81, respectively, for their synchronization, and also configured to control each motor in such a way that they rotate at the same speed.

[0070]

In another method for the control, the dancer roll 41b

is configured to move when it is controlled so as to maintain a tension on the multilayer optical film 10. Specifically, the distortion cancelling unit 91 is configured to control the dancer roll 41b in such a way that during the bonding of the polarizing film 111 to the liquid crystal cell P, the dancer roll 41b is shifted based on the results of detecting distortion in the multilayer optical film 10 in advance. The dancer roll can be shifted so as to cancel out the distortion based on the data on the amount of distortion (or data on the distribution of distortion during the period from the generation of distortion at the initial drive stage to the reduction of the distortion) detected in advance (or measured in advance during experimental production or earlier actual production) . For example, based on data on fluctuations over time in the amount of distortion detected in advance, the dancer roll is shifted in a direction where the distortion can be cancelled out. When the multilayer optical film stretches in the longitudinal direction, the dancer roll is shifted so as to cancel out the increase in the length of the multilayer optical film. Alternatively, the dancer roll may be shifted at the time when the multilayer optical film starts to stretch, so that the increase in the length of the multilayer optical film can be reduced. Alternatively, a sensor or sensors may be used to detect the vertical position of the dancer roll, and based on the detected data, feedback control of each feed roll may be

performed.

[0071]

For example, the timing of the operation of each unit or apparatus is calculated by a method using detection sensors placed at predetermined positions or by a method using a rotary encoder or the like for detecting the rotating part of the feed unit or the feed mechanism. The distortion cancelling unit 91 and various control units (not shown) may be implemented in cooperation with software programs and hardware resources such as CPU and memories. In this case, program software, procedures, various settings, and other data are previously stored in memories. Alternatively, the units may include private circuits, firmware, and others.

[0072]

(Example of modification of Embodiment 1)

In Embodiment 1 described above, the bonding unit 81 is configured to bond the polarizing film to one surface Pa of the liquid crystal cell P, which is non-limiting. In the invention, for example, the optical film may be bonded to the other surface Pb of the liquid cell P, or the optical films may be bonded to both surfaces of the liquid crystal cell P. As a non-limiting example, the bonding unit 81 is configured to bond the polarizing film to the upper side of the liquid crystal cell P. Alternatively, the bonding unit 81 may be configured to bond the polarizing film to the lower side of the liquid crystal cell

P. The bonding unit 81 is configured to perform a process including bonding the polarizing film 111 to the liquid crystal cell P in such a way that the bonding is started from the long side of the liquid crystal cell P and performed along the direction in which the polarizing film 111 is supplied (or along the direction of the short side of the liquid crystal cell P), while feeding the liquid crystal cell P in a direction parallel to the short side of the liquid crystal cell P. Alternatively, the bonding unit 81 may be configured to perform a process including bonding the polarizing film 111 to the liquid crystal cell P in such a way that the bonding is started from the short side of the liquid crystal cell P and performed along the direction in which the polarizing film 111 is supplied (or along the direction of the long side of the liquid crystal cell P), while feeding the liquid crystal cell P in a direction parallel to the long side of the liquid crystal cell P.

[0073]

In Embodiment 1, the optical film roll used is a roll of a long multilayer optical film including a carrier film and a long optical film placed thereon. This structure of the optical film roll is non-limiting. Alternatively, for example, a roll of a long multilayer optical film including a carrier film and a long optical film placed on the carrier film and having a plurality of score lines each formed in the transverse direction (a roll of a scored optical film) may also be used as needed.

When configured to supply the optical film from the scored optical film roll, the optical film supply unit does not need to have the cutting unit.

[0074]

In Embodiment 1, the cutting unit is configured to perform a process including cutting the long optical film in the transverse direction to form, on the carrier film, optical film pieces of a size corresponding to the size of the optical cell. To improve yield, however, the cutting unit may be configured to perform a process including cutting (skip-cutting) the long optical film in the transverse direction in such a way that defective parts of the long optical film are skipped, optical film pieces of a size corresponding to the size of the optical cell (non-defective optical film pieces suitable to be bonded to optical cells, respectively) are formed on the carrier film, and defect-containing optical film pieces are each made smaller than the size of the optical cell (more preferably, made as small as possible).

