

PASTE COATING APPARATUS AND PASTE COATING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a paste coating apparatus and a paste coating method for coating paste on a substrate.

Description of the Related Art

In manufacturing an organic EL (Electro Luminescence) panel, in a process for sticking a sealing glass sheet on a substrate on which an organic EL element is vapor-deposited, the sealing glass sheet is stuck on the substrate by coating paste (glass paste) on the substrate and irradiating glass paste with a laser beam.

In this process, as uniformity with high accuracy of the height (coating height) of glass paste coated on the substrate is required, glass paste is often coated on the substrate by a printing method.

In a printing method, glass paste is coated on a substrate through a screen provided with a pattern (coating pattern) for coating glass paste, and a problem is caused that individual screens are necessary for respective forms of coating patterns.

Further, there is a limit of the size allowed for manufacturing a screen because a screen is an extremely thin member. Accordingly, there is a problem that the size of an organic EL panel manufactured by a printing method using a screen is limited.

A screen is formed to coat glass paste, which is at the portion of a coating pattern, on a substrate, and the portion except the portion for forming the coating pattern is a portion to be masked. As glass paste of the mask portion remains, this remaining glass paste becomes surplus (a waste), which causes a problem of a low efficiency in the use of glass paste.

As a method of coating glass paste solving such problems with a printing method, there is known a method of coating glass paste on a substrate from a nozzle that moves along a coating pattern.

For example, Patent Document 1 (JP 2002-316082 A) discloses a paste coating apparatus that coats paste moving a nozzle while adjusting nozzle height in coating paste from and after the second time, based on nozzle height in the last coating of paste.

In case of coating glass paste moving a nozzle, in order to coat paste continuously and without discontinuity in the periphery of an organic EL element vapor-deposited on a substrate, it is preferable that glass paste is coated such that glass paste is overlapping with each other between the start point of moving a nozzle and the end point of moving the nozzle. With such an arrangement, it is possible to coat paste continuously without a discontinuity between the start point and the end point. However, if the nozzle contacts glass paste coated previously at the overlapping portion, glass paste is scraped off, and further the scraped-off glass paste overlaps previously coated glass paste, and coating height thereby becomes high. Accordingly, there is a problem that coating height of glass paste cannot be made uniform.

For the paste coating apparatus disclosed by Patent Document 1, it is not considered to prevent the nozzle from scraping off paste when paste is coated with an overlap between a start point of moving the nozzle and an end point of moving the nozzle.

Further, in case of coating paste moving a nozzle, coating height may be slightly different depending on a difference in the moving direction of the nozzle even when the height of the nozzle (nozzle height) from a substrate and the moving speed of the nozzle are unchanged. This is caused, depending on the moving direction, by a slight change in the height from the substrate to a jetting opening for jetting paste due to a shape error or a fitting error (inclination or the like) at the tip end portion of the nozzle. The paste coating apparatus disclosed by Patent Document 1 can maintain

coating height with high accuracy, absorbing a change in coating height caused by the non-flatness of a substrate, however, cannot absorb a slight change in coating height generated by a difference in the moving direction of the nozzle, and the accuracy of coating height is low in this regard.

SUMMARY OF THE INVENTION

In this situation, an object of the present invention is to provide a paste coating apparatus and a paste coating method that enable satisfactorily maintaining of coating height of glass paste in a predetermined error range.

According to the invention, a paste coating apparatus includes: a nozzle for continuously coating paste; and a control section for continuously coating the paste in a periphery of a predetermined region on a plane of a substrate, by moving the nozzle, wherein the control section: moves the nozzle, setting nozzle height from the substrate to the nozzle to be lower than a predetermined standard height, at a start end portion that extends by a predetermined length from a start point of starting movement of the nozzle; moves the nozzle, setting the nozzle height to be higher than the standard height, at a terminal end portion that extends by another predetermined length to an end point of terminating the movement of the nozzle; moves the nozzle, setting the nozzle height to be the standard height at a part excluding the start end portion and the terminal end portion; and moves the nozzle such that the paste is coated with an overlap at least partially between the start end portion and the terminal end portion. Further, in a paste coating method according to the invention, paste is coated in such a manner.

Further, according to the invention, a paste coating method of continuously coating paste in a periphery of a predetermined region on a plane of a substrate by moving a nozzle for continuously coating the paste along the periphery of the region includes: a preparation process that sets correction amounts of nozzle height that is from the substrate to the nozzle in moving the nozzle, for respective moving directions during

the movement of the nozzle along the periphery of the region; and a coating process that moves the nozzle along the periphery of the region, correcting the nozzle height by the correction amounts corresponding to the respective moving directions of the nozzle.

Still further, according to the invention, a paste coating apparatus coats paste on a substrate by this coating method.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a paste coating apparatus;

FIG. 2A is a side view of a coating head, FIG. 2B is a perspective view of the coating head;

FIG. 3A shows a first coating pattern of coating glass paste in the periphery of a vapor-deposited portion, FIG. 3B shows a second coating pattern of coating glass paste in the periphery of the vapor deposited portion;

FIG. 4A shows the start end portion of the first pattern, FIG. 4B shows the terminal end portion of the first pattern;

FIG. 5A shows the start end portion of the second pattern, FIG. 5B shows the terminal end portion of the second pattern;

FIG. 6A is a side view of the coating head of a paste coating apparatus in Example 2, FIG. 6B is a perspective view of the coating head;

FIG. 7A shows the shape of the tip end portion of an inclined nozzle and coating height, FIG. 7B shows the shape of a nozzle with a concave and/or a convex and coating height;

FIG. 8A shows an example of divisions of a coating pattern, FIG. 8B illustrates a nozzle correction amount, FIG. 8C shows measuring points; and

FIG. 9 shows connection points where nozzle height N_h is changed in coating glass paste.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments and examples of the present invention will be described below, referring to the drawings as appropriate.

Example 1

A paste coating apparatus 100 in Example 1 includes, as shown in FIG. 1, a support table 1, a frame 2, fixed sections 3A, 3B, movable sections 4A, 4B, a coating head 5, a substrate holding table 6 on which a substrate 8 is to be mounted, a control section 9, a monitor 11, and a keyboard 12.

Further, coordinate axes are set wherein X axis represents the longitudinal direction of the support table 1, Y axis represents the lateral direction, and Z axis represents the height direction (vertical direction).

One coating head 5 is shown in FIG. 1, however, the paste coating apparatus 100 may be provided with plural coating heads 5.

Further, an X-axis moving mechanism including the fixed sections 3A, 3B and the movable sections 4A, 4B is provided on the support table 1. The fixed sections 3A, 3B are, for example, fixed along X axis direction at the both end portions, with respect to Y axis direction, of the support table 1 and function as the guide members of the movable sections 4A, 4B. The movable section 4A and the movable section 4B are movably provided respectively on the fixed section 3A and the fixed section 3B, and further, a frame 2 is arranged connecting the movable section 4A and the movable section 4B (in other words, along Y axis direction). The frame 2 is arranged such as to extend along Y axis direction.

The X-axis moving mechanism is arranged such that the movable sections 4A, 4B can move along the fixed sections 3A, 3B by a drive unit such as a ball screw mechanism, a linear motor, or the like.

The frame 2 is provided with the coating head 5 that is movable in the longitudinal direction (namely in Y axis direction). Hereinafter, the moving

mechanism for moving the coating head 5 in the longitudinal direction of the frame 2 will be referred to as the Y-axis moving mechanism. The Y-axis moving mechanism is arranged such that the coating head 5 is movable along the frame 2 by a drive unit, such as a ball screw mechanism, a linear motor, or the like.

Further, in the region between the fixed sections 3A, 3B on the upper surface of the support table 1, the substrate holding table 6 is provided as a table for mounting thereon a substrate 8 on which an organic El element is vapor-deposited. The substrate holding table 6 is arranged to be able to fix the substrate 8 mounted thereon by an absorption-fixing mechanism, not shown, or the like.

Still further, the support table 1 is provided with the monitor 11 and the keyboard 11 for operation, and incorporates the control section 9 as a control unit for controlling the paste coating apparatus 100.

Yet further, the paste coating apparatus 100 is provided with a pressure source 10 that pressurizes air and supplies the air to a paste storage section (syringe 55) of the coating head 5, thus providing a syringe 55 with a pressure (jetting pressure) for jetting glass paste Gp from a nozzle 5a.

The pressure source 10 is connected through a pressurizing pipe 10c to the syringe 55 of the coating head 5 to pressurize inside the syringe 55 by supplying pressurized air, and thereby supplies a jetting pressure to the coating head 5. The pressurizing pipe 10c is provided with a positive pressure regulator 10a for adjusting the pressure of the air having been pressurized by the pressure source 10 to a desired pressure (jetting pressure) and a valve 10b for shutting off flow of the pressurized air. The valve 10b is an electrical on-off valve to open and close the pressurizing pipe 10c, according to a control signal from the control section 9, and is arranged such that flow of air in the pressurizing pipe 10c is shut off when the valve 10b is closed.

