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Device for etching the periphery edge of a substrate and method for controlling etching thereof

Abstract

The present invention relates to a substrate edge etching apparatus including: a substrate support assembly having a horizontally rotatable chuck base, chuck pins disposed on top of the chuck base to support a substrate, a purge gas inlet hole extending from an underside center of the chuck base to an interior of the chuck base in an upward and downward direction thereof, and a purge gas outlet hole extending radially from the purge gas inlet hole and then extending upwardly to penetrate top of the chuck base; a purge gas supply assembly for supplying a purge gas to the purge gas inlet hole; a chemical liquid supply unit for supplying a chemical liquid to top of the substrate; a bowl assembly having bowls surrounding the periphery of the substrate support assembly and configured to be able to ascend and descend; and a fan filter unit spaced apart from top of the substrate support assembly.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION OF THE INVENTION

(1) The present application claims the benefit of Korean Patent Application No. 10-2022-0022448 filed in the Korean Intellectual Property Office on Feb. 21, 2022, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

(2) The present invention relates to a substrate edge etching apparatus and a method for controlling etching thereof, and more specifically, to a substrate edge etching apparatus and a method for controlling etching thereof that are capable of etching a peripheral edge of a substrate by means of the application of a chemical liquid thereto, in a state where a treatment surface of the substrate, on

which a circuit pattern is formed, is facingly placed on top thereof, while an etched amount is being controlled.

Background of the Related Art

(3) Generally, a process of forming a circuit pattern on a substrate includes various steps such as oxidation, photolithography, etching, deposition, metallization, and the like, which are performed on one surface of the substrate.

(4) While such steps are being performed, all kinds of foreign substances are attached to a peripheral edge of the substrate to the form of layers.

(5) Accordingly, the peripheral edge of the substrate cannot be utilized in forming the circuit pattern, and of course, it actually has no circuit pattern formed thereon.

(6) If the peripheral edge of the substrate is fixed by chuck pins to perform the circuit pattern formation process, however, the layers of foreign substances attached to the peripheral edge of the substrate may be cracked, so that the foreign substances may enter the inside of the substrate, and otherwise, particles generated from the foreign substances may invade the inside of the substrate, thereby making it difficult to form the circuit pattern on the substrate.

(7) To prevent such problems from occurring, there is a need to in advance etch and remove the layers of foreign substances formed on the peripheral edge of the substrate, and FIG. **1** schematically shows a process of etching a peripheral edge of a substrate.

(8) The substrate edge etching is largely divided into wet etching and dry etching.

(9) The wet etching is performed by protecting a portion to be not etched on top of a substrate by means of a mask, submerging the substrate into a chemical liquid (etching liquid) filled in a bath, and etching the peripheral edge of the substrate.

(10) The dry etching is performed by generating plasma, exciting reactive gas in the plasma, and etching the peripheral edge of the substrate.

(11) If a relatively wide peripheral edge of the substrate is etched, a real area on which a circuit pattern is formed becomes small inefficiently, and contrarily, if a relatively narrow peripheral edge of the substrate is etched, the layers of foreign substances attached to the peripheral edge of the substrate are partially broken when the peripheral edge of the substrate is fixed by the chuck pins. Accordingly, the peripheral edge of the substrate has to be etched in an appropriate width.

(12) The conventional wet etching has the process of protecting the portion where the circuit pattern is formed by means of the mask and the process of removing the mask after etching, so that disadvantageously, etching time may be extended and the etching may be performed in a complicated configuration.

(13) If it is desired to adjust a width of an etched portion, further, the mask has to be frequently changed into masks with different diameters, which causes the etching to be performed inconveniently and needs long etching time.

SUMMARY OF THE INVENTION

(14) Accordingly, the present invention has been made in view of the above-mentioned problems occurring in the related art, and it is an object of the present invention to provide a substrate edge etching apparatus and a method for controlling etching thereof that are capable of rotating a chuck base to perform etching, in a state where a substrate is reversely located on the chuck base to allow a treatment surface on which a circuit pattern is formed to be facingly on top of the chuck base, while a chemical liquid is being supplied to top of the substrate and a purge gas such as nitrogen gas N2 and the like is being supplied to underside of the substrate, thereby keeping a given etched amount on the peripheral edge of the substrate.