[0075]

In Embodiment described above, a method for continuously manufacturing an optical display panel, the method including:

a first feed step including feeding a multilayer optical film downstream with a pair of first nip rolls, wherein the multilayer optical film includes a pressure-sensitive adhesive-bearing optical film and a long carrier film on which

the optical film is placed with the pressure-sensitive adhesive interposed therebetween;

a step including performing accumulation with a dancer roll located downstream of the first nip rolls;

a peeling step including peeling off the optical film from the carrier film by inwardly folding back the carrier film;

a second feed step including feeding the carrier film downstream with a pair of second nip rolls after the optical film is peeled off from the carrier film in the peeling step;

a take-up step including taking up the carrier film on a roll located downstream of the second nip rolls;

an optical cell feed step including feeding an optical cell;

a bonding step including bonding the optical film to the optical cell with the pressure-sensitive adhesive interposed therebetween to form an optical display panel while feeding the optical cell, wherein the optical film is peeled off in the peeling step; and

a distortion cancelling step including reducing, during the bonding of the optical film to the optical cell, distortion generated in the multilayer optical film.

[0076]

The distortion cancelling step includes an inertia force control step including performing control in such a way that a force applied per 100 mm width of the carrier film due to the

inertia force of the dancer roll becomes 1.8 N or less during the bonding of the optical film to the optical cell. The inertia force controlling step may include detecting the acceleration when the dancer roll is moving and then controlling the movement of the dancer roll based on the detected acceleration.

[0077]

In the other embodiment, the dancer roll is configured to automatically move in such a way as to maintain a tension on the multilayer optical film. The distortion cancelling step includes a dancer roll position-limiting control step including controlling the dancer roll in such a way that the dancer roll stays at a certain position during the bonding of the optical film to the optical cell.

[0078]

In the other embodiment, the dancer roll position-limiting control step includes controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed.

[0079]

In the other embodiment, the dancer roll position-limiting control step includes controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and bonding the optical film to the optical cell

by the bonding step are performed synchronously at the same speed, feeding the multilayer optical film by first nip rolls, bonding the optical film to the optical cell by the bonding step, and feeding the carrier film by the second nip rolls are performed synchronously.

[0080]

In the other embodiment, the dancer roll position-limiting control step includes controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed, feeding the multilayer optical film by first nip rolls, bonding the optical film to the optical cell by the bonding step, and feeding the carrier film by the second nip rolls are performed at the same speed.

[0081]

In the other embodiment, the dancer roll position-limiting control step may include controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls, feeding the carrier film by the second nip rolls, and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed.

[0082]

In the other embodiment, the dancer roll is configured to move when the dancer roll is controlled so as to maintain

a tension on the multilayer optical film. The distortion cancelling step includes controlling the dancer roll in such a way that during the bonding of the optical film to the optical cell, the dancer roll is shifted based on results of detecting, in advance, distortion generated in the multilayer optical film.

[0083]

<Embodiment 2>

Embodiment 2 has the same function as Embodiment 1 described above, except that Embodiment 2 has the specific features described below.

[0084]

In Embodiment 2, the distortion cancelling unit 91 is configured to control the dancer roll 41b in such a way that the dancer roll 41b is allowed to move under braking so that oscillation resulting from the movement of the dancer roll 41b can be reduced or eliminated (substantially eliminated). This makes it possible to suppress the formation of air bubbles at the initial stage of the bonding.

EXAMPLES

[0085]

Examples 1 to 6 were performed as described below using the continuous manufacturing system of Fig. 1. Polarizing films (VEGQ1724DU manufactured by Nitto Denko Corporation) were

bonded to liquid crystal cells (40 inches in size), respectively, using the manufacturing system shown in Fig. 1.

[0086]

Examples 1 to 6 and Comparative Examples 1 to 3 were performed under different conditions as shown in Table 1. Specifically, the following were varied: the thickness of the multilayer optical film, the film feed (supply) speeds in the infeed roll unit, the outfeed roll unit, and the bonding unit (hereinafter referred to as the "infeed speed," the "outfeed speed," and the "bonding speed," respectively), the timing with other units (synchronous or asynchronous), the maximum inertia force (N) of the dancer roll, the operation of the dancer roll (stationary (staying) or moving), and the dancer roll control method (control with a tension controlling weight or control based on data on the amount of distortion detected in advance). The maximum inertia force was calculated as the product of the mass (the mass of the dancer roll and the tension controlling weight) and the acceleration calculated from the displacement rate of the dancer roll. After the bonding, the occurrence of air bubbles was evaluated. In the evaluation of the occurrence of air bubbles, 500 bonded products were visually observed, and the rate of air bubble-containing products was calculated.