As shown in FIGs. 2A and 2B, the coating head 5 has a base table section 50 fitted to the frame 2 through the Y-axis moving mechanism such as to be able to be

driven, and the base table section 50 is provided with a detector 51 for detecting the linear scale 2a of the frame 2. The linear scale 2a is extended along Y axis direction on one side surface of the frame 2, while the detector 51 for detecting the linear scale 2a is fitted to the base table section 50, facing the linear scale 2a. The control section 9 (see FIG. 1) controls the Y-axis moving mechanism, based on a result of detecting the linear scale 2a by the detector 51, and thereby controls the position, with respect to Y axis direction, of the coating head 5 (nozzle 55a). It is preferable that the X-axis moving mechanism is also provided with a linear scale and a detector, not shown, so that the position, with respect to X axis direction, of the coating head 5 (nozzle 55a) can be controlled.

A Z-axis guide 52 having a Z-axis servo motor 52a is fitted to the base table section 50 of the coating head 5, and a Z-axis table 53 moving in Z axis direction (vertical direction) by the Z-axis servo motor 52a is fitted to the Z-axis guide 52. Further, the Z-axis table 53 is provided with the paste storage section (syringe 55) for storing glass paste Gp. Further, the syringe 55 is provided with the nozzle 55a for coating the stored paste (glass paste Gp in Example 1) on a substrate 8 (see FIG. 1) and a distance meter (for example, an optical distance meter 54) for measuring the height (nozzle height Nh) from the substrate 8 mounted on the substrate holding table 6 to the nozzle 55a.

The optical distance meter 54 shown in FIG. 2B includes a light emitting section and a light receiving section, wherein nozzle height Nh from the substrate 8 to the nozzle 55a is measured, based on the amount of received light of a reflection light that is reflection of a light (a laser beam) projected from the light emitting section to the substrate 8 (see FIG. 1).

Concretely, according to the fact that the longer nozzle height Nh is, the more the amount of light, received by the light receiving section, of the reflection light drops, the optical distance meter 54 measures nozzle height Nh, based on the ratio of the

amount of light received by the light receiving section to the amount of light emitted from the light emitting section.

Controlled by the control section 9 (see FIG. 1) based on a measurement value by the optical distance meter 54 installed on the Z-axis table 53, the Z-axis servo motor 52a moves the syringe 55 (nozzle 55a) in Z axis direction, vertically in other words, through the Z-axis table 53.

The paste coating apparatus 100 (see FIG. 1) with such a structure is a device, as shown in FIG. 3A for example, that coats glass paste Gp for joining a sealing glass sheet with the substrate 8 on which an organic EL element is vapor-deposited. The paste coating apparatus 100 coats glass paste Gp on the periphery of a predetermined region defined by a vapor-deposit section A1 where an organic EL element is vapor-deposited, in a substantially rectangular flat shape for example, such that glass paste Gp is coated up to a predetermined height (coating height Ht). A sealing glass sheet is, in a subsequent process, stuck on the substrate 8 on which glass paste Gp has been coated by the paste coating apparatus 100, and then a laser beam is irradiated on glass paste Gp so that the sealing glass sheet is joined. Herein, the sealing glass sheet is vacuum-stuck in a vacuum environment so that the vapor-deposit section A1 of the organic EL element becomes in a vacuum state.

It is required that the vapor-deposit section A1, formed on the substrate 8, of the organic EL element is maintained in the vacuum state by the sealing glass sheet. Accordingly, the paste coating apparatus 100 (see FIG. 1) is required to continuously coat glass paste Gp without discontinuity on the periphery of the vapor-deposit section A1 where the organic EL element is vapor-deposited substantially in a rectangular shape.

For example, the control section 9 (see FIG. 1) of the paste coating apparatus 100, as shown in FIG. 3A, moves the nozzle 55a to a start point Ps that is a point (the hollow circle) in the periphery of the vapor-deposit section A1 of the organic EL

element on the substrate 8, wherein movement of the nozzle 55a starts at the start point Ps. That is, the start point Ps is set to a point in the periphery of the vapor-deposit section A1.

Further, the control section 9 transmits a control signal to the valve 10b (see FIG. 1) of the pressurizing pipe 10c to open the valve. Air whose pressure has been adjusted as appropriate is supplied from the positive pressure regulator 10a (see FIG. 1) to the syringe 55 (see FIG. 1), and a jetting pressure is thereby supplied to the syringe 55. The pressure inside the syringe 55 rises by the jetting pressure, and the stored glass paste Gp is pushed out by the jetting pressure from the syringe 55 to be continuously coated from the nozzle 55a.

In this state, the control section 9 (see FIG. 1) moves the nozzle 55a along the periphery of the vapor-deposit section A1. In case of moving the nozzle 55a in X axis direction, the control section 9 moves the movable sections 4A, 4B (see Fig. 1) along the fixed sections 3A, 3B (see FIG. 1) by the X-axis moving mechanism. In case of moving the nozzle 55a in Y axis direction, the control section 9 moves the coating head 5 along the frame 2 (see FIG. 1) by the Y-axis moving mechanism.

Accompanying the movement of the nozzle 55a, glass paste Gp to be coated from the nozzle 55a is continuously coated on the periphery of the vapor-deposit section A1 so that a coating pattern (a first pattern Pt1) is continuously formed along the track of the movement of the nozzle 55a.

Then, when the nozzle 55a has made one circuit of the periphery of the vapor-deposit section A1 and returns to the position of the start point Ps, the control section 9 (see FIG. 1) transmits a control signal to the valve 10b (see FIG. 1) of the pressurizing pipe 10c to close the valve. Further, the control section 9 moves the nozzle 55a up to an end point Pe (the hollow square), where movement of the nozzle 55a is terminated, such that the nozzle 55a overlaps the spatial portion along and above glass paste Gp having been previously coated. That is, the end point Pe is also set as a

point on the periphery of the vapor-deposit section A1.

Even if the valve 10b is closed and supply of the jetting pressure to the syringe 55 (see FIG. 1) is stopped, the high pressure state inside the syringe 55 continues due to the residual pressure of the jetting pressure, and coating of glass paste Gp from the nozzle 55a is continued. Then, the pressure inside the syringe 55, where supply of the jetting pressure has been stopped, gradually decreases. Accompanying the decrease in the pressure inside the syringe 55, the coating amount of glass paste Gp from the nozzle 55a decreases, and coating of glass paste Gp from the nozzle 55a stops when the pressure inside the syringe 55 has decreased down approximately to the atmospheric pressure.

In such a manner, by providing an overlap portion 101, where glass paste Gp is coated from the start point Ps to the end point Pe such as to overlap the coating pattern for coating glass paste Gp, it is possible to form the first pattern Pt1 in a continuous rectangular shape without discontinuity in the periphery of the vapor-deposit section A1 by coating glass paste Gp.

Alternatively, as shown in FIG. 3B, the control section 9 sets a start point Ps (hollow circle) at a point on a line extended from one side of the vapor-deposit section A1 substantially in a rectangular shape, and moves the nozzle 55a to the start point Ps. In this arrangement, the start point Ps is set at a point that is outside the periphery of the vapor-deposit section A1.

Further, the control section 9 transmits a control signal to the valve 10b (see FIG. 1) of the pressurizing pipe 10c to open the valve, and supplies air, whose pressure having been adjusted as appropriate, from the positive pressure regulator 10a (see FIG. 1) to the syringe 55 (see FIG. 1). As the jetting pressure is supplied to the syringe 55, glass paste Gp is continuously coated from the nozzle 55a.

In this state, the control section 9 (see FIG. 1) moves the nozzle 55a along the periphery of the vapor-deposit section A1. Glass paste Gp is coated from the nozzle

55a on the periphery of the vapor-deposit section A1 so that a coating pattern (a second pattern Pt2) along the track of the movement of the nozzle 55a is continuously formed. Then, when the nozzle 55a has made one circuit of the periphery of the vapor-deposit section A1 and reaches the portion where glass paste Gp has been coated from the start point Ps to the vapor-deposit section A1 (this portion will be referred to as the start end portion 101S), the control section 9 moves the nozzle 55a such that the nozzle 55a moves across the start end portion 101S, and stops the nozzle 55a at a point (hollow square), which is determined as appropriate and set as an end point Pe. Then, the control section 9 transmits a control signal to the valve 10b (see FIG. 1) of the pressurizing pipe 10c to close the valve. In this arrangement, the end point Pe is set at a point that is outside the periphery of the vapor-deposit section A1.

In such a manner, by providing an intersection point 103 (solid circle), where glass paste Gp intersects, to a coating pattern of coating glass paste Gp, it is possible to form the second pattern Pt2 in a continuous shape without discontinuity in the periphery of the vapor-deposit section A1 by coating glass paste Gp.

Further, when the control section 9 (see FIG. 1) coats glass paste Gp on the substrate 8 in the first pattern Pt1 or the second pattern Pt2, the control section 9 moves the nozzle 55a, adjusting nozzle height Nh to coating height Ht of glass paste Gp to be coated on the substrate 8.

For example, in case of setting a standard value of coating height Ht (standard coating height StdH) to '30 μm ', the control section 9 moves the nozzle 55a, maintaining nozzle height Nh be the standard coating height StdH of '30 μm ', in other words, assigning the standard coating height StdH to the standard height of nozzle height Nh. For example, the control section 9 obtains a measurement value by the optical distance meter 54 (see FIG. 2A), moves the Z-axis table 53 (see FIG. 2A) in Z axis direction (vertical direction) so that this measurement value becomes the standard coating height StdH (30 μm), and maintains nozzle height Nh to be '30 μm '.

