POLISHING METHOD, POLISHING DEVICE AND SILICON WAFER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to the Chinese patent application No. 202411582864.9 filed on November 7, 2024, disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of silicon wafer machining, in particular to a polishing method, a polishing device and a silicon wafer.

BACKGROUND

[0003] In the field of semiconductor manufacturing, requirements for surface flatness of a silicon wafer become increasingly stringent along with the development of the technology. In order to improve the surface flatness of the silicon wafer, generally a manufacturing process includes two key steps: double-side polishing and final polishing. In the double-side polishing, both the front and back surfaces of the silicon wafer are polished, while the final polishing focuses exclusively on polishing the front surface of the silicon wafer.

[0004] In the final polishing process, the silicon wafer is chucked onto a polishing head and pressed against a polishing pad beneath the polishing head. Through relative movement with the polishing pad, the front surface of the silicon wafer undergoes fine polishing. In this process, a material removal amount has a decisive influence on the flatness of the silicon wafer after the polishing, especially the global flatness and edge flatness. In addition, the profile of the silicon wafer prior to the final polishing also affects the flatness after the final polishing.

[0005] In the current continuous processing workflow, the influence of the surface profile variations among different silicon wafers prior to the final polishing on a final polishing performance has not been fully taken into consideration. Instead, identical process parameters are uniformly applied to all these different silicon wafers.

Usually, this undifferentiated treatment causes the polished silicon wafers to fail to meet stringent dimensional and geometric form requirements.

SUMMARY

[0006] Based on the above, the present disclosure intends to provide a polishing method, a polishing device and a silicon wafer. Through the polishing method, the distribution of a pressure applied to the silicon wafer is accurately controlled according to the deformation of a template assembly along with a temperature, so as to customize a material removal amount according to the expected dimension and the expected shape of the silicon wafer as well as the specific profile of the silicon wafer prior to the polishing, thereby to achieve a desired polishing effect.

[0007] The technical solutions of the present disclosure are implemented as follows.

[0008] In a first aspect, the present disclosure provides in some embodiments a polishing method, including: holding a silicon wafer with a polishing head, wherein in a case that the silicon wafer is held with the polishing head, a first surface of the silicon wafer is exposed and a second surface of the silicon wafer opposite to the first surface is adjacent to a template assembly of the polishing head; and adjusting a temperature of the template assembly, to deform the template assembly to bring the template assembly into at least partial contact with the second surface of the silicon wafer being held, such that, in a polishing process, a pressure applied to the template assembly is transferred to the silicon wafer via a portion of the template assembly in contact with the second surface of the silicon wafer.

[0009] In some possible embodiments of the present disclosure, the template assembly includes a plurality of deformable regions, the plurality of deformable regions are deformed independent of each other, and the adjusting a temperature of the template assembly includes: independently adjusting temperatures of the plurality of deformable regions of the template assembly.

[0010] In some possible embodiments of the present disclosure, the adjusting a temperature of the template assembly includes: heating one or more target deformable regions in the plurality of deformable regions of the template assembly independently.

[0011] In some possible embodiments of the present disclosure, the adjusting the temperature of the template assembly includes: determining the one or more target deformable regions from the plurality of deformable regions of the template assembly according to profile of the first surface of the silicon wafer being held.

[0012] In some possible embodiments of the present disclosure, the template assembly includes a pad body and a chucking pad connected to the pad body and configured to chuck the silicon wafer; correspondingly, the adjusting the temperature of the template assembly to deform the template assembly to bring the template assembly into at least partial contact with the second surface of the silicon wafer being held includes: adjusting a temperature of the pad body, to deform the pad body, and to deform the chucking pad along with the pad body to be brought into at least partial contact with the second surface of the silicon wafer being held.

[0013] In a second aspect, the present disclosure provides in some embodiments a polishing device, for performing the polishing method in the first aspect, including: a polishing head configured to hold a silicon wafer, wherein in a case that the silicon wafer is held with the polishing head, a first surface of the silicon wafer is exposed and a second surface of the silicon wafer opposite to the first surface is adjacent to a template assembly of the polishing head; and a temperature adjustment assembly, configured to adjust a temperature of the template assembly, to deform the template assembly to bring the template assembly into at least partial contact with the second surface of the silicon wafer being held, wherein in a polishing process, a pressure applied to the template assembly is transferred to the silicon wafer via a portion of the template assembly in contact with the second surface of the silicon wafer.

