

COATING METHOD AND COATING APPARATUS, AND MANUFACTURING METHOD AND
MANUFACTURING APPARATUS OF THE COMPONENTS FOR DISPLAYS

[Technical Field]

5 The present invention is applied to the field of manufacture
of, for example, color filters and array substrates for color liquid
crystal displays, plasma display panels, optical filters or the
like. In detail, the present invention relates to a coating method
and a coating apparatus capable of discharging intruded gas inside
10 of a coating die of a die coater for coating a coating liquid on
surface of a member to be coated such as a glass substrate, and
a manufacturing method of the components for displays using the
same and manufacturing apparatus comprising the same.

15 [Background Technology]

In manufacture of the color liquid crystal displays comprising
a color filter, an array substrate or the like, many manufacturing
processes are included in which a coated film is formed by coating
a low viscosity liquid material on surface of a member to be coated
20 such as a glass substrate and dried. For example, in a manufacturing
process of a color filter, a black coated film of a photo resist
is formed on a glass substrate, the coated film is processed by
a photo-lithography method into a lattice shape, and into the lattice,
red, blue and green coated films of photo resists are successively
25 formed by the same photo-lithography method. Other than the
manufacturing process of the color filter, there are manufacturing
processes such as a coating of a photoresist material for a spacer
which forms a space for a liquid crystal injected between the color
filter and the array substrate, or forming an overcoat film to smoothen
30 an unevenness of the color filter.

which forms a space for a liquid crystal injected between the color filter and the array substrate, or forming an overcoat film to smoothen an unevenness of the color filter.

As coating apparatuses for forming these coated films, a spin coater, a bar coater or the like have conventionally been used. However, recently, because of easiness of decreasing coating liquid consumption, decreasing electric power consumption, upsizing of apparatus accompanied by upsizing of the glass substrate, or the like, the die coater disclosed in the patent reference 1 has widely been used.

However, in case where such a sheet-like member to be coated such as glass substrate is coated by using such a die coater, gas, i.e., a bubble often intrudes inside the coating die. As reasons of the gas intrusion, 1) a gas intrusion through connected portions of piping or through sliding portions of pump in which the coating liquid flows, 2) a foaming of gas dissolved in the coating liquid inside the coating die, 3) At open/shut operations of valve used for feeding the coating liquid, a suction of gas or a foaming of gas caused by volume change of the coating liquid, 4) a suction of gas from the discharging aperture, or the like, are mentioned. When gas intruded inside the coating die by the above reasons, a delay of discharging pressure at the start of coating arises and the coating thickness at the start of coating becomes thin, or the gas is directly discharged to the member to be coated from the discharging aperture, to thereby generate defects such as pinholes or longitudinal streaks.

To solve such problems, inventions have been made in which, when gas intruded inside the coating die, before arising the above-mentioned problems, the gas is discharged from the discharging aperture by revolving the coating die such that the discharging

aperture opens upward, or a gas outlet is provided to the coating die, and the gas is discharged together with the coating liquid from the gas outlet. However, in the method in which the coating die is revolved, in order to discharge the gas from the discharging aperture opened upward as disclosed in the patent reference 2, coating/production must temporarily be stopped to revolve the coating die, and furthermore, a revolving mechanism to revolve the coating die and a manual operation by an operator to wipe off the coating liquid that has adhered to the coating die after gas discharge are necessary.

However, in order to manually wipe a coating die which is upsized accompanied with upsizing of substrate by an operator, a lot of time and labor is necessary. As a result, the coating/production must be stopped for a long time, and the operation rate and the productivity of the coating apparatus for coating/production are notably decreased. Furthermore, in order to revolve the upsized coater, a revolving apparatus with high precision and high power is necessary, and the apparatus cost becomes high.

On the other hand, in the means for discharging gas from the gas outlet provided to the coating die, since the gas is discharged in a state in which the discharging aperture opens downward during the coating/production, the revolving of the coating die is unnecessary and the above-mentioned problems can be avoided. Where, in the method disclosed in the patent reference 3, the gas discharge piping connected to the gas outlet is located at a position being higher than the gas outlet so that the gas can be discharged from the gas outlet by taking advantage of buoyancy. However, at this position, a liquid pressure generated from a difference of height between the highest and the lowest part of the gas discharge piping works as resistance, to thereby make the amount of coating liquid

consumption and gas discharging time large. Therefore, the gas discharge ability is significantly low.

And, in the method disclosed in the patent reference 4, a portion open to the atmosphere is provided on the way of the gas discharge piping. However, in this method, too, since the uppermost portion of the drainage channel positioned higher than the discharging aperture is open to the atmosphere, in order to discharge gas, it is necessary to feed as much as 1000 cc of a coating liquid of 5 cp which is about the same viscosity as the coating liquid for production of a liquid crystal display, to thereby significantly decrease the discharge efficiency. In view of cost, it is impossible to apply such a system, in which a coating liquid is consumed uselessly, to a very expensive coating liquid for producing liquid crystal display.

Furthermore, in the patent reference 5, an invention having a structure in which gas easily flows to the gas outlet by making the upper side of manifold slopes upward from the feed port to the gas outlet, is disclosed. However, by simply making the upper side of manifold slopes upward, it is difficult to sufficiently take advantage of buoyancy of the gas, and accordingly, it is difficult to discharge the gas deposited to the upper side of the manifold. Furthermore, in the invention disclosed by the patent reference 6 or the patent reference 7, since the cross-sectional area of the manifold at the position where the gas outlet is provided is made larger than the cross-sectional area of the manifold at the position where the feed port is provided, the velocity of the flow inside the manifold decreases as it approaches to the gas outlet. As a result, the ability for moving gas decreases, especially when the coating die is upsized, the gas discharge efficiency significantly decreases.

Furthermore, if micro bubbles of which diameter is less than 1 mm, that is, a very small bubbles, intrude inside the coating die, since buoyancy act to the micro bubbles or sweeping power of the coating liquid are very small, the moving speed of the gas to the gas outlet becomes extremely small, and on the way of the moving, the gas deposits on the wall of manifold and often does not move. In particular, when the coating die is upsized, the distance to be moved of the micro bubble becomes long, and it becomes extremely difficult to discharge the micro bubbles from the gas outlet. However, in any of the above-mentioned inventions, there is utterly no description on a method for efficiently discharging the micro bubbles from the coating die. When a micro bubbles intrudes inside, there is no way for discharging the micro bubbles other than increasing a feed rate or feed time of the coating liquid at discharge. For that reason, even if the micro bubbles could be discharged, a large amount of coating liquid and a long time become necessary. Accordingly, it is extremely difficult in view of cost to apply these existing systems to a very expensive coating liquid for producing a liquid crystal display, to discharge micro bubbles of less than 1 mm diameter. Furthermore, by the existing above-mentioned means, since there are some cases in which the micro bubbles cannot be completely discharged, coating defects such as pinholes or longitudinal streaks are often generated by discharging the micro bubbles from the discharging aperture to the member to be coated.

[Patent reference 1] JP06-339656A

[Patent reference 2] JP09-253556A

[Patent reference 3] JP-2557582B

[Patent reference 4] JP2000-176351A

[Patent reference 5] JP2001-334197A

[Patent reference 6] JP2005-144376A

[Patent reference 7] JP2006-95459A

[Disclosure of the Invention]

5 [Problem to be Solved by the Invention]

The present invention is made to solve the above-mentioned problems. The object of the present invention is to provide a coating apparatus and a coating method, and a manufacturing apparatus of the components for displays using the same and a manufacturing method
10 comprising the same, of which tact time is short, productivity is high and which are capable of forming a high quality coating film, by realizing a means capable of discharging any gas intruded inside the coating die with a small amount of coating liquid and in a short time. The object of the present invention is achieved by the method
15 mentioned below.

[Means for Solving the Problem]

A coating method of the present invention is a coating method for forming a coating film on a surface of a member to be coated
20 wherein applying a coating apparatus which is provided with a liquid feed means for feeding a coating liquid to a coating die, the coating die having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels that are connected to
25 the gas outlets and are located at the positions being almost as high as the gas outlets or being lower than the gas outlets and have open/shut-valves on their way, waste tanks for storing the waste liquid discharged from the outlets of the gas drainage channels, a supporting means for supporting the member to be coated, and a
30 moving means for relatively moving the coating die and the supporting

means to each other, and wherein relatively moving the coating die and the member to be coated to each other while dispensing the coating liquid to the member to be coated from the discharging aperture, comprising the step of discharging the coating liquid and gas from
5 the gas outlets by opening the open/shut-valves of the gas drainage channels while feeding the liquid from the liquid feed means before and/or after forming the coating film on the surface of the member to be coated. In the coating method of the present invention, it is preferable that the coating liquid and gas are discharged from
10 the gas outlets by opening the open/shut-valves in a state that the outlets of the gas drainage channels are open to the atmosphere.

Furthermore, another coating method of the present invention is a coating method for forming a coating film on a surface of a member to be coated wherein applying a coating apparatus which is
15 provided with a liquid feed means for feeding a coating liquid to a coating die, the coating die having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels that are connected to the gas outlets and are located at
20 the positions making their own outlets lower than the discharging aperture and have open/shut-valves on their way, waste tanks for storing the waste liquid discharged from the outlets of the gas drainage channels, a supporting means for supporting the member to be coated, and a moving means for relatively moving the coating
25 die and the supporting means to each other, and wherein relatively moving the coating die and the member to be coated to each other while dispensing the coating liquid to the member to be coated from the discharging aperture, comprising the step of discharging the coating liquid and gas from the gas outlets by opening the
30 open/shut-valves of the gas drainage channels while feeding the

liquid from the liquid feed means before and/or after forming thecoating film on the surface of the member to be coated. In the coating method of the present invention, it is preferable that the coating liquid and gas are discharged from the gas outlets by opening
5 the open/shut-valves in a state that the outlets of the gas drainage channels are open to the atmosphere. In the coating method of the present invention, it is preferable that the coating liquid and the gas are discharged from gas outlets by opening the open/shut-valves in a state that each liquid storage portion of
10 the waste tanks is open to the atmosphere, the liquid level of the waste liquid stored in each of the waste tanks is lower than the discharging aperture of the coating die, and the outlets of the gas drainage channels are immersed in the waste liquid in each of the waste tanks.

15 Still another coating method of the present invention is, in a coating method in which a coating die having a manifold for distributing the coating liquid in the coating width direction, a discharging aperture for dispensing the coating liquid from and gas outlets for discharging gas together with the coating liquid
20 from, and relatively moving the member to be coated and the coating die to each other while dispensing the coating liquid from the discharging aperture of the coating die, comprising the steps of feeding gas to the manifold filled with the coating liquid; subsequently feeding the coating liquid to the manifold; discharging
25 the gas and a part of the coating liquid from the gas outlets; and then coating the coating liquid on the surface of the member to be coated.

