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THIN FLAT WORKPIECE FIXING METHOD AND ITS FIXING SYSTEM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a thin flat workpiece fixing method and its fixing system, which is preferably applied to a thin flat workpiece fixing method and its fixing system for fixing a silicon wafer when grinding the wafer.

DESCRIPTION OF THE RELATED ART

In recent years, arts corresponding to increase of the diameter of a silicon wafer have progressed in the semiconductor fabrication field because functions and integration degree of various semiconductor devices have been improved.

Therefore, improvement of the working accuracy in various processes including not only the wafer working process for forming a semiconductor device such as an integrated circuit on a silicon wafer but also the silicon wafer manufacturing process for cutting a single-crystal ingot into slices and the dicing process for cutting a silicon wafer and separating it into each semiconductor substrate has been requested more severely year by year.

Among the above processes, the silicon wafer manufacturing process comprises a series of such working processes as slicing, lapping, etching, and polishing so as to manufacture a silicon wafer with a predetermined thickness from a single-crystal ingot through the above processes in order.

It is expected that the diameter of a silicon wafer is further increased in future. However, when thickness variation or warpage occurs in a silicon wafer, the conventional silicon wafer manufacturing process has a problem that it is difficult to meet a requested working accuracy because the accuracy of the flat surface working art for eliminating thickness variation or warpage produced in a silicon wafer is limited.

As one of the methods for solving the above problem, a method of replacing lapping and etching processes in the conventional silicon wafer manufacturing process with the grinding process is proposed (Takao Abe et al., "Super-Flat Surface of Large Diameter Silicon Wafers", Journal of IEICE (Institute of Electronics, Information, and Communication Engineers)). In this case, to support and fix a silicon wafer at the time of grinding, the following methods are listed: a method of attracting a silicon wafer by a vacuum chuck, a method of attaching a silicon wafer by wax, and a method of attaching a silicon wafer to a plate by wax and then attracting the plate by a vacuum chuck.

To fix a silicon wafer at the time of dicing serving as the post-process of the silicon wafer manufacturing process, there is a method of attaching the silicon wafer onto a carrier frame with an adhesive tape attached through the adhesive tape and thereafter dicing the silicon wafer while fixing the carrier frame to a vacuum chuck.

As a fixing method for working a workpiece (e.g. hard disk substrate) with a small minimum length to the maximum length of an external shape like a silicon wafer, a vacuum chuck and wax have conventionally been used similarly to the silicon wafer fixing method.

However, the silicon wafer fixing method using a vacuum chuck has a problem that warpage is newly produced on a silicon wafer since a stress applied to the silicon wafer at the time of fixing is released when the silicon wafer is taken out of the vacuum chuck after grinding because the warpage of the silicon wafer is reformed before the silicon wafer is attracted.

Moreover, in the case of the silicon wafer fixing method using wax, it is very difficult to keep the thickness of the wax constant for each silicon wafer and a strain may occur in the silicon wafer when the wax is cured because the wax contracts in accordance with the thickness of the silicon wafer.

Furthermore, the silicon wafer fixing method using an adhesive tape has a problem that a working error occurs in the adhesive tape because the adhesive tape made of an elastic body has a low rigidity. Furthermore, there is a problem that a defect such as chipping occurs when removing a silicon wafer from the adhesive tape after dicing.

SUMMARY OF THE INVENTION

In view of the foregoing, an object of this invention is to provide a thin flat workpiece fixing method and its fixing system capable of increasing the working yield of thin flat workpieces and improving the quality and reliability of the workpieces.

The foregoing object and other objects of the invention have been achieved by the provision of a thin flat workpiece fixing method and its fixing system which cures a photosetting resin layer by applying a photosetting resin to one side of a light-transmitting base member to form a photosetting resin layer, mounting a thin flat

workpiece on the photosetting resin layer, and thereafter applying rays from the other side of the base member.

Thus, it is possible to fix the workpiece to one side of the base member without causing a strain in the thin flat workpiece.

The nature, principle and utility of the invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings in which like parts are designated by like reference numerals or characters.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Fig. 1 is a local sectional view showing the structure of the wafer fixing system of the first embodiment;

Fig. 2 is a local sectional view showing the structure of the wafer fixing system of the second embodiment;

Fig. 3 is a local sectional view showing the structure of the wafer fixing system of the third embodiment;

Fig. 4 is a local sectional view showing the structure of the wafer fixing system of the fourth embodiment;

Figs. 5A and 5B are a schematic diagram and a local sectional view for explaining a state of applying grease to a silicon wafer in the fourth embodiment;

Figs. 6A and 6B are a top view and a local sectional view showing the structure of the wafer fixing system of the fifth embodiment;