In the process for joining a sealing glass sheet, it is preferable that coating height H_t of glass paste G_p is uniform over the whole circuit of a coating pattern (the first coating pattern $Pt1$ or the second coating pattern $Pt2$) so that the rise in temperature of glass paste G_p by irradiation with a laser beam becomes uniform over the whole circuit of the coating pattern. In this situation, the control section 9 (see FIG. 1) is arranged to move the nozzle 55a (see FIG. 2A), maintaining nozzle height N_h with high accuracy to be the standard coating height $StdH$.

In such a manner, a coating pattern (the first pattern $Pt1$ or the second pattern $Pt2$) is formed by coating glass paste G_p such that coating height H_t of glass paste G_p coated on a substrate 8 is maintained to be the standard coating height $StdH$ (for example, 30 μm).

Further, in the process for joining a sealing glass sheet by a laser beam, it is required that coating height H_t is subjected to error management with high accuracy so that the temperature of glass paste G_p irradiated with a laser beam is uniform over the whole circuit of a coating pattern and the sealing glass sheet is satisfactorily joined. For example, a sealing glass sheet can be satisfactorily joined if it is possible to restrict a change in coating height H_t to a range of error (hereinafter, referred to as allowable error ΔH_t) within, for example, approximately ' $\pm 10 \mu m$ ' from the standard coating height $StdH$ of '30 μm ' over the whole circuit of a coating pattern.

In this situation, the control section 9 is configured to form a coating pattern, controlling nozzle height N_h such that nozzle height N_h varies within a range of the allowable error ΔH_t ($\pm 10 \mu m$) from the standard coating height $StdH$ (30 μm).

That is, the allowable error ΔH_t is an error allowed for coating height H_t of glass paste G_p .

However, with the first pattern $Pt1$ shown in FIG. 3A, there is a case that coating height H_t of glass paste G_p becomes higher than the standard coating height $StdH$ in the overlap portion 101. For example, when the nozzle 55a moves,

overlapping glass paste Gp having been previously coated from the start point Ps to the end point Pe, there is a case that glass paste Gp is scrapped off if the nozzle 55a contacts the glass paste Gp previously coated. In this case, although glass paste Gp is newly coated from the nozzle 55a on the posterior side with respect to the moving direction of the nozzle 55a, there is a case that glass paste Gp is scraped off by the nozzle 55a on the anterior side with respect to the moving direction of the nozzle 55a, and when the movement of the nozzle 55a stops at the end point Pe, the scraped-off glass paste Gp is accumulated at a position corresponding to the anterior side with respect to the moving direction of the nozzle 55a, resulting in that coating height Ht becomes high.

Further, with the second pattern Pt2 shown in FIG. 3B, there is a case that the nozzle 55a moves through the intersection point 103 where glass paste Gp intersects, scraping off glass paste Gp having been coated at the start end portion 101S. In this case, glass paste Gp coated in the periphery of the vapor-deposit section A1 continuously from the start end portion 101S may be scraped off together with the start end portion 101S, resulting in that coating height Ht of glass paste Gp becomes low.

In this situation, the control section 9 (see FIG.1) in Example 1 controls the operation of the coating head 5 (nozzle 55a) such that coating height Ht, in the vicinities of the start point Ps and the end point Pe of the coating pattern formed by coating glass paste Gp, can be satisfactorily managed.

First Embodiment

A first embodiment for carrying out Example 1 is an embodiment for coating glass paste Gp in the shape of the first pattern Pt1 shown in FIG. 3A.

When coating glass paste Gp in the shape of the first pattern Pt1, the control section 9 (see FIG. 1) transmits a control signal at the start point Ps to the valve 10b (see FIG. 1) to open the valve, and starts coating glass paste Gp, setting nozzle height Nh to a height lower than the standard coating height StdH. For example, as shown in FIG. 4A, the control section 9 (see FIG. 1) coats glass paste Gp at nozzle height Nh lower

than the standard coating height $StdH$ by an amount equivalent to the allowable error ΔHt allowed for a coating height Ht . In this state, the control section 9 moves the nozzle 55a along the periphery of the vapor-deposit section A1 (see FIG. 1) by a predetermined length (a first predetermined length $L11$), and then moves up the nozzle 55a such that nozzle height Nh becomes the standard coating height $StdH$. Glass paste Gp is coated at a coating height Ht lower than the standard coating height $StdH$ by the allowable error ΔHt for the first predetermined length $L11$ starting from the start point Ps .

In the first embodiment, this portion with the predetermined length (first predetermined length $L11$) from the start point Ps will be referred to as a start end portion 101S. That is, the control section 9 (See FIG. 1) moves the nozzle 55a, setting nozzle height Nh to be lower than the standard coating height $StdH$ by the amount equivalent to the allowable error ΔHt , and executes a process (start end portion forming process) for forming the start end portion 101S extending by the first predetermined length $L11$ along the periphery of the vapor-deposit section A1 (see FIG. 3A). In such a manner, glass paste Gp is coated at a coating height Ht that is lower than the standard coating height $StdH$ by the allowable error ΔHt , extending by the first predetermined length $L11$ (start end portion 101S) from the start point Ps . The start end portion 101S is formed along the periphery of the vapor-deposit section A1.

The start end portion forming process is a process for forming the start end portion 101S by setting the start point Ps to a point on the periphery of the vapor-deposit section A1 and moving the nozzle 55a along the periphery of the vapor-deposit section A1.

Incidentally, the nozzle 55a may be moved such that nozzle height Nh is set to be lower than the standard coating height $StdH$ by the amount equivalent to the allowable error ΔHt , at least at a part of the portion extending by the first predetermined length $L11$ from the start point Ps .

For example, the nozzle 55a may be moved such that nozzle height N_h is set to be lower than the standard coating height $StdH$ by the amount equivalent to the allowable error ΔH_t only in the region where the overlap portion 101 is formed.

For example, if the standard coating height $StdH$ is '30 μm ' and the allowable error ΔH_t is ' $\pm 10 \mu\text{m}$ ', the control section 9 (see FIG. 1) coats glass paste G_p , setting nozzle height N_h to '20 μm (30 $\mu\text{m} - 10 \mu\text{m}$) for the portion (start end portion 101S) extending by the first predetermined length L_{11} from the start point Ps . Thereafter, the control section 9 coats glass paste G_p , moving up the nozzle 55a until nozzle height N_h becomes the standard coating height $StdH$ (30 μm).

When the nozzle 55a has made approximately one circuit of the periphery of the vapor-deposit section A_1 (see FIG. 3A) and reached, as shown in FIG. 4B, a position that is a predetermined length (second predetermined length L_{12}) before the start point Ps , the control section 9 (see FIG. 1) executes a process for closing the valve 10b (see FIG. 1) by transmitting a control signal to the valve 10b.

Supply of the jetting pressure to the syringe 55 (see FIG. 1) is stopped, and glass paste G_p stored in the syringe 55 is coated from the nozzle 55a by the residual pressure of the jetting pressure.

The process for closing the valve 10b is a process (coating stopping process) that stops coating of glass paste G_p from the nozzle 55a. The control section 9 executes the coating stopping process that stops coating of glass paste G_p prior to execution of a process (terminal end portion forming process) that forms a terminal end portion 101E.

Further, when the nozzle 55a has reached a position that is a predetermined length (a third predetermined length L_{13}) before the start point Ps , the predetermined length being shorter than the second predetermined length L_{12} , the control section 9 (see FIG. 1) moves up the Z-axis table 53 (see FIG. 2A) to move up the nozzle 55a, thereby increasing nozzle height N_h . Concretely, the control section 9 moves up the

nozzle 55a by the amount equivalent to the allowable error ΔH_t . For example, if the standard coating height StdH is '30 μm ' and the allowable error ΔH_t is ' $\pm 10 \mu\text{m}$ ', the control section 9 moves up the nozzle 55a by 10 μm , and changes nozzle height Nh from a height of the standard coating height StdH (30 μm) to '40 μm (30 μm + 10 μm)'. As described above, in the first embodiment, the portion where the nozzle 55a moves at nozzle height Nh higher than the standard coating height StdH is referred to as the terminal end portion 101E. The length of the terminal end portion 101E will be referred to as the fourth predetermined length L14. That is, the terminal end portion 101E is a portion extending by the fourth predetermined length L14 to the end point Pe, and is formed on the periphery of the vapor-deposit section A1 (see FIG. 3A). Further, in the first pattern Pt1, glass paste Gp is coated at a coating height Ht that is higher than the standard coating height StdH by the allowable error ΔH_t , at least at a part of the terminal end portion 101E.

In the first embodiment, supply of the jetting pressure from the pressure source 10 (see FIG. 1) to the syringe 55 (see FIG. 1) is stopped before the terminal end portion 101E, for which nozzle height Nh becomes higher, is formed.

Glass paste Gp is then coated from the nozzle 55a by the residual pressure of the jetting pressure. When the nozzle 55a moves in this state from the start point Ps to the end point Pe, overlapping with glass paste Gp having previously been coated, glass paste Gp is coated from the nozzle 55a, overlapping glass paste Gp previously coated, and the overlap portion 101 is thus formed.

Herein, the coating amount of glass paste Gp is an amount that varies depending on the residual pressure value in the syringe 55 (see FIG. 2A), and is not a controlled coating amount. However, at the overlap portion 101, as glass paste Gp has been previously coated at a coating height Ht, which is lower than the standard coating height StdH by the allowable error ΔH_t , in case that glass paste Gp is newly coated with an overlap on the previously coated glass paste Gp, a height higher than the height,

which is lower than the standard coating height StdH by the allowable error ΔH_t , is ensured as a coating height H_t .