(15) To accomplish the above-mentioned objects, according to one aspect of the present invention, there is provided a substrate edge etching apparatus including: a substrate support assembly having a horizontally rotatable chuck base, chuck pins disposed on top of the chuck base to support a substrate, a purge gas inlet hole extending from an underside center of the chuck base to an interior of the chuck base in an upward and downward direction thereof, and a purge gas outlet hole

extending radially from the purge gas inlet hole and then extending upwardly to penetrate top of the chuck base; a purge gas supply assembly for supplying a purge gas to the purge gas inlet hole; a chemical liquid supply unit for supplying a chemical liquid to top of the substrate; a bowl assembly having bowls surrounding the periphery of the substrate support assembly and configured to be able to ascend and descend; and a fan filter unit spaced apart from top of the substrate support assembly.

(16) To accomplish the above-mentioned objects, according to another aspect of the present invention, there is provided a method for controlling etching of the substrate edge etching apparatus according to one aspect of the present invention, the method including the step of controlling any one or more of a rotational speed of the substrate support assembly, a flow rate of the purge gas supplied from the purge gas supply assembly, a flow rate of the chemical liquid supplied from the chemical liquid supply unit, and a height to the top of the bowl from top of the substrate to thus adjust an etched amount.

(17) According to the present invention, desirably, if the etched amount is less than a given reference value, the rotational speed of the substrate support assembly is decreased, and if the etched amount is more than the given reference value, the rotational speed of the substrate support assembly is increased, so that the etched amount corresponds to the given reference value.

(18) According to the present invention, desirably, if the etched amount is less than a given reference value, the flow rate of the purge gas is decreased, and if the etched amount is more than the given reference value, the flow rate of the purge gas is increased, so that the etched amount corresponds to the given reference value.

(19) According to the present invention, desirably, if the etched amount is less than a given reference value, the flow rate of the chemical liquid is increased, and if the etched amount is more than the given reference value, the flow rate of the chemical liquid is decreased, so that the etched amount corresponds to the given reference value.

(20) According to the present invention, desirably, if the etched amount is less than a given reference value, the height to the top of the bowl from top of the substrate is increased to decrease a flow speed of air passing between the bowls and the peripheral edge of the substrate, and if the etched amount is more than the given reference value, the height to the top of the bowl from top of the substrate is decreased to increase the flow speed of air, so that the etched amount corresponds to the given reference value.

(21) According to the present invention, desirably, any one or more of the rotational speed of the substrate support assembly, the flow rate of the purge gas supplied from the purge gas supply assembly, the flow rate of the chemical liquid supplied from the chemical liquid supply unit, and the height to the top of the bowl from top of the substrate are controlled to thus adjust the number of etched portions invaded unevenly on the periphery of the underside of the substrate.

(22) According to the present invention, desirably, the number of etched portions invaded is adjusted to two or less.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The above and other objects, features and advantages of the present invention will be apparent from the following detailed description of the embodiments of the invention in conjunction with the accompanying drawings, in which:

(2) FIG. **1** is a schematic view showing a process of etching an edge of a substrate;

(3) FIG. **2** is a longitudinal sectional view showing a substrate edge etching apparatus according to the present invention;

(4) FIG. **3** is a longitudinal sectional view showing a substrate support assembly and a purge gas

supply assembly of FIG. **2**;
(5) FIG. **4** is a graph showing a relation between a rotational speed of the substrate support assembly and an etched amount according to the present invention;
(6) FIG. **5** is a graph showing a relation between a flow rate of a purge gas and an etched amount according to the present invention;
(7) FIG. **6** is a graph showing a relation between a flow rate of a chemical liquid supplied and an etched amount according to the present invention; and
(8) FIG. **7** is a graph showing a relation between heights of bowls and an etched amount according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

