WAFER REACTION DEVICE

[0001] This application claims priority to Chinese Patent Application No. 202410336746.3, filed with the China National Intellectual Property Administration on March 22, 2024. The entire contents thereof are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present disclosure relates to the field of semiconductor manufacturing technology, and in particular, to a wafer reaction device.

BACKGROUND OF THE INVENTION

[0003] Atomic layer deposition (ALD) is generally a method of depositing substances layer by layer on a substrate surface in the form of monoatomic films. A wafer reaction device is a device that uses atomic layer deposition to coat a film on a wafer.

[0004] In the related art, a wafer reaction device typically includes a reaction chamber, and the reaction chamber is provided with a reaction cavity. A wafer is generally placed in the reaction cavity. A first gas inlet channel, in communication with the reaction cavity, is disposed above the wafer for introducing a carrier gas and a first reaction gas into the reaction cavity. A plurality of second gas inlet channels, in communication with the reaction cavity, are disposed around a sidewall of the reaction cavity, all of which are disposed above the wafer for introducing a carrier gas and a plurality of second reaction gases into the reaction cavity. A gas outlet channel, in communication with the reaction cavity, is disposed below the wafer. The carrier gas and the first reaction gas, as well as the carrier gas and the plurality of second reaction gases, are respectively introduced into the reaction cavity sequentially through the first gas inlet channel and the plurality of second gas inlet channels, diffuse to below the wafer and react on the wafer surface, and are then discharged through the gas outlet channel.

[0005] However, the wafer reaction device in the prior art is difficult to effectively control the reaction space, and easily leads to uneven gas distribution on the wafer surface, resulting in uneven deposition layers on the wafer surface, thereby affecting the film coating quality

of the wafer.

SUMMARY OF THE INVENTION

[0006] The present disclosure provides a wafer reaction device, comprising:

[0007] a reaction mechanism, wherein the reaction mechanism is formed with a reaction cavity, at least a portion of an inner wall of the reaction cavity is inclined, and a wafer placement position for carrying a wafer is disposed within the reaction cavity; and

[0008] a pipeline integration mechanism, wherein the pipeline integration mechanism comprises a first gas inlet pipe, a plurality of second gas inlet pipes, and a gas outlet member, the first gas inlet pipe and the plurality of second gas inlet pipes are configured to respectively deliver different reaction gases into the reaction cavity, a gas outlet end of the first gas inlet pipe and gas outlet ends of the plurality of second gas inlet pipes are all in communication with a gas inlet end of the gas outlet member, a gas outlet end of the gas outlet member is arranged to correspond to a gas inlet end of the reaction cavity, and the gas outlet end of the gas outlet member is provided with a plurality of gas outlet holes to allow the reaction gases to diffuse along the inner wall of the reaction cavity to the wafer placement position.

[0009] The pipeline integration mechanism further comprises a communication assembly.

[0010] The communication assembly is configured as an annular structure, the gas outlet ends of the plurality of second gas inlet pipes are in communication with the gas outlet member via the communication assembly, and the communication assembly is provided around the first gas inlet pipe.

[0011] The communication assembly comprises a storage member and a communication member.

[0012] The storage member is configured as an annular structure, the gas outlet ends of the plurality of second gas inlet pipes are in communication with a gas inlet end of the storage member, a gas outlet end of the storage member is in communication with gas inlet ends of a plurality of communication members, and gas outlet ends of the plurality of communication members are in communication with the gas inlet end of the gas outlet member.

[0013] A radial dimension of the storage member is greater than an inner diameter of the gas outlet ends of the second gas inlet pipes, and an inner diameter of the communication member is smaller than the inner diameter of the gas outlet ends of the second gas inlet pipes.

[0014] The pipeline integration mechanism further comprises a purge gas inlet pipe, gas inlet branch pipes, and a gas inlet channel.

[0015] The purge gas inlet pipe is in communication with one end of the gas inlet channel, the gas inlet channel is configured as an annular structure, the other end of the gas inlet channel is in communication with respective ends of the gas inlet branch pipes, and the other ends of the gas inlet branch pipes are correspondingly in communication with the plurality of second gas inlet pipes.

[0016] The pipeline integration mechanism further comprises a purge gas outlet pipe, gas outlet branch pipes, and a gas outlet channel.

[0017] The purge gas outlet pipe is in communication with one end of the gas outlet channel, the gas outlet channel is configured as an annular structure, the other end of the gas outlet channel is in communication with respective ends of the gas outlet branch pipes, and the other ends of the gas outlet branch pipes are correspondingly in communication with the plurality of second gas inlet pipes.

[0018] The purge gas inlet pipe is used for introducing a purge gas, and the purge gas outlet pipe is used for discharging the purge gas and impurity gases.

[0019] The pipeline integration mechanism further comprises first injection members and second injection members.

[0020] A plurality of first injection members are detachably disposed within the gas inlet branch pipes, and an inner diameter of the first injection members is smaller than an inner diameter of the gas inlet branch pipes.

[0021] A plurality of second injection members are detachably disposed within the gas outlet branch pipes, and an inner diameter of the second injection members is smaller than an inner diameter of the gas outlet branch pipes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] In order to more clearly illustrate the technical solutions in the embodiments of the present disclosure, the drawings required for use in the description of the embodiments or the prior art will be briefly introduced below. Obviously, the drawings in the following description are only some embodiments of the present disclosure. For a person skilled in the art, other drawings can be obtained based on these drawings without creative effort.

[0023] FIG. 1 is a structural cross-sectional view of the wafer reaction device according to some embodiments of the present disclosure.