Further, even when the pressure inside the syringe 55 drops approximately to the atmospheric pressure before the nozzle 55a reaches the end point P_e and coating of glass paste Gp stops, coating height that is lower than the standard coating height StdH by the allowable error ΔH_t can be ensured. In other words, coating height H_t does not become lower than the standard coating height StdH at the start end portion 101S by an amount exceeding the allowable error ΔH_t . Further, as nozzle height N_h is higher than the standard coating height StdH by the amount equivalent to the allowable error ΔH_t , it does not occur that glass paste Gp is coated at a height exceeding the allowable error ΔH_t from the standard coating height StdH. From the above, it is possible to restrict coating height H_t of glass paste Gp to a range within the allowable error ΔH_t from the standard coating height StdH at the start end portion 101S.

Further, even in case that coating height H_t of glass paste Gp previously coated at the start end portion 101S is higher than the standard coating height StdH, as nozzle height H_t of the nozzle 55a moving with an overlap with the start end portion 101S is higher than the standard coating height StdH by the amount equivalent to the allowable error ΔH_t , contact between glass paste Gp previously coated at the start end portion 101S and the nozzle 55a is prevented, and it does not occur that glass paste Gp is scraped off by the nozzle 55a. Thus, it is prevented that coating height H_t becomes higher by glass paste Gp scraped off by the nozzle 55a.

The predetermined length (the first predetermined length L11) of the start end portion 101S, the second predetermined length L12 before the start point P_s , the valve 10b (see FIG. 1) being closed at the second predetermined length L12, the third predetermined length L13 before the start point P_s , the nozzle 55a being moved up at third predetermined length L13, and the predetermined length (the fourth predetermined length L14) at the terminal end portion 101E are preferably values that are suitably set,

according to a result of preliminary testing, measurement, or the like.

For example, the third predetermined length L13 and the fourth predetermined length L14 are preferably set such that the nozzle 55a moves, overlapping the start end portion 101S, during when the nozzle 55a moves at the terminal end portion 101E formed in the fourth predetermined length L14. Further, the first predetermined length L11 is preferably set such that the end point Pe is formed overlapping the position of the start end portion 101S. That is, the terminal end portion 101E is preferably formed such that the terminal end portion 101E and the start end portion 101S at least partially overlap with each other.

Further, the second predetermined length L12 is preferably set as follows. That is, coating of glass paste Gp stops at a certain time that is after the time the valve 10b is closed at a position being the second predetermined length L12 before the start point Ps and is before the time the nozzle moves up to the end point Pe, and glass paste Gp is coated, overlapping the start end portion 101S, to form the overlap portion 101. In other words, an arrangement is preferably made such that glass paste Gp is coated with an overlap at least at a part of the portion where the start end portion 101S and the terminal end portion 101E overlap with each other.

With this arrangement, in the terminal end portion forming process, the end point Pe is set to a point in the periphery of the vapor-deposit section A1 (see FIG. 3A), and the nozzle 55a is moved along the periphery of the vapor-deposit section A1 such that the start end portion 101S and the terminal end portion 101E at least partially overlap with each other, and the terminal end portion 101E is thus formed.

With such an arrangement, before the nozzle 55a having made approximately one circuit of the vapor-deposit section A1 (see FIG. 3A) reaches the start point Ps (namely, at the portion extending by the third predetermined length L13 before the start point Ps), as nozzle height Nh becomes higher by the amount equivalent to the allowable error ΔH_t , it is avoided that glass paste Gp is scraped off by a contact of the

nozzle 55a with glass paste Gp previously coated at the start end portion 101S even in case that coating height Ht of glass paste Gp previously coated at the start end portion 101S is higher than the standard coating height StdH. Accordingly, it is prevented that the coating height Ht becomes high, exceeding the allowable error ΔHt , by glass paste Gp scraped off by the nozzle 55a.

In such a manner, the control section 9 (see FIG. 1) executes the terminal end forming process that moves the nozzle 55a, setting nozzle height Nh to be higher than the standard coating height StdH by the amount equivalent to the allowable error ΔHt , and thereby forms the terminal end portion 101E with the fourth predetermined length L14 extending to the end point Pe along the periphery of the vapor-deposit section A1 (see FIG. 3A), with an overlap at least partially between the start end portion 101S and the terminal end portion 101E.

Further, the control section 9 executes a process (normal moving process) that moves the nozzle 55a, making nozzle height Nh be the standard coating height StdH from the front end of the start end portion 101S to the rear end of the terminal end portion 101E (in other words, the part excluding the start end portion 101S and the terminal end portion 101E), and coats glass paste Gp on the substrate 8 (see FIG. 1) by moving the nozzle 55a along the first pattern Pt1.

As described above, in the first embodiment for coating glass paste Gp along the first pattern Pt1, shown in FIG. 3A, executing a start end portion forming process for forming the start end portion 101S, the control section 9 (see FIG. 1) coats, as shown in FIG. 4A, glass paste Gp at a coating height Ht lower than the standard coating height StdH by the allowable error ΔHt at the start end portion 101S extending by the first predetermined length L11 from the start point Ps. Further, executing the terminal end forming process for forming the terminal end portion 101E, the control section 9 moves up nozzle height Nh by the amount equivalent to the allowable error ΔHt at the position that is the third predetermined length L13 before the start point Ps and moves the nozzle

55a with the fourth predetermined length L14 up to the end point Pe, overlapping the start end portion 101S. Between the start end portion forming process and the terminal end portion forming process, in execution of the normal moving process for moving the nozzle 55a, the control section 9 coats glass paste Gp on the substrate 8, making nozzle height Nh be the standard coating height StdH. With such an arrangement, in forming the first pattern Pt1 by coating glass paste Gp, the coating height Ht in the vicinities of the start point Ps and the end point Pe can be restricted to a range within the allowable error ΔHt from the standard coating height StdH.

Second Embodiment

A second embodiment for carrying out Example 1 is an embodiment for coating glass paste Gp in the shape of the second pattern Pt2, shown in FIG. 3B.

In coating glass paste Gp in the shape of the second pattern Pt2, the control section 9 (See FIG. 1) transmits a control signal to the valve 10b (see FIG. 1) at a start point Ps that is set on a line extended from one side of a vapor-deposit section A1 substantially in a rectangular shape on the plane of a substrate 8 to open the valve, and starts coating of glass paste Gp, setting nozzle height Nh to be lower than the standard coating height StdH. For example, as shown in FIG. 5A, glass paste Gp is coated at nozzle height Nh lower than the standard coating height StdH by the amount equivalent to the allowable error ΔHt that is allowed for coating height Ht. In this state, the control section 9 moves the nozzle 55a by a predetermined length (fifth predetermined length L21) toward the vapor-deposit section A1, along the side with the start point Ps on its extended line. The portion (the region extending by the fifth predetermined length L21 from the start point Ps) where glass paste Gp is coated, in such a manner, at a coating height Ht lower than the standard coating height StdH by the allowable error ΔHt is a start end portion 101S in the second embodiment. The length (fifth predetermined length L21) of the start end portion 101S is preferably longer than the distance between the start point Ps and the vapor-deposit section A1.

The start point Ps in the second pattern Pt2 is a point that is outside the periphery of the vapor-deposit section A1, and the control section 9 (see FIG. 1) sets nozzle height Nh to be lower than the standard coating height StdH by the amount equivalent to the allowable error ΔH_t , moves the nozzle 55a from the start point Ps toward the periphery of the vapor-deposit section A1, and in such a manner, and thus executes the start end portion forming process for forming the start end portion 101S extending by the fifth predetermined length L21.

In case that the fifth predetermined length L21 of the start end portion 101S is longer than the distance between the start point Ps and the vapor-deposit section A1, the start end portion 101S is formed including a part of the periphery of the vapor-deposit section A1. However, at the start end portion 101S, coating height Ht is lower than the standard coating height StdH by the allowable error ΔH_t , and even in case that the start end portion 101S is formed including a part of the periphery of the vapor-deposit section A1, it is possible to restrict coating height Ht in the periphery of the vapor-deposit section A1 to a range within the allowable error ΔH_t from the standard coating height StdH.

For example, if the standard coating height StdH is '30 μm ' and the allowable error ΔH_t is ' $\pm 10 \mu\text{m}$ ', the control section 9 (see FIG. 1) coats glass paste Gp, making nozzle height Nh be '20 μm (30 $\mu\text{m} - 10 \mu\text{m}$)' at the part extending by the fifth predetermined length L21 from the start point Ps. Then, the control section 9 coats glass paste Gp in the periphery of the vapor-deposit section A1, setting nozzle height Nh to be the standard coating height StdH (30 μm).

Alternatively, the control section 9 may move the nozzle 55a, setting nozzle height Nh to be lower than the standard coating height StdH by the amount equivalent to the allowable error ΔH_t only at a part of the portion extending by the fifth predetermined length L21 from the start point Ps.

For example, the control section 9 may move the nozzle 55a, setting nozzle

height N_h to be lower than the standard coating height $StdH$ by the amount equivalent to the allowable error ΔH_t only in the vicinity of an intersection point 103 where glass paste G_p intersects.