(9) Hereinafter, an embodiment of the present invention will be explained in detail with reference to the attached drawings.
(10) As shown in FIGS. **2** and **3**, a substrate edge etching apparatus **1000** includes: a substrate support assembly **100** having a horizontally rotatable chuck base **110**, chuck pins **120** disposed on top of the chuck base **110** to support a substrate W, a purge gas inlet hole **111** extending from an underside center of the chuck base **110** to an interior of the chuck base **110** in an upward and downward direction thereof, and a purge gas outlet hole **112** extending radially from the purge gas inlet hole **111** and then extending upwardly to penetrate top of the chuck base **110**; a purge gas supply assembly **300** for supplying a purge gas to the purge gas inlet hole **111**; a chemical liquid supply unit **600** for supplying a chemical liquid to top of the substrate W; a bowl assembly **700** having bowls **710** surrounding the periphery of the substrate support assembly **100** and configured to be able to ascend and descend; and a fan filter unit (not shown) spaced apart from top of the substrate support assembly **100**.
(11) Under the above-mentioned configuration, in a state where the substrate W is reversely located on the chuck base **110** to allow a treatment surface on which a circuit pattern formation layer W**1** is formed to be facingly on top of the chuck base **110**, the chuck base **110** rotates. In this case, the chemical liquid is supplied to top (that is, underside) of the substrate W from the chemical liquid supply unit **600**, and the purge gas such as nitrogen gas N2 and the like is supplied to underside (that is, the treatment surface) of the substrate W from the purge gas supply assembly **300**, so that the chemical liquid can be prevented from being introduced into the inside of the substrate W from the peripheral edge of the substrate W.
(12) The purge gas is introduced from the purge gas inlet hole **111**, passes through the purge gas outlet hole **112**, and is thus exhausted through a space between the substrate W and top of the chuck base **110**.
(13) If the chemical liquid is supplied to top of the substrate W, the chemical liquid somewhat enters a radial inside of the substrate W from the periphery of the substrate W by means of surface tension thereof and is then discharged to the outside of the substrate W by means of various reasons, so that the etching of the peripheral edge of the substrate W is cleanly performed.
(14) The purge gas is a gas supplied to prevent particles in the air from entering the circuit pattern forming layer W**1** of the substrate W, and representatively, an inert gas such as N2 may be used as the purge gas.
(15) The bowl assembly **700** serves to receive the chemical liquid scattering from the substrate W and the chuck base **110** and discharge the received chemical liquid and includes the bowls **710** and driving units **720** such as motors or pressure cylinders to movably ascend and descend the bowls **710**.
(16) Further, the bowls **710** of the bowl assembly **700** are overlaid onto one another in radial directions thereof and movably ascended and descended independently of one another by means of the driving units **720** connected correspondingly to the bowls **710**.
(17) The fan filter unit (not shown) is disposed on top of a chamber (not shown) in which the substrate edge etching apparatus **1000** is accommodated and thus serves to supply external air

filtered to the inside of the chamber.
(18) Hereinafter, an explanation on parts not mentioned above will be given with reference to FIGS. **2** and **3**. Before the explanation, the purge gas supply assembly **300** as will be discussed later is just one example, and accordingly, various examples of the purge gas supply assembly **300** may be provided.
(19) In specific, the purge gas supply assembly **300** includes a purge gas guide tube **310** spaced apart from a periphery of the purge gas inlet hole **111** to surround the periphery of the purge gas inlet hole **111** in a radial direction thereof in a plan view and having a hollow hole **311** penetratingly extending in the upward and downward direction thereof in a side view and a hollow tube-shaped purge gas guide tube support shaft **320** spacedly overlaid onto top of the purge gas guide tube **310** in an outer radial direction of the purge gas guide tube **310** and adapted to mount a bearing **400** thereonto to support the driving shaft **210**.
(20) Under the above-mentioned configuration, the purge gas such as N2 and the like is introduced through the purge gas guide tube **310**. Next, a given amount of the purge gas is exhausted through the purge gas inlet hole **111** and the purge gas outlet hole **112** formed on the chuck base **110** to the space between the substrate W and top of the chuck base **110**, thereby performing a purge function, and simultaneously, the rest of the purge gas is exhausted to the outside in a direction distant from the substrate W through a path between the purge gas inlet hole **111** and the purge gas guide tube **310** and the bearing **400**, thereby preventing external particles from entering the substrate W through the bearing **400**.
(21) In specific, the chuck base **110** has a purge gas introduction tube **113** extending downward from the underside thereof to communicate with the purge gas inlet hole **111**, and if the purge gas introduction tube **113** is disposed spaced apart from the purge gas guide tube **310** inside the purge gas guide tube **310** in a radial direction thereof, the path through which the rest of the purge gas passes can be clearly defined, so that a flow rate of the purge gas is introduced dividedly in a relatively accurate way.
(22) Under the above-mentioned configuration, a path P**1** formed between the purge gas introduction tube **113** and the purge gas guide tube **310**, a path P**2** formed between the underside of the chuck base **110** and the top end of the purge gas guide tube **310**, and a path P**3** formed between the purge gas guide tube support shaft **320** and the driving shaft **210** provide a first purge gas exhaust path EX**1**.
(23) As the purge gas is exhausted to the outside through the first purge gas exhaust path EX**1**, a flow of external air is not introduced into a purge area through the bearing **400**, thereby preventing the circuit pattern formation layer W**1** of the substrate W from being damaged and easily discharging the particles introduced through a connecting part **170** between the driving shaft **210** and the chuck base **110** to the outside.
(24) The bearing **400** is formed of a rolling bearing, but it may be formed of a non-contact bearing such as a magnetic bearing.
(25) Further, the purge gas guide tube **310** has a plurality of communication holes **312** spaced apart from one another on an upper peripheral surface thereof in a circumferential direction thereof, and accordingly, the path P**1** formed between the purge gas guide tube **310** and the purge gas introduction tube **113**, the plurality of communication holes **312**, and a path P**4** formed between the purge gas guide tube **310** and the purge gas guide tube support shaft **320** provide a second purge gas exhaust path EX**2**.
(26) Under the above-mentioned configuration, the rest of the purge gas entering the path P**1** between the purge gas guide tube **310** and the purge gas introduction tube **113** excepting a given amount of the purge gas passing through the first purge gas exhaust path EX**1** is exhausted through the second purge gas exhaust path EX**2**, so that it is possible to completely discharge the foreign substances remaining between the purge gas guide tube **310** and the purge gas guide tube support shaft **320**.