[0014] In some possible embodiments of the present disclosure, the template assembly includes a plurality of deformable regions, the plurality of deformable regions are deformed independent of each other, and the temperature adjustment assembly includes a plurality of temperature adjustment members configured to independently

adjust temperatures of the plurality of deformable regions of the template assembly respectively.

[0015] In some possible embodiments of the present disclosure, at least a portion of temperature adjustment members among the plurality of temperature adjustment members are located at different positions in a radial direction of the silicon wafer being held.

[0016] In some possible embodiments of the present disclosure, the plurality of temperature adjustment members are arranged in a plurality of annular shapes concentric with the silicon wafer being held.

[0017] In some possible embodiments of the present disclosure, the template assembly includes a pad body and a chucking pad connected to the pad body and configured to chuck the silicon wafer; and the temperature adjustment assembly is configured to adjust a temperature of the pad body, to deform the pad body, and the chucking pad is configured to be deformed along with the pad body to be brought into at least partial contact with the second surface of the silicon wafer being held.

[0018] In a third aspect, the present disclosure provides in some embodiments a silicon wafer obtained through the polishing method in the first aspect. A total thickness variation of the silicon wafer is less than 100 nm, and a site front quotient range of the silicon wafer is less than 20 nm.

[0019] According to the polishing method in the embodiments of the present disclosure, in a case that the silicon wafer is held with the polishing head, a shape of the template assembly of the polishing head is accurately controlled through adjusting the temperature, so as to bring the template assembly into contact with the silicon wafer at a predetermined position, thereby to control, in a customized manner, the distribution of the pressure in different regions of the silicon wafer during the polishing. Through the customized pressure distribution, it is able to further achieve the customized distribution of the material removal amount. The predetermined position at which the template assembly is in contact with the silicon wafer is determined according to target profile of the silicon wafer and initial profile of the silicon wafer before the polishing, so in the polishing method, the distribution of the material removal amount for each

silicon wafer during the polishing is accurately controlled through accurately adjusting the pressure, so as to meet a specific requirement of each silicon wafer, thereby to finally obtain the silicon wafer with the expected profile.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Fig. 1 is a schematic view showing a polishing device according to an embodiment of the present disclosure;

[0021] Fig. 2 is a flow chart of a polishing method according to an embodiment of the present disclosure;

[0022] Fig. 3 is another schematic view showing a polishing device according to an embodiment of the present disclosure;

[0023] Fig. 4 is a schematic view showing a polishing head according to an embodiment of the present disclosure;

[0024] Fig. 5 is another schematic view showing the polishing head shown in Fig. 4;

[0025] Fig. 6 is a schematic view showing a portion of a polishing head according to an embodiment of the present disclosure;

[0026] Fig. 7 is another schematic view showing a portion of a polishing head according to an embodiment of the present disclosure; and

[0027] Fig. 8 is yet another schematic view showing a polishing head according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0028] The technical solution in the embodiments of the present disclosure will be described in a clear and thorough manner hereinafter with reference to the drawings.

[0029] In the early-stage processing of a silicon wafer, such as wire sawing and lapping, a microscopic damage and a stress concentration may be introduced into a surface of the silicon wafer. The final polishing process can remove microscopic defects on the surface of the silicon wafer, thereby improving the surface flatness of the silicon wafer.

[0030] Fig. 1 shows a polishing device 10 provided in some embodiments of the present disclosure. The polishing device 10 includes: a polishing table 11, a polishing pad 12 on an upper surface of the polishing table 11, and a driving shaft 13 below the polishing table 11. Driven by the driving shaft 13, the polishing pad 12 rotates together with the polishing table 11. For example, when the polishing table 11 is driven by the driving shaft 13 to rotate in a counterclockwise direction, the polishing pad 12 rotates in the counterclockwise direction along with the polishing table 11.