[Table 1]

	Thickness (μm)	Infeed unit		Outfeed unit		Bonding unit		Dancer roll			Air bubble occurrence rate
		Timing	Speed (initial drive stage)	Timing	Speed (initial drive stage)	Timing	Speed (initial drive stage)	Maximum inertia force (per 100 mm width)	Operation	Control type	
Example 1	145	Synchronous	4	Synchronous	4	Synchronous	4	0	Stationary	Weight	0.0%
Example 2	145	Synchronous	2	Synchronous	4	Synchronous	4	1.69	Moving	Weight	0.6%
Example 3	145	Synchronous	4	Asynchronous	4	Synchronous	4	0	Stationary	Weight	0.4%
Example 4	145	Synchronous	4	Synchronous	3	Synchronous	4	0	Stationary	Weight	0.2%
Example 5	250	Synchronous	4	Synchronous	4	Synchronous	4	0	Stationary	Weight	0.0%
Example 6	145	Synchronous	3	Synchronous	4	Synchronous	4	0	Moving	Control based on distortion amount data	0.0%
Comparative Example 1	145	Asynchronous	0	Synchronous	4	Synchronous	4	2.70	Moving	Weight	1.6%
Comparative Example 2	145	Synchronous	1	Synchronous	4	Synchronous	4	2.03	Moving	Weight	1.2%
Comparative Example 3	250	Asynchronous	0	Synchronous	4	Synchronous	4	2.70	Moving	Weight	1.4%

[0088]

In Example 1, fluctuations in the speed of the multilayer optical film were small because all of the infeed speed, the outfeed speed, and the bonding speed were synchronously controlled to the same speed so that the dancer roll was allowed to stay (kept stationary). As a result, no air bubbles were observed. Fig. 2A shows the infeed speed (equal to the outfeed speed or the bonding speed), the multilayer optical film speed, and the displacement of the dancer roll during the bonding period, in which the polarizing film was bonded to the liquid crystal cell, in Example 1. Fig. 2B is an enlarged graph of the initial drive stage part of Fig. 2A.

[0089]

In Example 2, the infeed speed was set lower than the outfeed speed or the bonding speed. Therefore, the multilayer optical film held inside the dancer roll unit was partially discharged (supplied downstream), and thus the dancer roll was moving. In Example 2, however, the result was better than in Comparative Examples 1 to 3 because the acceleration was small so that the speed did not significantly fluctuate.

[0090]

In Example 3, the movement of the outfeed roll lagged behind the movement of the infeed roll and the bonding roll, and they were asynchronous. As a result, the outfeed roll started to move during the movement of the infeed roll and the

bonding roll when the polarizing film started to be peeled off from the carrier film, which might cause, for example, chattering (small oscillations) at the start of the peeling. In Example 3, air bubbles occurred a little although the result was better than in Comparative Examples 1 to 3.

[0091]

In Example 4, the outfeed speed was set lower than the infeed speed or the bonding speed. As a result, the peeling was unstable because during the continuous peeling off of the polarizing film from the carrier film, the peeling was not performed exactly along the peeling unit (folding back with the carrier film inside was not properly performed) and the folded back part (turning part) of the carrier film separated and protruded from the front end of the peeling unit. In Examples 3 and 4, where the outfeed roll moves behind the infeed roll and the bonding roll (or moves at a speed lower than that of the infeed roll and the bonding roll), if the infeed roll and the bonding roll move synchronously, the tension controlling weight will not move, because the polarizing film was held between a pair of bonding rolls before the movement.

[0092]

Example 5 was performed under the same conditions as those in Example 1, except that the thickness of the multilayer optical film was 250 μm . In Example 5, no air bubbles were observed.

[0093]

In Example 6, the control was performed based on data on the amount of distortion detected in advance. The infeed speed was slightly lower than the outfeed speed and the bonding speed, but higher than that in Example 2. As in Example 2, the multilayer optical film held inside the dancer roll unit was partially discharged (supplied downstream), and thus the dancer roll was moving. However, since the dancer roll moved by itself, almost no inertia force occurred, and the speed did not significantly fluctuate, so that no air bubbles occurred.