[0024] FIG. 2 is a structural diagram of the pipeline integration mechanism in FIG. 1.

[0025] FIG. 3 is a cross-sectional view of FIG. 2.

[0026] FIG. 4 is a cross-sectional view of a partial structure of FIG. 1.

[0027] FIG. 5 is a structural cross-sectional view of FIG. 1.

[0028] FIG. 6 is a first partial structural diagram of FIG. 1.

[0029] FIG. 7 is a second partial structural diagram of FIG. 1.

[0030] FIG. 8 is a third partial structural diagram of FIG. 1.

[0031] FIG. 9 is a top view of FIG. 1.

[0032] FIG. 10 is a fourth partial structural diagram of FIG. 1.

[0033] FIG. 11 is a structural diagram of a ceramic gas distributor assembled to an outer housing in FIG. 1.

[0034] FIG. 12 is a structural diagram of a heat conduction plate in FIG. 4.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0035] The technical solutions in some embodiments of the present disclosure will be clearly and completely described below with reference to the accompanying drawings. Obviously, the described embodiments are only a part of the embodiments of the present disclosure, rather than all of the embodiments. Based on the embodiments provided in the present disclosure, all other embodiments obtained by a person skilled in the art fall within the protection scope of the present disclosure.

[0036] Unless the context otherwise requires, throughout the specification and claims, the term "comprise" and its other forms, such as the third-person singular form "comprises" and the present participle form "comprising," are to be interpreted as open and inclusive,

i.e., "including, but not limited to." In the description of the specification, the terms "one embodiment," "some embodiments," "exemplary embodiments," "example," "specific example," or "some examples" are intended to indicate that a particular feature, structure, material, or characteristic associated with the embodiment or example is included in at least one embodiment or example of the present disclosure. The schematic representations of the above terms do not necessarily refer to the same embodiment or example. Furthermore, the described particular features, structures, materials, or characteristics may be included in any suitable manner in any one or more embodiments or examples.

[0037] Hereinafter, the terms "first" and "second" are used for descriptive purposes only and are not to be understood as indicating or implying relative importance or implicitly specifying the quantity of the indicated technical features. Thus, a feature defined with "first" or "second" may explicitly or implicitly include one or more of that feature. In the description of the embodiments of the present disclosure, unless otherwise specified, "a plurality of" means two or more.

[0038] Atomic layer deposition is generally a method of depositing substances layer by layer on a substrate surface in the form of monoatomic films. A wafer reaction device is a device that uses atomic layer deposition to coat a film on a wafer.

[0039] In the related art, a wafer reaction device typically includes a reaction chamber, the reaction chamber is provided with a reaction cavity. A wafer is generally placed in the reaction cavity. A first gas inlet channel, in communication with the reaction cavity, is disposed above the wafer for introducing a carrier gas and a first reaction gas into the reaction cavity. A plurality of second gas inlet channels, in communication with the reaction cavity, are disposed around a sidewall of the reaction cavity, all of which are disposed above the wafer for introducing a carrier gas and a plurality of second reaction gases into the reaction cavity. A gas outlet channel, in communication with the reaction cavity, is disposed below the wafer. The carrier gas and the first reaction gas, as well as the carrier gas and the plurality of second reaction gases, are respectively introduced into the reaction cavity sequentially through the first gas inlet channel and the plurality of second gas inlet channels, diffuse to below the wafer and react on the wafer surface, and are then discharged through the gas outlet channel.

[0040] However, the wafer reaction device in the prior art is difficult to effectively control the reaction space, and easily leads to uneven gas distribution on the wafer surface, resulting in uneven deposition layers on the wafer surface, thereby affecting the film coating quality of the wafer.

[0041] Therefore, the embodiments of the present disclosure provide a wafer reaction device to solve the technical problems of the wafer reaction device in the prior art that it is difficult to effectively control the reaction space, easily leads to uneven gas distribution on the wafer surface, resulting in uneven deposition layers on the wafer surface, and affecting the film coating quality of the wafer.

[0042] FIG. 1 is a structural cross-sectional view of a wafer reaction device according to some embodiments of the present disclosure.

[0043] Referring to FIG. 1, an embodiment of the present disclosure provides a wafer reaction device, comprising:

[0044] a reaction mechanism 100, wherein the reaction mechanism 100 is formed with a reaction cavity, at least a portion of an inner wall of the reaction cavity is inclined, and a wafer placement position 122a for carrying a wafer is disposed within the reaction cavity; and

[0045] a pipeline integration mechanism 200, wherein the pipeline integration mechanism 200 comprises a first gas inlet pipe 210, a plurality of second gas inlet pipes 220, and a gas outlet member 230, the first gas inlet pipe 210 and the plurality of second gas inlet pipes 220 are configured to respectively deliver different reaction gases into the reaction cavity, a gas outlet end of the first gas inlet pipe 210 and gas outlet ends of the plurality of second gas inlet pipes 220 are all in communication with a gas inlet end of the gas outlet member 230, a gas outlet end of the gas outlet member 230 is arranged to correspond to a gas inlet end of the reaction cavity, and the gas outlet end of the gas outlet member 230 is provided with a plurality of gas outlet holes to allow the reaction gases to diffuse along the inner wall of the reaction cavity to the wafer placement position 122a.

[0046] Exemplarily, the first gas inlet pipe 210 is used for introducing a carrier gas (the carrier gas may be nitrogen) and a precursor A, and the plurality of second gas inlet pipes 220 are used for respectively introducing a carrier gas (the carrier gas may be nitrogen) and

a precursor B1, a carrier gas and a precursor B2, a carrier gas and a precursor B3, etc., which are not listed one by one here.