[0031] In addition, a polishing head 14 is provided in a space above the polishing table 11. The polishing head 14 at least includes: a head body 141, a rotation driving member 142 connected to the head body 141, and an assembling mold 143 located below the head body 141. A rubber pad 144 is received in a first receiving cavity CS1 in the assembling mold 143. A to-be-polished silicon wafer S is also received in the first receiving cavity CS1. The rubber pad 144 may be connected to the head body 141. Compressed dry air is supplied into the first receiving cavity CS1 of the assembling mold 143 via a vacuum/air pipe 145 to form a working pressure. The working pressure is applied onto the rubber pad 144, and delivered to the to-be-polished silicon wafer S via the rubber pad 144.

[0032] The head body 141 may be driven by the rotation driving member 142 to rotate, so that the head body 141 rotates and the silicon wafer S in the first receiving cavity CS1 of the assembling mold 143 also rotates along with the rotation of the head body 141. For example, when the rotation driving member 142 rotates in a counterclockwise direction, the head body 141 and the to-be-polished silicon wafer S also rotate in the counterclockwise direction along with the rotation driving member 142.

[0033] The polishing device 10 may further include a nozzle 15 located in a space above the polishing pad 12 and close to a center of the polishing pad 12. The nozzle 15 is connected to a storage tank (not shown) for storing a slurry, and a dripping flow rate of the slurry is controlled via a valve.

[0034] During the execution of a polishing operation, a certain working pressure is applied by the rotary polishing head 14 to press the silicon wafer against the rotary

polishing pad 12, and the slurry composed of submicron-sized or nano-sized abrasive particles and a chemical solution is dripped onto the polishing pad 12 via the nozzle 15. Next, the slurry is evenly distributed over the polishing pad 12 under a transport action of the polishing pad 12 and the effect of a centrifugal force. During the distribution, the slurry flows between a surface of the silicon wafer S and the polishing pad 12, so as to form a liquid thin film made of the slurry therebetween. Chemical constituents of the slurry chemically react with a surface material of the silicon wafer, so as to transform an insoluble material into a readily soluble substance, or soften a substrate with high hardness. Then, through the micro-mechanical frictional action of the abrasive particles, these chemical constituents are removed from the surface of the silicon wafer and dissolved in the flowing liquid to be carried away, i.e., the planarization is achieved through the alternating processes of chemical film formation and mechanical film removal.

[0035] It is found that, for the polishing device 10, the overall pressure is applied by the polishing head to the to-be-polished silicon wafer S via the single rubber pad 144 in a vertical direction, so the material removal amount in each region on the entire polished surface of the silicon wafer S is substantially the same. However, in actual production, due to the presence of various factors in the preceding processing, the profile and the flatness of different silicon wafers are different before the final polishing. In this case, when a scheme of evenly removing the material is still used when polishing each silicon wafer, the polished silicon wafer probably cannot meet the target profile requirement.

[0036] Based on the above, it is believed through researches that, in order to enable the polished silicon wafer to meet the target profile requirement, a targeted scheme for the distribution of the material removal amount needs to be set according to the target profile of each silicon wafer and the initial profile prior to the polishing. In other words, for a single silicon wafer, a uniform material removal amount should no longer be set for each region on the to-be-polished surface. Instead, a corresponding material removal amount is set according to specific conditions of different regions. For different silicon wafers, a uniform scheme for the distribution of the material removal

amount should no longer be used. Instead, a corresponding material distribution scheme should be adopted according to the target profile and the initial profile of each silicon wafer.

[0037] It is further found through researches that, the material removal during the polishing mainly relies on the friction generated by the abrasive particles in the slurry between the polishing pad and the surface of the silicon wafer. When the pressure applied to the silicon wafer increases, both a contact area and a contact intensity between the abrasive particles and the surface of the silicon wafer increase, so the abrasive particles are embedded into the surface of the silicon wafer in a larger range and to a greater depth, and thereby more materials are removed. Hence, it is believed that, if different pressures are applied by the polishing head to different regions of the same silicon wafer during the polishing, the material removal amount in different regions of the silicon wafer are different, so as to obtain the silicon wafer that meets the target profile requirement.