[0094]

Comparative Example 1 was performed under the same conditions as those in Example 1, except that the infeed speed was zero and the control was asynchronous. As a result, the acceleration of the dancer roll was high so that the film speed significantly fluctuated accordingly. Thus, many air bubbles were observed. Fig. 3A shows the infeed speed, the bonding speed, and the displacement of the dancer roll during the bonding period, in which the polarizing film was bonded to the liquid crystal cell, in Comparative Example 1. Fig. 3B is an enlarged graph of the initial drive stage part of Fig. 3A. As compared with Figs. 2A and 2B, Figs. 3A and 3B clearly show significant fluctuations in the speed of the multilayer optical film.

[0095]

Comparative Example 2 was performed under the same conditions as those in Example 2, except that the infeed speed was lower than that in Example 2. As a result, the bonding speed significantly differed from the infeed speed, and the multilayer optical film held inside the dancer roll unit was discharged (supplied downstream) so that the dancer roll moved with a high acceleration. The rate of occurrence of air bubbles was high due to the high acceleration and the significant fluctuations in the film speed.

[0096]

Comparative Example 3 was performed under the same conditions as those in Comparative Example 1, except that the thickness of the multilayer optical film was 250 μm . Even with a larger thickness, the multilayer optical film held inside the dancer roll unit was also discharged (supplied downstream) so that the dancer roll moved with a high acceleration. The rate of occurrence of air bubbles was high due to the high acceleration and the significant fluctuations in the film speed. However, the result was better than in Comparative Example 1. The results show that the invention is more significantly effective on thinner multilayer optical films even though their smaller thickness can have a greater effect on fluctuations in their speed because they have lower stiffness and higher elasticity.

DESCRIPTION OF REFERENCE SIGNS

[0097]

1 optical film roll
21 cutting unit
31 infeed roll unit
31a, 31b pair of opposed first nip rolls
41 accumulating unit
51 peeling unit
61 outfeed roll unit
61a, 61b pair of opposed second nip rolls
71 take-up unit
71a take-up roll
81 bonding unit
P liquid crystal cell
LD liquid crystal display panel
X feed units

CLAIMS

1. A system for continuously manufacturing an optical display panel, the system comprising:

a pair of first nip rolls configured to feed a multilayer optical film downstream, wherein the multilayer optical film comprises a pressure-sensitive adhesive-bearing optical film and a long carrier film on which the optical film is placed with the pressure-sensitive adhesive interposed therebetween;

an accumulating unit having a dancer roll located downstream of the first nip rolls;

a peeling unit configured to peel off the optical film from the carrier film by inwardly folding back the carrier film;

a pair of second nip rolls configured to feed downstream the carrier film from which the optical film is peeled off by the peeling unit;

a take-up unit configured to take up the carrier film on a roll located downstream of the second nip rolls;

an optical cell feed unit configured to feed an optical cell;

a bonding unit configured to perform a process comprising bonding the optical film to the optical cell with the pressure-sensitive adhesive interposed therebetween to form an optical display panel while feeding the optical cell, wherein the optical film is peeled off by the peeling unit; and

a distortion cancelling unit configured to reduce, during the bonding of the optical film to the optical cell, distortion generated in the multilayer optical film by controlling an inertia force of the dancer roll.

2. The system according to claim 1, wherein the distortion cancelling unit comprises the inertia force control unit configured to perform control in such a way that a force

applied per 100 mm width of the carrier film due to the inertia force of the dancer roll becomes 1.8 N or less during the bonding of the optical film to the optical cell.

3. The system according to claim 2, wherein the inertia force control unit is configured to detect an acceleration when the dancer roll is moving and then to suppress the movement of the dancer roll.

4. The system according to any one of claims 1 to 3, wherein

the dancer roll is configured to automatically move in such a way as to maintain a tension on the multilayer optical film, and

the distortion cancelling unit comprises a dancer roll position-limiting control unit configured to control the dancer roll in such a way that the dancer roll stays at a certain position during the bonding of the optical film to the optical cell;

wherein the dancer roll position-limiting control unit is configured to control the dancer roll in such a way that the first nip rolls for feeding the multilayer optical film and the bonding unit move synchronously at the same speed.