A method of manufacturing components for displays of the present invention is characterized by using any one of the above
30 described coating methods.

A coating apparatus of the present invention is a coating apparatus provided with a liquid feed means having a liquid feed channel for feeding a coating liquid to a coating die, the coating die having a manifold for distributing the coating liquid in the coating width direction and having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels connected to the gas outlets and having open/shut-valves on their way, a supporting means for supporting a member to be coated, and a moving means for relatively moving the coating die and the supporting means to each other, wherein the gas drainage channels are located at the positions being almost as high as the gas outlets or being lower than the gas outlets. Furthermore, another coating apparatus of the present invention is a coating apparatus provided with a liquid feed means having a liquid feed channel for feeding a coating liquid to a coating die, the coating die having a manifold for distributing the coating liquid in the coating width direction and having a discharging aperture for dispensing the coating liquid from and further having gas outlets for discharging gas together with the coating liquid from, gas drainage channels connected to the gas outlets and having open/shut-valves on their way, a supporting means for supporting a member to be coated, and a moving means for relatively moving the coating die and the supporting means to each other, wherein outlets of the gas drainage channels are located at the positions being lower than the discharging aperture.

Still another coating apparatus of the present invention is a coating apparatus provided with a liquid feed means having a liquid feed channel for feeding a coating liquid to a coating die, the coating die having a manifold for distributing the coating liquid

in the coating width direction, and having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels connected to the gas outlets and having open/shut-valves
5 on their way, a supporting means for supporting a member to be coated, and a moving means for relatively moving the coating die and the supporting means to each other, wherein gas feed channels for feeding gas to the coating die is connected at least to any one of the coating die, the liquid feed channel and the gas drainage channels. In the
10 coating apparatus of the present invention, it is preferable that an inlet of the gas feed channel is open to the atmosphere.

In the coating apparatus of the present invention, it is preferable that the coating die has a feed port through which the coating liquid is fed from the liquid feed channel to the coating
15 die, the cross-sectional area of the manifold in the coating width direction decreases from the feed port to the gas outlets, and moreover an upper side of the manifold is parallel to a discharging aperture surface including the discharging aperture, or slopes upward from the feed port to the gas outlets relatively to the discharging aperture
20 surface as a base. In the coating apparatus of the present invention, it is preferable that a land length of a slot of the coating die is decreased from the central portion to both ends in the coating width direction.

A manufacturing apparatus of the components for displays of
25 the present invention is characterized by using a coating apparatus described in any one of the above.

[Effect of the Invention]

By using the coating method and coating apparatus of the present
30 invention, in a state that the gas drainage channels, connected

to the gas outlets of the coating die, are located at the positions being almost as high as the gas outlets or lower than the gas outlets, and further, the outlets of gas drainage channels are located at the position being lower than the discharging aperture, by opening
5 the open/shut-valves of the gas drainage channels while feeding a liquid from the liquid feed means, the coating liquid is discharged from the gas outlets with the gas. Accordingly, the liquid pressure generated from a difference of height between the highest and the lowest part of each of the gas drainage channels does not work as
10 resistance, and since a siphonage can be available for quickening to discharge gas, it is possible to discharge the gas in a short time.

Furthermore, since a predetermined amount or more of gas is fed to the manifold of the coating die from the gas feed channel
15 connected to any one of the coating die, the liquid feed channel or the gas drainage channels to unite the micro bubbles to the gas region formed inside, and after removing the micro bubbles, the fed gas is discharged out of the coating die together with the small amount of the coating liquid, it becomes possible to discharge
20 undischageable micro bubbles quite certainly in a short time.

Furthermore, since a coating die in which the cross-sectional area of the manifold in the coating width direction decreases from the feed port to the gas outlet, and an upper side of the manifold is parallel to the discharging aperture surface including the
25 discharging aperture or, slopes upward from the feed port to the gas outlet relatively to the discharging aperture surface as a base, is used, even if the coating die is upsized, since the velocity of the flow of the coating liquid inside the manifold from the feed port toward the gas outlets is high, gas moves to the gas outlets
30 quickly, and further, since the move of the gas is not prevented

by the inclination of the upper side of the manifold, it is possible to discharge the gas outside in a shorter time and more certainly.

According to the above-mentioned coating method and coating apparatus, since it is possible to carry out the gas discharge operation during the coating/production, there is no interruption for a long time of the coating/production by the gas discharge operation. Accordingly, it is easy not only to increase the operation rate of the coating apparatus but also to shorten the tact time, and it is possible to significantly increase productivity.

Furthermore, since the very expensive coating liquid for producing liquid crystal display is not consumed uselessly when gas is discharged, it contributes to a cost reduction greatly. In addition, by the excellent gas discharge performance, since the gas inside the coating die can be discharged completely, it is possible to completely solve the problems caused by the gas inside the coating die such that the coating thickness at starting of the coating becomes thin due to a delay of the discharging pressure at start of the coating, or coating defects such as pinholes or longitudinal streaks are brought about by directly discharging the gas from the discharging aperture to the member to be coated. Furthermore, since a revolving apparatus is unnecessary, it is possible to easily respond to upsizing of the substrate.

According to the manufacturing method of the components for displays and the manufacturing apparatus of the present invention, since components for displays are produced by using the above-mentioned coating method and coating apparatus, it becomes possible to produce the components for displays of excellent coating quality in a low cost and in a high yield.

[Brief Explanation of the Drawings]

[Fig. 1] Fig. 1 is a constitutional illustration of the die coater 1 which is a coating apparatus equipped with the coating die 10.

[Fig. 2] Fig. 2 is an elevational cross-sectional illustration of the coating die 10 in which inside the coating die 10 is viewed from coating direction.

[Fig. 3] Fig. 3 is a side cross-sectional illustration perpendicular to the coating width direction of the coating die 10.

[Fig. 4] Fig. 4 is an elevational illustration of the coating die 10 with the feed portion and the discharge part of the coating liquid 2.

[Fig. 5] Fig. 5 is an elevational cross-sectional illustration of the coating die 10 showing a state in which the gas 100 is discharged at filling operation of the coating liquid.

[Fig. 6] Fig. 6 is an elevational cross-sectional illustration of the coating die 10 showing a state in which the gas 100 intruded during coating operation is discharged.

[Fig. 7] Fig. 7 is an elevational cross-sectional illustration showing a state in which the micro bubbles 101 inside the coating die 10 is removed by the gas fed to the coating die 10.

[Explanation of the codes]

Here, the codes and numerals in the drawings are as follows.

1: die coater
2: coating liquid
3: substrate
10: coating die
11: front lip
12: rear lip

13: manifold
 14: slot
 15: discharging aperture
 16: feed port
 5 17A, 17B: gas outlet
 18: internal feed channel
 19A, 19B: internal gas drainage channel
 20: upper side of manifold
 21: discharging aperture surface
 10 22: coating die holding base
 30: bench
 31: guide rail
 32: stage
 33: linear motor
 15 34: support
 40: lifting device unit
 41: lifting base
 42: guide
 43: motor
 20 44: ball screw
 50: wiping unit
 51: wiping head
 52: wiping head driving device
 53: head holder
 25 54: tray
 55: wiping unit holding base
 60: coating liquid feeding device unit
 61: coating liquid tank
 62: feeding channel to pump
 30 63: open/shut-valve for suction

64: syringe pump
 65: open/shut-valve for extrusion
 66: feed channel to die
 67: syringe
 5 68: piston
 69: piston holding base
 70: piston lift guide
 71: syringe pump motor
 72: ball screw for syringe pump
 10 80A, 80B: gas drainage channel
 81A, 81B: open/shut-valve for discharge
 82A, 82B: waste tank
 83: waste liquid
 84A, 84B: drainage channel
 15 85A, 85B: open/shut-valve for drainage
 86A, 86B: vacuum pump
 87A, 87B: higher side sensor
 88A, 88B: lower side sensor
 89: liquid level
 20 90A, 90B: outlet of gas drainage channel
 91: gas feed channel
 92: open/shut-valve for gas feed
 93: inlet of gas feed channel
 95: controller
 25 96: control panel
 97: bead
 100: gas
 101: micro bubbles
 102: fed gas
 30 X: coating direction (substrate moving direction)

Ha: central land length
Hb: end land length
 α : inclination angle of upper side of manifold
Sa: manifold cross-sectional area of feed port portion
5 Sb: manifold cross-sectional area of gas outlet portion
 θ : inclination angle of gas drainage channel
H: level difference between the discharging aperture and the
liquid level of waste liquid staying at the waste tank
H': level difference between the discharging aperture and
10 the outlet of gas drainage channel
Q3: height of lower side sensor
Q4: height of higher side sensor

[Best Embodiment for Carrying Out the Invention]

15 Hereunder, preferable embodiments for carrying out the present
invention are explained with reference to the drawings. With
reference to Fig. 1, the die coater 1 of the present invention is
shown. The die coater 1 is provided with a bench 30, and on the
bench 30, a pair of guide rail is provided. Above this guide rail
20 31, a stage 32 is provided. The stage 32 is driven by the linear
motor 33, and it is possible to freely move back and forth in X
direction indicated in Fig. 1. Furthermore, the upper surface of
the stage 32 constitutes a vacuum surface having a plural of unshown
vacuum holes, which can suction and hold the substrate 3 which is
25 the member to be coated. Furthermore, in the bench 30, a gate-shaped
support 34 is provided. To both sides of the support 34, a pair
of lifting device units 40 capable of moving up and down is provided.
The coating die 10 to coat is equipped to this lifting device unit
40 with its discharging aperture 15 facing downward. The lifting
30 device units 40 is constituted with the lifting base 41 which lifts

up and down the coating die holding base 22 which holds the coating die 10, a guide 42 which guides the lifting base 41 up and down, the motor 43, the ball screw 44 which converts a revolving motion of the motor 43 to a straight motion of the lifting base 41. Since
5 this lifting device units 40 can be operated independently at both ends (left and right) of the coating width direction of the coating die 10, it is possible to control an inclination of the coating die 10 in the coating width direction relatively to the horizontal line. By this way, it is possible to make the discharging aperture
10 surface 21 of the coating die 10 and the substrate 3 which is the member to be coated parallel in the coating width direction of the coating die 10 and, at the same time, to arbitrarily adjust a clearance which is a distance between the surface of substrate 3 and the discharging aperture surface 21.

15 Furthermore, to the bench 30, the wiping unit 50 is provided. This wiping unit 50 can move back and forth freely, like the stage 32, in X direction which is the coating direction along the guide rail 31. The wiping unit 50 is constituted with the wiping head 51, the wiping head driving device 52, the head holder 53, the tray
20 54 and the wiping unit holding base 55. Here, the wiping head 51 has a shape which fits to the shape of the lowermost portion of the coating die 10, and is preferable to be made of an elastic material such as synthetic resin.

