

METHOD FOR IMPROVING UNIFORMITY OF WAFER **ELECTROPLATING THICKNESS**

TECHNICAL FIELD

The present invention belongs to the technical field of semiconductor manufacturing, and in particular relates to a method for improving the uniformity of wafer electroplating thickness.

BACKGROUND

In the production process of semiconductor integrated circuits, it is necessary to perform electroplating on the surface of a wafer to form a metal layer. Therefore, the wafer electroplating process involves placing the wafer in an electroplating solution, the wafer being connected to a negative voltage as a cathode, connecting a positive voltage to a soluble or an insoluble anode, and depositing metal ions in the electroplating solution onto the wafer surface under the action of an electric field. With the development of semiconductor technology, the requirements for the uniformity of wafer surface electroplating are becoming increasingly stringent, and even slight variations in electroplating thickness can compromise wafer quality and yield.

SUMMARY

In order to achieve high-quality wafer electroplating and improve the uniformity of electroplating thickness, the present invention provides a method for improving the uniformity of wafer electroplating thickness.

The present invention provides a method for improving the uniformity of wafer electroplating thickness, comprising:

performing the electroplating process on a wafer in an electroplating chamber provided with a diffuser plate;

measuring the electroplating thickness on the wafer surface after the completion of the electroplating process;

inputting the electroplating thickness into a wafer model, dividing the wafer model into a plurality of concentric ring regions along the radial direction, and arranging a plurality of concentric ring regions corresponding to the wafer model on a diffuser plate model corresponding to the diffuser plate, wherein through holes with uniform aperture are uniformly distributed on the diffuser plate model;

taking the electroplating thickness value of any ring region on the wafer model as a reference value, calculating the differences between the electroplating thickness values of other ring regions of the wafer model and the reference value, and determining the pending adjustment rate of the electroplating thickness of each ring region of the wafer model;

setting the pending adjustment rate of the total area of the through holes of each ring region on the diffuser plate model to be equal to the pending adjustment rate of the electroplating thickness of each ring region on the wafer model, and determining the pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, so as to obtain an optimized diffuser plate model.

According to a specific embodiment of the present application, the reference value is the maximum value, the minimum value, or the average value of the electroplating thicknesses of all ring regions on the wafer model.

According to a specific embodiment of the present application, the plurality of concentric ring regions on the wafer model are adjacent to each other and do not overlap with each other, and the common center of the plurality of concentric ring regions on the wafer model is at the center of the wafer model.

According to a specific embodiment of the present application, the method further comprises: on the basis of the determined pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, when the total area of the through holes of a ring region on the diffuser plate model is adjusted, keeping the total number of the through holes on the ring region unchanged, defining the through hole on the ring region whose aperture needs to be adjusted as a second through hole, and presetting the aperture of the second through hole, wherein the aperture of the second through hole is greater or smaller than the aperture of the first

through hole; calculating the number of the second through holes on the ring region, allowing the adjusted electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model to reach the reference value.

According to a specific embodiment of the present application, calculating the number of the through holes to be adjusted on the ring region includes:

calculating the number n of the second through holes whose apertures need to be adjusted by using the following formula 1:

$$n = \frac{s_i * (h_i - h_0)}{h_0 * (\pi r_2^2 - \pi r_1^2)} \quad \text{formula 1}$$

wherein, n is the number of the second through holes whose apertures need to be adjusted;

s_i is the initial total area of the through holes of the ring region;

h_i is the electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model;

h_0 is the reference value of electroplating thickness;

r_2 is the radius of the adjusted second through hole;

r_1 is the radius of the first through hole on the ring region.

According to a specific embodiment of the present application, the number of the through holes to be adjusted is smaller than the number of the through holes on the ring region.

According to a specific embodiment of the present application, the method further comprises uniformly distributing the through holes whose apertures need to be adjusted on the ring region to be adjusted.

According to a specific embodiment of the present application, the method

further comprises uniformly distributing the through holes whose apertures need to be adjusted in at least two quadrants of the diffuser plate model, wherein the second through holes in quadrants are arranged symmetrically about the center of the diffuser plate model.

According to a specific embodiment of the present application, the method further comprises: on the basis of the determined pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, when the total area of the through holes of a ring region is adjusted, keeping the apertures of the through holes on the ring region unchanged, and calculating the number of the through holes needed on the ring region, allowing the adjusted electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model to reach the reference value.