[0047] In specific implementation, the first gas inlet pipe 210 and the plurality of second gas inlet pipes 220 sequentially introduce the corresponding reaction gases in order.

[0048] Exemplarily, a microwave plasma generator is further disposed between the gas outlet ends of the first gas inlet pipe 210 and the plurality of second gas inlet pipes 220 and the gas outlet member 230, wherein the microwave plasma generator is used to perform microwave plasma treatment on the reaction gases introduced through the first gas inlet pipe 210 and the second gas inlet pipes 220.

[0049] Exemplarily, the pipeline integration mechanism 200 comprises a first component 201, a second component 202, a third component 203, and a fourth component 204 stacked sequentially. The first component 201, the second component 202, the third component 203, and the fourth component 204 may be integrally formed, or may be separately formed and then connected by bolts.

[0050] In specific implementation, the first gas inlet pipe 210 may comprise a first pipe and a first channel, wherein the first channel is a gas inlet channel 252 extending along the first component 201, the second component 202, the third component 203, and the fourth component 204, and the first pipe is in communication with the first channel. An external first gas supply apparatus introduces reaction gas into the first channel via the first pipe. Similarly, the second gas inlet pipe 220 may comprise a second pipe and a second channel, wherein the second channel is a gas inlet channel 252 extending along the first component 201, the second component 202, the third component 203, and the fourth component 204, and the second pipe is in communication with the second channel. An external second gas supply apparatus introduces reaction gas into the second channel via the second pipe.

[0051] From the above description, it can be seen that the present solution achieves the following technical effects.

[0052] The embodiment of the present disclosure provides a wafer reaction device. In the embodiment of the present disclosure, by integrating the first gas inlet pipe 210 and the plurality of second gas inlet pipes 220 and communicating them with the gas outlet member 230, on the one hand, the gas outlet ends of the first gas inlet pipe 210 and the plurality of

second gas inlet pipes 220 can be centralized, effectively controlling the reaction space. On the other hand, when introducing reaction gases into the reaction cavity, first, the carrier gas and the first reaction gas are introduced into the gas outlet member 230 via the first gas inlet pipe 210 for concentration, and then uniformly discharged through the gas outlet holes of the gas outlet member 230; then, the carrier gas and different second reaction gases are respectively introduced into the gas outlet member 230 sequentially via the plurality of second gas inlet pipes 220 for concentration, and uniformly discharged through the gas outlet holes of the gas outlet member 230, thereby achieving uniform gas diffusion. Therefore, by integrating the first gas inlet pipe 210 and the plurality of second gas inlet pipes 220, the embodiment of the present disclosure enables the reaction gases to diffuse uniformly within a smaller reaction space. Furthermore, in the present disclosure, by arranging the inner wall of the reaction cavity to be inclined and the gas outlet end of the gas outlet member 230 to correspond to the gas inlet end of the reaction cavity, the reaction gases from the gas outlet member 230 can diffuse to the wafer on the wafer placement position 122a via the inclined inner wall of the reaction cavity, avoiding uneven spraying of reaction gases, thereby achieving uniform gas distribution on the wafer surface and improving the film coating quality of the wafer. Through the arrangement of the embodiment of the present disclosure, a wafer reaction device that enables uniform gas distribution on the wafer surface and improves the film coating quality of the wafer is provided.

[0053] FIG. 2 is a structural diagram of the pipeline integration mechanism in FIG. 1; FIG. 3 is a cross-sectional view of FIG. 2.

[0054] Referring to FIG. 2 and FIG. 3, in some examples, the pipeline integration mechanism 200 further comprises a communication assembly 240.

[0055] The communication assembly 240 is configured as an annular structure, the gas outlet ends of the plurality of second gas inlet pipes 220 are in communication with the gas outlet member 230 via the communication assembly 240, and the communication assembly 240 is provided around the first gas inlet pipe 210.

[0056] Exemplarily, the communication assembly 240 may be an annular channel provided on the third component 203 and the fourth component 204, the annular channel

is in communication with the gas outlet ends of the plurality of second gas inlet pipes 220, i.e., in communication with the gas outlet ends of the second channels.

[0057] Exemplarily, the plurality of second gas inlet pipes 220 are provided around the first gas inlet pipe 210.

[0058] In the embodiment of the present disclosure, by providing the communication assembly 240, when the second gas inlet pipes 220 introduce reaction gas, the reaction gas can be concentrated and diffused via the communication assembly 240, avoiding the reaction gas diffusing toward the reaction cavity only from the gas outlet ends of the second gas inlet pipes 220, thereby improving the uniformity of gas diffusion, facilitating uniform deposition on the wafer surface, and improving the film coating quality of the wafer.

[0059] In some examples, the communication assembly 240 comprises a storage member 241 and a communication member 242.

[0060] The storage member 241 is configured as an annular structure, the gas outlet ends of the plurality of second gas inlet pipes 220 are in communication with a gas inlet end of the storage member 241, a gas outlet end of the storage member 241 is in communication with gas inlet ends of a plurality of communication members 242, and gas outlet ends of the plurality of communication members 242 are in communication with the gas inlet end of the gas outlet member 230.

[0061] A radial dimension of the storage member 241 is greater than an inner diameter of the gas outlet ends of the second gas inlet pipes 220, and an inner diameter of the communication member 242 is smaller than the inner diameter of the gas outlet ends of the second gas inlet pipes 220.