In case where the lowermost portion of the coating die 10 is
25 wiped with the wiping unit 50, the wiping unit 50 is moved in X direction to the lower portion of the coating die 10, and the coating die 10 is gone down by the lifting device units 40, to thereby the wiping head 51 contact with the lowermost portion of the coating die 10. And, in a state contacted with the lowermost portion of
30 the coating die 10, by moving the wiping head 51 by the wiping head

driving device 52 in the coating width direction which is perpendicular to the X direction of the coating die 10, a remaining coating liquid, particles and the like deposited to the lowermost portion of the coating die 10 are removed. The remaining coating
5 liquid, particle or the like removed by the coating die 10 are received by the tray 54 provided under the wiping head 51, and collected in an unshown tank through an unshown drainage channel. Where, this tray 54 can also be used for collecting the coating liquid 2 or a solvent discharged from the discharging aperture 15 when a coating
10 liquid 2 is changed or to prevent drying of the discharging aperture surface 21 which is the lowermost portion of the coating die 10.

Furthermore, to the die coater 1, the coating liquid feeding device unit 60 which feeds the coating liquid 2 to the coating die 10 is provided. Where, when referred to Fig. 4 in which the feeding
15 channel connected to the coating die 10 and the drainage channels are shown in detail, to the coating liquid feeding device unit 60, the coating liquid tank 61 which stores the coating liquid 2 is provided. The coating liquid 2 stored in the coating liquid tank 61 is fed to the syringe pump 64, through the feeding channel to
20 pump 62 and the open/shut-valve for suction 63 connected to a downstream of the coating liquid tank 61. The coating liquid 2 fed to the the syringe pump 64 is sent to the manifold 13 from the feed port 16 of the coating die 10, via open/shut-valve for extrusion 65 and the feed channel to die 66.

25 Here, the syringe pump 64 is constituted with the syringe 67, the piston 68, the piston holding base 69 which holds the piston 68, the piston lift guide 70 which guides the piston holding base 69 up and down, the syringe pump motor 71 which is a driving unit which moves the piston holding base 69 up and down, the ball screw for
30 syringe pump 72 which actually moves the piston holding base 69

by converting the revolving motion of the syringe pump motor 71 to the straight motion of the piston holding base 69. This syringe pump 64 is a constant volume dischargeable pump and can feed the coating liquid 2 of an amount required for forming a coated film to the coating die 10, by extruding the coating liquid 2 filled inside the syringe 67 by the piston 68. In case where the coating liquid 2 is filled inside the syringe 67, the piston 68 is gone down in a state in which the open/shut-valve for suction 63 provided upstream of the syringe 67 is kept "open" and the open/shut-valve for extrusion 65 provided downstream of the syringe 67 is kept "closed". Furthermore, in case where the coating liquid 2 inside the syringe 67 is fed to the coating die 10, the piston 68 is gone up in a state in which the open/shut-valve for suction 63 is kept "closed" and the open/shut-valve for extrusion 65 is kept "open".

When referred to Fig. 1 again, the coating die 10 provided to the die coater 1 is constituted with the front lip 11 and the rear lip 12 extending in the coating width direction (the direction perpendicular to the paper), laid on the other in the coating direction and fixed with a plural of unshown assembling bolts. Where, the coating direction agrees with the X direction of Fig. 1. Furthermore, in the coating die 10, the manifold 13 is formed to distribute the coating liquid 2 fed to the coating die 10 in the coating width direction. This manifold 13 has a shape, similar to the front lip 11 and the rear lip 12, extending to the coating width direction. Where, the coating width direction agrees to the longitudinal direction of the coating die 10. Under the manifold 13, the slot 14 which is a gap between the front lip 11 and the rear lip 12 is formed, and this slot 14 extends also in the coating width direction. And, the lowermost portion of the slot 14 corresponds to the discharging aperture 15 of the coating die 10.

Fig. 2 is an elevational cross-sectional illustration of the coating die 10, which views inside the coating die 10 from the coating direction perpendicular to the coating width direction. When referred to Fig. 2 (a), to the coating die 10, the feed port 16 to which the coating liquid 2 is fed and the gas outlets 17A and 17B which discharge the gas 100 intruded inside the coating die 10 with the coating liquid 2, shown in Fig. 4, are provided.

Here, a number and a position of the feed port 16 are not limited. As shown in Fig. 2, in case where the number of the feed port 16 is one, if the feed port 16 is located at the center of the coating width direction of the manifold 13, it is preferable since the passage length to distribute the coating liquid 2 in the coating width direction becomes shortest. Such an arrangement of the feed port 16 becomes useful, especially when the coating die 10 is upsized.

In case where the feed port 16 is located at the center of the coating width direction of the manifold 13, it is preferable to provide the gas outlets 17B as a pair at both end positions in the coating width direction of the manifold 13. By this way, even when a gas which flows in from the feed port 16, a gas generated by foaming inside the coating die 10 and a gas suctioned from the discharging aperture 15 became the gas 100 stayed in the manifold 13 as shown in Fig. 4, it is possible to discharge the gas 100 from the gas outlets 17B along with a flow of the coating liquid 2 in the manifold 13. Furthermore, in order to discharge gas accumulated in the upper portion of the feed port 16 or gas intruded from the feed port 16, before arriving at the manifold 13, it is preferable to provide the gas outlet 17A above the feed port 16.

Next, when referred to Fig. 3 which is a side cross-sectional illustration perpendicular to the coating width direction of the coating die 10, in Fig. 3 (a) a cross-sectional view of the position

of the feed port 16, and in Fig. 3 (b) a cross-sectional view of the position of the gas outlets 17B is shown. As shown in Fig. 3 (a), it is preferable that the feed port 16 is connected with an upper position of the manifold 13 via internal feed channel 18, and on the other hand, it is preferable that the gas outlet 17A is connected to an upper portion of the internal feed channel 18 where gas is apt to gather.

In addition, as shown in Fig. 3 (b), it is preferable that the gas outlets 17B is connected to the upper portion of the manifold 13 where gas is apt to gather through the internal gas drainage channel 19B. Where, the internal gas drainage channels 19A and 19B may partially have channels extending vertically, but it is preferable that they are channels extending horizontally around the gas outlets 17A and 17B so that a flow rate of the coating liquid 2 which flows in the internal gas drainage channels 19A and 19B would not decrease due to a liquid pressure generated from a difference of height between the highest and the lowest part of each of the internal gas drainage channels 19A and 19B. Accordingly, it is preferable that the gas outlets 17A and 17B are provided to any one of the front, side or back side of the coating die 10, not to the upper side.

When referred to Fig. 2 again, in order to efficiently discharge gas inside the manifold 13 along with a flow of the coating liquid 2, it is preferable that the upper side 20 of the manifold 13, as shown in Fig. 2 (a), is parallel to the discharging aperture surface 21 or as shown in Fig. 2 (b), slopes upward from the feed port 16 to the gas outlets 17B relatively to the discharging aperture surface 21 as a base. By such a constitution, when gas is moved to the gas outlets 17B with the coating liquid 2, since buoyancy which acts to the gas is available for quickening to move the gas, the gas

can be discharged easily, to thereby achieve a high gas discharge efficiency. On the other hand, in case where the upper side 20 of the manifold 13, slopes downward from the feed port 16 to the gas outlets 17B relatively to the discharging aperture surface 21 as a base, when the gas is moved to the gas outlets 17B with the coating liquid 2, since a power is necessary to push back to the gravity direction against the buoyancy which acts to the gas, it becomes difficult to discharge the gas, and the discharge efficiency significantly decreases.

10 In case where the upper side 20 of the manifold 13 slopes upward from the feed port 16 to the gas outlets 17B, since buoyancy which acts to the gas can be used for extrusion, the inclination angle α of the upper side 20 of the manifold 13, relatively to the discharging aperture surface 21 as a base, may be any value, but preferably
15 it is 5° or less, more preferably it is 3° or less. If the inclination angle α is too large, accompanied by that, the total height of the coating die 10 (distance from the discharging aperture surface 21 to the coating die holding base 22 of Fig. 1) is increased and the coating die 10 is upsized. By that, problems such as an increase
20 of production cost or decrease of handling property arise. Furthermore, since it becomes difficult to make an areal pressure between the both lips at fixing the front lip 11 and the rear lip 12 uniform in the coating width direction, the gap of slot 14 becomes not uniform in the coating direction to thereby affect
25 disadvantageously to discharging accuracy.

Here, it is preferable that all portions of the upper side 20 of the manifold 13 may be parallel to the discharging aperture surface 21 or may slopes linearly upward from the feed port 16 to the gas outlets 17B relatively to the discharging aperture surface
30 21 as a base, but a portion which slopes downward may be included

on the way.

Where, inclination angle α is expressed, as shown in Fig. 2 (b) concretely, as the angle made by the dotted line parallel to the discharging aperture surface 21 and the upper side 20 of the manifold 13. The upper side 20 of the manifold 13 is the straight portion expressed by 20 of Fig. 2, but in more detail, it is the line or surface of the uppermost portion of the manifold 13 of Fig. 3 which connects in the coating width direction.

Furthermore, as shown in Fig. 2 (a), it is preferable that a land length, of the slot 14, which is the length from the discharging aperture 15 to the lower portion of the manifold 13, satisfies H_a (central land length) $>$ H_b (end land length). In Fig. 2 (a), the land length decreases from the central portion of the manifold 13 to both ends. If, H_a (central land length) $= H_b$ (end land length), since pressure drops at both ends become higher than the central portion in the slot 14, outputs at both ends become lower than the central portion, but by controlling as H_a (central land length) $>$ H_b (end land length), since the pressure drops at both ends in the slot 14 becomes lower than central portion, it becomes possible to dispense at both ends the coating liquid 2 of about the same amount as the central portion. As a result, it is possible to dispense the coating liquid 2 from the discharging aperture 15 uniformly in the coating width direction.

When referred to Fig. 3 again, the cross-sectional area of the manifold 13 in the coating width direction, i.e., the area of the cross-section perpendicular to the coating width direction gradually decreases from the feed port 16 to the gas outlets 17B, and S_a (manifold cross-sectional area of feed port portion) $>$ S_b (manifold cross-sectional area of gas outlet portion). By making the manifold cross-sectional area of gas outlet portion S_b smaller

than the manifold cross-sectional area of feed port portion Sa, velocity of the flow the coating liquid 2 toward the gas outlets 17B becomes high, and it becomes possible to quickly move the gas inside the manifold 13 with the coating liquid 2 toward the gas outlets 17B, to thereby discharge the gas in a short time, and at the same time, a stagnated portion in the manifold 13 becomes difficult to generate. As a result, not only it is possible to discharge the gas even from an upsized coating die 10 in a short time, but also it is possible to solve a problem of deterioration of the coating liquid 2 due to the stagnation of the coating liquid 2.

