

WAFER ELECTROPLATING DEVICE

TECHNICAL FIELD

The present application relates to the technical field of semiconductors, and in particular, to a wafer electroplating device.

BACKGROUND

In the manufacturing process of integrated circuits, devices are usually required to be coated. Coating methods include electrolytic plating, evaporation, printing, and the like. Electrolytic plating has been widely used due to the relatively stable performance of the method.

Taking copper plating on a wafer as an example, in the prior art, a seed layer is usually formed on the wafer first, and then copper is electroplated on the seed layer. To obtain a copper plating area as large as possible, the electrode makes electrical contact with the seed layer only at the edge of the wafer, and current flows from the edge of the wafer to the center of the wafer, so that the entire wafer is coated.

However, the seed layer itself has resistance. When current flows through the seed layer from the edge of the wafer to the center of the wafer, the current gradually decreases as the flow distance increases. Therefore, positions equidistant from the wafer edge have the same current and thus the same film thickness, while positions at different distances from the wafer edge have different film thicknesses, resulting in obvious thickness differences between different circumferences of the wafer and affecting the uniformity of wafer coating.

SUMMARY

The embodiment of the present application provides a wafer electroplating device, which can make wafer coating more uniform.

The present application provides a wafer electroplating device, comprising: an electroplating tank, for containing an electroplating solution, an anode being arranged in the electroplating tank; a flow field plate, arranged between the anode and a wafer,

the flow field plate being provided with a plurality of through-holes for the electroplating solution to pass through to form a flow field, the flow field plate including at least one flow field transition zone, and each flow field transition zone including at least two flow field zones with different resistivities; wherein, the maximum resistivity of each flow field transition zone is the minimum resistivity of the flow field on the side with the maximum resistivity of flow fields on both adjacent sides in the radial direction, or the minimum resistivity of the flow field transition zone is the maximum resistivity of the flow field on the side with the minimum resistivity of flow fields on both adjacent sides in the radial direction, and the flow field zone with the maximum resistivity or the flow field zone with the minimum resistivity in the flow field transition zone extends to the boundary of the flow field on the side having the same resistivity as the flow field zone.

Specifically, the maximum resistivity in the flow field transition zone is the minimum resistivity of the flow field on the side with the maximum resistivity of flow fields on both adjacent sides, and the minimum resistivity in the flow field transition zone is the maximum resistivity of the flow field on the side with the minimum resistivity of flow fields on both adjacent sides.

Specifically, the flow field plate includes a central zone, and the flow field transition zone is arranged around the central zone.

Specifically, the resistivity is the same everywhere in the central zone.

Specifically, each flow field transition zone includes a plurality of flow field zones, and the plurality of flow field zones fill the entire flow field transition zone.

Specifically, any two adjacent flow field zones in each flow field transition zone have different resistivities.

Specifically, a plurality of flow field zones of each resistivity are present in each flow field transition zone, and flow field zones with the same resistivity are uniformly distributed in the flow field transition zone.

Specifically, each flow field transition zone is annular.

Specifically, a plurality of the flow field transition zones are included, and the plurality of flow field transition zones are arranged adjacently.

Specifically, the distance between the outer ring line of the outermost flow field transition zone on the flow field plate and the center of the flow field plate is smaller than or equal to the radius of the wafer.

Specifically, in the radial direction of each flow field transition zone, the flow field zones with the maximum resistivity and/or the flow field zones with the minimum resistivity account for the largest proportion on the ring edge line on the side of the flow field transition zone having the same resistivity as the flow field zones.

Specifically, the flow field zones with the maximum resistivity and/or the flow field zones with the minimum resistivity account for 100% on the ring edge line on the side of the flow field transition zone having the same resistivity as the flow field zones.

Specifically, on the 1/2 ring width line of each flow field transition zone, the flow field zones of each resistivity account for an equal proportion.

Specifically, in the radial direction of each flow field transition zone, the proportion of the flow field zones with the maximum and/or minimum resistivity changes smoothly.

Specifically, in the radial direction of each flow field transition zone, the proportion of the flow field zones with the maximum and/or minimum resistivity changes stepwise.

Specifically, the proportion of flow field zones with the same resistivity in two adjacent flow field transition zones changes from small to large and then to small in the radial direction.

Specifically, the at least two flow field zones are formed by equally dividing each flow field transition zone in the circumferential direction.