(27) While the chuck base **110** is rotating, in specific, a pressure around a connected portion between the purge gas guide tube **310** and the purge gas guide tube support shaft **320** becomes decreased to prevent particles in the flow of external air from entering through a minute gap occurring in a coupled structure between the purge gas guide tube **310** and the purge gas guide tube support shaft **320**.
(28) In a plan view, further, the chuck base **110** has a bypass path **114** formed on a center of top thereof to communicate with the purge gas outlet hole **112**, thereby preventing a negative pressure from being generated from the space S between the chuck base **110** and the substrate W to keep the substrate W from sagging down toward the top of the chuck base **110** or to keep external particles from being collected to the space S.
(29) Further, in a longitudinal sectional view, the chuck base **110** is configured to have an inside part **115** and an outside part **116** with respect to the purge gas outlet hole **112**, and in this case, the inside part **115** is lower in height than the outside part **116** (See a reference symbol 't' of FIG. **3**). Accordingly, the substrate W can be prevented from sagging down and coming into contact with top of the inside part **115** of the chuck base **110**.
(30) Further, the purge gas supply assembly **300** has a tube fitting **380** connected to an open lower end periphery of the purge gas guide tube **310** to connect a tube **370** on which a mass flow controller (MFC) **390** is mounted thereto.
(31) Hereinafter, a method for controlling etching of the substrate edge etching apparatus **1000** to thus adjust an etched amount (width of an etched portion) will be explained with reference to FIGS. **4** to **7**.
(32) FIGS. **4** to **7** are graphs showing the numerical values obtained through real tests, and conditions of the tests are indicated on the graphs.
(33) Further, dotted lines are curves that are obtained by linearizing individual values of etched amounts to show total etched amounts.
(34) Firstly, a rotational speed of the substrate support assembly **100** is controlled to adjust an etched amount.
(35) For example, as shown in FIG. **4**, if the rotational speed of the substrate support assembly **100** becomes increased, the etched amount becomes decreased.
(36) In specific, if the rotational speed of the substrate support assembly **100** becomes increased, a centrifugal force applied to the chemical liquid attached to the underside of the substrate W becomes increased to easily overcome the surface tension of the chemical liquid with respect to the substrate W, so that the chemical liquid escapes from the substrate W.
(37) Further, a relation between the rotational speed of the substrate support assembly **100** and the etched amount is obtained on conditions that a flow rate of the purge gas is 180 LPM, a flow rate of the chemical liquid is 1300 cc/min, and a height h to the top of the bowl **710** from the top of the substrate W is 12 mm.
(38) If the etched amount is less than a given reference value, accordingly, the rotational speed of the substrate support assembly **100** is decreased, and contrarily, if the etched amount is more than the given reference value, the rotational speed of the substrate support assembly **100** is increased, so that it is possible that the etched amount can easily correspond to the given reference value.
(39) Secondly, a flow rate of the purge gas supplied from the purge gas supply assembly **300** is controlled to adjust an etched amount.
(40) For example, as shown in FIG. **5**, if the flow rate of the purge gas becomes increased, the etched amount becomes decreased.
(41) In specific, if the flow rate of the purge gas supplied from the purge gas supply assembly **300** becomes increased, a flow rate of the purge gas passing through the space between the substrate W and the chuck base **110** becomes increased, and accordingly, the chemical liquid attached to the substrate W is moved together with the purge gas passing through the space, so that the surface tension of the chemical liquid with respect to the substrate W can be easily overcome to allow the