On the contrary, in case where the manifold cross-sectional area of gas outlet portion Sb is larger than the manifold cross-sectional area of feed port portion Sa, since the velocity of the flow of the coating liquid 2 which moves to the gas outlets 17B in the manifold 13 decreases, the time to discharge the gas increases. And, not only the gas discharge efficiency decreases, but also the deterioration of the coating liquid 2 by the stagnation becomes likely to occur. Here, regarding the cross-sectional area of the manifold 13 in the coating width direction, if it gradually decreases from the manifold cross-sectional area of feed port portion Sa to the manifold cross-sectional area of gas outlet portion Sb, any area change pattern can be applied. Furthermore, an area change pattern in which the area temporarily increases on the way may be applied. In order to more efficiently move the gas to the gas outlet 17B, it is preferable that Sb (manifold cross-sectional area of gas outlet portion)/Sa (manifold cross-sectional area of feed port portion) is $1/2$ or less.

When referred to Fig. 4 again, to the gas outlets 17A and 17B, the gas drainage channels 80A and 80B, and the open/shut-valves for discharge 81A and 81B are connected respectively. The gas 100

and the coating liquid 2 discharged from the gas outlets 17A and 17B is discharged into the waste tanks 82A and 82B through the open/shut-valves for discharge 81A and 81B, and the gas drainage channels 80A and 80B. Where, it is preferable to provide the
5 open/shut-valves for discharge 81A and 81B just around the gas outlets 17A and 17B so that the gas 100 discharged from the gas outlets 17A and 17B would not return to the inside the coating die 10. It is preferable to provide the open/shut-valves for discharge 81A and 81B in at least 100 mm or less from the gas outlets 17A and
10 17B. As the gas drainage channels 80A and 80B, a piping of any materials such as a piping made of a metal or a piping made of a synthetic resin can be applied. As the gas drainage channels 80A and 80B, since it is connected to the coating die 10 which moves up and down, it is preferable to use a piping made of a flexible
15 synthetic resin.

When the waste liquid 83 is stored in a predetermined amount or more in the waste tanks 82A and 82B, the waste liquid 83 is discharged to outside by the vacuum pumps 86A and 86B through the drainage channels 84A and 84B, and the open/shut-valves for drainage 85A
20 and 85B. To the waste tanks 82A and 82B, the higher side sensors 87A and 87B, and the lower side sensors 88A and 88B are provided. The higher side sensors 87A and 87B detect a volume of waste liquid 83 upon which a suction operation by the vacuum pumps 86A and 86B starts. The lower side sensors 88A and 88B detect a volume of the
25 waste liquid 83 upon which the suction operation by the vacuum pumps 86A and 86B stops. The difference of height between the higher side sensors 87A and 87B, and the lower side sensors 88A and 88B is, preferably 200 mm or less, more preferably 100 mm or less.

Where, regarding the discharging method of the waste liquid
30 83, any of a method of discharging the waste liquid 83 intermittently

by using the higher side sensors 87A and 87B, and the lower side sensors 88A and 88B, a method of keeping the liquid level 89 of the waste tanks 82A and 82B by letting flow out an excess amount of the waste liquid 83, when a predetermined amount of the waste liquid 83 is stored in the waste tanks 82A and 82B, or the like, may be applied. Furthermore, in Fig. 4, the two waste tanks 82A and 82B are provided, but the waste tanks 82A and 82B may be replaced with one tank to be shared, or the same number of tanks as the number the gas drainage channels 80A and 80B may be provided.

Where, in order to discharge the gas 100 in a more short time, it is necessary to provide a suction means to the gas drainage channels 80A and 80B. As the suction means, a vacuum pump or the like may be used, but the vacuum pump has problems such that the coating liquid 2 solidifies and deposits to inside the pump and the pump cannot be used for a long time, or it is difficult to precisely adjusting a discharge amount. Accordingly, it is preferable to apply a suction means in which a siphonage having an action similar to the vacuum pump is used. This suction means generates a sucking action by placing the outlets 90A and 90B of the gas drainage channels 80A and 80B at a position being lower than the discharging aperture 15, and at the same time, by filling the gas drainage channels 80A and 80B from the gas outlets 17A and 17B to the outlets 90A and 90B with a liquid. That is, it generates a sucking action by taking advantage of a liquid pressure generated from a difference of height between the discharging aperture 15 and the outlets 90A and 90B of the gas drainage channels 80A and 80B. By using the suction means in which this siphonage is applied, only by controlling the difference of height H' between the discharging aperture 15 and the outlets 90A and 90B of the gas drainage channels 80A and 80B, it is possible to precisely control the amount of discharge. Furthermore, since

a driving device such as a vacuum pump is not used, maintenance is easy.

In addition, the gas drainage channels 80A and 80B are located at the position being almost as high as the gas outlets 17A and 17B, or at the position being lower than that. By this arrangement, a sucking action by the siphonage is exhibited most efficiently. Where, what the gas drainage channels 80A and 80B are located at the position being almost as high as the gas outlets 17A and 17B, or at the position being lower than that means that the gas drainage channels 80A and 80B extends from the center of the gas outlets 17A and 17B in a direction of $\theta = \pm 30^\circ$ or less relatively to the horizontal line, and further, are located at the position being lower than vertically 50 mm above from the center of the gas outlets 17A and 17B. In case where θ is less than -30° , a resistance by buoyancy of the gas 100 becomes large, and it becomes difficult to discharge the gas 100 from the gas outlets 17A and 17B to the gas drainage channels 80A and 80B. In case where θ is more than $+30^\circ$, or the gas drainage channels 80A and 80B are located at the positions being higher than 50 mm above the center of the gas outlets 17A and 17B, the liquid pressure generated from a difference of height between the highest and the lowest part of each of the gas drainage channels 80A and 80B works as resistance, and an amount of the coating liquid 2 discharged from the gas drainage channels 80A and 80B decreases, and as a result, a discharge amount of the gas 100 decreases and it is not preferable.

And, it is preferable that the outlets 90A and 90B of the gas drainage channels 80A and 80B are open to the atmosphere, and further, it is preferable that it is open to the atmosphere at the lowermost portion of the gas drainage channels 80A and 80B. However, depending on a property of the coating liquid 2, when the discharge operation

of the gas is stopped, the gas is suctioned from the outlets 90A and 90B of the gas drainage channels 80A and 80B, and by that, dry solidified material may be produced to cause a clogging. Accordingly, in order to prevent a clogging with the dry solidified material, 5 it is preferable that the outlets 90A and 90B of the gas drainage channels 80A and 80B is immersed in the waste liquid 83 stored in the waste tanks 82A and 82B of which inside is under the atmospheric pressure.

Where, it is preferable that the liquid level 89 of the waste 10 liquid 83 stored in the waste tanks 82A and 82B is arranged at a position being lower than the discharging aperture 15. However, if the difference of height H between the discharging aperture 15 and the liquid level 89 of the waste liquid 83 stored in the waste tanks 82A and 82B and the difference of height H' between the 15 discharging aperture 15 and the outlets 90A and 90B of the gas drainage channels 80A and 80B are too large, due to the liquid pressure generated by the difference of height H or the difference of height H', the amount of coating liquid 2 discharged from the gas outlets 17A and 17B becomes too large relatively to the amount fed to inside 20 of the coating die 10. By that fact, a portion of the manifold 13 is made to be in a negative pressure, to thereby cause a phenomenon to suction gas from the discharging aperture 15. Therefore, it is necessary to control the passage resistance, or to control the ratio of the feed amount to inside the coating die 10 and the discharge 25 amount from the gas outlets 17A and 17B by providing a flow control valve at an arbitrary position of the gas drainage channels 80A and 80B. The passage resistance is decided by the difference of height H or the difference of height H', the diameter of gas outlets 17A and 17B, the diameter and length of the piping of gas drainage 30 channels 80A and 80B.

Where, a ratio $Q2/Q1$ of the discharge amount $Q2$ from the gas outlets 17A and 17B to the feed amount $Q1$ to inside the coating die 10, is preferably 0.5 to 0.95, more preferably 0.7 to 0.9. If it is more than this range, the discharging aperture 15 is apt to suction gas from outside, and if it is less than this range, an amount of the coating liquid 2 to be fed for discharging the gas 100 becomes large, to thereby make it impossible to efficiently discharge the gas 100. Furthermore, it is preferable to make the gas drainage channels 80A and 80B, so that it has an inner diameter in which the gas 100 does not stagnate in the piping. In order to make the ratio $Q2/Q1$ into a preferable range, and to prevent stagnation of the gas 100 in the piping, preferably, the difference of height H or the difference of height H' is set to 800 mm or less, an inner diameter of the gas outlets 17A and 17B is set to 10 mm or less, and an inner diameter of piping of the gas drainage channels 80A and 80B is set to 10 mm or less. Furthermore, more preferably, the difference of height H or the difference of height H' is set to 500 mm or less, an inner diameter of the gas outlets 17A and 17B is set to 6 mm or less, and an inner diameter of piping the gas drainage channels 80A and 80B is set to 6 mm or less.

By the way, the micro bubbles 101 of less than 1 mm diameter inside the coating die 10 cannot be easily discharged from the gas outlets 17A and 17B. In order to remove these micro bubbles 101, a large amount of gas is fed to the manifold 13 inside the coating die 10, to thereby unite the micro bubbles 101 to the gas. When this large volume gas is discharged outside by the above-mentioned method, as a result, the micro bubbles 101 are removed.

For this purpose, to the die coater 1 of this embodiment, as shown in Fig. 4, at a position downstream of the open/shut-valve for discharge 81A connected to the gas drainage channel 80A, the

gas feed channel 91 for feeding gas to inside the coating die 10 is connected. This gas feed channel 91 has the open/shut-valve for gas feed 92 and the inlet 93 of the gas feed channel 91 which is open to the atmosphere at an upstream side of the open/shut-valve for gas feed 92. In this gas feed channel 91, the open/shut-valve for gas feed 92 and the inlet 93 function as gas feed means. When the open/shut-valve for gas feed 92 is made "open", it becomes possible to feed an atmospheric gas inside the coating die 10 from the inlet 93. Where, it is preferable that at least a portion of the gas feed channel 91 is located at the position being higher than the gas drainage channel 80A, so that the coating liquid 2 of the gas drainage channel 80A does not run back when the open/shut-valve for gas feed 92 is opened.