As shown in FIG. 5B, when the nozzle 55a has made approximately one circuit of the vapor-deposit section A1 and reaches a position that is on the side perpendicular to the start end portion 101S and is predetermined length (sixth predetermined length L_{22}) before the start end portion 101S, the control section 9 (see FIG. 1) moves up the nozzle 55a. Concretely, the control section 9 moves up the nozzle 55a by the amount equivalent to the allowable error ΔH_t . For example, if the standard coating height $StdH$ is '30 μm ' and the allowable error ΔH_t is ' $\pm 10 \mu m$ ', the control section 9 moves up the nozzle 55a by 10 μm to change nozzle height N_h from the standard coating height $StdH$ (30 μm) to '40 μm (30 $\mu m + 10 \mu m$)'.

In this state, the control section 9 (see FIG. 1) moves the nozzle 55a across the start end portion 101S, and stops the movement of the nozzle 55a at the end point P_e that is set as appropriate. Further, the control section 9 transmits a control signal to the valve 10b (see FIG. 1) to close the valve.

The control section 9 moves up nozzle height N_h by the amount equivalent to the allowable error ΔH_t from the standard coating height $StdH$ and thus moves the nozzle 55a, thereby forming the terminal end portion 101E in the second embodiment.

The seventh predetermined length L_{23} represents the length of the terminal end portion 101E, in other words, the length that extends from the position that is the sixth predetermined length L_{22} before the start end portion 101S to the end point P_e , wherein the control section 9 sets nozzle height N_h to be higher in the above-described length.

In such a manner, in the second embodiment, the second pattern Pt2 (see FIG. 3B) is formed, wherein the start end portion 101S and the terminal end portion 101E intersect with each other at the intersection point 103.

That is, the control section 9 (see FIG. 1) executes the terminal end forming

process in which the control section 9 moves up nozzle height N_h by the amount equivalent to the allowable error ΔH_t from the standard coating height $StdH$ and moves the nozzle 55a toward the end point Pe outside the periphery of the vapor-deposit section A1 and such that the nozzle 55a intersects with the start end portion 101S at the intersection point 103, thereby forming the terminal end portion 101E extending by the seventh predetermined length L_{23} .

The control section 9 executes a normal moving process in which the control section 9 moves the nozzle 55a, making nozzle height N_h be the standard coating height $StdH$ between the front end of the start end portion 101S and the rear end of the terminal end portion 101E (in other words, at the part excluding the start end portion 101S and the terminal end portion 101E), and the control section 9 thus moves the nozzle 55a along the second pattern $Pt2$ (see FIG. 3B) to coat glass paste Gp on the substrate 8 (see FIG. 1).

Herein, the predetermined length (sixth predetermined length L_{22}) before the start end portion 101S, wherein the control section 9 (see FIG. 1) starts moving up the nozzle 55a at this part of the predetermined length, can be any length that enables the nozzle 55a to move up by the amount equivalent to the allowable error ΔH_t from the standard coating height $StdH$ during when the nozzle 55a moves by the sixth predetermined length L_{22} to the start end portion 101S.

In case that coating height H_t at the start end portion 101S and nozzle height N_h of the nozzle 55a at the time of moving across the start end portion 101S are equal to each other, the nozzle 55a may contact previously coated glass paste Gp due to an error or the like so that the previously coated glass paste Gp is scraped off. On this occasion, if a part of glass paste Gp coated along the vapor-deposit section A1 is scraped off together with glass paste Gp of the start end portion 101S, coating height H_t at the part becomes lower, and coating height H_t in the periphery of the vapor-deposit section A1 becomes non-uniform.

In the second embodiment, coating height H_t of glass paste G_p coated at the start end portion 101S is set to be lower by the allowable error ΔH_t than the standard coating height $StdH$, and nozzle height N_h at the time the nozzle 55a moves across the start end portion 101S is set to be higher by the amount equivalent to the allowable error ΔH_t than the standard coating height $StdH$. Thus, it is possible to avoid that glass paste G_p coated at the start end portion 101S and the nozzle 55a contact with each other when the nozzle 55a moves across the start end portion 101S.

Accordingly, it is possible to prevent that glass paste G_p coated in the periphery of the vapor-deposit section A1 is scraped off by the nozzle 55a together with glass paste G_p coated at the start end portion 101S, and it is possible to restrict coating height H_t of glass paste G_p in the periphery of the vapor-deposit section A1 to a range within the allowable error ΔH_t from the standard coating height $StdH$.

Further, nozzle height N_h at the terminal end portion 101E is higher by the amount equivalent to the allowable error ΔH_t than the standard coating height $StdH$, and it is thereby possible to restrict coating height H_t of glass paste G_p at the terminal end portion 101E to a range within the allowable error ΔH_t from the standard coating height $StdH$.

As described above, in the second embodiment in which glass paste G_p is coated along the second pattern $Pt2$, shown in FIG. 3B, the control section 9 (see FIG. 1) executes the start end portion forming process for forming the start end portion 101S (see FIG. 5A), and the control section 9 thereby coats glass paste G_p at a coating height H_t lower by allowable error ΔH_t than the standard coating height $StdH$ for the fifth predetermined length $L21$ extending from the start point P_s to form the start end portion 101S. Further, when the nozzle 55a has made approximately one circuit of the vapor-deposit section A1 of an organic element, the control section 9 executes the terminate end portion forming process for forming the terminal end portion 101E (see FIG. 5B), and thereby moves the nozzle 55a such that the nozzle 55a moves across the

start end portion 101S, setting nozzle height N_h to be higher by the amount equivalent to the allowable error ΔH_t at the position that is the six predetermined length L_{22} before the start end portion 101S. Between the start end portion forming process and the terminal end portion forming process, the control section 9 executes the normal moving process for moving the nozzle 55a, making nozzle height N_h be the standard coating height $StdH$, and the control section 9 thereby coats glass paste G_p on a substrate 8.

With such an arrangement, it is avoided that the nozzle 55a contacts the previously coated glass paste G_p when the nozzle 55a moves across the start end portion 101S, and it is thereby possible to prevent that glass paste G_p is scraped off by the nozzle 55a.

Further, it is possible to restrict coating height H_t in the vicinities of the start point P_s and the end point P_e in forming the second pattern $Pt2$ to a range within the allowable error ΔH_t from the standard coating height $StdH$.

Incidentally, the present example is also applicable to a case of coating glass paste G_p along a coating pattern other than the first pattern $Pt1$, shown in FIG. 3A, and the second pattern $Pt2$, shown in FIG. 3B.

Example 2

In Example 2 according to the present invention, a paste coating apparatus 100, shown in FIG. 1, is used wherein the coating head 5 is, as shown in FIGS. 6A and 6B, provided with a displacement sensor 56 for measuring a change (displacement) in the height (coating height H_t shown in FIG. 7A) of glass paste G_p coated on a substrate 8.

The displacement sensor 56 shown in FIG. 6B can be arranged, for example, similarly to the optical distance meter 54 so that the displacement sensor 56 measures the height from glass paste G_p to the nozzle 55a, based on the received light amount of a reflection light obtained by irradiating the peak portion (ridge portion) of glass paste G_p coated on the substrate 8. Further, as described later, the arrangement can be made such that the control section 9 (see FIG. 1) computes coating height H_t of glass paste

Gp, based on a measurement value by the displacement sensor 56.

Incidentally, instead of the displacement sensor 56, it is also possible to provide an image capturing device (an image capturing camera) that is capable of capturing an image of glass paste Gp coated on the substrate 8. In this case, further, an arrangement may be made such that, a focal length to the peak portion of glass paste Gp is measured, for example, by an autofocus function, and the control section 9 (See FIG. 1) computes coating height Ht of glass paste Gp, based on the measured focal length.

As shown in FIGS. 6A and 6B, the paste coating apparatus 100 (see FIG. 1) provided with the coating head 5 having the displacement sensor 56 coats glass paste Gp on the periphery of a predetermined region defined by the vapor-deposit section A1 of a substrate 8, for example, similarly to Example 1 as shown in FIG. 3A, such that glass paste Gp is coated up to a predetermined height (coating height Ht).

Further, similarly to Example 1, the control section 9 (see FIG. 1) of the paste coating apparatus 100 sets a start point Ps of starting movement of the nozzle 55a to, as shown in FIG. 3A, a point (the hollow circle) in the periphery of the vapor-deposit section A1 of the organic EL element on the substrate 8.

Then, the control section 9 forms the first pattern Pt1 by coating glass paste Gp from the start point Ps to the end point Pe (hollow square), similarly to Example 1.

When the nozzle 55a has made one circuit of the vapor-deposit section A1 and returns to the position of the start point Ps, the control section 9 (see FIG. 1) transmits a control signal to the valve 10b (see FIG. 1) of the pressurizing pipe 10c to close the valve. Further, the control section 9 moves the nozzle 55a with an overlap along the previously coated glass paste Gp. Herein, the nozzle 55a may move while going up.

The high pressure state of the pressure inside the syringe 55 is maintained due to the residual pressure of the jetting pressure even when supply of the jetting pressure to the syringe 55 (see FIG. 1) is stopped by closing the valve 10b, and coating of glass paste Gp from the nozzle 55a is continued. Accordingly, when the nozzle 55a moves

with an overlap with the previously coated glass paste Gp, glass paste Gp is coated with an overlap. Then, the pressure inside the syringe 55, to which supply of the jetting pressure has been stopped, gradually decreases. Accompanying the decrease in the pressure inside the syringe 55, the coating amount of glass paste Gp from the nozzle 55a (see FIG. 6A) decreases. Coating of glass paste Gp by the nozzle 55a stops when the pressure inside the syringe 55 has decreased approximately to the atmospheric pressure, and the nozzle 55a reaches the end point Pe (hollow square).