Figs. 7A and 7B are local sectional views showing the structure of the wafer fixing system of the sixth embodiment;

Fig. 8 is a local sectional view showing the structure of the wafer fixing system of the seventh embodiment;

Fig. 9 is a top view showing the structure of a polyester film used for the seventh embodiment;

Fig. 10 is a local sectional view showing the structure of the wafer fixing system of the eighth embodiment;

Fig. 11 is a top view showing the structure of a mask used for the eighth embodiment;

Fig. 12 is a top view showing an ultraviolet-setting resin curing state in the eighth embodiment;

Fig. 13 is a local sectional view showing the structure of the wafer fixing system of the ninth embodiment;

Fig. 14 is a top view showing the structure of a mask used for the ninth embodiment;

Figs. 15A and 15B are local sectional views showing a uniaxial stage moving state in the ninth embodiment;

Fig. 16 is a top view showing an ultraviolet-setting resin curing state in the ninth embodiment;

Fig. 17 is a local sectional view showing the structure of the wafer fixing system of the tenth embodiment;

Fig. 18 is a local sectional view showing the structure of the wafer fixing system of another embodiment; and

Fig. 19 is a local sectional view showing the structure of the wafer fixing system of still another embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Preferred embodiments of the present invention are described

below by referring to the accompanying drawings.

(1) First Embodiment

In Fig. 1, symbol 1 denotes a wafer fixing system used for the grinding process as a whole, in which circular opening 2A with a predetermined diameter is formed at the central portion of the top in the frame 2, and the stage 3 is movably set at the central portion of the bottom in the frame 2 facing the opening 2A in the direction shown by arrow Z (gravitational direction) or the direction opposite to the gravitational direction.

Fixed base 4 made of fused quartz (e.g. fused silica glass) having a predetermined thickness is set outside of the frame 2 so as to cover the opening 2A. Silicon wafer (diameter of approx. 6") 6 is mounted on the fixed base 4 through ultraviolet-setting resin 5 (trade name WR8951: KYORITSU KAGAKU KOGYO Co., Ltd.).

Moreover, high-pressure mercury lamp (2,000 W, 80 W/cm) 7 is set on the stage 3 integrally with the stage 3 so as to be vertically movable in order to control the light intensity of ultraviolet radiation (peak wavelength: 360 nm) L1 emitted from the high-pressure mercury lamp 7 to the ultraviolet-setting resin 5 in accordance with vertical movement of the stage 3.

Furthermore, openable shutter 8 is set to the top of high-pressure mercury lamp 7 so as to adjust the irradiation time of ultraviolet radiation L1 emitted from the high-pressure mercury lamp 7.

In this case, the interval between electrodes of high-pressure mercury lamp 7 (that is, arc length) is set longer than the diameter of silicon wafer 6. Moreover, the contact surface of fixed base 4 with the top of frame 2 (that is, the surface exposed in the frame 2

through the opening 2A) 4A is previously worked so as to have a flatness of $\lambda/10$ ($\lambda=500$ nm) or less. Moreover, the thickness of ultraviolet-setting resin 5 (approx. 0.2 mm) is adjusted in accordance with the weight of silicon wafer 6 by changing its viscosities.

Furthermore, top 4B at the opposite side to contact surface 4A of fixed base 4 is arranged so as to be vertical to ultraviolet radiation L1 emitted from the high-pressure mercury lamp 7 in the direction opposite to the direction shown by arrow Z because the top 4B serves as the reference plane for grinding silicon wafer 6. Thereby, it is possible to avoid thickness variation of ultraviolet-setting resin 5 from occurring due to the weight of silicon wafer 6.

In the case of the above structure, the wafer fixing system 1 opens the shutter 8 after the light intensity of ultraviolet radiation L1 emitted from the high-pressure mercury lamp 7 is stabilized (light intensity of irradiated ultraviolet radiation: average of approx. 200 mW). Then, ultraviolet radiation L1 emitted through the shutter 8 passes through the opening 2A and moreover passes through light-transmitting fixed base 4 and thereafter, it is applied to the bottom of ultraviolet-setting resin 5. Thereby, the ultraviolet-setting resin 5 is cured by irradiation with ultraviolet radiation L1 and it can be stuck between silicon wafer 6 and the fixed base 4 without causing any strain in silicon wafer 6.

According to the above structure, the ultraviolet-setting resin 5 is cured by applying ultraviolet radiation L1 whose light intensity is stabilized to the resin 5 from the contact surface 4A side of fixed base 4 after mounting silicon wafer 6 on the top 4B of light-transmitting fixed base 4 through the ultraviolet-setting resin 5 at

the stage before grinding silicon wafer 6. Thereby, it is possible to fix silicon wafer 6 to the fixed base 4 without causing any strain in silicon wafer 6.