Furthermore, in addition to the atmospheric gas feed from the inlet 93, a gas pressured by a pump or a compressed air source may also be fed from the inlet 93. In case where the pressurized gas is fed, if the gas feed rate is too high, it is feared that the gas arrived inside the coating die 10 and the coating liquid 2 are mixed and causes a foaming, to generate the micro bubbles 101, on the contrary. In such a case, it is preferable to provide a flow control valve or the like to the gas feed channel 91, to thereby enable it to slowly feed the gas. Here, in case where a gas pressurized by a pump or a compressed air source is fed, an arrangement of the gas feed channel 91 is not limited. As a material of the piping used for the gas feed channel 91, any of metals or synthetic resins may be used, but synthetic resins are preferable in view of handling property.

Furthermore, in this embodiment, the gas feed channel 91 is connected to the gas drainage channel 80A which is connected to the gas outlet 17A, but it may also be connected to the gas drainage

channel 80B which is connected to the gas outlets 17B at the end of the manifold 13 or to the feed channel to die 66 which is connected to the feed port 16 of the coating die 10. That is, the gas feed channel 91 may be connected to any position as far as it can feed
5 gas to inside the manifold 13. Other than the feed port 16 or the gas outlets 17A and 17B, a hole connected to the manifold 13 may be provided to the front lip 11 or the rear lip 12, and the gas feed channel 91 may also be connected to these holes. Furthermore, a plural of the gas feed channel 91 may also be connected to portions
10 capable of feeding gas to the coating die 10.

Here, all of the movable portions of the die coater 1, such as the open/shut-valves for discharge 81A and 81B which is opened or closed when the gas 100 is discharged, the open/shut-valve for gas feed 92 which is opened or closed when the micro bubbles 101
15 are removed, the linear motor 33, the motor 43, the coating liquid feeding device unit 60 including the syringe pump motor 71 which drives the piston 68 of the syringe pump 64, are operated by control signals of the controller 95. And, predetermined operations are done by transmitting control command signals to each apparatus
20 according to automatic operation programs installed in the controller 95. Furthermore, in case where it is necessary to change each operation condition, by inputting parameters for changes to the control panel 96 as required, they are transmitted to the controller 95, to thereby make it possible to change operations.

25 Next, an example of discharging gas inside the coating die 10 by using the die coater 1 is explained. First, with reference to Figs. 4 and 5, a discharge method of the gas 100 before the coating/production in which the gas 100 is discharged from a state in which entirely no coating liquid 2 is present and only gas is
30 filled inside the coating die 10, and then the coating liquid 2

is filled, is explained. First, in Fig. 4, the coating liquid 2 is filled from the coating liquid tank 61 to inside of the syringe 67. Next, in a state in which all of the open/shut-valves for discharge 81A and 81B and the open/shut-valve for gas feed 92 are made "close", the piston 68 of the syringe pump 64 is lifted, to thereby carry away the coating liquid 2 filled inside the syringe 67 toward the coating die 10. By this way, as shown in Fig. 5 (a), the coating liquid 2 is sent from the feed port 16 to the manifold 13. When the feed of the coating liquid 2 by the syringe pump 64 is continued, as shown in Fig. 5 (b), the coating liquid 2 is distributed in the coating width direction of the manifold 13 and the slot 14, and a part of the coating liquid 2 is dispensed from the discharging aperture 15 through the slot 14. When the feed of the coating liquid 2 by the syringe pump 64 is continued further, as shown in Fig. 5 (c), the coating liquid 2 is filled in all region of the slot 14 to be dispensed from the discharging aperture 15, but since the gas 100 is confined in upper side of both ends of longitudinal direction of the manifold 13, the gas 100 cannot be discharged from the discharging aperture 15. At this time, only when the coating liquid 2 is fed from the syringe pump 64, the open/shut-valves for discharge 81A and 81B is made "open", while the open/shut-valve for gas feed 92 is kept "closed". By this way, in the manifold 13, a flow of the coating liquid 2 from the feed port 16 to the gas outlets 17A and 17B is generated. By this flow, it is possible to discharge the gas 100 confined inside the coating die 10 can be discharged with the coating liquid 2 from the gas outlets 17A and 17B. When this gas discharge operation is repeated until the gas 100 inside the coating die 10 is completely discharged, as shown in Fig. 5 (d), only the coating liquid 2 is filled inside the coating die 10, to thereby complete the coating liquid feed

operation to the coating die 10. Such a discharge operation before the coating/production may be completed during one cycle of feed operation of the coating liquid 2 from the syringe pump 64 to the coating die 10, but may be completed by repeating plural times during
5 repeated feed operations of the coating liquid 2.

Next, with reference to Figs. 4 and 6, a gas discharge method during the coating/production, which is done when the gas 100 intrudes inside the coating die 10 filled with the coating liquid 2, is explained.

10 First, as shown in Fig. 6 (a), the gas 100 which intrudes inside the coating die 10 during the coating/production stays in upper portions of the manifold 13 or the feed port 16.

In order to discharge this gas 100, while keeping the open/shut-valve for gas feed 92 in the state of "closed", only when
15 the coating liquid 2 is fed from the syringe pump 64, the open/shut-valves for discharge 81A and 81B is made "open". By this way, in the manifold 13, a flow of the coating liquid 2 is generated from the feed port 16 toward the gas outlets 17A and 17B. The upper side 20 of the manifold 13 is parallel to the discharging aperture
20 surface 21 or, slopes upward from the feed port 16 to the gas outlets 17B relatively to the discharging aperture surface 21 as a base. Accordingly, a move of the gas 100 toward the gas outlets 17B is not prevented by the upper side 20 of the manifold 13. Furthermore, cross-sectional area of the manifold 13 in the coating width direction
25 decreases from the feed port 16 to the gas outlets 17B and, since S_a (manifold cross-sectional area of feed port portion) $>$ S_b (manifold cross-sectional area of gas outlet portion), the velocity of the flow of the coating liquid 2 toward the gas outlets 17B is also high. Therefore, as shown in Fig. 6 (b), all of the gas 100 stayed
30 inside the coating die 10, gathers quickly around the gas outlet

17A above the feed port 16 and around the gas outlets 17B at both ends of the manifold 13. Where, a gas discharge operation is repeated in which, in a state of the open/shut-valve for gas feed 92 is made "closed", only when the coating liquid 2 is fed to the coating die 10 from the syringe pump 64, the open/shut-valves for discharge 81A and 81B is made "open". As a result, as shown in Fig. 6 (c), the gas 100 is completely discharged from inside the coating die 10, only the coating liquid 2 is filled in the passages such as the manifold 13, and the discharge operation of the gas 100 intruded inside the coating die 10 is completed. Such a discharge operation during the coating/production may be done only one times, and may also be done repeatedly.

By the way, as shown in Fig. 7 (a), there are cases in which the micro bubbles 101 of less than 1 mm diameter intrude inside the coating die 10 filled with the coating liquid 2. Since these micro bubbles 101 are very small, buoyancy acts to the micro bubbles 101 is small. Furthermore, when they deposited to the wall of the manifold 13, they are difficult to be moved only by the flow of the fed coating liquid 2. Accordingly, there are cases in which the micro bubbles 101 cannot be discharged by the above-mentioned gas discharge method during the coating/production. A discharge method during the coating/production for discharging the micro bubbles 101, is explained hereunder with reference to Figs. 4 and 7.

First, the feed of the coating liquid 2 from the syringe pump 64 to the coating die 10 is stopped, and all of the open/shut-valve for gas feed 92 and the open/shut-valves for discharge 81A and 81B are made "open". By this operation, the coating liquid 2 is discharged from the discharging aperture 15 and the gas outlets 17A and 17B, and in response to the discharge amount of the coating

liquid 2, as shown in Fig. 7 (b), the fed gas 102 is fed to the feed port 16 and the manifold 13 through the gas feed channel 91, the gas drainage channel 80A, and the gas outlet 17A. By replacing the coating liquid 2 in the manifold 13 with the fed gas 102, a
5 space formed by the fed gas 102 is expanded from the gas outlet 17A to the coating width direction and is formed in the upper portion of the manifold 13.

Where, the space of the fed gas 102 is formed to the position where the micro bubbles 101 are present, as shown in Fig. 7 (c),
10 since the micro bubbles 101 are united or absorbed into the space of the fed gas 102, the micro bubbles 101 are removed. As shown in Fig. 7 (d), when the space of the fed gas 102 is formed in the upper portion in the longitudinal direction at least throughout the whole width of the manifold 13, all of the open/shut-valve for
15 gas feed 92, and the open/shut-valves for discharge 81A and 81B are made "closed" to stop the feed of the fed gas 102. After that, when the above-mentioned ordinary gas discharge operation during the coating/production is carried out, all of the fed gas 102 inside the coating die 10 is discharged, and only the coating liquid 2
20 is filled inside the coating die 10. As a result, the micro bubbles 101 which were present at first are discharged outside. In the above embodiment, in order to quickly feed the fed gas 102 to the manifold 13, all of the open/shut-valve for gas feed 92 and the open/shut-valves for discharge 81A and 81B are made "open". However, it is also
25 possible to feed the fed gas 102 to the manifold 13, by making the open/shut-valve for gas feed 92 and the open/shut-valve for discharge 81A "open", while the open/shut-valve for discharge 81B of the gas drainage channel 80B to which the gas feed channel 91 is not connected is kept "closed".

30 By any of the above gas discharge methods, it is preferable

that the open/shut operation of the open/shut-valves for discharge 81A and 81B is done only during the feeding of the coating liquid 2 by the syringe pump 64, to prevent a suction from the discharging aperture 15 or a running back from the gas outlets 17A and 17B of the gas 100. For that purpose, it is necessary to stop the feed by the syringe pump 64, always after the open/shut-valves for discharge 81A and 81B are made "closed". Furthermore, in the above embodiment, all of the open/shut-valves for discharge 81A and 81B are made "open" simultaneously, but each of them may be operated independently, or they may be operated according to a predetermined combination pattern, and any of them is allowed. In these cases, there is especially no limitation in the order of the open/shut operations, but it is preferable that the open/shut-valve for discharge 81A connected to the feed port 16 is made "open" first, to efficiently discharge the gas 100 stayed around the feed port 16, without letting flow it into the manifold 13. In the above embodiment, in order to discharge the gas 100, the micro bubbles 101, the fed gas 102 and the coating liquid 2 inside the coating die 10 from the gas outlets 17A and 17B, the syringe pump 64 is used as a feed means of the coating liquid 2. However, feed means is not limited to thereto, and the coating liquid 2 may be fed by pressurizing the coating liquid tank 61, or the coating liquid 2 may be fed by a separate pump which is publicly known.