Glass paste GP is coated with an overlap from the start point Ps to the end point Pe in such a manner, and it is thereby possible to form the first pattern Pt1 that is approximately in a continuous rectangular shape without discontinuity, as shown in FIG. 3A, in the periphery of the vapor-deposit section A1 by coating glass paste Gp.

Further, in forming the first pattern Pt1 by coating glass paste GP on the substrate 8, the control section 9 (see FIG. 1) moves the nozzle 55a, setting nozzle height Nh such that coating height Ht of glass paste Gp to be coated on the substrate 8 becomes the predetermined standard coating height StdH (FIG. 8B).

For example, in case that the standard coating height StdH of coating height Ht is '30 μm ', the control section 9 moves the nozzle 55a, adjusting nozzle height Nh such that the coating height Ht of glass paste Gp becomes '30 μm '. Such nozzle height Nh is preferably set in advance. It is preferable that nozzle heights Nh in coating glass paste Gp are respectively set, for example, for the kinds of glass paste Gp, standard coating heights StdH, and moving speeds of the nozzle 55a. In coating glass paste Gp, the control section 9 obtains a measurement value by the optical distance meter 54 (see FIG. 6A), moves the Z-axis table 53 (see FIG. 6A) in Z-axis direction (vertical direction) such that the measurement value becomes nozzle height Nh having been set, and thereby maintains coating height Ht of glass paste Gp to be the standard coating height StdH (for example, 30 μm).

In the process for joining a sealing glass sheet, it is preferable that coating

height H_t of glass paste G_p is uniform over the whole circuit of the first pattern $Pt1$ so that the rise in temperature of glass paste G_p by irradiation with a laser beam becomes uniform over the whole circuit of the first pattern $Pt1$. In this situation, the control section 9 (see FIG. 1) is preferably arranged such as to adjust nozzle height N_h with high accuracy so that coating height H_t of glass paste G_p is maintained with high accuracy to be the standard coating height $StdH$.

However, a shape error in manufacturing or the like may cause, as shown in FIG. 7A for example, distortion and inclination of the tip end portion of the nozzle 55a. Further, as shown in FIG. 7B, distortion with a convex and/or concave curvature may be caused at the tip end portion of the nozzle 55a. In case that the shape of the tip end portion of the nozzle 55a is distorted in such a way, coating height H_t of glass paste G_p slightly changes, as shown, depending on the moving direction of the nozzle 55a represented by an arrow in the figure, even if nozzle height N_h is constant.

Further, also in case that inclination of the nozzle 55a with respect to the syringe 55 (see FIG. 1) or inclination of syringe 55 with respect to the substrate holding table 6 (see FIG. 1) is caused, coating height H_t of glass paste G_p slightly changes, depending on the moving direction of the nozzle 55a.

For example, even in case that the kind (viscosity and the like) of glass paste G_p , the jetting pressure, nozzle height N_h , and the moving speed of the nozzle 55a are unchanged, coating height H_t of glass paste G_p coated on a substrate 8 is different, depending on whether the nozzle 55a moves in X axis direction or in Y axis direction. Also, depending on the difference in the moving direction along X axis direction (horizontal direction in FIG. 3A), or depending on the difference in the moving direction along Y axis direction (vertical direction in FIG. 3A), coating height H_t of glass paste G_p coated on the substrate 8 is different.

In this situation, the paste coating apparatus 100 (see FIG. 1) according to Example 2 is arranged to be able to coat glass paste G_p at the standard coating height

StdH with high accuracy, absorbing a difference in coating height H_t caused by a difference in the moving direction of the nozzle 55a (see FIG. 1).

Concretely, prior to a process (coating process) for coating glass paste G_p on the substrate 8 (see FIG. 1) by moving the nozzle 55a along the periphery of the first pattern Pt1 (see FIG. 3A), the paste coating apparatus 100 executes a process (preparation process) for measuring in advance differences in coating height H_t due to differences in the moving direction of the nozzle 55a, and sets correction amounts (nozzle correction amounts ΔH) of nozzle height N_h that correspond respective coating heights H_t which are different depending on the moving direction of the nozzle 55a. Then, in the coating process for coating glass paste G_p on the substrate 8, the paste coating apparatus 100 moves the nozzle 55a, correcting the nozzle heights N_h for the respective moving directions of the nozzle 55a by the nozzle correction amounts ΔH having been set for the respective moving directions of the nozzle 55a, thus absorbs a differences in coating height H_t due to differences in the moving direction of the nozzle 55a, and can thereby coat glass paste G_p at the standard coating height StdH with high accuracy.

For example, as shown in FIG. 8A, in case that the vapor-deposit section A1 is in a rectangular shape having line portions extending along X axis direction and Y axis direction, when the control section 9 (see FIG. 1) executes the preparation process for setting nozzle correction amounts ΔH , the control section 9 sets the first pattern Pt1 (see FIG. 3A) to be a rectangular shape (a rectangular shape with rounded corners in more detail) along the periphery of the vapor-deposit section A1, and divides the first pattern Pt1 into X-direction moving portions (X1, X2) where the nozzle 55a moves in X axis direction and Y-direction moving portions (Y1, Y2) where the nozzle 55a moves in Y axis direction.

In Example 2, the X-direction moving portion X1 and the X-direction moving portion X2 face each other, and the respective moving directions of the nozzle 55a are

opposite to each other. For example, if the X-direction moving portion X1 is assumed to be a moving portion where the nozzle 55a moves to the right in the figure, then the X-direction moving portion X2 is assumed to be a moving portion where the nozzle 55a moves to the left in the figure. Likewise, the Y-direction moving portion Y1 and the Y-direction moving portion Y2 face each other, and the respective moving directions of the nozzle 55a are opposite to each other. For example, if the Y-direction moving portion Y1 is assumed to be a moving portion where the nozzle 55a moves upward in the figure, then the Y-direction moving portion Y2 is assumed to be a moving portion where the nozzle 55a moves downward in the figure.

Further, the Y-direction moving portion Y1 is assumed to be a moving portion where the nozzle 55a moves from the X-direction moving portion X1 to the X-direction moving portion X2, and the Y-direction moving portion Y2 is assumed to be a moving portion where the nozzle 55a moves from the X-direction moving portion X2 to the X-direction moving portion X1.

Further, when the nozzle 55a moves from the X-direction moving portion X1 to the Y-direction moving portion Y1 (that is, when the moving direction of the nozzle 55a changes at an edge portion of the vapor-deposit section A1), the nozzle 55a moves such as to draw an arc, and this moving portion is accordingly referred to as the corner moving portion C11. Likewise, the moving portion where the nozzle 55a moves from the Y-direction moving portion Y1 to the X-direction moving portion X2 is referred to as the corner moving portion C12, the moving portion where the nozzle 55a moves from the X-direction moving portion X2 to the Y-direction moving portion Y2 is referred to as the corner moving portion C22, and the moving portion where the nozzle 55a moves from the Y-direction moving portion Y2 to the X-direction moving portion X1 is referred to as the corner moving portion C21.

When the control section 9 (see FIG. 1) executes the preparation process for setting nozzle correction amounts ΔH as described above, the control section 9 divides

the first pattern Pt1 (see FIG. 3A) into eight portions corresponding to the moving directions of the nozzle 55a.

Incidentally, the lengths of the X-direction moving portions X1, X2, and the lengths of the Y-direction moving portions Y1, Y2 are not required to be the same lengths as the lengths of the respective sides of the vapor-deposit section A1, and can be any length that enables satisfactory measuring of coating height Ht. Further, the lengths of the corner moving portions C11, C12, C21, and C22 can also be any length that enables satisfactory measuring of coating height Ht.

Incidentally, it is preferable that setting of nozzle correction amounts ΔH by the preparation process is executed as appropriate, for example, when production of organic EL panels is started, when the nozzle 55a or the syringe 55 (see FIG. 1) is replaced, when the kind (viscosity and the like) of glass paste Gp to be coated on a substrate 8 (see FIG. 1) is changed, when the shape of the first pattern Pt1 (see FIG. 3A) is changed. Alternatively, setting of nozzle correction amounts ΔH may be periodically executed at predetermined temporal intervals.

Further, an arrangement may be made such that the preparation process is started, for example, by operation by a manager who manages the paste coating apparatus 100 (see FIG. 1), or the preparation process is automatically started by executing a program integrated in the control section 9 (see FIG. 1).

When the control section 9 (see FIG. 1) has started the preparation process, the control section 9 moves the nozzle 55a (see FIG. 1) to a start position, having the start position be, for example, a connection point Pcx2 between the corner moving portion C21 and the X-direction moving portion X1. Then, the control section 9 sets nozzle height Nh to a predetermined standard height (referred to as the initial height FNh) and opens the valve 10b (see FIG. 1) to thereby supply the jetting pressure to the syringe 55 (see FIG. 1), thus starting coating of glass paste Gp from the nozzle 55a.

Herein, a substrate 8 to be mounted on the substrate holding table 6 in

executing the preparation process can be any substrate for the preparation process, in other words, the substrate 8 is not required to be a substrate 8 with a vapor-deposited organic EL element.