(2) Second Embodiment

In Fig. 2 in which a portion corresponding to that in Fig. 1 is provided with the same symbol, a wafer fixing system 10 has the same structure as the wafer fixing system 1 of the first embodiment except that ultraviolet-setting resin 11 differs. That is, the ultraviolet-setting resin 11 of the second embodiment is obtained by adding a plurality of fine ceramic grains 12 to ultraviolet-setting resin 5 of the first embodiment.

According to the above structure, the ultraviolet-setting resin 11 containing a plurality of ceramic grains 12 is cured by mounting silicon wafer 6 on the top 4B of light-transmitting fixed base 4 through the ultraviolet-setting resin 11 and thereafter applying ultraviolet radiation L1 whose light intensity is stabilized from the contact surface 4A side of fixed base 4 at the stage before grinding silicon wafer 6 similarly to the case of the first embodiment. Thereby, it is possible to fix silicon wafer 6 to the fixed base 4 without causing any strain in silicon wafer 6 and improve the rigidity of ultraviolet-setting resin 11.

(3) Third Embodiment

In Fig. 3 in which a portion corresponding to that in Fig. 1 is provided with the same symbol, a wafer fixing system 20 has a structure in which polyester film 21 with a thickness of 50 μ m is

attached to the bottom of silicon wafer 6 and silicon wafer 6 is mounted on the top 4B of fixed base 4 through the polyester film 21 and the ultraviolet-setting resin 5, in addition to the structure of wafer fixing system 1 of the first embodiment.

In this case, the polyester film 21 has an adhesive strength large enough for silicon wafer 6 and its diameter is set so as to be slightly smaller than that of silicon wafer 6. Thereby, when mounting silicon wafer 6 with the polyester film 21 attached on the top 4B of fixed base 4 through the ultraviolet-setting resin 5, the central portion of silicon wafer 6 bonds with the polyester film 21 and the margin of silicon wafer 6 contacts the ultraviolet-setting resin 5.

In this connection, the size (contact area) of polyester film 21 to silicon wafer 6 is previously set so that the resultant force of adhesive strengths of polyester film 21 and ultraviolet-setting resin 5 to silicon wafer 6 becomes larger than the frictional force between a grindstone (not illustrated) and silicon wafer 6 when silicon wafer 6 is ground.

According to the above structure, the ultraviolet-setting resin 5 is cured and stuck between the margin of silicon wafer 6 and the top 4B of fixed base 4 and the central portion of silicon wafer 6 is bonded to the polyester film 21 by mounting silicon wafer 6 with the polyester film 21 attached on the top 4B of fixed base 4 through the polyester film 21 and the ultraviolet-setting resin 5 and thereafter applying ultraviolet radiation L1 whose light intensity is stabilized from the contact surface 4A side of fixed base 4 at the stage before grinding silicon wafer 6, similarly to the case of the first embodiment.

As a result, it is possible to fix silicon wafer 6 to the fixed base 4 through the polyester film 21 and the ultraviolet-setting resin 5 without causing any strain in silicon wafer 6. Moreover, it is possible to adjust the adhesive force of silicon wafer 6 to the ultraviolet-setting resin 5 because the polyester film 21 smaller than silicon wafer 6 in diameter is attached to silicon wafer 6. Thus, it is possible to very easily remove ground silicon wafer 6 from the top 4B of fixed base 4.

(4) Fourth Embodiment

In Fig. 4 in which a portion corresponding to that in Fig. 3 is provided with the same symbol, a wafer fixing system 30 has the same structure as the wafer fixing system 20 of the third embodiment except that a material attached to silicon wafer 6 differs. That is, the wafer fixing system 30 of the fourth embodiment has a structure in which grease 31 is applied to the bottom of silicon wafer 6 at a predetermined thickness and in a predetermined pattern and silicon wafer 6 is mounted on the top 4B of fixed base 4 through the grease 31 and the ultraviolet-setting resin 5.

In this case, the grease 31 has an adhesive force large enough for silicon wafer 6 and is applied to the bottom of silicon wafer 6 in a striped pattern of a predetermined pitch and at a preset application amount of grease, as shown in Fig. 5A. Thereby, when mounting silicon wafer 6 coated with the grease 31 on the top 4B of fixed base 4 through the ultraviolet-setting resin 5 (Fig. 5B), a part of silicon wafer 6 bonds with the grease 31 and the other part of silicon wafer 6 contacts the ultraviolet-setting resin 5.

In this connection, an area of the bottom of silicon wafer 6 to be coated with the grease 31 is previously set so that the resultant force of adhesive strengths of the grease 31 and the ultraviolet-setting resin 5 to silicon wafer 6 becomes larger than the frictional force between a grind stone (not illustrated) and silicon wafer 6 when silicon wafer 6 is ground.