According to a specific embodiment of the present application, calculating the number of the through holes needed on the ring region includes:

calculating the number N of the through holes needed on the ring region by using the following formula 2:

$$N = \frac{s_i * (h_i - h_0) + n_0 * h_0 * \pi r^2}{h_0 * \pi r^2} \quad \text{formula 2}$$

wherein, N is the number of the through holes needed on the ring region;

s_i is the initial total area of the through holes of the ring region;

h_i is the electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model;

h_0 is the reference value of electroplating thickness;

r is the radius of the through holes on the diffuser plate model;

n_0 is the initial number of the through holes on the ring region.

The method for improving the uniformity of wafer electroplating thickness of the

present invention is conducive to improving the electroplating effect of an electroplating apparatus through the optimization of the diffuser plate, making the electroplating thickness of the wafer more uniform.

Meanwhile, when the diffuser plate is optimized and the total areas of the through holes of certain ring regions on the diffuser plate are adjusted, instead of unified adjustment of the apertures of all through holes in the regions, a certain number of through holes in the regions are selected to be adjusted in aperture so as to achieve the purpose of adjusting the total areas of the through holes. The method of the present invention can concentrate the required apertures to be adjusted on a preset number of through holes, which has the advantage of facilitating processing, and can facilitate the control of processing precision, thereby ensuring the uniformity of electroplating thickness.

In addition, the present application optimizes the diffuser plate in the electroplating apparatus by means of uniformly arranging the through holes whose apertures need to be adjusted in the adjustment region on the diffuser plate, or distributing the through holes whose apertures need to be adjusted in at least two quadrants of the diffuser plate and arranging the through holes whose apertures need to be adjusted symmetrically about the center of the diffuser plate, so as to ensure that each region of the wafer can receive the electroplating solution at a more appropriate flow rate as much as possible during the electroplating process, thereby ensuring the uniformity of electroplating thickness.

Other features and advantages of the present invention will be set forth in the following specification, and some of the features and advantages will become apparent from the specification, or can be understood by implementing the present invention. The objectives and other advantages of the present invention can be achieved and obtained through the structures depicted in the specification, claims, and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to further clarify the embodiments of the present invention or the technical solutions in the prior art, a brief introduction to the accompanying drawings

needed in the description of the embodiments or the prior art will be given below. Obviously, the accompanying drawings in the following description are some embodiments of the present invention, and those of ordinary skill in the art can also obtain other accompanying drawings according to these accompanying drawings without making creative efforts.

FIG. 1 is a schematic structural diagram of an electroplating apparatus according to an embodiment of the present invention;

FIG. 2 is a schematic flow chart of a method for improving the uniformity of wafer electroplating thickness according to an embodiment of the present invention;

FIG. 3 is a schematic structural diagram of wafer region division according to an embodiment of the present invention;

FIG. 4 is a schematic structural diagram of a diffuser plate according to an embodiment of the present invention;

FIG. 5 is a measurement result of the electroplating thickness of the wafer surface before the optimization of a diffuser plate according to an embodiment of the present invention;

FIG. 6 is a schematic distribution diagram of second through holes according to an embodiment of the present invention;

FIG. 7 is another schematic distribution diagram of second through holes according to an embodiment of the present invention;

FIG. 8 is a measurement result of the electroplating thickness of the wafer surface after the optimization of a diffuser plate according to an embodiment of the present invention.

EMBODIMENTS OF THE PRESENT INVENTION

In order to further clarify the objectives, technical solutions, and advantages of the embodiment of the present invention, the technical solutions in the embodiments

of the present invention will be clearly and completely described below with reference to the accompanying drawings in the embodiments of the present invention. Obviously, the described embodiments are a part of the embodiments of the present invention, rather than all the embodiments. All other embodiments obtained by those of ordinary skill in the art based on the embodiments of the present invention without making creative efforts shall fall within the protection scope of the present invention.

Referring to FIG. 1, an electroplating apparatus of the present invention comprises an electroplating chamber 100, a wafer holding device 200, and a diffuser plate 300. The electroplating chamber 100 is configured to contain electroplating solution. The wafer holding device 200 is configured to hold a wafer 400, allowing the surface to be electroplated of the wafer 400 to be located in the electroplating solution during electroplating. The diffuser plate 300 is arranged in the electroplating chamber 100. During the electroplating process, the electroplating solution is uniformly distributed and sprayed onto the surface to be electroplated of the wafer 400 through the rectification effect of the diffuser plate 300, making the electroplating thickness on the surface of the wafer 400 uniform.