Specifically, through-holes in at least part of flow field zones with the same resistivity on the flow field plate are identical.

Specifically, at least part of flow field zones with different resistivities on the flow field plate have different through-hole sizes.

Specifically, at least part of flow field zones with different resistivities on the flow field plate have different through-hole distribution densities.

Specifically, at least part of flow field zones with different resistivities on the flow field plate have different through-hole depths.

In the wafer electroplating device of the present application, the flow field plate is provided with at least one flow field transition zone, the resistivity in the flow field transition zone is between the resistivities of flow fields on both adjacent sides, and the resistivity of the flow field transition zone can provide a transition for the resistivities of the flow fields on both adjacent sides, so as to make the wafer coating more uniform.

Other features and advantages of the present application will become apparent from the following detailed description, or be learned partly through the practice of the present application.

It should be understood that the foregoing general description and the following detailed description are exemplary and explanatory only, and are not restrictive of the present application.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate the embodiment consistent with the present application and, together with the specification, serve to explain the principle of the present application. Obviously, the accompanying drawings in the following description are only some embodiments of the present application, and for those of ordinary skill in the art, other accompanying drawings can be obtained according to these accompanying drawings without making creative efforts. In the accompanying drawings:

FIG. 1 shows a schematic structural diagram of a wafer electroplating device according to an embodiment of the present application;

FIG. 2 shows a schematic structural diagram of a flow field plate according to an embodiment of the present application;

FIG. 3 shows a schematic diagram of a flow field transition zone according to an embodiment of the present application;

FIG. 4 shows a schematic structural diagram of a flow field plate according to an embodiment of the present application;

FIG. 5 shows a schematic structural diagram of a flow field plate according to an embodiment of the present application;

FIG. 6 shows a schematic structural diagram of a flow field plate according to an embodiment of the present application;

FIG. 7 shows a schematic diagram of a flow field transition zone according to an embodiment of the present application;

FIG. 8 shows a schematic diagram of a flow field transition zone according to an embodiment of the present application;

FIG. 9 shows a schematic diagram of a flow field transition zone according to an embodiment of the present application;

FIG. 10 shows a schematic structural diagram of a flow field plate according to an embodiment of the present application.

Wherein, 1, wafer; 2, electroplating tank; 3, chuck; 4, flow field plate; 5, electroplating solution; 6, anode; 7, cathode; 41, central zone; 42, flow field transition zone; 421, flow field zone.

PREFERRED EMBODIMENTS OF THE INVENTION

Exemplary embodiments will now be described more fully with reference to the accompanying drawings. However, the exemplary embodiments can be implemented in various forms and should not be construed as being limited to the examples set forth herein; rather, these embodiments are provided so that the present application will be

more thorough and complete, and will fully convey the concept of exemplary embodiments to those skilled in the art.

Furthermore, the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. In the following description, numerous specific details are provided to give a thorough understanding of the embodiment of the present application. Those skilled in the art will recognize, however, that the technical solution of the present application can be practiced without one or more of the specific details, or that other methods, components, devices, steps, and the like can be employed. In other cases, well-known methods, devices, implementations, or operations are not shown or described in detail to avoid obscuring various aspects of the present application.

Please refer to FIGS. 1 to 10. This embodiment provides a wafer electroplating device capable of improving the coating uniformity of a wafer 1.

As shown in FIG. 1, the wafer electroplating device comprises an electroplating tank 2, a chuck 3 for clamping the wafer 1 to rotate, and a flow field plate 4 provided with a plurality of through-holes. An electroplating solution 5 in the electroplating tank 2 contains plating cations, and the electroplating tank 2 is further provided with an anode 6, and the anode 6 is usually submerged in the electroplating solution 5. The chuck 3 is provided with a cathode 7, and the chuck 3 is used for driving the wafer 1 to enter or leave the electroplating tank 2. The flow field plate 4 is arranged between the anode 6 and the wafer 1, and the electroplating solution 5 flows through the through-holes on the flow field plate 4 to form a flow field on the flow field plate 4. The resistance of the flow field affects the number of cations passing through: a higher flow field resistance results in fewer cations passing through, and a lower flow field resistance results in more cations passing through. When the anode 6 and the cathode 7 are energized, plating cations in the electroplating solution 5 deposit, the deposited cations flow to the cathode 7 through the flow field, and the cations adhere to the wafer 1 to form a plating layer. The flow field plate 4 matches the shape of the electroplating tank 2 and can be square or circular, and the distribution range of the through-holes on the flow field plate 4 can be smaller than or equal to the area of the wafer 1. In other implementations of the embodiment of the present application, the distribution range of the through-holes on the flow field plate 4 can be larger than the area of the wafer

1, and the distribution range can be set as required.