According to the above structure, similarly to the case of the third embodiment, at the stage before grinding silicon wafer 6, the silicon wafer 6 coated with the grease 31 is mounted on the top 4B of fixed base 4 through the ultraviolet-setting resin 5, thereafter ultraviolet radiation L1 whose light intensity is stabilized is applied from the contact surface 4A side of fixed base 4. Thus, a part of silicon wafer 6 is bonded to the grease 31 while the ultraviolet-setting resin 5 is cured and stuck between the other part of silicon wafer 6 and the top 4B of fixed base 4.

As a result, it is possible to fix silicon wafer 6 to the fixed base 4 through the ultraviolet-setting resin 5 and the grease 31 without causing any strain in silicon wafer 6. Moreover, because the grease 31 is applied to silicon wafer 6 in a predetermined pattern and at a predetermined amount, it is possible to adjust the adhesive strength of silicon wafer 6 to the ultraviolet-setting resin 5 and resultingly, it is possible to very easily remove ground silicon wafer 6 from the top 4B of fixed base 4.

(5) Fifth Embodiment

In Figs. 6A and 6B in which a portion corresponding to that in Fig. 1 is provided with the same symbol, a wafer fixing system 40 has

a structure in which three support pins 41A to 41C horizontally set to the top 4B of fixed base 4 at almost the same height as the ultraviolet-setting resin 5 are embedded in the ultraviolet-setting resin 5, in addition to the structure of the wafer fixing system 1 of the first embodiment. These support pins 41A to 41C are arranged on the ultraviolet-setting resin 5 at equal intervals.

According to the above structure, the margin of silicon wafer 6 is brought into contact with and supported by three support pins 41A to 41C and the ultraviolet-setting resin 5 is cured and stuck between silicon wafer 6 and the fixed base 4 by mounting silicon wafer 6 on the top 4B of fixed base 4 through the ultraviolet-setting resin 5 in which three support pins 41A to 41C are embedded and thereafter applying ultraviolet radiation L1 whose light intensity is stabilized from the contact surface 4A side of fixed base 4 at the stage before grinding silicon wafer 6, similarly to the case of the first embodiment.

As a result, it is possible to fix silicon wafer 6 to the fixed base 4 through the ultraviolet-setting resin 5 without causing any strain in silicon wafer 6. Moreover, because silicon wafer 6 is supported by three support pins 41A to 41C, it is possible to keep the interval between silicon wafer 6 and the fixed base 4 constant independently of the thickness of ultraviolet-setting resin 5.

(6) Sixth Embodiment

In Figs. 7A and 7B in which a portion corresponding to that in Fig. 1 is provided with the same symbol, a wafer fixing system 50 has a structure in which discoid mask (first mask) 51 is removably set

from the inside of the frame 2 so as to cover the opening 2A of frame 2, in addition to the structure of the wafer fixing system 1 of the first embodiment. At the central portion of mask 51, circular window 51A with a diameter of approx. 5 mm is formed along the direction same as the traveling direction of ultraviolet radiation L1.

In the above structure, when applying ultraviolet radiation L1 while setting the mask 51 in the frame 2 (Fig. 7A), only rays L1A of ultraviolet radiation L1 passing through the circular window 51A of mask 51 are applied to the ultraviolet-setting resin 5 through the opening 2A and the fixed base 4. Thereby, the ultraviolet-setting resin 5 is cured only in a range irradiated with rays L1A, that is, central portion 5X corresponding to the circular window 51A and stuck between silicon wafer 6 and the fixed base 4. As a result, because portions other than the central portion 5X of ultraviolet-setting resin 5 are softened, the central portion of silicon wafer 6 is temporarily fixed to the fixed base 4 with an interval corresponding to the height of central portion 5X of ultraviolet-setting resin 5.

Thereafter, by removing the mask 51 out of the frame 2 and applying ultraviolet radiation L1 (Fig. 7B), ultraviolet radiation L1 is applied to the whole surface of ultraviolet-setting resin 5 temporarily fixed through the opening 2A and the fixed base 4. Therefore, the whole of ultraviolet-setting resin 5 is cured and the resin 5 can be stuck between silicon wafer 6 and the fixed base 4 without causing any strain in silicon wafer 6.

According to the above structure, the ultraviolet-setting resin 5 is cured only at the central portion 5X corresponding to the circular window 51A of mask 51 and stuck between silicon wafer 6 and

the fixed base 4 and silicon wafer 6 is supported by the central portion 5X of ultraviolet-setting resin 5 by setting the mask 51 in the frame 2 at the stage before grinding silicon wafer 6 and similarly to the case of the first embodiment, mounting silicon wafer 6 on the top 4B of fixed base 4 through the ultraviolet-setting resin 5 and thereafter, applying ultraviolet radiation L1 whose light intensity is stabilized from the contact surface 4A side of fixed base 4.