It is found in the actual process that the electroplating thickness on the surface of the wafer 400 is not uniform. In this regard, the present application provides a method for improving the uniformity of wafer electroplating thickness by optimizing the diffuser plate.

Specifically, according to FIG. 2, the method comprises the following steps:

Step S100: Perform the electroplating process on a wafer in an electroplating chamber provided with a diffuser plate.

Step S200: Measure the electroplating thickness on the wafer surface after the completion of the electroplating process.

Step S300: Input the electroplating thickness into a wafer model, divide the wafer model into a plurality of concentric ring regions along the radial direction of the wafer model, and arrange a plurality of concentric ring regions corresponding to the wafer model on a diffuser plate model corresponding to the diffuser plate, wherein through

holes with uniform aperture are uniformly distributed on the diffuser plate model.

Both the wafer model 400' and the diffuser plate model 300' are digital models. The wafer model 400' and the diffuser plate model 300' are obtained by converting the wafer 400 and the diffuser plate 300 in the physical system into the digital wafer model 400' and the digital diffuser plate model 300' via digital twin technology or 3D modeling technology, and the essence of the wafer model 400' and the diffuser plate model 300' is digital models. Simulation, analysis, and prediction can be performed on the basis of the generated digital models.

When regional division is performed on the wafer model 400', the wafer model 400' is divided into a plurality of concentric ring regions along the radial direction, the plurality of concentric ring regions are adjacent to each other and do not overlap with each other, and the common center of the plurality of concentric ring regions is at the center of the wafer model 400'. Specifically, as shown in FIG. 3, the wafer model 400' after regional division includes a ring region 401, a ring region 402, a ring region 403, a ring region 404, a ring region 405, a ring region 406, a ring region 407, and a ring region 408. Correspondingly, according to FIG. 4, the diffuser plate model 300' includes a ring region 301, a ring region 302, a ring region 303, a ring region 304, a ring region 305, a ring region 306, a ring region 307, and a ring region 308.

Step S400: Take the electroplating thickness value of any ring region on the wafer model as a reference value, calculate the differences between the electroplating thickness values of other ring regions of the wafer model and the reference value, and determine the pending adjustment rate of the electroplating thickness of each ring region of the wafer model.

Specifically, the electroplating thickness value of each ring region on the wafer model 400' is obtained, and the electroplating thickness value of any ring region is selected as the reference value. Herein, only one electroplating thickness value needs to be measured for each ring region. Exemplarily, the reference value is the maximum value, the minimum value, or the average value of the electroplating thicknesses of all ring regions. For the convenience of unified adjustment of the diffuser plate, the maximum value of the electroplating thicknesses is preferably selected as the reference value. Exemplarily, the maximum value of the electroplating thicknesses is

taken as the reference value to determine the region on the wafer model 400' where the reference value is located. In this embodiment, the reference value is in the ring region 401, and then the differences between the electroplating thickness values of the ring region 402, the ring region 403, the ring region 404, the ring region 405, the ring region 406, the ring region 407, and the ring region 408 and the reference value are respectively calculated to determine the pending adjustment rate of the electroplating thickness of each ring region on the wafer model 400'.

Wherein, the pending adjustment rate of the electroplating thickness $k_i = \frac{h_i - h_0}{h_0}$,

k_i is the pending adjustment rate of the electroplating thickness of the selected ring region; h_0 is the reference value of electroplating thickness; h_i is the electroplating thickness value of the selected ring region.

Step S500: Set the pending adjustment rate of the total area of the through holes of each ring region on the diffuser plate model to be equal to the pending adjustment rate of the electroplating thickness of each ring region on the wafer model, and determine the pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, so as to obtain an optimized diffuser plate model.

The diffuser plate 300 in the physical system is adjusted by using the optimized diffuser plate model, making the diffuser plate in the electroplating apparatus meet the requirements of the solution involved in the optimized diffuser plate model, and the electroplating thickness of each ring region of the wafer model to reach the reference value.

Specifically, the total area of the through holes of each ring region on the diffuser plate model 300' is adjusted according to the principle that the pending adjustment rate k_i of the electroplating thickness of each ring region on the wafer model 400' is equal to the pending adjustment rate k_m of the total area of the through holes of each ring region on the diffuser plate model 300' ($k_i = k_m$). Wherein, when the pending adjustment value of the total area of the through holes of each ring region is calculated, the pending adjustment rate k_m of the total area of the through holes of the selected

ring region is $k_m = \frac{\Delta s}{s_i}$, where Δs is the pending adjustment value of the total area of the through holes of the ring region; s_i is the initial total area of the through holes of the ring region. Accordingly, the pending adjustment value of the total area of the through holes of the selected ring region is $\Delta s = k_m * s_i = k_i * s_i$.