As shown in FIG. 2, the flow field plate 4 includes a central zone 41 and a flow field transition zone 42 arranged around the central zone 41. The resistivity of the flow field is the same everywhere in the central zone 41, and multiple resistivities of the flow field in the flow field transition zone 42 are present. A part of the flow field in the flow field transition zone 42 is taken as flow field zones, the resistivity of the flow field is the same everywhere in the same flow field zone, and the flow field transition zone 42 includes a plurality of flow field zones with different resistivities. For example, the flow field transition zone 42 may include flow field zones 421 with a resistivity of R_1 and a flow field zone 422 with a resistivity of R_2 , where $R_1 < R_2$. In the radial direction of the flow field plate 4, the maximum resistivity in the flow field transition zone 42 may be the minimum resistivity in the flow field on the side with the maximum resistivity of flow fields 43 on both adjacent sides. For example, if the flow field on one side of the flow fields 43 on both adjacent sides has resistivities including R_0 and R_1 , the flow field on the other side of the flow fields 43 on both adjacent sides has resistivities including R_2 and R_3 , and $R_0 < R_1 < R_2 < R_3$, then the maximum resistivity of the flow fields 43 on both adjacent sides is R_3 , the flow field on the side with the maximum resistivity of the flow fields 43 on both adjacent sides is the flow field on the side where the flow field zone with the resistivity of R_3 is located, and thus the maximum resistivity in the flow field transition zone 42 is R_2 , the minimum resistivity in the flow field on the side where the flow field zone with the resistivity of R_3 is located, so that the flow field transition zone 42 has the same resistivity as the flow field on one adjacent side in the radial direction. The flow field zone with the maximum resistivity in the flow field transition zone 42 extends to the boundary of the flow field on the side having the same resistivity as the flow field zone, so that the boundary and the flow field on one adjacent side have the same resistivity. For example, the flow field zone 422 with the resistivity of R_2 in the flow field transition zone 42 extends to the boundary of the flow field on the side having the resistivity of R_2 , so that during electroplating, when the rotating wafer 1 is electroplated, the film layer formed by cations passing through the flow field transition zone 42 and the film layer formed by cations passing through the flow field on the side with the maximum resistivity transition smoothly at the boundary, thereby making the film thickness of the wafer 1 change smoothly in the radial direction, reducing the thickness difference between

different circumferences on the wafer 1, and improving the uniformity of coating. In one implementation of the embodiment of the present application, if the flow field on the side with the maximum resistivity of the flow fields 43 on both adjacent sides has only one resistivity, the maximum resistivity in the flow field transition zone 42 is the resistivity of the flow field on the side with the maximum resistivity, and the maximum resistivity in the flow field transition zone 42 extends to the boundary of the flow field on the side with the maximum resistivity of the flow fields 43 on both adjacent sides. For example, if the resistivities of the flow fields 43 on both adjacent sides are R_1 and R_2 , respectively, and $R_1 < R_2$, then the maximum resistivity in the flow field transition zone 42 is R_2 , the resistivity of the flow field on the side with the maximum resistivity of the flow fields 43 on both adjacent sides, and the flow field zone 422 with the resistivity of R_2 in the flow field transition zone 42 extends to the boundary of the flow field on the side with the maximum resistivity R_2 of the flow fields 43 on both adjacent sides.

Specifically, the radial direction of the flow field plate 4 is the direction pointing from the center of the flow field plate to the edge of the flow field plate, or from the edge of the flow field plate to the center of the flow field plate. Hereinafter, the radial direction refers to the radial direction of the flow field plate 4. The flow fields 43 on both adjacent sides of the flow field transition zone 42 in the radial direction are flow fields adjacent to the boundary of the flow field transition zone 42 and located in the radial direction of the flow field transition zone 42. The flow field on one adjacent side refers to the flow field adjacent to the inner boundary of the flow field transition zone 42 or the flow field adjacent to the outer boundary of the flow field transition zone 42. The inner boundary of the flow field transition zone 42 is the boundary of the flow field transition zone 42 closer to the center of the flow field plate, and the outer boundary of the flow field transition zone 42 is the boundary of the flow field transition zone 42 closer to the edge of the flow field plate. The center of the flow field plate is the position on the flow field plate 4 through which the electroplating solution 5 for electroplating the center of the wafer 1 passes, and may be the circle center of the flow field plate 4 when the flow field plate 4 is circular. The resistivity refers to the resistance value per unit area in the flow field plate 4. In other implementations of the embodiment of the present application, the number of flow field transition zones 42 may be multiple.