Thereafter by removing the mask 51 out of the frame 2 and applying ultraviolet radiation L1 whose light intensity is stabilized again from the contact surface 4A side of fixed base 4, the whole of ultraviolet-setting resin 5 is cured and temporarily-fixed silicon wafer 6 can completely be fixed to the fixed base 4 through ultraviolet-setting resin 5 without causing any strain in the fixed silicon wafer 6. Moreover, because silicon wafer 6 is supported by the central portion 5X of temporarily-fixed ultraviolet-setting resin 5, it is possible to keep the interval between silicon wafer 6 and the fixed base 4 always constant.

(7) Seventh Embodiment

In Fig. 8 in which a portion corresponding to that in Fig. 3 is provided with the same symbol, a wafer fixing system 60 unlike the wafer fixing system 20 of the third embodiment, has a structure in which fixed base 61, ultraviolet-setting resin 62, and polyester film 63 are constituted by physically working the fixed base 4, the ultraviolet-setting resin 5, and the polyester film 21 of the third embodiment. That is, through-hole 61H with a predetermined diameter is formed at the center of fixed base 61 and moreover, through-holes

62H and 63H are formed on the ultraviolet-setting resin 62 and the polyester film 63 respectively by communicating with the through-hole 61H.

Moreover, as shown in Fig. 9, radial grooves 63G centering around the through-hole 63H are formed on one side 63A of polyester film 63 so as to communicate with the through-hole 63H and the other side 63B of film 63 is flattened. The radial grooves 63G are formed in a wide range about the through-hole 63H over almost the whole of one side 63A of polyester film 63.

In this case, the polyester film 63 is attached to the bottom of silicon wafer 6 so that one side 63A of film 63 contacts and silicon wafer 6 is mounted on the top 61B of fixed base 61 through the polyester film 63 and the ultraviolet-setting resin 62.

Moreover, vacuum pump 64 serving as negative pressure means is set to the outside of the frame 2 so as to apply a negative pressure by the vacuum pump 64 to pipe 65 extended into the frame 2. The pipe 65 is bent above the high-pressure mercury lamp 7 in the frame 2, inserted into the through-holes 61H and 62H of fixed base 61 and ultraviolet-setting resin 62 along the direction opposite to the direction shown by arrow Z, and connected with the through-hole 63H of polyester film 63.

In the above structure, the polyester film 63 is attached to the bottom of silicon wafer 6 so that one side 63A of film 63 contacts and thereafter, silicon wafer 6 is mounted on the top 61B of fixed base 61 through the polyester film 63 and the ultraviolet-setting resin 62. Thereafter, by driving the vacuum pump 64 and thereby applying a negative pressure, the air remaining in the radial grooves

63G formed on the polyester film 63 is discharged through the pipe 65 and resultingly, silicon wafer 6 is attracted and held by one side 63A of polyester film 63.

In this case, almost whole surface of silicon wafer 6 except its margin is attracted and held by one side 63A of polyester film 63 and other side 63B of polyester film 63 is mounted on the ultraviolet-setting resin 62. Therefore, the polyester film 63 is absorbed by the ultraviolet-setting resin 62 when attracted and resultingly, silicon wafer 6 can be prevented from deforming. In this connection, a negative pressure applied by the vacuum pump 64 is previously adjusted so that silicon wafer 6 is not deformed.

Thereafter, when ultraviolet radiation L1 whose light intensity is stabilized is applied from the contact surface 61A side of fixed base 61, the ultraviolet-setting resin 62 is cured and can be stuck between silicon wafer 6 and fixed base 61 without causing any strain in attracted and held silicon wafer 6.

According to the above structure, the ultraviolet-setting resin 62 is cured and stuck between the margin of silicon wafer 6 and the top 61B of fixed base 61 while silicon wafer 6 is temporarily fixed to the polyester film 63 by mounting silicon wafer 6 to which the polyester film 63 is attached so as to hold the radial grooves 63G formed on one side 63A of polyester film 63 on the top 61B of fixed base 61 through the polyester film 63 and the ultraviolet-setting resin 62 at the stage before grinding silicon wafer 6 and thereafter, keeping a state in which silicon wafer 6 is attracted and held by one side 63A of polyester film 63 and then, similarly to the case of the third embodiment, applying ultraviolet radiation L1 whose light

intensity is stabilized from the contact surface 61A side of fixed base 61.