It should be understood that the way to adjust the total area of the through holes of each ring region can be adjusting the aperture of the through holes on the ring region or adjusting the number of the through holes on the ring region.

Exemplarily, in one embodiment, when the total area of the through holes of a ring region on the diffuser plate model 300' is adjusted, the total number of the through holes on the ring region is kept unchanged, the through hole on the ring region whose aperture needs to be adjusted is defined as a second through hole, and the aperture of the second through hole is preset, wherein the aperture of the second through hole is greater or smaller than the aperture of the first through hole; the number of the second through holes on the ring region is calculated, allowing the adjusted electroplating thickness of the ring region on the wafer model 400' corresponding to the ring region on the diffuser plate model 300' to reach the reference value. The number n of the second through holes whose apertures need to be adjusted is calculated by using the following formula 1:

$$n = \frac{s_i * (h_i - h_0)}{h_0 * (\pi r_2^2 - \pi r_1^2)} \quad \text{formula 1}$$

wherein, n is the number of the second through holes whose apertures need to be adjusted;

s_i is the initial total area of the through holes of the ring region;

h_i is the electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model;

h_0 is the reference value of electroplating thickness;

r_2 is the radius of the adjusted second through hole;

r_l is the radius of the first through hole on the ring region.

It should be understood that when the pending adjustment rate k_i of the electroplating thickness of a ring region on the wafer model 400' is 0, the electroplating thickness of the ring region does not need to be adjusted. Correspondingly, the pending adjustment rate k_m of the total area of the through holes of the corresponding ring region on the diffuser plate model 300' is also 0, so the number n of the through holes to be adjusted on the ring region is 0, indicating that the total area of the through holes of the ring region does not need to be adjusted. According to FIG. 5, in the embodiment of the present invention, the ring region 301 on the diffuser plate model 300' is the ring region corresponding to the ring region where the reference value of the wafer model 400' is located, the total area of the through holes of the ring region 301 does not need to be adjusted, and the electroplating thickness values of the ring region 402, the ring region 403, the ring region 404, the ring region 405, the ring region 406, and the ring region 407 are equal to the electroplating thickness value of the ring region 401, that is, the pending adjustment rate k_i of the electroplating thicknesses of the ring region 402, the ring region 403, the ring region 404, the ring region 405, the ring region 406, and the ring region 407 is 0, and the electroplating thicknesses in these ring regions do not need to be adjusted. Therefore, the total areas of the through holes of the ring region 302, the ring region 303, the ring region 304, the ring region 305, the ring region 306, and the ring region 307 on the diffuser plate model 300' do not need to be adjusted either. However, the electroplating thickness value of the ring region 408 on the wafer model 400' is different from the reference value, and the electroplating thickness needs to be adjusted to the reference value. Therefore, the total area of the through holes of the ring region 308 on the diffuser plate model 300' is adjusted, and the specific adjustment method is based on the above Step S400 and Step S500, which will not be repeated herein. After the number of the second through holes to be adjusted is calculated, the adjustment is performed on the ring region 308 on the diffuser plate model 300'. During the adjustment, the through holes whose apertures need to be adjusted are uniformly distributed on the ring region to be adjusted, so as to ensure that the diffuser plate prepared according to the optimized diffuser plate model can supply the electroplating solution at a corresponding flow rate to the electroplating surface of the wafer 400 during electroplating, thereby making the electroplating

thickness of the electroplating surface of the wafer 400 more uniform. Exemplarily, after the number n of the second through holes whose apertures need to be adjusted on the ring region 308 is determined to be 8, the specified number of the second through holes 3081 are uniformly distributed on the ring region 308, as specifically as shown in FIG. 6. It should be understood that after the optimized diffuser plate model is obtained, actual processing can be performed on the diffuser plate 300 in the physical system according to the optimized diffuser plate model, or a new diffuser plate 300 that meets the requirements of the optimization solution can be prepared.