In the radial direction of the flow field plate 4, the minimum resistivity in the flow field transition zone 42 may be the maximum resistivity in the flow field on the side with the minimum resistivity of the flow fields 43 on both adjacent sides, and the flow field zone with the minimum resistivity in the flow field transition zone 42 extends to the boundary of the flow field on the side having the same resistivity as the flow field zone. For example, if the flow field on one side of the flow fields 43 on both adjacent sides has resistivities including R_0 and R_1 , the flow field on the other side of the flow fields 43 on both adjacent sides has resistivities including R_2 and R_3 , and $R_0 < R_1 < R_2 < R_3$, then the minimum resistivity of the flow fields 43 on both adjacent sides is R_0 , the flow field on the side with the minimum resistivity of the flow fields 43 on both adjacent sides is the flow field on the side where the flow field zone with the resistivity of R_0 is located, and thus the minimum resistivity in the flow field transition zone 42 is R_1 , the maximum resistivity in the flow field on the side where the flow field zone with the resistivity of R_0 is located, and the flow field zones 421 with the resistivity of R_1 extend to the flow field on the side having the resistivity of R_0 , so that the same resistivity exists between the flow field transition zone 42 and the flow field on the side with the minimum resistivity, and the same resistivity exists between the boundary and the flow field on the side with the minimum resistivity, thereby making the film layer formed by cations passing through the flow field transition zone 42 and the film layer formed by cations passing through the flow field on the side with the minimum resistivity transition smoothly at the boundary, and improving the uniformity of coating. The resistivity increases gradually from the flow field on the side with the minimum resistivity, through the flow field transition zone 42, to the flow field on the side with the maximum resistivity. Compared with the case where the flow fields 43 on both adjacent sides of the flow field transition zone 42 are directly adjacent without the arrangement of the flow field transition zone 42, the solution including the arrangement of the flow field transition zone 42 can make the resistivity change in the flow field plate 4 smoother, which is further conducive to uniform coating. In one implementation of the embodiment of the present application, if the flow field on the side with the minimum resistivity of the flow fields 43 on both adjacent sides has only one resistivity, the minimum resistivity in the flow field transition zone 42 is the resistivity of the flow field on the side with the minimum resistivity, and the flow field zone with the minimum resistivity in the flow field transition zone 42 extends to the boundary of the flow field on the side with the minimum resistivity of the flow fields 43 on both

adjacent sides. For example, if the resistivities of the flow fields 43 on both adjacent sides are R_1 and R_2 , respectively, and $R_1 < R_2$, then the minimum resistivity in the flow field transition zone 42 is R_1 , the resistivity of the flow field on the side with the minimum resistivity of the flow fields 43 on both adjacent sides, and the flow field zone with the minimum resistivity in the flow field transition zone 42 extends to the boundary of the flow field on the side with the minimum resistivity R_1 of the flow fields 43 on both adjacent sides.

In the flow fields 43 on both adjacent sides of the flow field transition zone 42, the resistivity of the flow field on each side may be one or more, and the resistivity in the flow field on the side with the maximum resistivity is always greater than the resistivity in the flow field on the side with the minimum resistivity. For example, the resistivity of the inner flow field of the flow field transition zone 42 may be always greater than the resistivity of the outer flow field, or the resistivity of the outer flow field of the flow field transition zone 42 may be always greater than the resistivity of the inner flow field, where the inner flow field is a flow field closer to the center of the flow field plate than the flow field transition zone 42, and the outer flow field is a flow field closer to the edge of the flow field plate than the flow field transition zone 42. For example, if the resistivity of the adjacent inner flow field is R_1 everywhere and the resistivity of the adjacent outer flow field is R_2 everywhere, and $R_1 < R_2$, the flow field transition zone 42 may include two flow field zones with resistivities of R_1 and R_2 , respectively.