As a result, it is possible to fix silicon wafer 6 to the fixed base 61 through the polyester film 63 and the ultraviolet-setting resin 62 without causing any strain in attracted and held silicon wafer 6. Moreover, by adjusting a negative pressure applied by the vacuum pump 64, it is possible to very easily remove ground silicon wafer 6 from the top 61B of fixed base 61.

(8) Eighth Embodiment

In Fig. 10 in which a portion corresponding to that in Fig. 7A is provided with the same symbol, a wafer fixing system 70 unlike the wafer fixing system 50 of the sixth embodiment, has a structure in which mask (third mask) 71 capable of adjusting the size of circular window 71A is fixed to the inside of the frame 2.

As shown in Fig. 11, the mask 71 has the same structure as the aperture of a general camera (not illustrated), in which the circular window 71A is formed at the central portion by a plurality of vanes 71W overlapped in a predetermined direction so that the diameter of circular window 71A can be changed in accordance with movement of vanes 71W.

The center of circular window 71A of mask 71 is previously set so as to be located on the same axis with the center between electrodes of high-pressure mercury lamp 7 and the center of silicon wafer 6. Moreover, the maximum diameter of circular window 71A of mask 71 is set to a value larger than the diameter of silicon wafer 6.

In the above structure, it is started to apply ultraviolet

radiation L1 whose light intensity is stabilized while the circular window 71A of mask 71 is closed and then the diameter of circular window 71A is slowly increased, and thereby only ultraviolet radiation L1 passing through the circular window 71A is applied to the ultraviolet-setting resin 5 through the opening 2A and the fixed base 4. Resultingly, the range of irradiation of ultraviolet-setting resin 5 with ultraviolet radiation L1 is slowly expanded toward the margin of the resin 5 as the diameter of circular window 71A increases.

Thereby, the ultraviolet-setting resin 5 is slowly cured from the central portion toward its margin as shown in Fig. 12 and slowly stuck between silicon wafer 6 and the fixed base 4. Therefore, it is possible to avoid a strain due to contraction of ultraviolet-setting resin 5 and resultingly, it is possible to prevent a strain from occurring in silicon wafer 6 correspondingly to the strain of ultraviolet-setting resin 5.

According to the above structure, because the circular window 71A of mask 71 is closed at the stage before grinding silicon wafer 6 and similarly to the case of the sixth embodiment, silicon wafer 6 is mounted on the top 4B of fixed base 4 through the ultraviolet-setting resin 5 and thereafter, ultraviolet radiation L1 whose light intensity is stabilized is applied from the contact surface 4A side of fixed base 4 and also the diameter of circular window 71A of mask 71 is slowly increased. Thereby, the ultraviolet-setting resin 5 is slowly cured from its central portion toward its margin in accordance with the circular window 71A of mask 71 and thus, it is possible to fix silicon wafer 6 to the fixed base 4 through the ultraviolet-setting resin 5 while avoiding a strain due to contraction of ultraviolet-

setting resin 5 without causing any strain in silicon wafer 6.

(9) Ninth Embodiment

In Fig. 13 in which a portion corresponding to that in Fig. 7A is provided with the same symbol, a wafer fixing system 80 unlike the wafer fixing system 50 of the sixth embodiment, has a structure in which mask (second mask) 81 on which rectangular window 81A of a predetermined shape is formed is fixed to the inside of the frame 2 and uniaxial stage 82 is set between the frame 2 and fixed stage 4 as moving means so as to cover the opening 2A of frame 2 from the outside.

The uniaxial stage 82 comprises sliding section 82A provided with the fixed base 4 and fixed section 82B fixed from the outside so as to cover the opening 2A of frame 2 and is constituted so that the sliding section 82A is movable from the fixed section 82B in a predetermined range in the direction shown by arrow X or the direction opposite to the direction shown by arrow X. In this case, moving speed of sliding section 82A of uniaxial stage 82 to the fixed section 82B is determined by a thickness of ultraviolet-setting resin 5 and an irradiation time necessary for curing the resin 5.

Moreover, through-holes 82AH and 82BH are formed on the sliding section 82A and the fixed section 82B respectively so as to communicate with the opening 2A of frame 2. The through-holes 82AH and 82BH are formed almost equally to or smaller than the opening 2A of frame 2.

The major side of rectangular window 81A of mask 81 is parallel with the direction shown by arrow Y, that is, the direction vertical to the moving direction (X direction) of sliding section 82A of

uniaxial stage 82 and formed so as to be longer than the diameter of silicon wafer 6 and shorter than the interval between electrodes (arc length) of high-pressure mercury lamp 7, as shown in Fig. 14. However, the length of the minor side of rectangular window 81A is previously set along the X direction so that the minimum light intensity necessary for ultraviolet radiation L1 emitted from the high-pressure mercury lamp 7 to cure the ultraviolet-setting resin 5 is secured.