The initial height FNh is preferably a standard nozzle height Nh, which enables coating of glass paste Gp at the standard coating height StdH on a substrate 8 (see FIG. 1), and is preferably a value predetermined, based on, for example, the kind of glass paste Gp, the standard coating height StdH, the moving speed of the nozzle 55a, and the like. For example, an arrangement can be made such that the control section 9 sets the initial height FNh, based on the kind of glass paste Gp, the moving speed of the nozzle 55a, and the like that a manager sets on the paste coating apparatus 100 (FIG. 1), using the monitor (see FIG. 1) and the keyboard 12 (see FIG. 1).

Adjusting the height of the nozzle 55a (see FIG. 1) so that nozzle height Nh becomes the initial height FNh, concretely, so that a measurement value by the optical distance meter 54 (see FIG. 1) becomes the value of the initial height FNh, the control section 9 (see FIG. 1) moves the nozzle 55a along the X-direction moving portion X1 at a moving speed having been set, and thus coats glass paste Gp on the substrate 8 (see FIG. 1) mounted on the substrate holding table 6 (see FIG. 1). Further, based on a measurement value by the displacement sensor 56, the control section 9 computes the vertical difference (a deviation amount) of coating height Ht of glass paste Gp coated on the substrate 8 from the standard coating height StdH, and sets a nozzle correction amount ΔH to this deviation amount.

For example, as shown in FIG. 8B, representing a measurement value, which is measured by the displacement sensor 56 (see FIG. 6A) when coating height Ht is the standard coating height StdH, by a standard measurement value L1, if an actual coating height Ht of glass paste Gp coated on the substrate 8 is different from the standard coating height StdH, a measurement value (an actual measurement value L2) by the displacement sensor 56 is different from the standard measurement value L1. In this

case, the control section 9 computes the difference between the standard measurement value $L1$ and the actual measurement value $L2$ ($L1-L2$), and can thereby compute the deviation amount (nozzle correction amount ΔH) of coating height Ht from the standard coating height $StdH$.

The control section 9 may compute the deviation amount (nozzle correction amount ΔH) of coating height Ht from the standard coating height $StdH$ at arbitrary several points on the X-direction moving portion $X1$.

For example, as shown in FIG. 8C, setting plural measurement points ($P1$ to $P5$ are shown as an example in FIG. 8C) on the X-direction moving portion $X1$, the control section 9 (see FIG. 1) obtains measurement values (actual measurement values $L2$) by the displacement sensor 56 at the measurement points $P1$ to $P5$. Then, the control section 9 computes respective differences between the standard measurement value $L1$ and the actual measurement values $L2$ at the measurement points $P1$ to $P5$, and assigns the average value of the differences at the measurement points $P1$ to $P5$ to the nozzle correction amount ΔH ($\Delta HX1$) at the X-direction moving portion $X1$.

Incidentally, in Example 2, a deviation amount (a nozzle correction amount ΔH) of a coating height Ht is taken to be positive in case coating height Ht is higher than the standard coating height $StdH$, and taken to be negative in case coating height Ht is lower than the standard coating height $StdH$.

Likewise, the control section 9 computes a nozzle correction amount $\Delta HC11$ at the corner moving portion $C11$, a nozzle correction amount $\Delta HY1$ at the Y-direction moving portion $Y1$, a nozzle correction amount $\Delta HC12$ at the corner moving portion $C12$, a nozzle correction amount $\Delta HX2$ at the X-direction moving portion $X2$, a nozzle correction amount $\Delta HC22$ at the corner moving portion $C22$, a nozzle correction amount $\Delta HY2$ at the Y-direction moving portion $Y2$, and a nozzle correction amount $\Delta HC21$ at the corner moving portion $C21$.

Further, the control section 9 preferably stores all of the nozzle correction

amounts ΔH ($\Delta HX1$, $\Delta HC11$, $\Delta HY1$, $\Delta HC12$, $\Delta HX2$, $\Delta HC22$, $\Delta HY2$, $\Delta HC21$) in a storage section, not shown.

With an arrangement of computing the nozzle correction amounts ΔH ($\Delta HX1$, $\Delta HC11$, $\Delta HY1$, $\Delta HC12$, $\Delta HX2$, $\Delta HC22$, $\Delta HY2$, $\Delta HC21$) in such a manner, the preparation process sets nozzle correction amounts ΔH for the respective moving directions of the nozzle 55a (see FIG. 1) along the periphery of the vapor-deposit section A1.

The preparation process is a process that executes for the each moving direction of the nozzle 55a the process for, when glass paste Gp is coated accompanying the movement of the nozzle 55a with nozzle height Nh having been set to the initial height FNh, setting the nozzle correction amount ΔH to the deviation between coating height Ht of glass paste Gp and the standard coating height StdH.

Further, as shown in FIG. 9, in executing the coating process for coating glass paste Gp on the substrate 8 provided with the vapor-deposit section A1 by vapor-depositing an organic EL element, if the start point Ps is at the X-direction moving portion X1, the control section 9 moves the nozzle 55a to the start point Ps and sets nozzle height Nh to a value corrected from the initial height FNh by the nozzle correction amount $\Delta HX1$. That is, the control section 9 corrects nozzle height Nh by the nozzle correction amount $\Delta HX1$.

For example, if coating height Ht at the X-direction moving portion X1 is higher than the standard coating height StdH, in other words, the deviation amount of coating height Ht from the standard coating height StdH is positive (the nozzle correction amount $\Delta HX1$ is positive), the control section 9 determines that coating height Ht of glass paste Gp at the X-direction moving portion X1 is high than appropriate, and sets nozzle height Nh to a height lower than the initial height FNh by an amount equivalent to the nozzle correction amount $\Delta HX1$. On the other hand, if the deviation amount of coating height Ht from the standard coating height StdH is negative

(the nozzle correction amount $\Delta HX1$ is negative), the control section 9 determines that coating height Ht of glass paste Gp at the X-direction moving portion $X1$ is lower than appropriate, and sets nozzle height Nh to a height higher than the initial height FNh by an amount equivalent to the nozzle correction amount $\Delta HX1$.

That is, if the nozzle correction amount $\Delta HX1$ is positive, nozzle height Nh is corrected to a direction downward, and if the nozzle correction amount $\Delta HX1$ is negative, nozzle height Nh is corrected to a direction upward

Then, the control section 9 moves the nozzle 55a along the X-direction moving portion $X1$, maintaining nozzle height Nh having been corrected, and thus coats glass paste Gp on the substrate 8.

Further, in case of moving the nozzle 55a along the corner moving portion $C11$ continuously from the movement along the X-direction moving portion $X1$, the control section 9 (see FIG. 1) corrects nozzle height Nh at the connection point $Pxc1$ between the X-direction moving portion $X1$ and the corner moving portion $C11$ by the nozzle correction amount $\Delta HC11$. That is, the control section 9 sets nozzle height Nh to a value corrected from the initial height FNh by the nozzle correction amount $\Delta HC11$. Then, the control section 9 moves the nozzle 55a along the corner moving portion $C11$, maintaining the corrected nozzle height Nh , and thus coats glass paste Gp on the substrate 8.

Likewise, the control section 9 (see FIG. 1) corrects the nozzle height Nh at the connection point $Pcy1$ between the corner moving portion $C11$ and the Y-direction moving portion $Y1$ by the nozzle correction amount $\Delta HY1$, then moves the nozzle 55a along the Y-direction moving portion $Y1$, maintaining the corrected nozzle height Nh , and thus coats the glass paste Gp on the substrate 8.

Further, the control section 9 corrects the nozzle height Nh at the connection point $Pyc1$ between the Y-direction moving portion $Y1$ and the corner moving portion $C12$ by the nozzle correction amount $\Delta HC12$, then moves the nozzle 55a along the

corner moving portion C12, maintaining the corrected nozzle height N_h , and thus coats the glass paste Gp on the substrate 8.

Still further, the control section 9 corrects the nozzle height N_h at the connection point Pcx1 between the corner moving portion C12 and the X-direction moving portion X2 by the nozzle correction amount $\Delta HX2$, then moves the nozzle 55a along the X-direction moving portion X2, maintaining the corrected nozzle height N_h , and thus coats the glass paste Gp on the substrate 8.

Yet further, the control section 9 corrects the nozzle height N_h at the connection point Pxc2 between the X-direction moving portion X2 and the corner moving portion C22 by the nozzle correction amount $\Delta HC22$, then moves the nozzle 55a along the corner moving portion C22, maintaining the corrected nozzle height N_h , and thus coats the glass paste Gp on the substrate 8.

Further, the control section 9 corrects the nozzle height N_h at the connection point Pcy2 between the corner moving portion C22 and the Y-direction moving portion Y2 by the nozzle correction amount $\Delta HY2$, then moves the nozzle 55a along the Y-direction moving portion Y2, maintaining the corrected nozzle height N_h , and thus coats the glass paste Gp on the substrate 8.

Still further, the control section 9 corrects the nozzle height N_h at the connection point Pyc2 between the Y-direction moving portion Y2 and the corner moving portion C21 by the nozzle correction amount $\Delta HC21$, then moves the nozzle 55a along the corner moving portion C21, maintaining the corrected nozzle height N_h , and thus coats the glass paste Gp on the substrate 8.