The number of flow field zones in the flow field transition zone 42 may be more than two, the number of resistivity types may be more than two, one or more flow field zones may be present for each resistivity, and the plurality of flow field zones fill the flow field transition zone 42, so that the coating thickness can be adjusted everywhere in the flow field transition zone 42. As shown in FIG. 3, 3 resistivity types may be present, namely R_1 , R_2 , and R_3 , where $R_1 < R_2 < R_3$. As shown in FIG. 4, 4 resistivity types may be present, namely R_1 , R_2 , R_3 , and R_4 , where $R_1 < R_2 < R_3 < R_4$. In other implementations of the embodiment of the present application, gaps may be left between flow field zones in the flow field transition zone 42, that is, only part of positions in the flow field transition zone 42 are subjected to transition, which can also improve the uniformity of the film layer when the rotating wafer 1 is electroplated.

Among the plurality of flow field zones in the flow field transition zone 42, any two adjacent flow field zones have different resistivities, so that the flow field zones with the same resistivity in the flow field transition zone 42 are arranged dispersedly, allowing plating ions of different concentrations passing through the flow field transition zone 42 to be doped with each other, which is conducive to uniform coating. Further, the flow field zones with the same resistivity are uniformly distributed in each flow field transition zone, further improving the coating uniformity. Wherein, each flow field zone includes one or more rows of through-holes, and the through-holes in the same flow field zone are identical and uniformly distributed. In each flow field transition zone, the through-holes in the flow field zones with the same resistivity are identical, facilitating hole drilling. In each flow field transition zone, the flow field zones with different resistivities have one or more of different through-hole sizes, different through-hole distribution densities, and different through-hole depths. Specifically, when the through-hole distribution density and the through-hole depth are the same, a larger aperture results in a lower resistivity, and a smaller aperture results in a higher resistivity. When the through-hole depth and the aperture are the same, a denser through-hole distribution results in a lower resistivity, and a sparser through-hole distribution results in a higher resistivity. When the through-hole distribution density and the aperture are the same, a smaller through-hole depth results in a lower resistivity, and a larger through-hole depth results in a higher resistivity. In other implementations of the embodiment of the present application, the through-holes in the flow field zones with the same resistivity may be different; for example, the resistivity of a flow field zone with deeper and denser through-holes may be equal to the resistivity of a flow field zone with shallower and sparser through-holes.

With reference to FIG. 4 again, the flow field transition zone 42 may be annular around the central zone 41 (dashed lines are used as boundaries of the flow field transition zone in the figure), so that all parts on the circumferences of the wafer 1 corresponding to the flow field transition zone 42 are uniformly coated, further reducing the thickness difference between different circumferences on the wafer 1. The center of the annular flow field transition zone 42 may coincide with the center of the flow field plate, so that all parts on the circumferences of the wafer 1 corresponding to the annular flow field transition zone 42 are uniformly coated.

The number of annular flow field transition zones 42 is multiple, and may be 3 as shown in FIG. 4. An inner flow field 43 and an outer flow field 43 are located on the two radial sides of the three flow field transition zones, respectively. The plurality of annular flow field transition zones 42 are arranged adjacently, so that the resistivity can change gradually among the plurality of annular flow field transition zones 42. In the plurality of adjacently arranged annular flow field transition zones 42, the resistivity can transition gradually in the radial direction of the flow field plate 4, so that the resistivity transitions gradually from the resistivity of the inner flow field 43 of the innermost annular flow field transition zone 42 to the resistivity of the outer flow field 43 of the outermost annular flow field transition zone 42. In other implementations of the embodiment of the present application, only one annular flow field transition zone 42 may be arranged.

If the resistivity of the flow field changes continuously and the change trend remains unchanged from the center of the flow field plate to the edge of the flow field plate, that is, the resistivity always increases from small to large or decreases from large to small, all the annular flow field transition zones 42 on the flow field plate 4 may be arranged adjacently.

If the change trend of the flow field resistivity changes from the center of the flow field plate to the edge of the flow field plate, that is, the change trend includes at least two of three change trends of resistivity increasing from small to large, resistivity decreasing from large to small, and resistivity remaining unchanged, then in the flow field of the flow field plate 4, in a part of the flow field where the resistivity continuously increases from small to large or continuously decreases from large to small, a plurality of annular flow field transition zones 42 are arranged adjacently, and in a part of the flow field where the resistivity remains unchanged, no annular flow field transition zone 42 is arranged.