[0038] Based on the above, the present disclosure intends to provide a polishing method, a polishing device and a silicon wafer. Through the polishing method, the distribution of a pressure applied to the silicon wafer is accurately controlled according to the deformation of a template assembly along with a temperature, so as to customize the material removal amount according to an expected dimension and an expected shape of the silicon wafer as well as the specific profile of the silicon wafer prior to the polishing, thereby to achieve a desired polishing effect.

[0039] The embodiments of the present disclosure will be described hereinafter with reference to the drawings.

[0040] Referring to Fig. 2, the present disclosure provides in some embodiments a polishing method, which includes: S101, holding a silicon wafer with a polishing head, wherein in a case that the silicon wafer is held with the polishing head, a first surface of the silicon wafer is exposed and a second surface of the silicon wafer opposite to the first surface is adjacent to a template assembly of the polishing head; and S102, adjusting a temperature of the template assembly, to deform the template assembly to bring the template assembly into at least partial contact with the second surface of the

silicon wafer being held, such that, in a polishing process, a pressure applied to the template assembly is transferred to the silicon wafer via a portion of the template assembly in contact with the second surface of the silicon wafer.

[0041] Referring to Fig. 3, the present disclosure further provides in some embodiments a polishing device 100. The polishing device 100 includes a polishing head 200, as shown in Fig. 4. The polishing method in Fig. 1 will be described hereinafter in details in conjunction with the polishing device 100 and the polishing head 200.

[0042] The polishing head 200 is configured to hold a silicon wafer S, so as to expose a first surface S1 of the silicon wafer S. The polishing head 200 includes a template assembly 21 and a temperature adjustment assembly 22. The template assembly 21 is arranged inside the polishing head 200 in such a manner that, in a case that the silicon wafer is held with the polishing head 200, the template assembly 21 is adjacent to a second surface S2 of the silicon wafer being held S. The first surface S1 is opposite to the second surface S2. The temperature adjustment assembly 22 is configured to adjust a temperature of the template assembly 21, so that the template assembly 21 is deformed to be at least partially in contact with the second surface S2 of the silicon wafer being held S, and in the polishing process, the pressure applied to the template assembly 21 is transferred to the silicon wafer S via a portion of the template assembly 21 in contact with the second surface S2 of the silicon wafer S.

[0043] As shown in Fig. 2, the polishing head 200 includes a body 23 and a holding member 24 extending from one surface of the body 23. When the polishing head 200 is used, the holding member 24 is located on a lower surface of the body 23, and is of an approximately annular shape, so as to form, together with the body 23, a chamber 25 opened downward to receive the silicon wafer S.

[0044] In the embodiments of the present disclosure, one of the first surface S1 and the second surface S2 of the silicon wafer is a front surface of the silicon wafer, and the other is a back surface of the silicon wafer. When the silicon wafer S is received in the chamber 25, the to-be-polished first surface S1 is exposed to an ambient environment, and the second surface S2 faces the body 23.

[0045] A surface of the template assembly 21 adjacent to the second surface S2 of the silicon wafer S has a shape and a dimension corresponding to the second surface S2. The template assembly 21 may also be arranged in the chamber 25, and the temperature adjustment assembly 22 is located between the body 23 and the template assembly 21. The temperature adjustment assembly 22 is arranged in such a manner as to be adjacent to the template assembly 21 or in direct contact with the template assembly 21, so as to transfer, directly or via air, its temperature to the template assembly 21.

[0046] The temperature adjustment assembly 22 is configured to at least partially adjust the temperature of the template assembly 21. In some embodiments of the present disclosure, the temperature adjustment assembly 22 is configured to adjust a temperature in any region on the surface of the template assembly 21 adjacent to the temperature adjustment assembly 22.