[0062] Exemplarily, the storage member 241 may be an annular channel provided on the third component 203, and the communication members 242 may be a plurality of communication channels provided on the fourth component 204 and being in communication with the storage member 241.

[0063] In the embodiment of the present disclosure, by providing the storage member 241, when the second gas inlet pipes 220 introduce reaction gas, the reaction gas can be stored in the storage member 241 and diffused along the annular structure, avoiding the reaction gas diffusing toward the reaction cavity only from the gas outlet ends of the second gas inlet

pipes 220. Furthermore, in the embodiments of the present disclosure, by providing the communication members 242 and setting the radial dimension of the storage member 241 to be greater than the inner diameter of the gas outlet ends of the second gas inlet pipes 220, and setting the inner diameter of the communication members 242 to be smaller than the inner diameter of the gas outlet ends of the second gas inlet pipes 220, the speed of reaction gas entering the storage member 241 is greater than the speed of reaction gas entering the communication members 242, thereby enabling the reaction gas to be uniformly output from the communication members 242 to the gas outlet member 230, improving the uniformity of reaction gas in the reaction cavity.

[0064] In some examples, the first gas inlet pipe 210 comprises a first gas inlet section 211, a second gas inlet section 212, and a third gas inlet section 213 connected sequentially.

[0065] An inner diameter of the second gas inlet section 212 is greater than an inner diameter of the first gas inlet section 211, an inner diameter of the third gas inlet section 213 is greater than the inner diameter of the second gas inlet section 212, and at least a portion of the third gas inlet section 213 is inclined.

[0066] In the embodiment of the present disclosure, by configuring the first gas inlet pipe 210 as the first gas inlet section 211, the second gas inlet section 212, and the third gas inlet section 213 connected sequentially, and setting the inner diameter of the second gas inlet section 212 to be greater than the inner diameter of the first gas inlet section 211, setting the inner diameter of the third gas inlet section 213 to be greater than the inner diameter of the second gas inlet section 212, and inclining at least a portion of the third gas inlet section 213, the first reaction gas in the first gas inlet pipe 210 can sequentially pass through the first gas inlet section 211 and the second gas inlet section 212 for uniform diffusion, and then pass through the inclined inner wall of the third gas inlet section 213 for uniform diffusion into the gas outlet member, thereby achieving uniform diffusion of the first reaction gas.

[0067] Exemplarily, the first gas inlet pipe 210 further comprises an inclined section 214.

[0068] A first end of the inclined section 214 is in communication with the first gas inlet section 211, a second end of the inclined section 214 is in communication with the second gas inlet section 212, and an inner diameter of the inclined section 214 gradually increases

from the first end to the second end.

[0069] The third gas inlet section 213 comprises a first uniform zone 213a, a connection zone 213b, and a second uniform zone 213c connected sequentially, a gas inlet end of the first uniform zone 213a is connected to a gas outlet end of the second gas inlet section 212, and an inner diameter of the first uniform zone 213a gradually increases from the gas outlet end of the second gas inlet section 212 toward the connection zone 213b.

[0070] Two ends of the connection zone 213b respectively connect the first uniform zone 213a and the second uniform zone 213c, and an inner diameter of the second uniform zone 213c gradually increases from a gas outlet end of the connection zone 213b toward a gas outlet end of the second uniform zone 213c.

[0071] In the embodiment of the present disclosure, by providing the inclined section 214, on the one hand, it can serve to connect the first gas inlet section 211 and the second gas inlet section 212. On the other hand, by setting the inner diameter of the inclined section 214 to gradually increase from the first end to the second end, the first reaction gas can be uniformly diffused in the inclined section 214 along the inner wall of the inclined section. In the embodiment of the present disclosure, by configuring the third gas inlet section 213 to comprise the first uniform zone 213a, the connection zone 213b, and the second uniform zone 213c connected sequentially, the first reaction gas can be uniformly diffused to the gas outlet member 230 through the first uniform zone 213a and the second uniform zone 213c.

[0072] In other implementations, the pipeline integration mechanism 200 further comprises a purge gas inlet pipe 250, gas inlet branch pipes 251, and a gas inlet channel 252.

[0073] The purge gas inlet pipe 250 is in communication with one end of the gas inlet channel 252. The gas inlet channel 252 is configured as an annular structure. The other end of the gas inlet channel 252 is in communication with respective ends of the gas inlet branch pipes 251. The other ends of the gas inlet branch pipes 251 are correspondingly in communication with the plurality of second gas inlet pipes 220.

[0074] The pipeline integration mechanism 200 further comprises a purge gas outlet pipe 260, gas outlet branch pipes 261, and a gas outlet channel 262.

[0075] The purge gas outlet pipe 260 is in communication with one end of the gas outlet channel 262. The gas outlet channel 262 is configured as an annular structure. The other

end of the gas outlet channel 262 is in communication with respective ends of the gas outlet branch pipes 261. The other ends of the gas outlet branch pipes 261 are correspondingly in communication with the plurality of second gas inlet pipes 220.

[0076] The purge gas inlet pipe 250 is used for introducing a purge gas, and the purge gas outlet pipe 260 is used for discharging the purge gas and impurity gases.

[0077] Exemplarily, the purge gas inlet pipe 250 can be provided on the second component 202, the gas inlet channel 252 can also be provided on the second component 202, and the gas inlet branch pipes 251 can be provided on the third component 203.

[0078] Exemplarily, the purge gas outlet pipe 260 can be provided on the first component 201, the gas outlet channel 262 can also be provided on the first component 201, and the gas outlet branch pipes 261 can be provided on the second component 202.