For example, as shown in FIG. 5, if the resistivity first increases from small to large and then decreases from large to small from the center of the flow field plate to the edge of the flow field plate, in the flow field where the resistivity continuously increases from small to large, a first inner annular flow field transition zone 42a, a first middle annular flow field transition zone 42b, and a first outer annular flow field transition zone 42c are arranged adjacently in sequence. The minimum resistivity R_2

in the first middle annular flow field transition zone 42b is the maximum resistivity R_2 in the first inner annular flow field transition zone 42a, the flow field zones with the minimum resistivity (R_2) in the first middle annular flow field transition zone 42b extend to the inner ring edge line of the first middle annular flow field transition zone 42b, the maximum resistivity R_3 in the first middle annular flow field transition zone 42b is the minimum resistivity R_3 in the first outer annular flow field transition zone 42c, and the flow field zones with the maximum resistivity (R_3) in the first middle annular flow field transition zone 42b extend to the outer ring edge line of the first middle annular flow field transition zone 42b. In the flow field where the resistivity continuously decreases from large to small, a second inner annular flow field transition zone 42d, a second middle annular flow field transition zone 42e, and a second outer annular flow field transition zone 42f are arranged adjacently in sequence. The minimum resistivity R_2 in the second middle annular flow field transition zone 42e is the maximum resistivity R_2 in the second outer annular flow field transition zone 42f, the flow field zones with the minimum resistivity (R_2) in the second middle annular flow field transition zone 42e extend to the outer ring edge line of the second middle annular flow field transition zone 42e, the maximum resistivity R_3 in the second middle annular flow field transition zone 42e is the minimum resistivity R_3 in the second inner annular flow field transition zone 42d, and the flow field zones with the maximum resistivity (R_3) in the second middle annular flow field transition zone 42e extend to the inner ring edge line of the second middle annular flow field transition zone 42e.

Other flow fields may be present between the inner ring line of the innermost annular flow field transition zone 42 of the flow field plate 4 and the boundary of the central zone 41, and other flow fields may be present between the outer ring line of the outermost annular flow field transition zone 42 of the flow field plate 4 and the edge of the flow field plate. The distance between the outer ring line of the outermost flow field transition zone 42 on the flow field plate 4 and the center of the flow field plate may be smaller than or greater than the radius of the wafer 1. Since a certain distance is reserved between the flow field plate 4 and the wafer 1, cations diffuse or gather according to the shape of the electroplating tank 2 when moving from the flow field plate 4 to the wafer 1, so that the cations reach the wafer 1. In other implementations of the embodiment of the present application, as shown in FIG. 6, the flow field plate 4 includes three flow field transition zones 42g, 42f, and 42h, respectively. The inner

ring line of the innermost annular flow field transition zone 42g on the flow field plate 4 may be the boundary of the central zone 41, and the distance between the outer ring line of the outermost flow field transition zone 42h on the flow field plate 4 and the center of the flow field plate may be equal to the radius of the wafer 1.

With continued reference to FIG. 6, in the plurality of adjacently arranged annular flow field transition zones 42g, 42f, and 42h, the flow field zones with the maximum resistivity of any one of the flow field transition zones 42g, 42f, and 42h account for the largest proportion, preferably 100%, on the ring edge line on the side of the adjacent flow field transition zone having the same resistivity as the flow field zones. For example, if in the flow field transition zones 42g, 42f, and 42h in FIG. 5, the resistivities satisfy $R_0 < R_1 < R_2 < R_3 < R_4$, then in the flow field transition zone 42f, the flow field zones with the resistivity of R_2 account for the largest proportion on the ring edge line on the side of the flow field zone 42h also having the resistivity of R_2 , that is, the flow field zones with the resistivity of R_2 account for the largest proportion on the outer ring line of the flow field transition zone 42f, so that the resistivity on the ring edge line on that side is the maximum resistivity in the flow field transition zone 42f, and the resistivities in the adjacent flow field transition zone 42h having the same resistivity as the flow field zones are all greater than or equal to the maximum resistivity R_2 . The ring edge line on that side can provide a transition for the flow field transition zone 42h and the adjacent flow field transition zone 42f, making the coating more uniform.