[0047] The template assembly 21 is made of a material which is deformable upon heated. In some embodiments of the present disclosure, the template assembly 21 is made of a material which, upon heated, undergoes significant variation in shape, but insignificant variation in volume, e.g., a shape-memory alloy or a shape-memory polymer. In this case, in order to prevent the template assembly 21 from damaging the second surface S2 of the silicon wafer S, the template assembly 21 may include a pad body which is deformable and a buffer layer. The buffer layer is supported by a flexible material, one side of the buffer layer is connected to a deformable layer, and the other side of the buffer layer is in direct contact with the second surface S2 of the silicon wafer S, so as to absorb an impact of the deformable layer on the silicon wafer.

[0048] In some other embodiments of the present disclosure, the template assembly 21 may be made of a thermally expandable material which is expandable and deformable upon heated, e.g., polyurethane or silicone rubber. In a case that the template assembly 21 is locally heated, local deformation occurs. In addition, when the template assembly 21 is made of a material such as polyurethane or silicone rubber, the template assembly 21 may be in direct contact with the second surface S2 of the silicon wafer S, without damaging it.

[0049] The polishing method will be further described hereinafter with reference to Figs. 3 to 5.

[0050] In a state as shown in Fig. 4, the to-be-polished silicon wafer S has already been mounted onto the polishing head 200, the temperature adjustment assembly 22 has not started to operate yet, and the template assembly 21 is of an initial shape. The template assembly 21 may be arranged in the polishing head in such a manner as to be partially in contact with the second surface S2 of the silicon wafer S, or not in contact with, but only adjacent to, the second surface S2 of the silicon wafer S. In an embodiment of the present disclosure as shown in Fig. 4, the initial shape of the template assembly 21 is set to have a flat surface. In other embodiments of the present disclosure not shown in the drawings, the template assembly 21 is provided with any other initial shape according to the profile of the silicon wafer S prior to the polishing, so as to be deformed more efficiently to be at least partially in contact with the second surface S2 of the silicon wafer S.

[0051] As clearly shown in the drawings, the initial profile of the to-be-polished silicon wafer S is not good, with a certain degree of warp, so the first surface S1 is uneven, i.e., it includes convex portions and concave portions. In the embodiments of the present disclosure, the convex portion refers to a portion on the first surface or the second surface of the silicon wafer protruding outward relative to a geometrical center plane of the silicon wafer, and the concave portion refers to a portion on the first surface or the second surface of the silicon wafer recessed inward relative to the geometrical center plane.

[0052] If the flatness of the first surface S1 intends to be improved through a polishing operation, a material removal amount of the convex portion of the first surface S1 should be greater than a material removal amount of the concave portion of the first surface S1. However, in a case that the template assembly 21 is provided with a flat surface, it is impossible to provide an ideal support for the silicon wafer S. As shown in Fig. 4, the convex portion on the first surface S1 of the silicon wafer S corresponds to the concave portion on the second surface S2 in a thickness direction of the silicon wafer, and the flat template assembly 21 cannot be brought into intimate contact with

the concave portion on the second surface S2, so in the polishing process, it is impossible to provide sufficient support for the convex portion on the first surface S1. In this way, the pressure applied by the polishing head cannot be directly transferred to the first surface S1 from the entire second surface S2 in the thickness direction of the silicon wafer, and thereby it is impossible to effectively remove the material of the convex portion on the first surface S1.

[0053] In order to solve the above-mentioned problem, the temperature adjustment assembly 22 adjusts the temperature of the template assembly 21 according to the target profile of the to-be-polished silicon wafer S and the initial profile of the first surface S1. Fig. 5 shows the template assembly 21 which is locally expanded and deformed due to a temperature change. After the local deformation, the template assembly 21 is in contact with a portion of the second surface S2 corresponding to the convex portion of the first surface S1 in the thickness direction of the silicon wafer. In this way, the pressure applied by the polishing head is accurately transferred to the silicon wafer S via a portion of the template assembly 21 in contact with the second surface S2, so as to effectively remove a material of a portion of the silicon wafer S, especially a portion of the first surface S1 of the silicon wafer S corresponding to the portion of the template assembly 21 in contact with the second surface S2 in the thickness direction. Meanwhile, fewer materials or no material is removed from other portions on the first surface S1.