In another embodiment, for the convenience of processing and manufacturing, and to further ensure the uniformity of electroplating, the second through holes 3081 whose apertures need to be adjusted are uniformly distributed in at least two quadrants of the ring region (the ring region 308 in this embodiment) on the diffuser plate model 300' where the total area of the through holes needs to be adjusted, and the second through holes 3081 on the ring region where the total area of the through holes is adjusted are arranged symmetrically about the center of the diffuser plate model 300'. Therefore, when simulation analysis is performed by using the diffuser plate model 300', the second through holes 3081 whose apertures need to be adjusted are preferably uniformly distributed in at least two quadrants of the ring region (the ring region 308 in this embodiment) on the diffuser plate model 300' where the total area of the through holes needs to be adjusted, and the second through holes 3081 on the ring region where the total area of the through holes is adjusted are arranged symmetrically about the center of the diffuser plate model 300', as specifically shown in FIG. 7.

Further, for the convenience of processing and manufacturing, the number of the through holes whose apertures need to be adjusted on each ring region is required to be smaller than the total number of the through holes on the ring region.

According to FIG. 8, after the above adjustment of the total area of the through holes of the ring region 308 on the diffuser plate model 300' and the uniform distribution of the second through holes whose apertures need to be adjusted in the mode of FIG. 7, the diffuser plate 300 prepared according to the optimized diffuser plate model 300' is placed into the electroplating apparatus to perform the electroplating process on the wafer again, and then the electroplating thickness of surface on the wafer 400 is measured. The measurement result of the electroplating

thickness on the surface of the wafer 400 is shown in FIG. 8. It can be seen that the electroplating thickness on the electroplating surface of the wafer 400 by the optimized electroplating apparatus is relatively uniform, the uniformity of the electroplating thickness is improved, and the electroplating quality is further improved.

In this embodiment, when the diffuser plate model is optimized and the total areas of the through holes of certain ring regions on the diffuser plate model are adjusted, instead of unified adjustment of the apertures of all through holes on the ring regions, a certain number of through holes on the ring regions are selected to be adjusted in aperture so as to achieve the purpose of adjusting the total areas of the through holes. The method of the present invention can concentrate the required apertures to be adjusted on a preset number of through holes, which has the advantage of facilitating processing during the actual processing of the diffuser plate in the physical system, and can facilitate the control of processing precision, thereby ensuring the uniformity of electroplating thickness.

In addition, the present application uniformly arranges the through holes whose apertures need to be adjusted in the adjustment ring region on the diffuser plate model, or distributes the through holes whose apertures need to be adjusted in at least two quadrants of the diffuser plate model and arrange the through holes whose apertures need to be adjusted symmetrically about the center of the diffuser plate model, which can ensure that the diffuser plate prepared according to the optimized diffuser plate model can make the wafer receive the electroplating solution at a more appropriate flow rate as much as possible during the electroplating process of the wafer, further ensuring the uniformity of electroplating thickness.

In another embodiment, when the total area of the through holes of a ring region is adjusted, the apertures of the through holes on the ring region are kept unchanged, and the number of the through holes needed on the ring region is calculated, allowing the adjusted electroplating thickness of the ring region on the wafer model 400' corresponding to the ring region on the diffuser plate model to reach the reference value. The number N of the through holes needed on the ring region is calculated by using the following formula 2:

$$N = \frac{s_i*(h_i-h_0)+n_0*h_0*\pi r^2}{h_0*\pi r^2} \quad \text{formula 2}$$

wherein, N is the number of the through holes needed on the ring region;

s_i is the initial total area of the through holes of the ring region;

h_i is the electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model;

h_0 is the reference value of electroplating thickness;

r is the radius of the through holes on the diffuser plate model;

n_0 is the initial number of the through holes on the ring region.

After the number N of the through holes needed on the adjusted ring region is calculated, the adjustment is performed on the basis of the initial number n_0 of the through holes in the adjusted ring region. Exemplarily, when the calculated number N of the through holes needed on the adjusted ring region is 105 and the initial number n_0 of the through holes on the adjusted ring region is 100, the number of the through holes on the adjusted ring region needs to be adjusted from 100 to 105 when the total area of the through holes of the adjusted ring region is adjusted.

Through the optimization of the diffuser plate model in the present invention, i.e., the optimization of the structure of the diffuser plate in the physical system, the electroplating effect of the electroplating apparatus on the wafer is improved, and the electroplating thickness of the wafer is more uniform.

Although the present invention has been described in detail with reference to the foregoing embodiments, those of ordinary skill in the art should understand that the technical solutions recorded in the foregoing embodiments can still be modified, or equivalent replacements can be performed on some of the technical features; and these modifications or replacements do not make the essence of the corresponding technical solutions deviate from the spirit and scope of the technical solutions of the embodiments of the present invention.