[0079] Exemplarily, the purge gas can be an inert gas, such as nitrogen.

[0080] By providing the purge gas inlet pipe 250, the gas inlet branch pipes 251, the gas inlet channel 252, the purge gas outlet pipe 260, the gas outlet branch pipes 261, and the gas outlet channel 262, the embodiment of the present disclosure enables purging of the second gas inlet pipes 220, thus effectively purging residual reaction gases (e.g., precursor A, precursor B1, precursor B2, etc.) and purging nitrogen, ensuring the purity of atoms deposited on the wafer each time.

[0081] Exemplarily, the pipeline integration mechanism 200 further comprises first injection members 251a and second injection members 261a.

[0082] A plurality of the first injection members 251a are detachably disposed within the gas inlet branch pipes 251, and an inner diameter of the first injection members 251a is smaller than an inner diameter of the gas inlet branch pipes 251.

[0083] A plurality of the second injection members 261a are detachably disposed within the gas outlet branch pipes 261, and an inner diameter of the second injection members 261a is smaller than an inner diameter of the gas outlet branch pipes 261.

[0084] In specific implementation, both the first injection members 251a and the second injection members 261a can be capillary tubes. When it is necessary to purge the second gas inlet pipes 220 by introducing gas, the purge gas outlet pipe 260 is closed, and purge nitrogen is input into the gas inlet end of the purge gas inlet pipe 250. The purge nitrogen

enters the plurality of second gas inlet pipes 220 via the gas inlet channel 252 and the gas inlet branch pipes 251. Since capillary tubes are provided at the gas inlet branch pipes 251, the pressure of the purge nitrogen entering the gas inlet branch pipes 251 from the gas inlet channel 252 increases, thereby enhancing the purging force of the purge nitrogen for the second gas inlet pipes 220. Furthermore, by setting the inner diameter of the capillary tubes to be smaller than the inner diameter of the gas inlet branch pipes 251, the embodiment of the present disclosure can prevent reaction gases from entering the purge gas inlet pipe 250 and other pipes connected to the purge gas inlet pipe 250 via the gas inlet channel 252 when the second gas inlet pipes 220 are introducing reaction gases, thereby avoiding contamination, thus protecting the gas inlet channel 252, the purge gas inlet pipe 250, and the other pipes connected to the purge gas inlet pipe 250.

[0085] When the purge gas inlet pipe 250 is closed, the purge gas outlet pipe 260 discharges the purge gas and impurity gases from the second gas inlet pipes 220. The purge nitrogen and impurity gases in the second gas inlet pipes 220 enter the purge gas outlet pipe 260 sequentially via the gas outlet branch pipes 261 and the gas outlet channel 262. Since capillary tubes are provided at the gas outlet branch pipes 261 and the inner diameter of the capillary tubes is set to be smaller than the inner diameter of the gas outlet branch pipes 261, it prevents reaction gases from entering the purge gas outlet pipe 260 and other pipes connected to the purge gas outlet pipe 260 via the gas outlet channel 262 when the second gas inlet pipes 220 are introducing reaction gases, thereby avoiding contamination, thus protecting the gas outlet channel 262, the purge gas outlet pipe 260, and the other pipes connected to the purge gas outlet pipe 260.

[0086] By providing the first injection members 251a, the embodiment of the present disclosure can enhance the purging force of the purge nitrogen for the second gas inlet pipes 220, and prevent contamination of the gas inlet channel 252, the purge gas inlet pipe 250, and other pipes connected to the purge gas inlet pipe 250. Furthermore, by providing the second injection members 261a, the embodiment of the present disclosure can protect the gas outlet channel 262, the purge gas outlet pipe 260, and other pipes connected to the purge gas outlet pipe 260.

[0087] FIG. 4 is a cross-sectional view of a partial structure of FIG. 1. FIG. 5 is a structural

cross-sectional view of FIG. 1.

[0088] Referring to FIG. 1, FIG. 4, and FIG. 5, in another implementation, an inner diameter of the reaction cavity gradually increases from the gas inlet end toward the wafer placement position 122a.

[0089] Exemplarily, the reaction cavity is configured as a tapered structure, wherein an angle between a tapered surface and a central axis of the reaction cavity is 20° to 70°. For example, the angle between the tapered surface and the central axis of the reaction cavity can be values such as 20°, 25°, 30°, 60°, or 70°, etc.

[0090] By configuring the inner diameter of the reaction cavity to gradually increase from the gas inlet end toward the wafer placement position 122a, the embodiment of the present disclosure enables the reaction gases to uniformly diffuse along the inner wall of the reaction cavity to the wafer placement position 122a, thereby achieving a uniform deposition layer on the wafer surface and improving the film coating quality of the wafer.

[0091] In some examples, the reaction cavity comprises at least a first diffusion zone 1211, a buffer zone 1221, a second diffusion zone 1222, and a placement zone 1223 in a direction from the gas inlet end to the wafer placement position 122a.

[0092] An inner diameter of the first diffusion zone 1211 gradually increases from the gas inlet end toward the buffer zone 1221.

[0093] the buffer zone 1221 extends from an end of the first diffusion zone 1211 facing away from the gas inlet end toward the second diffusion zone 1222.

[0094] An inner diameter of the second diffusion zone 1222 gradually increases from an end of the buffer zone 1221 facing away from the first diffusion zone 1211 toward the placement zone 1223.

[0095] The placement zone 1223 extends from an end of the second diffusion zone 1222 facing away from the buffer zone 1221 toward the wafer placement position 122a. The wafer placement position 122a is disposed at a bottom of the placement zone 1223.