[0054] After the template assembly 21 is deformed to achieve a desired effect of being in contact with the second surface S2 of the silicon wafer S, the polishing operation is performed. A sufficient polishing pressure is transferred via the template assembly 21 onto the convex portion on the first surface S1, so the convex portion is polished before the concave portion. It means that, after the first surface S1 is subjected to one polishing operation, a polishing amount of the convex portion on the first surface S1 is greater than a polishing amount of the concave portion, i.e., the material removal amount of the convex portion on the first surface S1 is greater than the material removal amount of the concave portion, so the polished silicon wafer has better flatness. Generally speaking, for the entire silicon wafer, due to the scheme for the distribution

of the material removal amount customized according to the initial profile of the first surface S1, the silicon wafer S1 polished through the polishing head 200 has a desired flatness level.

[0055] According to the polishing method and the polishing device in the embodiments of the present disclosure, in a case that the silicon wafer is held with the polishing head, the shape of the template assembly of the polishing head is accurately controlled through adjusting the temperature, so as to bring the template assembly into contact with the silicon wafer at a predetermined position, thereby to control, in a customized manner, the distribution of the pressure in different regions of the silicon wafer during the polishing. Through the customized pressure distribution, it is able to further achieve the customized distribution of the material removal amount. The predetermined position at which the template assembly is in contact with the silicon wafer is determined according to the target profile of the silicon wafer and the initial profile of the silicon wafer before the polishing, so in the polishing method, the distribution of the material removal amount for each silicon wafer during the polishing is accurately controlled through accurately adjusting the pressure, so as to meet a specific requirement of each silicon wafer, thereby to finally obtain the silicon wafer with the expected profile.

[0056] In some embodiments of the present disclosure, referring to Figs. 4 and 5, the template assembly 21 includes a plurality of deformable regions, the plurality of deformable regions are deformed independent of each other, and the temperature adjustment assembly 22 includes a plurality of temperature adjustment members configured to independently adjust temperatures of the plurality of deformable regions of the template assembly 21 respectively. Correspondingly, the adjusting the temperature of the template assembly 21 includes independently adjusting a temperature of each deformable region of the template assembly 21.

[0057] To be specific, in order to locally adjust the temperature of the template assembly 21, the temperature adjustment assembly 22 is divided into a plurality of temperature adjustment members independent of each other. These temperature adjustment members may independently control the temperatures of the deformable

regions respectively, so as to adjust the temperatures of different regions of the template assembly. In an embodiment of the present disclosure as shown in Fig. 5, three temperature adjustment members in the plurality of temperature adjustment members of the temperature adjustment assembly 22, i.e., a first temperature adjustment member 22A, a second temperature adjustment member 22B and a third temperature adjustment member 22C, adjust the temperatures of three portions of the template assembly 21 adjacent thereto respectively.

[0058] A heat transfer path in a thickness direction of the template assembly 21 is shortest, so portions of the template assembly 21 that are substantially aligned with the three temperature adjustment members in the thickness direction of the template assembly 21 are deformed to the greatest extent in response to a temperature adjustment effect. In comparison, a deformation degree in other regions of the template assembly 21 is relatively smaller, or no deformation occurs. Hence, after the local deformation, the entire template assembly 21 is in a state as shown in Fig. 5. Through the deformed template assembly 21, an intimate contact with at least a portion of the second surface S2 of the silicon wafer S may be achieved.

[0059] A distribution mode of the temperature adjustment members of the temperature adjustment assembly 22 may be determined according to the initial profile of the silicon wafer S before the polishing. In the field of silicon wafer manufacturing, common types of warps of the silicon wafer include: bow-like warp, in which a center portion of the silicon wafer is relatively high and the silicon wafer has a bow-like shape; and dish-like warp, in which the center portion of the silicon wafer is relatively low and the silicon wafer has a dish-like shape. In some embodiments of the present disclosure, for the above-mentioned two types of warps, at least some of the plurality of temperature adjustment members are arranged at different positions in a radial direction of the silicon wafer being held S.