Yet further, the control section 9 corrects the nozzle height N_h at the connection point Pcx2 between the corner moving portion C21 and the X-direction moving portion X1 by the nozzle correction amount $\Delta HX1$, then moves the nozzle 55a along the X-direction moving portion X1, maintaining the corrected nozzle height N_h , and thus coats the glass paste Gp on the substrate 8.

As described above, in the coating process that coats the glass paste Gp on the substrate 8 (see FIG. 3A), moving the nozzle 55a (see FIG. 3A) along the periphery of the vapor-deposited section A1 (see FIG. 3A), the control section 9 coats the glass paste Gp on the substrate 8 for the respective moving directions, moving the nozzle 55a with corrections of the nozzle height Nh by the nozzle correction amounts ΔH ($\Delta HX1$, $\Delta HC11$, $\Delta HY1$, $\Delta HC12$, $\Delta HX2$, $\Delta HC22$, $\Delta HY2$, $\Delta HC21$) corresponding to the respective moving directions.

In such a manner, on the coating apparatus 100 (see FIG. 1) according to Example 2, the control section 9 executes the preparation process prior to the coating process for coating the glass paste Gp on the substrate 8 (see FIG. 1), wherein, based on the difference in the coating height Ht due to a difference in the moving direction of the nozzle 55a (see FIG. 1), the control section 9 sets a nozzle correction amount ΔH for correction of the nozzle height Nh individually for each moving direction of the nozzle 55a. Further, in the coating process in which the control section 9 moves the nozzle 55a along the periphery of the vapor-deposited section A1 (see FIG. 1), the control section 9 corrects the nozzle height Nh by a nozzle correction amount ΔH for each moving direction of the nozzle 55a, and thus coats the glass paste GP on the substrate 8.

With this arrangement, it is possible to absorb differences in the coating height Ht caused by differences in the moving direction of the nozzle 55a, and coat the glass paste Gp on the substrate 8 at the standard coating height StdH with high accuracy.

An arrangement may be made to execute the preparation process such as to compute, when the syringe 55 (see FIG. 1) or the nozzle 55a (see FIG. 1) has been replaced, plural nozzle correction amounts ΔH in advance, corresponding to plural combinations of the kind of glass paste Gp, the moving speed of the nozzle 55a, and the standard coating height StdH.

Further, an arrangement may be made such that, for example, at the time of

starting the coating process for coating the glass paste Gp on the substrate 8 (see FIG. 1), when a manager of the paste coating apparatus 100 (see FIG. 1) has set the kind of glass paste GP, the moving speed of the nozzle 55a, and the standard coating height StdH, using the monitor 11 (see FIG. 1) or the keyboard 12 (see FIG. 1), the control section 9 reads a corresponding initial height FNh and nozzle correction amounts ΔH ($\Delta HX1, \Delta HC11, \Delta HY1, \Delta HC12, \Delta HX2, \Delta HC22, \Delta HY2, \Delta HC21$) from the storage section, not shown, and coats the glass paste Gp on the substrate 8, correcting a nozzle height Nh as appropriate.

Further, the configuration of the paste coating apparatus 100 is not limited to a configuration including the displacement sensor 56 (see FIG. 6A) at the coating head 5 (see Fig. 1). For example, the paste coating apparatus 100 may be configured as follows. That is, setting the initial height FNh to the nozzle height Nh, the control section 9 (see FIG. 1) moves the nozzle 55a at all of the moving portions (X-direction moving portions X1, X2, Y-direction moving portions Y1, Y2, corner moving portions C11, C12, C22, C21), and thus coats glass paste Gp on a substrate 8. Thereafter, by a measurement device, not shown, provided with a displacement sensor 56, deviations between the coating height Ht of glass paste Gp and the reference coating height reference coating height StdH are measured at all the moving portions, and the measured deviations at the respective moving portions are set as the nozzle correction amounts ΔH ($\Delta HX1, \Delta HC11, \Delta HY1, \Delta HC12, \Delta HX2, \Delta HC22, \Delta HY2, \Delta HC21$) at the respective moving portions.

According to the invention, it is possible to provide a paste coating apparatus and a paste coating method that enable satisfactorily maintaining of coating height of glass paste in a predetermined error range.

What is claimed is:

1. A paste coating apparatus, comprising:
 - a nozzle for continuously coating paste; and
 - a control section for continuously coating the paste in a periphery of a predetermined region on a plane of a substrate, by moving the nozzle, wherein the control section:
 - moves the nozzle, setting nozzle height from the substrate to the nozzle to be lower than a predetermined standard height, at a start end portion that extends by a predetermined length from a start point of starting movement of the nozzle;
 - moves the nozzle, setting the nozzle height to be higher than the standard height, at a terminal end portion that extends by another predetermined length to an end point of terminating the movement of the nozzle;
 - moves the nozzle, setting the nozzle height to be the standard height at a part excluding the start end portion and the terminal end portion; and
 - moves the nozzle such that the paste is coated with an overlap at least partially between the start end portion and the terminal end portion.
2. The paste coating apparatus according to claim 1,
 - wherein at the start end portion, the control section sets the nozzle height to be lower than the standard height by an amount equivalent to an allowable error allowed for coating height of the paste to be coated on the substrate,
 - and wherein at the terminal end portion, the control section sets the nozzle height to be higher than the standard height by the amount equivalent to the allowable error.
3. The paste coating apparatus according to claim 1 or 2,
 - wherein the control section moves the nozzle such as to form the start end

portion along the periphery of the region, setting the start point to a point in the periphery of the region, and to form the terminal end portion along the periphery of the region, setting the end point to be another point in the periphery of the region, such that the terminal end portion and the start end portion at least partially overlap with each other.

4. The paste coating apparatus according to claim 3, further comprising:
a paste storage section for storing the paste; and
a pressure source for supplying a jetting pressure to the paste storage section to coat the paste from the nozzle,

wherein supply of the jetting pressure from the pressure source to the paste storage section is stopped before the terminal end portion is formed.

5. The paste coating apparatus according to claim 1 or 2,
wherein, setting the start point to a point outside the periphery of the region, the control section moves the nozzle from the start point toward the periphery of the region to form the start end portion,

and wherein, setting the end point to another point outside the periphery of the region, the control section moves the nozzle from the periphery of the region toward the end point to form the terminal end portion such that the terminal end portion intersects with the start end portion.

6. A paste coating method of continuously coating paste in a periphery of a predetermined region on a plane of a substrate by moving a nozzle for continuously coating the paste, comprising:

a start end portion forming process that moves the nozzle, setting nozzle height from the substrate to the nozzle to be lower than a predetermined standard height, and

thereby forms a start end portion that extends by a predetermined length from a start point of starting movement of the nozzle;

a terminal end portion forming process that moves the nozzle, setting the nozzle height to be higher than the standard height, and thereby forms a terminal end portion that extends by another predetermined length to an end point of terminating the movement of the nozzle; and

a normal moving process that moves the nozzle, setting the nozzle height to be the standard height at a part excluding the start end portion and the terminal end portion,

wherein the nozzle is moved such that the paste is coated with an overlap at least partially between the start end portion and the terminal end portion.

7. The paste coating method according to claim 6,

wherein the start end portion forming process sets the nozzle height to be lower than the standard height by an amount equivalent to an allowable error allowed for coating height of the paste to be coated on the substrate,

and wherein the terminal end portion forming process sets the nozzle height to be higher than the standard height by the amount equivalent to the allowable error.

8. The paste coating method according to claim 6 or 7,

wherein the start end portion forming process moves the nozzle along the periphery of the region, setting the start point to a point in the periphery of the region, and thus forms the start end portion,

and wherein the terminal end portion forming process moves the nozzle along the periphery of the region, setting the end point to be another point in the periphery of the region, such that the terminal end portion overlaps at least partially with the start end portion, and thus forms the terminal end portion.

9. The paste coating method according to claim 8, further comprising:
a coating stopping process that stops coating of the paste,
wherein the coating stopping process is executed prior to execution of the terminal end portion forming process.
10. The paste coating method according to claim 6 or 7,
wherein, setting the start point to a point outside the periphery of the region,
the start end portion forming process moves the nozzle toward the periphery of the region, and thus forms the start end portion,
and wherein, setting the end point to another point outside the periphery of the region, the terminal end portion forming process moves the nozzle from the periphery of the region toward the end point such that the terminal end portion intersects with the start end portion, and thus forms the terminal end portion.
11. A paste coating method of continuously coating paste in a periphery of a predetermined region on a plane of a substrate by moving a nozzle for continuously coating the paste along the periphery of the region, comprising:
a preparation process that sets correction amounts of nozzle height that is from the substrate to the nozzle in moving the nozzle, for respective moving directions during the movement of the nozzle along the periphery of the region; and
a coating process that moves the nozzle along the periphery of the region, correcting the nozzle height by the correction amounts corresponding to the respective moving directions of the nozzle.
12. The paste coating method according to claim 11,
wherein, for each moving direction of the nozzle along the periphery of the region, the preparation process executes a process that sets the correction amount to a

difference between coating height of the paste coated on the substrate when the nozzle moves with the nozzle height being set to a standard height, and the standard coating height to be a target value of the coating height.

13. A paste coating apparatus that coats paste in a periphery of a predetermined region on a plane of a substrate, comprising:
- a nozzle for coating the paste,
 - wherein the paste is coated by moving the nozzle,
 - and wherein the paste is coated on the substrate by the paste coating method according to claim 11 or 12.