Further, in the radial direction of each flow field transition zone 42, the proportion of the flow field zones with the maximum resistivity changes smoothly, wherein the proportion of a flow field zone refers to the proportion of the length of the flow field in the flow field zone to the length of the ring line where the flow field is located. Specifically, the proportion of each flow field zone with the maximum resistivity may change smoothly. For example, if the through-holes in flow field zones with different resistivities have the same size and depth but different quantities, the proportion of the number of through-holes in the flow field zones to the number of through-holes on the ring line where the through-holes are located changes smoothly in the radial direction, and the through-holes at the edge of the flow field zones 421 may be arranged in a smooth straight line or a smooth curve, as shown in FIG. 7, which is further conducive

to uniform coating. In other implementations of the embodiment of the present application, as shown in FIG. 8, the proportion of the flow field zones with the maximum resistivity may also change stepwise gradually, that is, the proportion of the flow field zones changes after the flow field zones extend a certain distance in the radial direction of the flow field plate 4, and the through-holes at the edges of the flow field zones are arranged stepwise. In other implementations of the embodiment of the present application, the proportion of the flow field zone with the maximum resistivity may also change gradually in a zigzag or other shapes.

Similarly, in the plurality of adjacently arranged annular flow field transition zones 42, the flow field zone with the minimum resistivity of any one flow field transition zone 42 accounts for the largest proportion, preferably 100%, on the ring edge line on the side of the flow field transition zone 42 having the same resistivity as the flow field zone, which can also make the coating more uniform. For example, if the minimum resistivity of a certain flow field transition zone 42 is the same as the maximum resistivity in the adjacent outer flow field transition zone 42, the flow field zone with the minimum resistivity on the outer ring line of the flow field transition zone 42 accounts for 100%; if the minimum resistivity of the flow field transition zone 42 is the same as the maximum resistivity in the adjacent inner flow field transition zone 42, the flow field zone with the minimum resistivity on the inner ring line of the flow field transition zone 42 accounts for 100%. Further, in the radial direction of each flow field transition zone 42, the proportion of the flow field zone with the minimum resistivity changes smoothly, stepwise, or gradually in other shapes. In other implementations of the embodiment of the present application, as shown in FIG. 8, the ring edge line on the flow field transition zone 42 may include multiple resistivities.

With reference to FIG. 7 again, on the 1/2 ring width line of each annular flow field transition zone 42, the flow field zones of each resistivity account for an equal proportion, so that the resistance value on the 1/2 ring width line of each annular flow field transition zone 42 is between the resistance values of the ring lines on both sides, the resistivity in each annular flow field transition zone 42 changes gradually, and uniform coating is further facilitated. For example, if the annular flow field transition zone 42 includes two types of flow field zones with resistivities of R_1 and R_2 , respectively, and $R_1 < R_2$, the two types of flow field zones with resistivities of R_1 and

R_2 each account for 50% on the 1/2 ring width line of the annular flow field transition zone 42.

With reference to FIG. 4 again, the proportion of the flow field zones with the same resistivity in two adjacent flow field transition zones 42 changes from small to large and then to small in the radial direction. Taking the flow field zones 423 and 424 both with the resistivity of R_3 in FIG. 4 as an example, since on the two adjacent flow field transition zones 42, the flow field zones with the same resistivity are both the flow field zones with the maximum resistivity in the flow field transition zone 42 with a smaller resistivity and the flow field zones with the minimum resistivity in the flow field transition zone 42 with a larger resistivity, the proportion of the flow field zones with the same resistivity in the radial direction changes from small to large and then to small, which can make the flow field zones with the same resistivity in the two adjacent flow field transition zones 42 arranged adjacently and facilitate hole drilling. Secondly, the flow field zones with the same resistivity have the same resistivity on the ring edge line between two adjacent flow field transition zones 42 and on both sides of the ring edge line, which can reduce the resistivity jump on the ring edge line between two adjacent flow field transition zones 42 and facilitate uniform coating.

In other implementations of the embodiment of the present application, as shown in FIG. 10, the flow field zones 421 are formed by equally dividing the flow field transition zone 42.

Other embodiments of the present application will be readily apparent to those skilled in the art upon consideration of the specification and practice of the embodiment disclosed herein. The present application is intended to cover any variations, uses, or adaptive changes of the present application following the general principle of the present application and including common general knowledge or conventional means in the art that are not disclosed in the present application.

It should be understood that the present application is not limited to the precise structure described above and shown in the accompanying drawings, and that various modifications and changes may be made without departing from the scope of the present application. The scope of the present application is limited only by the appended claims.