[0060] As shown in Fig. 6, a surface of the temperature adjustment assembly 22 adjacent to the template assembly 21 is of an approximately circular shape. The temperature adjustment members of the temperature adjustment assembly 22 are divided into two groups, a first group of temperature adjustment members includes four

first temperature adjustment members 22A, and a second group of temperature adjustment members includes four second temperature adjustment members 22B. The second group of temperature adjustment members is located at a position farther away from a center of the temperature adjustment assembly 22 than the first group of temperature adjustment members.

[0061] Through the arrangement of the plurality of temperature adjustment members in the above-mentioned distribution mode, when the silicon wafer including the bow-like or dish-like warp is polished, the first temperature adjustment members 22A or the second temperature adjustment members 22B are selectively enabled, so as to enable a portion of the template assembly 21 in a central region or a peripheral region to be deformed, thereby to bring the template assembly 21 into contact with a central region or a peripheral region of the second surface S2 of the silicon wafer S, and increase the polishing amount, i.e., the material removal amount, of the first surface S1 of the silicon wafer S in the central region or the peripheral region.

[0062] In some embodiments of the present disclosure, as shown in Fig. 7, the plurality of temperature adjustment members are arranged in a plurality of annular shapes concentric with the silicon wafer being held S.

[0063] As shown in Fig. 7, the temperature adjustment assembly 22 is divided into a plurality of temperature adjustment members independent of each other, and the plurality of temperature adjustment members are arranged in concentric annular shapes and at various radial positions from a center to an edge of the silicon wafer S. Through an independent temperature adjustment capability in each annular region, it is able to separately adjust the temperature in a corresponding annular region of the template assembly 21, so that a portion of template assembly 21 in the annular region is deformed and in contact with a corresponding annular region of the second surface S2 of the silicon wafer S, and thereby the pressure is transferred to the silicon wafer S more evenly. For the silicon wafer with common types of warps, e.g., bow-like warp or dish-like warp, the distribution of the material removal amount is more suitable for its initial profile.

[0064] In some embodiments of the present disclosure, as shown in Fig. 5, the temperature adjustment assembly 22 includes a controller 221 and a heater 222. The controller 221 is configured to control the heater 222 to heat the template assembly 21 at one or more target temperature adjustment members in the plurality of temperature adjustment members. Correspondingly, the adjusting the temperature of the template assembly 21 includes heating one or more target deformable regions in the plurality of deformable regions of the template assembly 21 independently.

[0065] The controller 221 is configured to selectively enable one or more temperature adjustment members in the plurality of temperature adjustment members. The selected temperature adjustment member is also called as a target temperature adjustment member. A plurality of heaters 222 are arranged in such a manner as to correspond to the plurality of temperature adjustment members respectively. Each heater takes charge of independently adjusting the temperature of the temperature adjustment member where the heater is located, so as to accurately control the material removal amount in different regions of the first surface S1 of the silicon wafer S.

[0066] Further, in some embodiments of the present disclosure, the controller 221 is configured to determine one or more target temperature adjustment members in the plurality of temperature adjustment members according to the profile of the first surface S1 of the silicon wafer being held S. Correspondingly, the adjusting the temperature of the template assembly includes determining the one or more target deformable regions from the plurality of deformable regions of the template assembly 21 according to profile of the first surface S1 of the silicon wafer being held S.

[0067] In order to improve the versatility of the polishing head 200, the temperature adjustment assembly 22 may be set to include more temperature adjustment members. When the polishing head 200 is used, one or more temperature adjustment members are selected from all the temperature adjustment members as the target temperature adjustment member according to the specific profile of the to-be-polished silicon wafer S, and the selected target temperature adjustment member is enabled to perform an adjustment operation on the template assembly 21. The temperature adjustment members that are not selected are in a non-working state during

the polishing. As mentioned hereinabove, according to a technical concept of the present disclosure, the scheme for the distribution of the material removal amount of the silicon wafer is determined according to the target profile of the silicon wafer and the initial profile before the polishing. When the polishing method and the polishing device provided in the embodiments of the present disclosure are used, the profile of the incoming silicon wafer is detected, i.e., the profile is detected before the silicon wafer is polished. Next, a profile detection result is compared with a target profile parameter of the silicon wafer, and a specific scheme for the distribution of the material removal amount is formulated according to a comparison result. Correspondingly, a pressure distribution scheme is obtained for the silicon wafer in the subsequent polishing process.