5. The system according to claim 4, wherein the dancer roll position-limiting control unit is configured to control the dancer roll by allowing the first nip rolls, the bonding unit, and the second nip rolls to move synchronously.

6. The system according to claim 4 or 5, wherein the dancer roll position-limiting control unit is configured to control the dancer roll by allowing the first nip rolls, the bonding unit, and the second nip rolls to move at the same speed.

7. The system according to any one of claims 4 to 6, wherein the dancer roll forms an accumulating part with a tension controlling weight.

8. The system according to claim 1 or 2, wherein the dancer roll is configured to move when the dancer roll is controlled so as to maintain a tension on the multilayer optical film, and the distortion cancelling unit is configured to control the dancer roll in such a way that during the bonding of the optical film to the optical cell, the dancer roll is shifted based on results of detecting, in advance, distortion generated in the multilayer optical film.

9. The system according to any one of claims 1 to 8, wherein the optical film has a thickness of 200 μm or less.

10. The system according to any one of claims 1 to 9, wherein the optical film comprises a polarizing film.

11. A method for continuously manufacturing an optical display panel, the method comprising:

a first feed step comprising feeding a multilayer optical film downstream with a pair of first nip rolls, wherein the multilayer optical film comprises a pressure-sensitive adhesive-bearing optical film and a long carrier film on which the optical film is placed with the pressure-sensitive adhesive interposed therebetween;

a step comprising performing accumulation with a dancer roll located downstream of the first nip rolls;

a peeling step comprising peeling off the optical film from the carrier film by inwardly folding back the carrier film;

a second feed step comprising feeding the carrier film downstream with a pair of second nip rolls after the optical film is peeled off from the carrier film in the peeling step;
a take-up step comprising taking up the carrier film on a roll located downstream of the second nip rolls;
an optical cell feed step comprising feeding an optical cell;
a bonding step comprising bonding the optical film to the optical cell with the pressure-sensitive adhesive interposed therebetween to form an optical display panel while feeding the optical cell, wherein the optical film is peeled off in the peeling step; and
a distortion cancelling step comprising reducing, during the bonding of the optical film to the optical cell, distortion generated in the multilayer optical film by controlling an inertia force of the dancer roll.

12. The method according to claim 11, wherein the distortion cancelling step comprises the inertia force control step comprising performing control in such a way that a force applied per 100 mm width of the carrier film due to the inertia force of the dancer roll becomes 1.8 N or less during the bonding of the optical film to the optical cell.

13. The method according to claim 12, wherein the inertia force control step comprises detecting an acceleration when the dancer roll is moving and then suppressing the movement of the dancer roll.

14. The method according to any one of claims 11 to 13, wherein

the dancer roll is configured to automatically move in such a way as to maintain a tension on the multilayer optical film, and

the distortion cancelling step comprises a dancer roll position-limiting control step comprising controlling the dancer roll in such a way that the dancer roll stays at a certain position during the bonding of the optical film to the optical cell;

wherein the dancer roll position-limiting control step comprises controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls and bonding the optical film to the optical cell by the bonding step are performed synchronously at the same speed.

15. The method according to claim 14, wherein the dancer roll position-limiting control step comprises controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls, bonding the optical film to the optical cell by the bonding step, and feeding the carrier film by the second nip rolls are performed synchronously.

16. The method according to claim 14 or 15, wherein the dancer roll position-limiting control step comprises controlling the dancer roll in such a way that feeding the multilayer optical film by first nip rolls, bonding the optical film to the optical cell by the bonding step, and feeding the carrier film by the second nip rolls are performed at the same speed.

17. The method according to any one of claims 14 to 16, wherein the dancer roll forms an accumulating part with a tension controlling weight.

18. The method according to claim 11 or 12, wherein the dancer roll is configured to move when the dancer roll is controlled so as to maintain a tension on the

multilayer optical film, and

the distortion cancelling step comprises controlling the dancer roll in such a way that during the bonding of the optical film to the optical cell, the dancer roll is shifted based on results of detecting, in advance, distortion generated in the multilayer optical film.

19. The method according to any one of claims 11 to 18, wherein the optical film has a thickness of 200 μm or less.

20. The method according to any one of claims 11 to 19, wherein the optical film comprises a polarizing film.