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

Embodiments~~In this situation, an object~~ of the present invention seek~~s~~ 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 a first aspect, there is provided a paste coating apparatus, comprising:

a support table which has a length in a longitudinal direction, a width in a width direction and a height in a height direction;

a substrate holding table on which a substrate is mounted, the substrate holding table being arranged on the support table;

a nozzle for coating paste on the substrate; and

a moving unit which moves the nozzle in the longitudinal direction, the width direction or the height direction,

wherein the paste coating apparatus continuously coats the paste in a periphery of a predetermined region on a plane of a substrate, by moving the nozzle,

and wherein the paste coating apparatus further comprises:

a control section which

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; and

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,

and wherein the allowable error is an allowable range of a coating height for preferably joining the substrate by making temperature rise of the paste by heat irradiation be uniform over a whole circuit of a coating pattern when the substrate is joined.

According to a second aspect, there is provided 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,

the method being performed by a past coating apparatus including:

a support table which has a length in a longitudinal direction, a width in a width direction and a height in a height direction;

a substrate holding table on which a substrate is mounted, the substrate holding table being arranged on the support table;

a nozzle for coating paste on the substrate; and

a moving unit which moves the nozzle in the longitudinal direction, the width direction or the height direction,

and wherein the method comprises:

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 controlled to move such that the paste is coated with an overlap at least partially between the start end portion and the terminal end portion

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,

and wherein the allowable error is an allowable range of a coating height for preferably joining the substrate by making temperature rise of the paste by heat irradiation be uniform over a whole circuit of a coating pattern when the substrate is joined.

According to a third aspect, there is provided 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 in a X axis direction and/or a Y axis direction, 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,

and wherein, for each of an X axis direction moving part, a Y axis direction moving part, a reverse X axis direction moving part of which moving direction is opposite to a moving direction of the X axis direction moving part, a reverse Y axis direction moving part of which moving direction is opposite to a moving direction of the Y axis direction moving part, a first corner moving part that connects the X axis direction moving part to the Y axis direction moving part, a second corner moving part that connects the Y axis direction moving part to the reverse X axis direction moving part, a third corner moving part that connects the reverse X axis direction moving part to the reverse Y axis direction moving part, and a fourth corner moving part that connects the reverse Y axis direction moving part to the X axis direction moving part along the periphery of the region,

the preparation process executes in advance by using a substrate which is for the preparation process 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 so as to correct an error in a paste coating height for each of moving directions, the error being generated by a deformation of a distal end portion of the nozzle in the X axis direction and/or in the Y axis direction.

According to a fourth aspect, there is provided a paste coating apparatus that coats paste in a periphery of a predetermined region on a plane of a substrate, comprising:

a support table which has a length in a longitudinal direction, a width in a width direction and a height in a height direction;

a substrate holding table on which a substrate is mounted, the substrate holding table being arranged on the support table;

a nozzle for coating paste on the substrate, and

a moving unit which moves the nozzle in the longitudinal direction, the width direction or the height direction,

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 the third aspect.

According to an embodiment~~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 an embodiment~~the invention~~, paste is coated in such a manner.

Further, according to an embodiment~~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 an embodiment~~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 dhows connection points where nozzle height Nh is changed in coating glass paste.