[0096] Exemplarily, the first diffusion zone 1211 and the second diffusion zone 1222 are configured as tapered structures, and the buffer zone 1221 and the placement zone 1223 are configured as cylindrical structures.

[0097] For example, an angle between the tapered surfaces of the first diffusion zone 1211

and the second diffusion zone 1222 and the central axis of the reaction cavity can be 20° to 70°. For example, the angle between the tapered surfaces and the central axis of the reaction cavity can be values such as 20°, 25°, 30°, 60°, or 70°, etc.

[0098] In the embodiment of the present disclosure, by configuring the reaction cavity to have the first diffusion zone 1211, the buffer zone 1221, the second diffusion zone 1222, and the placement zone 1223 in the direction from the gas inlet end to the wafer placement position 122a, compared to providing only the first diffusion zone 1211, the area of the reaction cavity can be reduced. Under the condition of a constant volume of introduced reaction gases, a smaller reaction cavity area can better ensure the concentration of reaction gases and the controllability of the reaction gases, allowing the reaction gases to uniformly deposit on the wafer surface for reaction, thereby improving the uniformity of the deposition layer on the wafer surface.

[0099] Exemplarily, the reaction mechanism 100 comprises a reaction outer housing 110 and a reaction inner housing 120, the reaction outer housing 110 forms an accommodation cavity 111, and the reaction inner housing 120 is disposed within the accommodation cavity 111.

[00100] The reaction inner housing 120 comprises a first housing 121 and a second housing 122, one end of the first housing 121 is in communication with the pipeline integration mechanism 200, and the other end of the first housing 121 is extending toward the wafer placement position 122a.

[00101] The first diffusion zone 1211 is formed within the first housing 121. The buffer zone 1221, the second diffusion zone 1222, and the placement zone 1223 are formed within the second housing 122.

[00102] A sidewall of the reaction mechanism 100 is further provided with a wafer transfer channel in communication with the accommodation cavity 111, and the second housing 122 is capable of reciprocating movement in a vertical direction, so that a wafer can be placed into the wafer placement position 122a of the placement zone 1223 via the wafer transfer channel.

[00103] Exemplarily, an outer sidewall of an end of the first housing 121 facing away from the pipeline integration mechanism 200 is configured as a vertical cylindrical surface,

facilitating relative movement with respect to the second housing 122 when the second housing 122 moves reciprocally in the vertical direction.

[00104] Exemplarily, the placement zone 1223 is provided with the wafer placement position 122a, and the wafer placement position 122a is disposed at the bottom of the placement zone 1223. The wafer placement position 122a can be configured as a wafer carrying tray, one end of the wafer carrying tray is disposed on the inner wall of the reaction cavity, and the other end extending toward the central axis of the reaction cavity.

[00105] In specific implementation, the second housing 122 moves in the vertical direction toward the pipeline integration mechanism 200. When the wafer placement position 122a moves to a middle position of the wafer transfer channel, the second housing 122 stops moving. A wafer transfer member transfers a wafer from the wafer transfer channel into the reaction cavity, until the wafer transfer member is directly above the wafer carrying tray. The wafer transfer member moves the wafer downward until the wafer completely falls onto the wafer carrying tray, the wafer is disengaged from the wafer transfer member. After the wafer transfer member moves out of the wafer transfer channel, the second housing 122 moves in the vertical direction away from the pipeline integration mechanism 200 until the second housing 122 reaches a preset position.

[00106] By configuring the first housing 121 and the second housing 122, and providing the sidewall of the reaction mechanism 100 with a wafer transfer channel, with the second housing 122 capable of reciprocating movement in the vertical direction, the embodiment of the present disclosure facilitates wafer transfer.

[00107] FIG. 6 is a first partial structural diagram of FIG. 1. FIG. 7 is a second partial structural diagram of FIG. 1. FIG. 8 is a third partial structural diagram of FIG. 1. FIG. 9 is a top view of FIG. 1.

[00108] Referring to FIG. 6 to FIG. 9, in some examples, the wafer reaction device further comprises a lifting mechanism 300. The lifting mechanism 300 comprises a movable frame 310, a driving member 320, a movable rod 330, and a guide sealing member 340.

[00109] A fixed end of the driving member 320 is disposed on the reaction outer housing 110, and a lifting end of the driving member 320 is disposed on the movable frame 310.

[00110] One end of the guide sealing member 340 is fixed to the movable frame 310, and

the other end of the guide sealing member 340 is fixed to the reaction outer housing 110. One end of the movable rod 330 is connected to the movable frame 310, and the other end of the movable rod 330 sequentially passes through the guide sealing member 340, the accommodation cavity 111, and is connected to the second housing 122.

[00111] The lifting end is configured to drive the movable frame 310 to move in the vertical direction, so that the movable rod 330 drives the second housing 122 to move up and down in the vertical direction.

[00112] Exemplarily, the guide sealing member 340 comprises a sealing bellows 341 and a straight tube 342. One end of the sealing bellows 341 is connected to the movable frame 310, the other end of the sealing bellows 341 is connected to one end of the straight tube 342, and the other end of the straight tube 342 is connected to an upper end of the reaction outer housing 110. One end of the movable rod 330 is connected to the movable frame 310, and the other end of the movable rod 330 sequentially passes through the sealing bellows 341, the straight tube 342, the accommodation cavity 111, and is connected to the second housing 122.