In the above structure, as shown in Fig. 15A, one end of through-hole 82AH of sliding section 82A of uniaxial table 82 is positioned so as to communicate with the rectangular window 81A of mask 81 in the direction shown by arrow Z through the through-hole 82BH of fixed section 82B and the opening 2A of frame 2.

Then, it is started to apply ultraviolet radiation L1 whose light intensity is stabilized and the sliding section 82A is slowly moved from the fixed section 82B in the direction shown by arrow X. Thereby, only ultraviolet radiation L1 passing through the rectangular window 81A is applied to the ultraviolet-setting resin 5 through the opening 2A, the through-holes 82BH and 82AH, and the fixed base 4. As a result, the range of irradiation of ultraviolet-setting resin 5 with ultraviolet radiation L1 on the ultraviolet-setting resin 5 is slowly expanded toward the moving direction in accordance with movement of sliding section 82A.

Thereafter, as shown in Fig. 15B, when the other end of through-hole 82AH of sliding section 82A moves to a position communicating with the rectangular window 81A of mask 81 in the direction shown by arrow Z, movement of sliding section 82A is stopped.

Thereby, the ultraviolet-setting resin 5 is slowly cured from

one end of its margin up to the other end of the margin passing through the center (Fig. 16) and slowly stuck between silicon wafer 6 and the fixed base 4. Therefore, it is possible to avoid a strain due to contraction of ultraviolet-setting resin 5 and resultingly prevent a strain from occurring in silicon wafer 6 in accordance with the strain of ultraviolet-setting resin 5.

According to the above structure, the uniaxial stage 82 is positioned so that one end of the margin of ultraviolet-setting resin 5 faces the rectangular window 81A of mask 81 at the stage before grinding silicon wafer 6 and similarly to the case of the sixth embodiment, silicon wafer 6 is mounted on the top 4B of fixed base 4 through the ultraviolet-setting resin 5 and thereafter, ultraviolet radiation L1 whose light intensity is stabilized is applied from the contact surface 4A side of fixed base 4 and the uniaxial stage 82 is slowly moved in the direction along the flat surface of silicon wafer 6. Thereby, the portion of ultraviolet-setting resin 5 corresponding to the rectangular window 81A of mask 81 is slowly cured in accordance with movement of uniaxial stage 82 and thus, it is possible to fix silicon wafer 6 to the fixed base 4 through the ultraviolet-setting resin 5 while avoiding a strain due to contraction of ultraviolet-setting resin 5 without causing any strain in silicon wafer 6.

(10) Tenth Embodiment

In Fig. 17 in which a portion corresponding to that in Fig. 10 is provided with the same symbol, a wafer fixing system 90 has a structure in which rotary stage 91 is set as rotation means between the frame 2 and the fixed stage 4 so as to cover the opening 2A of

frame 2 from the outside, in addition to the structure of wafer fixing system 70 of the eighth embodiment.

The rotary stage 91 comprises rotary section 91A to which the fixed base 4 is set and fixed section 91B secured from the outside so as to cover the opening 2A of frame 2, in which the rotary section 91A can rotate on the fixed section 91B in the direction shown by arrow θ or the direction opposite to the direction shown by arrow θ by using the direction shown by arrow Z as a rotary axis. Through-holes 91AH and 91BH are formed on the rotary section 91A and the fixed section 91B so as to communicate with the opening 2A of frame 2 respectively. These through-holes 91AH and 91BH are formed equally to or slightly smaller than the opening 2A of frame 2 in size.

The speed for the diameter of circular window 71A of mask 71 to increase and the rotational speed of rotary section 91A of rotary stage 91 are determined by the thickness of ultraviolet-setting resin 5 and the irradiation time necessary for curing ultraviolet-setting resin 5.

In the above structure, irradiation with ultraviolet radiation L1 whose light intensity is stabilized is started while circular window 71A of mask 71 is closed and only ultraviolet radiation L1 passing through the circular window 71A is applied to the ultraviolet-setting resin 5 through the opening 2A, the through-holes 91BH and 91AH, and the fixed base 4 by slowly increasing the diameter of circular window 71A of mask 71 while rotating the rotary section 91A of rotary stage 91 on the fixed section 91B at a predetermined speed. As a result, the range of irradiation of ultraviolet-setting resin 5 with ultraviolet radiation L1 is rotated and slowly expanded toward

the margin of resin 5 as the diameter of circular window 71A increases.

Thereby, the ultraviolet-setting resin 5 is slowly cured from the central portion toward the margin while rotating about the central portion and stuck between silicon wafer 6 and the fixed base 4. Therefore, it is possible to avoid a strain of ultraviolet-setting resin 5 due to its contraction and resultingly prevent a strain from occurring in silicon wafer 6 in accordance with the strain of ultraviolet-setting resin 5.