chemical liquid to escape from the substrate W.
(42) Further, a relation between the flow rate of the purge gas and the etched amount is obtained on conditions that a rotational speed of the substrate support assembly is 1800 RPM, a flow rate of the chemical liquid is 1300 cc/min, and a height h to the top of the bowl **710** from the top of the substrate W is 12 mm.
(43) If the etched amount is less than a given reference value, accordingly, the flow rate of the purge gas is decreased, and contrarily, if the etched amount is more than the given reference value, the flow rate of the purge gas is increased, so that it is possible that the etched amount can easily correspond to the given reference value.
(44) Thirdly, a flow rate of the chemical liquid supplied from the chemical liquid supply unit **600** is controlled to adjust an etched amount.
(45) For example, as shown in FIG. **6**, if the flow rate of the chemical liquid becomes increased, the etched amount becomes increased, but it can be appreciated that there is an appropriate limit value.
(46) In specific, if the flow rate of the chemical liquid supplied from the chemical liquid supply unit **600** becomes increased, an amount of the chemical liquid flowing to the center of the substrate W is increased, thereby additionally generating power for moving the chemical liquid to the inside of the substrate W by means of the surface tension of the chemical liquid. In this case, if the flow rate of the chemical liquid is over a given limit value, the chemical liquid more than the given limit value serves as a remainder that does not act as the power for moving the chemical liquid to the inside of the substrate W anymore.
(47) Further, a relation between the flow rate of the chemical liquid and the etched amount is obtained on conditions that a rotational speed of the substrate support assembly **100** is 1800 RPM, a flow rate of the purge gas is 200 LPM, and a height h to the top of the bowl **710** from the top of the substrate W is 12 mm.
(48) Within the range of the relation between the flow rate of the chemical liquid and the etched amount, accordingly, if the etched amount is less than a given reference value, the flow rate of the chemical liquid is increased, and contrarily, if the etched amount is more than the given reference value, the flow rate of the chemical liquid is decreased, so that it is possible that the etched amount can easily correspond to the given reference value.
(49) Lastly, the height h to the top of the bowl **710** is controlled to adjust a distance between the bowls **710** and the peripheral edge of the substrate W, thereby adjusting an etched amount.
(50) For example, as shown in FIG. **7**, if the distance becomes decreased, the etched amount becomes generally decreased.
(51) In specific, if the distance between the bowls **710** and the peripheral edge of the substrate W is decreased, a flow speed of air supplied from the fan filter unit disposed above the substrate W is increased, and accordingly, a pressure is locally decreased to move the chemical liquid attached to the substrate W together with the air supplied, so that the surface tension of the chemical liquid with respect to the substrate W can be easily overcome to allow the chemical liquid to escape from the substrate W.
(52) As shown in FIG. **2**, the distance between the bowls **710** and the peripheral edge of the substrate W is determined according to the adjustment in the height h to the top of the bowl **710** from top of the substrate W, and the higher the bowls **710** are in height, for example, the wider the distance is.
(53) Further, a relation between the height h to the top of the bowl **710** from top of the substrate W and the etched amount is obtained on conditions that a rotational speed of the substrate support assembly is 1800 RPM, a flow rate of the purge gas is 200 LPM, and a flow rate of the chemical liquid is 1300 cc/min.
(54) If the etched amount is less than a given reference value, the height h to the top of the bowl **710** from top of the substrate W is increased to decrease a flow speed of air passing between the bowls **710** and the peripheral edge of the substrate W, and contrarily, if the etched amount is more

than the given reference value, the height h to the top of the bowl **710** from top of the substrate W is decreased to increase the flow speed of air, so that it is possible that the etched amount can easily correspond to the given reference value.