Here, in the above gas discharge method, the gas 100, the micro bubbles 101, the fed gas 102 and the coating liquid 2 discharged from inside the coating die 10, is discharged to the waste tanks 82A and 82B through the gas drainage channels 80A and 80B, and the coating liquid 2 is stored as the waste liquid 83. Where, as shown in Fig. 4, when it is detected that the liquid level 89 of the waste liquid 83 becomes higher than Q4 by the higher side sensors 87A

and 87B provided to the waste tanks 82A and 82B, the vacuum pumps 86A and 86B are operated. And, the open/shut-valves for drainage 85A and 85B is made "open", and the waste liquid 83 is suctioned from the drainage channels 84A and 84B by the vacuum pumps 86A and 86B, to thereby discharge the waste liquid 83 into an unshown drainage channel. After that, when it is detected that liquid level 89 of the waste liquid 83 becomes lower than Q3 by the lower side sensors 88A and 88B, the discharge operation of the waste liquid 83 is stopped by making the open/shut-valves for drainage 85A and 85B "closed" and stop the vacuum pumps 86A and 86B.

Where, there are cases in which the discharge amount of the coating liquid 2 from the gas outlets 17A and 17B varies and the gas discharge amount becomes uncontrollable, when the vacuum pumps 86A and 86B are operated during the gas discharge operation from the coating die 10. Accordingly, it is preferable that the vacuum pumps 86A and 86B are operated when the gas discharge operation is not carried out, that is, when the open/shut-valves for discharge 81A and 81B are made "closed".

In the above description, an example in which a method for removing the micro bubbles 101 by the fed gas 102 is applied in combination with a method of discharging the gas 100 by using the flowing power of the coating liquid 2, is explained. However, regarding discharging method of the gas 100 combined with the removing method of the micro bubbles 101 by the fed gas 102, a suction method in which a mechanical suction means such as a pump is connected to the gas drainage channels 80A and 80B, a method of discharging the gas 100 by a buoyancy by providing the gas outlets 17A and 17B to the upper surface of the coating die 10 and using the internal gas drainage channels 19A and 19B as vertically extending channels, or the like may also be applied.

Next, an example of coating method in which the substrate 3 is coated by the die coater 1 provided with the coating die 10 of the present invention, is explained.

First, after carrying out returning each movable portion
5 provided to the die coater 1 to the starting point, the each movable portion moves to a predetermined standby position. By this time, parameters for realizing an aimed coating condition have been inputted in the control panel 96. Furthermore, discharging the gas 100 inside the coating die 10 and filling the coating liquid 2 has
10 been completed by the above-mentioned gas discharging method before the coating/production. From the coating liquid tank 61 to the inside the coating die 10, coating liquid 2 has already been filled. At this time, all of the open/shut-valves for discharge 81A and 81B and the open/shut-valve for gas feed 92 are kept "closed" and the
15 wiping unit 50 is located apart from the coating die 10.

At the time of completing the above preparations, the wiping unit 50 is moved just under the coating die 10. Subsequently, to the surface of the stage 32 a plural of unshown lift pin is lifted, and the substrate 3 is loaded on upper portion of the lift pin from
20 an unshown loader. And the lift pin is gone down, the substrate 3 is put on the surface of the stage 32, the position of the substrate 3 is adjusted by an unshown centering device, and the substrate 3 is vacuumed and held by a plural of unshown vacuum holes. In parallel to this, the coating liquid feeding device unit 60 is operated and
25 a small amount of the coating liquid 2 is dispensed from the coating die 10 to the tray 54. Then, the coating die 10 is gone down by the lifting device units 40, while contacting the lowermost portion of the coating die 10 with the wiping head 51, the wiping head 51 is moved on longitudinal direction of the coating die 10. When
30 vicinity of the discharging aperture surface 21 of the coating die

10 is cleaned by wiping of the wiping head 51, the coating die 10 is lifted by the lifting device units 40, and the wiping unit 50 is returned to its home position of coating direction apart from beneath the coating die 10.

5 Next, the stage 32 which vacuum holds the substrate 3 starts to move, and the thickness of the substrate 3 is measured by an unshown sensor. And then, the start-of-coating line of the substrate 3 moves to just beneath the discharging aperture surface 21 of the coating die 10 and the stage 32 stops. Then, by taking account of
10 the thickness of the substrate 3 measured by the unshown sensor, the coating die 10 is gone down by the lifting device units 40 so that the clearance, which is the distance from the discharging aperture surface 21 of the coating die 10 to the surface of the substrate 3, becomes a predetermined value.

15 When going down of the coating die 10 is finished, coating liquid feeding device unit 60 is moved, and the coating liquid 2 filled inside the syringe 67 is extruded by the piston 68 a little bit. By this way, the bead 97 of the coating liquid 2 can be formed between the discharging aperture 15 of the coating die 10 and the
20 substrate 3. After a specified time from forming the bead 97, the stage 32 which vacuum holds the substrate 3 is moved in a constant speed by the linear motor 33, and further, when the coating liquid 2 is continuously dispensed from the discharging aperture 15 to the moving surface of the substrate 3, a coated film is formed on
25 the substrate 3.

 After that, when an end-of-coating portion of the substrate 3 comes to the position of the discharging aperture 15 of the coating die 10, the piston 68 is stopped and the feed of the coating liquid 2 is stopped, and then the coating die 10 is lifted by operating
30 the lifting device units 40. By this operation, the bead 97 formed

between the substrate 3 and the coating die 10 is completely disconnected and the coating is finished. After that, the stage 32 continues to move and stops at a position for carrying out the substrate 3. In parallel to this, the coating die 10 is returned
5 to its home position in vertical direction. And then, the vacuum to the substrate 3 on the stage 32 is released and by elevating the unshown lift pin, the substrate 3 is lifted. At this time, unshown unloader holds the substrate 3 and carry out the substrate 3 to a next step. Subsequently, the stage 32 is returned to its home
10 position, and the piston 68 of the syringe pump 64 goes down, to thereby fill inside the syringe 67 with a new coating liquid 2. After that, the wiping unit 50 is moved under the coating die 10, and waits for loading of next substrate 3, and after this, the same operation is repeated.

15 Where, during coating operation, gas may intrude inside the coating die 10 by such as (1) intrusion of gas from coating liquid feeding device unit 60, (2) foaming of gas dissolved in the coating liquid 2, (3) suction of gas by open/shut operation of the open/shut-valve for suction 63 or the open/shut-valve for extrusion
20 65, (4) suction of gas from the discharging aperture 15 of the coating die 10. When gas intrudes in the coating die 10, a delay of starting of discharging pressure at start of coating may occur, and a coating thickness at start of coating becomes thin to worsen thickness uniformity in coating direction, or by extrusion of gas from the
25 discharging aperture 15 to the substrate 3, coating defect such as pinholes or longitudinal streaks may generate. Where, by using the above-mentioned gas discharging method during the coating/production, and by repeating the gas discharge operation only by the predetermined conditions, the gas 100 is completely
30 discharged, and when a coating to the substrate 3 is started again,

it is possible to completely avoid a thinning of film at start of coating or generating a coating defect.

However, there is a case in this gas discharge method in the coating/production, in which the thinning at start of coating or
5 generating of coating defect cannot be avoided. That is a case in which the micro bubbles 101 intrudes inside the coating die 10. In this case, by carrying out the micro bubble discharge operation in the above-mentioned coating/production, the micro bubbles 101 inside the coating die 10 can be discharged, and the thinning at
10 start of coating or generation of coating defect can completely be avoided. In addition, these gas discharge operation may be carried out when coating thickness becomes unstable or when a coating defect is generated, and may be carried out in every coating operation to a specified number of the substrate 3, and furthermore, before
15 re-starting the coating operation after temporarily stopping the coating operation for some reasons.

Where, as a viscosity of the coating liquid 2 to which the present invention is applicable, it is preferably 1 to 1000 mPa·s, more preferably 1 to 50 mPa·s. It is preferable that the coating
20 liquid 2 is a Newtonian liquid in view of coatability, but it may also have thixotropy. The present invention is especially effective, when a coating liquid in which, as a solvent, those having a high volatility, for example, propylene glycol mono methyl ether acetate (PGMEA), butyl acetate, ethyl lactate, or the like are used, is
25 coated. As examples of the coating liquid 2 which can actually be applicable, an RGB resist and a black matrix resist for color filter, a resist for photo spacer, a posi-resist for array substrate, an overcoat material or the like, are mentioned. In addition, as a member to be coated which is the substrate 3, other than a glass,
30 metallic sheets such as aluminum sheet, a ceramic sheet, silicone

wafer or the like may be used. Furthermore, when the gas discharge operation during the coating/production is carried out in every predetermined number of coatings, it is carried out preferably in every 5 to 100 substrates, more preferably in every 15 to 50 substrates.

5 Regarding the micro bubble discharge operation during the coating/production, too, when it is carried out in every predetermined number of coatings, it is carried out, preferably in every 50 to 5000 substrates, more preferably in every 100 to 1000 substrates. And, in the micro bubble discharge operation, as
10 an amount of gas to be fed inside the coating die 10 and a feed time, any amount of gas and any time may be applied as far as a space can be formed with the fed gas 102 at least in the upper portion of the manifold 13, in order to surely remove the micro bubbles 101 stayed in the manifold 13.

15

[EXAMPLE]

Hereunder, the present invention is explained in detail with reference to Examples.

20 Example 1

A color filter is manufactured by using the die coater shown in Figs. 1 and 4 as it is. Here, as a coating die, of which discharging aperture gap is 100 μm , length of longitudinal direction is 1300 mm, coating width is 1100 mm, [central land length $H_a = 40 \text{ mm}$] >
25 [end land length $H_b = 38 \text{ mm}$], which is provided with 4 mm diameter gas outlets at three points of above the feed port and at both ends of the manifold, and the upper side of manifold is parallel to the discharging aperture surface, S_a (manifold cross-sectional area of feed port portion) = 34 mm^2 , S_b (manifold cross-sectional area
30 of gas outlet portion at both ends) = 8.5 mm^2 and S_b (manifold

cross-sectional area of gas outlet portion)/ S_a (manifold cross-sectional area of feed port portion) = $1/4$, was used. And, as each gas drainage channel connected to the coating die, a Teflon (trademark) tube of inner diameter 4 mm was used and horizontally
5 connected to each gas outlet of the coating die, and it was set up so that a horizontal portion of each gas drainage channel downstream of the connected portion passes a position being 20 mm lower than the center of each outlet. Furthermore, each gas drainage channel was arranged so that its outlet was positioned 450 mm lower than
10 the coating die's discharging aperture to immerse the outlet of each gas drainage channel into a waste liquid stored in each of the waste tanks which were open to the atmosphere. Where, as to a difference of height H between the liquid level of the waste liquid in each of the waste tanks and the coating die's discharging aperture,
15 the waste tanks were located so that the liquid level of the waste liquid stored in each of the waste tanks was 400 mm lower than the coating die's discharging aperture. And, the open/shut-valve for discharge was provided at a position being 50 mm apart from each gas outlet. As the gas feed channel having the open/shut-valve for
20 gas feed, Teflon (trademark) piping of inner diameter 6 mm was used to connect the position between the outlet of gas drainage channel connected to the gas outlet of feed port portion and the open/shut-valves for discharge, and the inlet of gas feed channel was opened to the atmosphere to set up it at a position being higher
25 than the coating die's discharging aperture. Furthermore, as the coating liquid, each color liquid of black matrix, R color, G color and B color was prepared. As coating liquid for the black matrix, carbon black as light-shielding material, acrylic resin as binder, propylene glycol mono methyl ether acetate (PGMEA) as solvent were
30 used respectively and adjusted to a solid content to 10% and a

viscosity to 10 mPa·s. Similarly, as R color coating liquid, acrylic resin as binder , PGMEA as solvent , Pigment Red 177 as pigment were used, and adjusted a solid content to 15% and a viscosity to 5 mPa·s. As G color coating liquid, the pigment of the R color coating liquid was replaced with Pigment Green 36, and adjusted a solid content to 15% and a viscosity to 5 mPa·s. As a coating liquid for B color, the pigment of the coating liquid for R color was replaced with Pigment Blue 15, and adjusted a solid content to 15% and a viscosity to 5 mPa·s. All of these coating liquids have photosensitive characteristics.