[0068] According to the embodiments of the present disclosure, through the cooperation of the controller 221 and the heater 222 in the temperature adjustment assembly 22, and the target temperature adjustment member is appropriately selected according to the specific profile data, so as to independently control the heating of the plurality of temperature adjustment members, thereby to accurately adjust the pressure applied by the template assembly 21 to different regions of the silicon wafer S. Through this control mode, it is able to not only improve the polishing accuracy and evenness, but also increase the flexibility and adaptability of the polishing head 200, thereby to increase the production efficiency and yield.

[0069] In some embodiments of the present disclosure, as shown in Fig. 8, the template assembly 21 includes a pad body 211 and a chucking pad 212 connected to the pad body 211 and configured to chuck the silicon wafer S. The temperature adjustment assembly 22 is configured to adjust a temperature of the pad body 211, to deform the pad body 211, and the chucking pad 212 is configured to be deformable along with the pad body 211 to be at least partially in contact with the second surface S2 of the silicon wafer being held S.

[0070] As shown in Fig. 8, the pad body 211 is arranged in such a manner as to be adjacent to the temperature adjustment assembly 22 or in direct contact with the temperature adjustment assembly 22. The chucking pad 212 may be located at a side of

the pad body 211 opposite to the temperature adjustment assembly 22, and connected to the pad body 211. A surface of the chucking pad 212 adjacent to the second surface S2 of the silicon wafer S may be set to have a shape and a dimension corresponding to the second surface S2 of the silicon wafer S.

[0071] In some embodiments of the present disclosure, the pad body 211 may be made of a material which, upon heated, undergoes significant variation in shape, but insignificant variation in volume, e.g., a shape-memory alloy or a shape-memory polymer.

[0072] In some other embodiments of the present disclosure, the pad body 211 may be made of a thermally expandable material which is expandable and deformable upon heated, e.g., polyurethane or silicone rubber. In a case that the template assembly 21 is locally heated, local deformation occurs.

[0073] In some embodiments of the present disclosure, the chucking pad 212 may be made of a flexible material, so as to be deformed along with the pad body 211 connected thereto. The silicon wafer S is firmly secured onto the polishing head 200 through the chucking pad 212, e.g., through vacuum chucking or electrostatic chucking, so that the silicon wafer S does not slide or detach from the polishing head 200 during the polishing.

[0074] The chucking pad 26 is deformable along with the pad body 211, so the template assembly 21 including the chucking pad 26 can still achieve the desired distribution of the material removal amount.

[0075] For example, the chucking pad is made of a material such as foamed polyurethane, or a composite material of polyester and polyurethane.

[0076] In some embodiments of the present disclosure, the following silicon wafer is obtained through the polishing device provided in the embodiments of the present disclosure. A total thickness variation (TTV) of the silicon wafer is less than 100 nm, and a site front quotient range (SFQR) is less than 20 nm. The TTVs and SFQRs of silicon wafers 1# to 5# after the silicon wafers are polished using the polishing method provided in the embodiments of the present disclosure are shown in the table 1 below.

Table 1

No.	TTV (nm)	SFQR (nm)
Silicon wafer 1#	69.3	17.8
Silicon wafer 2#	78.1	15.7
Silicon wafer 3#	67.1	14.9
Silicon wafer 4#	75.6	15.1
Silicon wafer 5#	75.0	15.6

[0077] It should be appreciated that, in a case of no conflict, the technical solutions in the embodiments of the present disclosure may be combined randomly.

[0078] The above are merely the specific embodiments of the present disclosure, but shall not be construed as limiting the scope of the present disclosure. Any person skilled in the art may make modifications or substitutions without departing from the spirit of the present disclosure, and these modifications and substitutions shall also fall within the scope of the present disclosure. Hence, the scope of the present disclosure shall be subject to the scope defined by the appended claims.