(55) Additionally, as shown in FIGS. **4** to **7**, the number of etched portions invaded indicates the number of portions invaded radially inside the substrate because the escape force of the chemical liquid is not perfectly balanced with surface tension thereof to thus fail to originate boundaries of the etched portions from the periphery of the underside of the substrate.

(56) While the etched amount is satisfied, desirably, the number of etched portions invaded is kept to zero, but in an unavoidable case, the number of etched portions invaded is limited to maximum two.

(57) As described above, the substrate edge etching apparatus according to the present invention is configured to have the substrate support assembly having the horizontally rotatable chuck base, the chuck pins disposed on top of the chuck base to support the substrate, the purge gas inlet hole extending from the underside center of the chuck base to the interior of the chuck base in the upward and downward direction thereof, and the purge gas outlet hole extending radially from the purge gas inlet hole and then extending upwardly to penetrate top of the chuck base, the purge gas supply assembly for supplying the purge gas to the purge gas inlet hole, the chemical liquid supply unit for supplying the chemical liquid to top of the substrate, a bowl assembly having bowls surrounding the periphery of the substrate support assembly and configured to be able to ascend and descend, and the fan filter unit spaced apart from top of the substrate support assembly, whereby in a state where the substrate is reversely located on the chuck base to allow the treatment surface on which the circuit pattern formation layer is formed to be facingly on top of the chuck base, the chuck base rotates, while the chemical liquid is being supplied to top of the substrate and the purge gas such as nitrogen gas N2 and the like is being supplied to underside of the substrate, and accordingly, a given etched amount can be kept on the peripheral edge of the substrate.

(58) According to the present invention, further, any one or more of the rotational speed of the substrate support assembly, the flow rate of the purge gas supplied from the purge gas supply assembly, the flow rate of the chemical liquid supplied from the chemical liquid supply unit, and the height to the top of the bowl to top of the substrate are controlled to thus adjust the etched amount, so that the method for controlling the etching is easily performed under the simple configuration.

(59) According to the present invention, in addition, any one or more of the rotational speed of the substrate support assembly, the flow rate of the purge gas supplied from the purge gas supply assembly, the flow rate of the chemical liquid supplied from the chemical liquid supply unit, and the height to the top of the bowl to top of the substrate are controlled to thus adjust the number of etched portions invaded unevenly on the periphery of the underside of the substrate.

(60) The present invention may be modified in various ways and may have several exemplary embodiments. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto, and it should be understood that the invention covers all the modifications, equivalents, and replacements within the idea and technical scope of the invention.

Claims

1. A method for controlling etching of substrate edge using a substrate edge etching apparatus, the substrate edge etching apparatus comprising: a substrate support assembly having a horizontally rotatable chuck base, chuck pins disposed on top of the chuck base to support a substrate, a purge gas inlet hole extending from an underside center of the chuck base to an interior of the chuck base in an upward and downward direction thereof, and a purge gas outlet hole extending radially and horizontally from the purge gas inlet hole and then extending upwardly to penetrate top of the

chuck base near the substrate edge; a purge gas supply assembly for supplying a purge gas to the purge gas inlet hole; a chemical liquid supply unit for supplying a chemical liquid to top of the substrate; a bowl assembly having bowls surrounding the periphery of the substrate support assembly and configured to be able to ascend and descend; and a fan filter unit spaced apart from top of the substrate support assembly, wherein etching of the underside of the substrate is performed while rotating the chuck base in a state where the substrate is reversely located on the chuck base and thereby a treatment surface on which a circuit pattern is formed faces toward the top of the chuck base, wherein while a chemical liquid is supplied to top of the substrate, purge gas introducing from the underside center of the chuck base through the purge gas inlet hole is supplied to underside of the substrate near the substrate edge through the purge gas outlet hole, thereby radial etched width of the peripheral edge of the underside of the substrate is determined by a balance between escape force of the chemical liquid due to supply of the purge gas and surface tension of the chemical liquid, wherein if the etched width is less than a given reference value, the flow rate of the purge gas is decreased, and if the etched width is more than the given reference value, the flow rate of the purge gas is increased, so that the etched width can be adjusted to the given reference value.

2. The method according to claim 1, wherein the etched width is adjusted by a rotational speed of the substrate support assembly.

3. The method according to claim 2, wherein if the etched width is less than the given reference value, the rotational speed of the substrate support assembly is decreased, and if the etched width is more than the given reference value, the rotational speed of the substrate support assembly is increased, so that the etched width corresponds to the given reference value.