[00113] In specific implementation, the driving member 320 is typically disposed on one side of the movable frame 310. To improve the stability of the wafer reaction device, the wafer reaction device is further provided with a support mechanism 400. The support mechanism 400 comprises a sleeve 410 and an extension sliding rod 420. One end of the sleeve 410 is connected to the reaction outer housing 110, and the other end of the sleeve 410 extends toward the movable frame 310. One end of the extension sliding rod 420 is connected to the movable frame 310, and the other end of the extension sliding rod 420 passes through the sleeve 410 and is connected to the reaction outer housing 110. By providing the sleeve 410 and the extension sliding rod 420, the stability of the reciprocating movement of the second housing 122 in the vertical direction is further improved, thereby enhancing the stability of wafer transfer.

[00114] By providing the lifting mechanism 300 and the support mechanism 400, the embodiment of the present disclosure ensures stable vertical movement of the second housing 122, enabling the wafer to be smoothly placed into or removed from the reaction cavity.

[00115] FIG. 10 is a fourth partial structural diagram of FIG. 1.

[00116] In another implementation, referring to FIG. 10, an annular first protrusion 122b is disposed around an outer sidewall of the second housing 122.

[00117] The lifting mechanism 300 further comprises an adjustment assembly 350, and the adjustment assembly 350 comprises an adjustment rod 351, a first adjustment knob 352, a first locking nut 353, a first washer 354, a second adjustment knob 355, a second locking nut 356, and a second washer 357.

[00118] One end of the adjustment rod 351 is rotatably connected to the other end of the movable rod 330, and the other end of the adjustment rod 351 passes through the first protrusion 122b.

[00119] One end of the first adjustment knob 352 abuts against one side of the first protrusion 122b via the first washer, and the other end of the first adjustment knob abuts against the first locking nut 353, with the first locking nut 353, the first adjustment knob 352, and the first washer 354 sequentially sleeved on an outer sidewall of the adjustment rod 351.

[00120] One end of the second adjustment knob 355 abuts against the other side of the first protrusion 122b via the second washer, and the other end of the second adjustment knob 355 abuts against the second locking nut 356, with the second washer 357, the second adjustment knob 355, and the second locking nut 356 sequentially sleeved on the outer sidewall of the adjustment rod 351.

[00121] Exemplarily, one end of the adjustment rod 351 is provided with threads, and the other end of the movable rod 330 is provided with a threaded hole matching the adjustment rod 351, allowing the adjustment rod to rotate along the threaded hole.

[00122] Exemplarily, a plurality of movable rods 330 are disposed around the second housing 122, and furthermore, a plurality of adjustment assemblies 350 are disposed around the second housing 122.

[00123] Exemplarily, an annular second protrusion 122c is further disposed around the outer sidewall of the second housing 122, and the second protrusion 122c is disposed below the first protrusion 122b. A connecting member is disposed between the first protrusion 122b and the second protrusion 122c, so that the second protrusion 122c provides support

to the first protrusion 122b.

[00124] In specific implementation, when it is necessary to adjust the adjustment rod 351 toward the movable rod 330, the second locking nut 356 and the second adjustment knob 355 can be loosened sequentially, and then the adjustment rod 351 is rotated to move the adjustment rod 351 toward the movable rod 330. When the adjustment rod 351 moves to a preset position, the second washer 357 is abutted against the other side of the first protrusion 122b, the second adjustment knob 355 is abutted against the second washer 357 and the second adjustment knob 355 is tightened, and then the second locking nut 356 is abutted against the second adjustment knob 355 and the second locking nut 356 is tightened. Then, the first locking nut 353 and the first adjustment knob 352 are loosened, the first washer 354 is abutted against one side of the first protrusion 122b, the first adjustment knob 352 is abutted against the first washer 354 and the first adjustment knob 352 is tightened, and then the first locking nut 353 is abutted against the first adjustment knob 352 and the first locking nut 353 is tightened. It should be noted that the method for adjusting the adjustment rod 351 away from the movable rod 330 is similar to the method for adjusting the adjustment rod 351 toward the movable rod 330.

[00125] By providing the adjustment rod 351, the embodiment of the present disclosure enables adjustment of the vertical position of the second housing 122 via the adjustment rod 351, further adjusting the position of the wafer carrying tray, and thereby adjusting the position of the wafer to keep the wafer horizontal, ensuring uniform deposition on the wafer surface and improving the film coating quality. By providing the first adjustment knob 352 and the second adjustment knob 355, the embodiment of the present disclosure can fix the position of the adjustment rod 351. By providing the first locking nut 353 and the second locking nut 356, the embodiment of the present disclosure can fix the first adjustment knob 352 and the second adjustment knob 355, thereby improving the stability of the adjustment assembly 350. By providing the first washer 354 and the second washer 357, the embodiment of the present disclosure reduces pressure, prevents loosening, and provides some protection for the adjustment assembly 350.

[00126] FIG. 11 is a structural diagram of a ceramic gas distributor assembled to the outer housing in FIG. 1.

[00127] Referring to FIG. 11, in some examples, the wafer reaction device further comprises a ceramic gas distributor 500.

[00128] The ceramic gas distributor 500 is disposed on a top of the first housing 121. A gas outlet end of the ceramic gas distributor 500 is configured as a cylindrical structure. The gas outlet end is provided with a plurality of gas dispersion holes 510, and the gas dispersion holes 510 is in communication with the accommodation cavity 111.

[00129] The ceramic gas distributor 500 is used for delivering an inert gas into the accommodation cavity 111, so that a pressure within the accommodation cavity 111 is greater than a pressure within the reaction cavity.