First, in order to coat the coating liquid for the black matrix, the coating liquid tank was filled with the coating liquid, and a filling operation of the coating liquid to inside of the coating die was carried out. At this stage, in order to carry out gas discharge operation before coating/production, feeding conditions of a syringe pump are, a feeding speed 5000 μ l/sec, an amount to be fed 40000 μ l and feeding time 8 sec. Under this feeding condition, by repeating a gas discharge operation cycle, in which all of the open/shut-valves for discharge were made "open" 1 second after starting the pump feed and were made "closed" 7 second after starting the pump feed, three times, the gas inside the coating die was completely discharged. During this gas discharge operation, the open/shut-valve for gas feed was always kept in "closed" condition.

After the above coating liquid feed operation, on a non-alkali glass substrate of 1100 × 1300 mm and 0.7 mm thickness, a coated film of 10 μ m thickness was coated at a clearance which is the distance between the coating die and the substrate of 100 μ m and coating speed of 3 m/min. Where, 300 sheets of the substrate were coated. During the coating operation, in order to prevent a deterioration of film thickness precision or a generation of coating defect caused

by gas such as gas intrusion from feed system, foaming of gas dissolved in the coating liquid or suction of gas from the coating die's discharging aperture, as a gas discharge operation during coating/production, under conditions of feed speed of 5000 $\mu\text{l}/\text{sec}$,
5 feed amount of 40000 μl and feed time of 8 sec, a gas discharge operation cycle in which all of the open/shut-valve for discharge were made "open" 1 second after the start of feed and were made "closed" 7 second after the start of feed was carried out in every 20 substrates coating. During this gas discharge operation cycle,
10 too, the open/shut-valve for gas feed was always kept in condition of "closed". Furthermore, in order to discharge micro bubbles which are impossible to discharge by the above gas discharge operation, the coating/production is once stopped in every 100 substrates coating, and as the micro bubble discharge operation, all of the
15 open/shut-valve for gas feed and the open/shut-valves for discharge were kept "open" for 30 seconds to feed gas inside the coating die and after removing the micro bubbles, the gas discharge operation before the coating/production was carried out.

The coated substrate was dried by a hot plate heated to 100°C
20 for 10 minutes and after being subjected to an exposure·development·stripping, cured by a hot plate of 260°C for 30 minutes to obtain a black matrix pattern of 1 μm thickness.

Next, in the same condition as the coating liquid for the black matrix except for making a thickness of the coated film to 13 μm ,
25 the R color coating liquid was continuously coated to the 100 substrates on which the black matrix was formed. The coated substrates were dried on a hot plate heated to 90°C for 10 minutes, and after being subjected to an exposure·development·stripping, to thereby leave R color coated film of 2 μm thickness only in the red
30 pixel regions, it was subjected to a curing on a hot plate of 260°C

for 30 minutes.

Next, in the same condition as the coating liquid for the R color except for making a thickness of the coated film to 20 μm , the G color coating liquid was continuously coated to the 100
5 substrates on which the black matrix and red pixel regions were formed. The coated substrates were dried on a hot plate heated to 100°C for 10 minutes, and after being subjected to an exposure·development·stripping to thereby leave G color coated film of 2 μm thickness only in the green pixel regions, it was subjected to a
10 curing on a hot plate of 260°C for 30 minutes.

Furthermore, in the same conditions as the G color coating liquid, B color coating liquid was continuously coated to the 100 substrates on which the black matrix, the red pixel regions and the green pixel regions were formed. The coated substrates were
15 also subjected to drying and exposure·development·stripping in exactly the same conditions as the G color coating liquid, to thereby leave B color coated film of 2 μm thickness only in the blue pixel regions. Here, in the coating of each color coating liquid, according to measurement of the coating thickness in condition after drying
20 and before pattern forming, except 10 mm edge portion, for all the coated substrates, both in the coating direction and in the coating width direction, it was within an aimed film thickness precision of $\pm 3\%$ or less. In parallel, though coating unevenness was inspected, quality of the coating film was very good for all the coated
25 substrates. Coating defects caused by gas, such as pinholes or longitudinal streaks generated by discharging gas inside the coating die from the discharging aperture to the member to be coated were entirely not observed.

And finally, an ITO was deposited by sputtering to thereby
30 prepare 300 sheets of color filters. All of the obtained color

filters not only satisfy film thickness precision, but also there is no coating defect and are perfect in quality. And, producing efficiency was very high since the gas discharging operation before or during the coating/producing could be done quickly.

5

Comparative example 1

Color filters were produced under the same condition as Example 1, except that each outlet of gas drainage channel was located 50 mm higher than the coating die's discharging aperture, and the waste tanks were located such that the liquid level of the waste liquid stored in each of the waste tanks in which each outlet of gas drainage channel was immersed was 200 mm higher than the coating die's discharging aperture. As a result, in any of the gas discharging operations during the coating liquid feed operation and during the coating/production, a flow rate of the coating liquid discharged from the each gas outlet decreased and, the gas inside the coating die became unable to be discharged from the each gas outlet in a short time. This is because the liquid pressure generated from a difference of height between the liquid level of the waste liquid of the waste tank and the coating die's discharging aperture surface worked as resistance. As a result, not only the gas discharge operation time increased and the production efficiency significantly decreased, but also the gas remained in inside the coating die. Due to decrease of film thickness precision in coating direction and coating defects or the like, 60 defective products in 300 sheets were produced and color filters in good quality could not be obtained.

In addition, after finalizing coating of 300 substrates, in order to seek a condition by which no micro bubbles remain in inside the coating die, a feed condition in which the micro bubbles can completely be discharged was searched. As a result, it was found

that a gas discharge operation cycle in which, under a condition of feed rate 5000 $\mu\text{l}/\text{sec}$, amount of feed 100000 μl and feed time 20 sec, 1 second after starting the feed, all of the open/shut-valves for discharge connected to the feed port and both ends were made
5 "open" and 19 second after, all of them were made "closed", was necessary 4 times at the coating liquid feed operation, and 2 times at the coating/production. By this fact, it was found that both of the time required for the gas discharge and the amount of feed increase, to thereby decrease gas discharge efficiency. This is
10 because the liquid level of the waste liquid stored in each of the waste tanks is located at the position being 200 mm higher than the coating die's discharging aperture.

Comparative example 2

15 Color filters were made in the same condition as Example 1 except that each gas drainage channel was located at the position being 100 mm higher than the center of each gas outlet. As a result, in any of the gas discharging operations during coating liquid feed operation and during the coating/production, a flow rate of the
20 coating liquid discharged from the each gas outlet decreased and, the gas inside the coating die became unable to be discharged from the each gas outlet in a short time. This is because the liquid pressure generated from a difference of height between the each gas drainage channel and the gas outlet worked as resistance. Thereby,
25 not only the gas discharge operation time increased and the production efficiency significantly decreased, but also the gas remained in inside the coating die. Due to decrease of film thickness precision in coating direction and coating defects or the like, 28 defective products in 300 sheets were produced and color filters in good quality
30 could not be obtained.

In addition, after finalizing coating of 300 substrates, in order to seek a condition by which no gas remains in inside the coating die, a feed condition in which the gas can completely be discharged was searched. As a result, it was found that a gas
5 discharge operation cycle in which, under a condition of feed rate 5000 $\mu\text{l}/\text{sec}$, amount of feed 70000 μl and feed time 14 sec, 1 second after starting the feed, all of the open/shut-valves for discharge connected to the feed port and both ends were made "open" and 13 second after, all of them were made "closed", was necessary 3 times
10 at the coating liquid feed operation, and 2 times at the coating/production. By this fact, it was found that both of the time required for the gas discharge and the amount of feed increased compared to Example 1, to thereby decrease gas discharge efficiency. This is because the gas drainage channels passes through the positions
15 being 100 mm higher than the gas outlets.

Comparative example 3

Color filters were produced under quite the same condition as Example 1, except that the gas feed channel and the open/shut-valve
20 for gas feed were not provided and the micro bubble discharge operation in every 100 sheets was not carried out. As a result, the film thickness precision was $\pm 3\%$ or less, which was aimed, in both of coating direction and the coating width direction. However, because micro bubbles in inside the coating die were not sufficiently
25 discharged, coating defects were generated and 8 products in 300 sheets were defective products, and color filters in good quality could not be obtained.

In addition, after finalizing coating of 300 substrates, in order to seek a condition by which no micro bubbles remain in inside
30 the coating die, a feed condition in which the micro bubbles can

completely be discharged was searched, but it was found that in any condition, the micro bubbles could not be discharged.

Comparative example 4

5 Color filters were produced in the same condition as Example 1, except setting S_a (manifold cross-sectional area of feed port portion) = 34 mm^2 , S_b (manifold cross-sectional area of gas outlet portion) = 51 mm^2 and S_b (manifold cross-sectional area of gas outlet portion)/ S_a (manifold cross-sectional area of feed port portion) = 3/2. As a result, in any of the gas discharge operations before the coating/production and during the coating/production, the velocity of the flow in the manifold of the coating liquid toward the gas outlets at both ends decreased and, the gas inside the coating die became unable to be discharged from the gas outlets of both ends in a short time. Thereby, the gas was left inside the coating die, and due to decrease of film thickness precision in coating direction and coating defects or the like, 72 defective products in 300 sheets were produced and color filters in good quality could not be obtained.