What is claimed is:

1. A wafer electroplating device, comprising:

an electroplating tank, for containing an electroplating solution, an anode being arranged in the electroplating tank;

a flow field plate, arranged between the anode and a wafer, the flow field plate being provided with a plurality of through-holes for the electroplating solution to pass through to form a flow field, the flow field plate including at least one flow field transition zone, and each flow field transition zone including at least two flow field zones with different resistivities;

wherein, the maximum resistivity of each flow field transition zone is the minimum resistivity of the flow field on the side with the maximum resistivity of flow fields on both adjacent sides in the radial direction, or the minimum resistivity of the flow field transition zone is the maximum resistivity of the flow field on the side with the minimum resistivity of flow fields on both adjacent sides in the radial direction, and the flow field zone with the maximum resistivity or the flow field zone with the minimum resistivity in the flow field transition zone extends to the boundary of the flow field on the side having the same resistivity as the flow field zone.

2. The wafer electroplating device according to claim 1, wherein the maximum resistivity in the flow field transition zone is the minimum resistivity of the flow field on the side with the maximum resistivity of flow fields on both adjacent sides, and the minimum resistivity in the flow field transition zone is the maximum resistivity of the flow field on the side with the minimum resistivity of flow fields on both adjacent sides.

3. The wafer electroplating device according to claim 2, wherein the flow field plate includes a central zone, and the flow field transition zone is arranged around the central zone.

4. The wafer electroplating device according to claim 3, wherein the resistivity is the same everywhere in the central zone.

5. The wafer electroplating device according to claim 2, wherein each flow field transition zone includes a plurality of flow field zones, and the plurality of flow field zones fill the entire flow field transition zone.

6. The wafer electroplating device according to claim 5, wherein any two adjacent flow field zones in each flow field transition zone have different resistivities.

7. The wafer electroplating device according to claim 6, wherein a plurality of flow field zones of each resistivity are present in each flow field transition zone, and flow field zones with the same resistivity are uniformly distributed in the flow field transition zone.

8. The wafer electroplating device according to claim 7, wherein each flow field transition zone is annular.

9. The wafer electroplating device according to claim 8, wherein a plurality of the flow field transition zones are included, and the plurality of flow field transition zones are arranged adjacently.

10. The wafer electroplating device according to claim 9, wherein the distance between the outer ring line of the outermost flow field transition zone on the flow field plate and the center of the flow field plate is smaller than or equal to the radius of the wafer.

11. The wafer electroplating device according to claim 10, wherein in the radial direction of each flow field transition zone, the flow field zones with the maximum resistivity and/or the flow field zones with the minimum resistivity account for the largest proportion on the ring edge line on the side of the flow field transition zone having the same resistivity as the flow field zones.

12. The wafer electroplating device according to claim 11, wherein the flow field zones with the maximum resistivity and/or the flow field zones with the minimum resistivity account for 100% on the ring edge line on the side of the flow field transition zone having the same resistivity as the flow field zones.

13. The wafer electroplating device according to claim 12, wherein on the 1/2 ring

width line of each flow field transition zone, the flow field zones of each resistivity account for an equal proportion.

14. The wafer electroplating device according to claim 13, wherein in the radial direction of each flow field transition zone, the proportion of the flow field zones with the maximum and/or minimum resistivity changes smoothly.

15. The wafer electroplating device according to claim 13, wherein in the radial direction of each flow field transition zone, the proportion of the flow field zones with the maximum and/or minimum resistivity changes stepwise.

16. The wafer electroplating device according to claim 13, wherein the proportion of flow field zones with the same resistivity in two adjacent flow field transition zones changes from small to large and then to small in the radial direction.

17. The wafer electroplating device according to claim 1, wherein the at least two flow field zones are formed by equally dividing each flow field transition zone in the circumferential direction.

18. The wafer electroplating device according to claim 1, wherein through-holes in at least part of flow field zones with the same resistivity on the flow field plate are identical.

19. The wafer electroplating device according to claim 1, wherein at least part of flow field zones with different resistivities on the flow field plate have different through-hole sizes.

20. The wafer electroplating device according to claim 1, wherein at least part of flow field zones with different resistivities on the flow field plate have different through-hole distribution densities.

21. The wafer electroplating device according to claim 1, wherein at least part of flow field zones with different resistivities on the flow field plate have different through-hole depths.