[00130] In specific implementation, the pipeline integration mechanism 200 is used to introduce an inert gas (nitrogen) and reaction gases such as precursor A, precursor B1, precursor B2, etc., into the reaction cavity. Simultaneously, the ceramic gas distributor 500 is used to deliver an inert gas (nitrogen) into the accommodation cavity 111, ensuring that the pressure within the accommodation cavity 111 is greater than the pressure within the reaction cavity to prevent reaction gases from leaking out of the reaction cavity.

[00131] By providing the ceramic gas distributor 500, the embodiment of the present disclosure allows the ceramic gas distributor 500 to deliver an inert gas into the accommodation cavity 111, making the pressure within the accommodation cavity 111 greater than the pressure within the reaction cavity, thereby preventing reaction gases from escaping through the gap between the first housing 121 and the second housing 122.

[00132] Referring to FIG. 4, in other implementations, the reaction inner housing 120 further comprises a third housing 123. The third housing 123 extends from a bottom of the wafer placement position 122a toward the second housing 122 and is sleeved on an outer sidewall of the second housing 122.

[00133] The wafer reaction device further comprises a first heating mechanism 600 and a second heating mechanism 700.

[00134] The first heating mechanism 600 is disposed between the third housing 123 and the reaction outer housing 110, and the second heating mechanism 700 is disposed below the wafer placement position 122a. Both the first heating mechanism 600 and the second heating mechanism 700 are used for heating the wafer.

[00135] In specific implementation, to prevent the temperature of the third housing 123 from being too high, which could cause injury if accidentally touched by personnel, the heating temperature of the first heating mechanism 600 can be set between 36°C and 40°C, providing a thermal insulation effect for the reaction cavity. Furthermore, the heating temperature of the second heating mechanism 700 can be set to a higher temperature required for wafer film coating, facilitating uniform heating of the wafer.

[00136] Exemplarily, the first heating mechanism 600 comprises a thermal insulation member and a heating assembly. The heating assembly can be configured as a heating wire. The thermal insulation member is disposed on an inner sidewall of the reaction outer housing 110, and the heating assembly is disposed between the thermal insulation member and the third housing 123.

[00137] By providing the first heating mechanism 600, the embodiment of the present disclosure provides thermal insulation for the reaction cavity. By providing the second heating mechanism 700, the wafer can be uniformly heated as the second heating mechanism 700 is provided below the wafer placement position 122a, improving the film coating quality.

[00138] FIG. 12 is a schematic structural diagram of the heat conduction plate in FIG. 4.

[00139] Exemplarily, continuing to refer to FIG. 4 and FIG. 12, the second heating mechanism 700 comprises a carrying member 710, a heating wire 720, and a heat conduction plate 730.

[00140] The carrying member 710 is disposed below the wafer placement position 122a. The heat conduction plate 730 is disposed between the carrying member 710 and the wafer placement position 122a, and the carrying member 710 and the heat conduction plate 730 are integrally formed. The heating wire 720 is disposed between the carrying member 710 and the heat conduction plate 730. The carrying member 710 is connected to a bottom of the third housing 123 via a plurality of annularly arranged connecting columns.

[00141] The heat conduction plate 730 comprises an inner circle and an annular region disposed outside the inner circle, the inner circle is arranged to correspond to the heating wire 720, and the annular region is provided with a plurality of gas vent holes 731.

[00142] Exemplarily, the carrying member 710 and the heat conduction plate 730 are

integrally provided. An outer sidewall of the carrying member 710 is provided with connecting protrusions extending toward the heat conduction plate 730. The carrying member 710 and the heat conduction plate 730 are connected via the connecting protrusions. The heating wire 720 is disposed between the carrying member 710 and the heat conduction plate 730, and the heating wire corresponds to the inner circle.

[00143] For example, the heating wire 720 can be arranged in annular loops, with equal distances between adjacent loops of the heating wire 720, to achieve uniform heating of the wafer.

[00144] For another example, the aperture of the gas vent holes 731 in middle regions on both sides along the horizontal direction is greater than the aperture in other regions. In specific implementation, the middle regions on both sides along the horizontal direction of the gas vent holes 731 are defined as a first region, and the other regions are defined as a second region. The aperture of the gas vent holes 731 in the first region is greater than the aperture of the gas vent holes 731 in the second region. The first region corresponds to the wafer carrying tray provided at the wafer placement position 122a.

[00145] For yet another example, a support base is disposed below the carrying member 710. The support base is used for supporting the carrying member 710 and is formed with a vacuum channel. The vacuum channel is in communication with the reaction cavity for evacuating the reaction cavity.

[00146] By configuring the heat conduction plate 730 as an annular structure, with the inner circle of the annular structure corresponding to the heating wire 720, the embodiment of the present disclosure allows the heating wire 720 to directly heat the wafer from below, not only achieving uniform heating of the wafer but also improving heating efficiency. By providing the plurality of gas vent holes 731 on the surface of the heat conduction plate 730, excess gas in the reaction cavity can be discharged, thus preventing the reaction gases from eroding the reaction cavity.

[00147] Finally, it should be noted that the above embodiments are only used to illustrate the technical solutions of the present disclosure, and are not limiting thereof. Although the present disclosure has been described in detail with reference to the foregoing embodiments, a person skilled in the art should understand that they can still modify the

technical solutions described in the foregoing embodiments, or equivalently replace some of the technical features thereof. These modifications or replacements do not cause the essence of the corresponding technical solutions to depart from the spirit and scope of the technical solutions of the embodiments of the present disclosure.