What is claimed is:

1. A method for improving the uniformity of wafer electroplating thickness, comprising:

performing the electroplating process on a wafer in an electroplating chamber provided with a diffuser plate;

measuring the electroplating thickness on the wafer surface after the completion of the electroplating process;

inputting the electroplating thickness into a wafer model, dividing the wafer model into a plurality of concentric ring regions along the radial direction, and arranging a plurality of concentric ring regions corresponding to the wafer model on a diffuser plate model corresponding to the diffuser plate, wherein through holes with uniform aperture are uniformly distributed on the diffuser plate model;

taking the electroplating thickness value of any ring region on the wafer model as a reference value, calculating the differences between the electroplating thickness values of other ring regions of the wafer model and the reference value, and determining the pending adjustment rate of the electroplating thickness of each ring region of the wafer model;

setting the pending adjustment rate of the total area of the through holes of each ring region on the diffuser plate model to be equal to the pending adjustment rate of the electroplating thickness of each ring region on the wafer model, and determining the pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, so as to obtain an optimized diffuser plate model.

2. The method for improving the uniformity of wafer electroplating thickness according to claim 1, wherein the reference value is the maximum value, the minimum value, or the average value of the electroplating thicknesses of all ring regions on the wafer model.

3. The method for improving the uniformity of wafer electroplating thickness according to claim 1, wherein the plurality of concentric ring regions on the wafer

model are adjacent to each other and do not overlap with each other, and the common center of the plurality of concentric ring regions on the wafer model is at the center of the wafer model.

4. The method for improving the uniformity of wafer electroplating thickness according to claim 1, wherein the method further comprises: on the basis of the determined pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, when the total area of the through holes of a ring region on the diffuser plate model is adjusted, keeping the total number of the through holes on the ring region unchanged, defining the through hole on the ring region whose aperture needs to be adjusted as a second through hole, and presetting the aperture of the second through hole, wherein the aperture of the second through hole is greater or smaller than the aperture of the first through hole; calculating the number of the second through holes on the ring region, allowing the adjusted electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model to reach the reference value.

5. The method for improving the uniformity of wafer electroplating thickness according to claim 4, wherein calculating the number of the through holes to be adjusted on the ring region includes:

calculating the number n of the second through holes whose apertures need to be adjusted by using the following formula 1:

$$n = \frac{s_i * (h_i - h_0)}{h_0 * (\pi r_2^2 - \pi r_1^2)} \quad \text{formula 1}$$

wherein, n is the number of the second through holes whose apertures need to be adjusted;

s_i is the initial total area of the through holes of the ring region;

h_i is the electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model;

h_0 is the reference value of electroplating thickness;

r_2 is the radius of the adjusted second through hole;

r_1 is the radius of the first through hole on the ring region.

6. The method for improving the uniformity of wafer electroplating thickness according to claim 5, wherein the number of the through holes to be adjusted is smaller than the number of the through holes on the ring region.

7. The method for improving the uniformity of wafer electroplating thickness according to claim 6, wherein the method further comprises uniformly distributing the through holes whose apertures need to be adjusted on the ring region to be adjusted.

8. The method for improving the uniformity of wafer electroplating thickness according to claim 6, wherein the method further comprises uniformly distributing the through holes whose apertures need to be adjusted in at least two quadrants of the diffuser plate model, and the second through holes in quadrants are arranged symmetrically about the center of the diffuser plate model.

9. The method for improving the uniformity of wafer electroplating thickness according to claim 1, wherein the method further comprises: on the basis of the determined pending adjustment value of the total area of the through holes of each ring region on the diffuser plate model, when the total area of the through holes of a ring region is adjusted, keeping the apertures of the through holes on the ring region unchanged, and calculating the number of the through holes needed on the ring region, allowing the adjusted electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model to reach the reference value.

10. The method for improving the uniformity of wafer electroplating thickness according to claim 9, wherein calculating the number of the through holes needed on the ring region includes:

calculating the number N of the through holes needed on the ring region by using the following formula 2:

$$N = \frac{s_i*(h_i-h_0)+n_0*h_0*\pi r^2}{h_0*\pi r^2} \quad \text{formula 2}$$

wherein, N is the number of the through holes needed on the ring region;

s_i is the initial total area of the through holes of the ring region;

h_i is the electroplating thickness of the ring region on the wafer model corresponding to the ring region on the diffuser plate model;

h_0 is the reference value of electroplating thickness;

r is the radius of the through holes on the diffuser plate model;

n_0 is the initial number of the through holes on the ring region.