20 In addition, after finalizing coating of 300 substrates, in order to seek a condition by which no gas remains in inside the coating die, a feed condition in which the gas can completely be discharged was searched. As a result, it was found that a gas discharge operation cycle in which, under a condition of feed rate 25 5000 $\mu\text{l}/\text{sec}$, amount of feed 70000 μl and feed time 14 sec, 1 second after starting the feed, all of the open/shut-valves for discharge connected to the feed port and both ends were made "open" and 13 second after starting the feed, all of them were made "closed", was necessary 3 times before the coating/production, and 2 times 30 during the coating/production. By this fact, it was found that,

only by fixing S_b (manifold cross-sectional area of gas outlet portion)/ S_a (manifold cross-sectional area of feed port portion) = $3/2$, compared to Example 1, both of the time required for the gas discharge and the amount of feed increased, to thereby decrease
5 gas discharge efficiency.

Comparative example 5

Color filters were produced under the same condition as Example 1, except that the upper side of the manifold slopes downward by
10 2° , relatively to the discharging aperture surface, from the feed port to the gas outlets of both ends. As a result, in any of the gas discharge operations before the coating/production and during the coating/production, the moving of the gas to be moved toward the gas outlets at both ends is prevented by the upper side of the
15 manifold, and the gas in inside the coating die became unable to be discharged from the gas outlets in a short time. Thereby, the gas was left inside the coating die, and due to decrease of film thickness precision in coating direction and coating defects or the like, 60 defective products in 300 sheets were produced and
20 color filters in good quality could not be obtained.

In addition, after finalizing coating of 300 substrates, in order to seek a condition by which no gas remains in inside the coating die, a feed condition in which the gas can completely be discharged was searched. As a result, it was found that a gas
25 discharge operation cycle in which, under a condition of feed rate 5000 $\mu\text{l}/\text{sec}$, amount of feed 70000 μl and feed time 14 sec, 1 second after starting the feed, all of the open/shut-valves for discharge connected to the feed port and both ends were made "open" and 13 second after, all of them were made "closed", was necessary 3 times
30 before the coating/production, and 2 times during the

coating/production. By this fact, it was found that, only by declining the upper side of the manifold downward by 2°, from the feedport to the gas outlets of both ends relatively to the discharging aperture surface as a base, both of the time required for the gas discharge and the amount of feed increased compared to Example 1, to thereby decrease gas discharge efficiency.

Comparative example 6

Color filters were produced under the same condition as Example 1, except that the upper side of the manifold slopes downward by 2°, from the feed port to the gas outlets of both ends relatively to the discharging aperture surface as a base and setting S_b (manifold cross-sectional area of gas outlet portion) / S_a (manifold cross-sectional area of feed port portion) = 3/2. As a result, in any of the gas discharging operations before the coating/production and during the coating/discharging, in addition to decreasing the velocity of the flow of the coating liquid toward the gas outlets of both ends, since the upper side of the manifold prevents the moving of the gas to move toward the gas outlets at both ends, the gas inside the coating die became unable to be discharged from the gas outlets in a short time. Thereby, the gas was left inside the coating die, and due to decrease of film thickness precision in coating direction and coating defects or the like, 122 defective products in 300 sheets were produced and color filters in good quality could not be obtained.

In addition, after finalizing coating of 300 substrates, in order to seek a condition by which no gas remains in inside the coating die, a feed condition in which the gas can completely be discharged was searched. As a result, it was found that a gas discharge operation cycle in which, under a condition of feed rate

5000 μ l/sec, amount of feed 100000 μ l and feed time 20 sec, 1 second after starting the feed, all of the open/shut-valves for discharge connected to the feed port and both ends were made "open" and 19 second after, all of them were made "closed", was necessary 4 times
5 before the coating/production, and 3 times during the coating/production. By this fact, it was found that, by declining the upper side of the manifold downward by 2°, from the feed port to the gas outlets at both ends relatively to the discharging aperture surface as a base, and by fixing the manifold cross-sectional area
10 of gas outlet portion Sb/manifold cross-sectional area of feed port portion Sa = 3/2, both of the time required for the gas discharge and the amount of feed increased compared to Example 1, to thereby decrease gas discharge efficiency.

15 Comparative example 7

Color filters were produced under the same condition as Example 1, except setting "central land length Ha = 40 mm" = "end land length Hb = 40 mm". As a result, since there was no problem in the gas discharge operations before the coating/production and during the
20 coating/production, there was no coating defect. However, by setting "central land length Ha = end land length Hb", a pressure drop at both ends of slot increased and outputs from both ends decreased. As a result, the film thickness precision in the coating width direction exceeded the aimed $\pm 3\%$, to thereby make all sheets
25 defective, and color filters of good quality could not be obtained.

[Industrial Applicability]

According to the present invention, since a gas in any state intruded inside the coating die, can be discharged with a small
30 amount of feed and in a short time, it becomes possible to form

a coated film of which tact time is short, productivity is high and of a high quality.

According to the present invention, the gas discharging ability of the die coater is improved, and without spoiling advantages of the die coater, a coating method and a coating apparatus capable
5 of forming a coated film having a high film thickness precision and no coating defect, and a manufacturing method of the components for displays and a manufacturing apparatus thereof, are provided.

The present invention is suitable for forming a coating film
10 on a member to be coated, and especially, it is preferably used in a manufacturing field for, especially, color filters and array substrates for color liquid crystal displays, plasma display panels, optical filters or the like.

CLAIMS

[Claim 1] A coating method for forming a coating film on a surface of a member to be coated wherein applying a coating apparatus which
5 is provided with a liquid feed means for feeding a coating liquid to a coating die, the coating die having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels that are connected to the gas outlets and are located at
10 the positions being almost as high as the gas outlets or being lower than the gas outlets and have open/shut-valves on their way, waste tanks for storing the waste liquid discharged from the outlets of the gas drainage channels, a supporting means for supporting the member to be coated, and a moving means for relatively moving the
15 coating die and the supporting means to each other, and wherein relatively moving the coating die and the member to be coated to each other while dispensing the coating liquid to the member to be coated from the discharging aperture, comprising the step of discharging the coating liquid and gas from the gas outlets by opening
20 the open/shut-valves of the gas drainage channels while feeding the liquid from the liquid feed means before and/or after forming the coating film on the surface of the member to be coated.

[Claim 2] A coating method for forming a coating film on a surface
25 of a member to be coated wherein applying a coating apparatus which is provided with a liquid feed means for feeding a coating liquid to a coating die, the coating die having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage
30 channels that are connected to the gas outlets and are located at

the positions making their own outlets lower than the discharging aperture and have open/shut-valves on their way, waste tanks for storing the waste liquid discharged from the outlets of the gas drainage channels, a supporting means for supporting the member
5 to be coated, and a moving means for relatively moving the coating die and the supporting means to each other, and wherein relatively moving the coating die and the member to be coated to each other while dispensing the coating liquid to the member to be coated from the discharging aperture, comprising the step of discharging the
10 coating liquid and gas from the gas outlets by opening the open/shut-valves of the gas drainage channels while feeding the liquid from the liquid feed means before and/or after forming thecoating film on the surface of the member to be coated.

15 [Claim 3] A coating method according to claim 1 or 2, wherein the coating liquid and gas are discharged from the gas outlets by opening the open/shut-valves in a state that the outlets of the gas drainage channels are open to the atmosphere.

20 [Claim 4] A coating method according to claim 2 or 3, wherein the coating liquid and the gas are discharged from gas outlets by opening the open/shut-valves in a state that each liquid storage portion of the waste tanks is open to the atmosphere, the liquid level of the waste liquid stored in each of the waste tanks is lower than
25 the discharging aperture of the coating die, and the outlets of the gas drainage channels are immersed in the waste liquid in each of the waste tanks.

[Claim 5] A coating method for coating a coating liquid on a surface
30 of a member to be coated, wherein applying a coating die having

a manifold for distributing the coating liquid in the coating width direction, a discharging aperture for dispensing the coating liquid from and gas outlets for discharging gas together with the coating liquid from, and relatively moving the member to be coated and the
5 coating die to each other while dispensing the coating liquid from the discharging aperture of the coating die, comprising the steps of feeding gas to the manifold filled with the coating liquid; subsequently feeding the coating liquid to the manifold; discharging the gas and a part of the coating liquid from the gas outlets; and
10 then coating the coating liquid on the surface of the member to be coated.

[Claim 6] A method of manufacturing components for displays applying the coating method described in any one of claims 1 to 5.

15

[Claim 7] A coating apparatus provided with a liquid feed means having a liquid feed channel for feeding a coating liquid to a coating die, the coating die having a manifold for distributing the coating liquid in the coating width direction and having a discharging
20 aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels connected to the gas outlets and having open/shut-valves on their way, a supporting means for supporting a member to be coated, and a moving means for relatively moving
25 the coating die and the supporting means to each other, wherein the gas drainage channels are located at the positions being almost as high as the gas outlets or being lower than the gas outlets.

[Claim 8] A coating apparatus provided with a liquid feed means
30 having a liquid feed channel for feeding a coating liquid to a coating

die, the coating die having a manifold for distributing the coating liquid in the coating width direction and having a discharging aperture for dispensing the coating liquid from and further having gas outlets for discharging gas together with the coating liquid from, gas drainage channels connected to the gas outlets and having open/shut-valves on their way, a supporting means for supporting a member to be coated, and a moving means for relatively moving the coating die and the supporting means to each other, wherein outlets of the gas drainage channels are located at the positions being lower than the discharging aperture.

[Claim 9] A coating apparatus provided with a liquid feed means having a liquid feed channel for feeding a coating liquid to a coating die, the coating die having a manifold for distributing the coating liquid in the coating width direction, and having a discharging aperture for dispensing the coating liquid from and having gas outlets for discharging gas together with the coating liquid from, gas drainage channels connected to the gas outlets and having open/shut-valves on their way, a supporting means for supporting a member to be coated, and a moving means for relatively moving the coating die and the supporting means to each other, wherein gas feed channels for feeding gas to the coating die is connected at least to any one of the coating die, the liquid feed channel and the gas drainage channels.

25

[Claim 10] A coating apparatus according to claim 9 wherein an inlet of the gas feed channel is open to the atmosphere.

[Claim 11] A coating apparatus according to any one of Claims 7 to 10, wherein the coating die has a feed port through which the

coating liquid is fed from the liquid feed channel to the coating die, the cross-sectional area of the manifold in the coating width direction decreases from the feedport to the gas outlets, and moreover an upper side of the manifold is parallel to a discharging aperture surface including the discharging aperture, or slopes upward from the feedport to the gas outlets relatively to the discharging aperture surface as a base.

[Claim 12] A coating apparatus according to claim 11, wherein a land length of a slot of the coating die is decreased from the central portion to both ends in the coating width direction.

[Claim 13] A manufacturing apparatus of producing components for displays applying the coating apparatus described in any one of claims 7 to 12.

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