Moreover, because ultraviolet radiation L1 is applied to the ultraviolet-setting resin 5 while the resin 5 is rotated, the resin 5 is uniformly irradiated with ultraviolet radiation L1 even if the high-pressure mercury lamp 7 is longitudinally long and thereby, the range of irradiation with ultraviolet radiation L1 is longitudinally long. Therefore, it is possible to prevent the ultraviolet-setting resin 5 from being unevenly irradiated.

According to the above structure, the ultraviolet-setting resin 5 is slowly cured from the central portion toward the margin while rotating about the central portion in accordance with the circular window 71A of mask 71 and thus, silicon wafer 6 can be fixed to the fixed base 4 through the ultraviolet-setting resin 5 while avoiding a strain of ultraviolet-setting resin 5 due to its contraction without causing any strain in silicon wafer 6 because circular window 71A of mask 71 is closed, silicon wafer 6 is mounted on the top 4B of fixed base 4 through the ultraviolet-setting resin 5 and thereafter, ultraviolet radiation L1 whose light intensity is stabilized is applied from the contact surface 4A side of fixed base 4, and the diameter of circular window 71A of mask 71 is slowly increased while

rotating the rotary stage 91 at the stage before grinding silicon wafer 6 similarly to the case of the eighth embodiment.

Moreover, because ultraviolet radiation L1 is applied to the ultraviolet-setting resin 5 while rotating the resin 5, it is possible to stably apply ultraviolet radiation L1 independently of the shape of high-pressure mercury lamp 7 and thus, further prevent a strain from occurring in the ultraviolet-setting resin 5 due to uneven irradiation, compared to the case of the eighth embodiment.

(11) Other Embodiments

In the above embodiments, a case is described in which the high-pressure mercury lamp 7 is used as a light source of wafer fixing systems 1 (10 to 90). However, the present invention is not limited to the above case. It is also possible to use optical-fiber-type ultraviolet radiation source 101 as shown in wafer fixing system 100 in Fig. 18 in which a portion corresponding to that in Fig. 1 is provided with the same symbol.

That is, articulated robot 102 is provided outside of the frame 2 and arm 102A of articulated robot 102 is inserted into the frame 2 through hole 2B formed on the side wall of the frame 2. Moreover, optical fiber 103 is extended from optical-fiber-type ultraviolet radiation source 101 and front end (light emitting portion) 103A of optical fiber 103 is held by arm 102A of articulated robot 102. In this case, the arm 102A can be moved in various directions in the frame 2 and thereby, the front end 103A of optical fiber 103 can be positioned over the whole of the opening 2A of frame 2. As a result, it is possible to irradiate the whole surface of ultraviolet-setting

resin 5.

For the above embodiments, a case is described in which the high-pressure mercury lamp 7 is used as a light source of wafer fixing systems 1 (10 to 90). However, the present invention is not limited to the above case. It is also possible to set tungsten halogen lamp 111 on the stage 3 instead of high-pressure mercury lamp 7 as shown in wafer fixing system 110 in Fig. 19 in which a portion corresponding to that in Fig. 1 is provided with the same symbol.

In this case, the tungsten halogen lamp 111 is provided with the shutter 8 similarly to the case of Fig. 1 and a parallel-ray optical system 112 is set above shutter 8. Ultraviolet radiation incoming into the parallel-ray optical system 112 is emitted as parallel rays and enters a pair of following galvanomirrors 113 and 114 in order. By adjusting these galvanomirrors 113 and 114, it is possible to irradiate the whole of the opening 2A of frame 2 and resultingly irradiate the whole surface of ultraviolet-setting resin 5.

Moreover, for the above embodiments, a case is described in which the fixed base 4 made of fused quartz is used as a light-transmitting base member. However, the present invention is not limited to the above case. It is also possible to apply various materials as long as they have a high ultraviolet-radiation transmission.

Furthermore, for the above embodiments, a case is described in which ultraviolet-setting resin 5 is used as a photosetting resin. However, the present invention is not limited to the above case. It is also possible to use a visible-radiation-setting resin (not illustrated). In this case, it is necessary to use a light source for

emitting visible radiation (sensitivity wavelength: 400 to 500 nm) and set the environment for fixing wafer 6 like a dark room. In this case, it is possible to use various materials with a high visible-radiation transmission as the base member.

Furthermore, for the above embodiments, a case is described in which ultraviolet-setting resin 5 is used as a photoresetting resin. However, the present invention is not limited to the above case. It is also possible to use a water-soluble ultraviolet-setting resin (not illustrated). In this case, it is possible to separate silicon wafer 6 from the fixed base 4 by grinding silicon wafer 6, then soaking it in a liquid solvent such as water or putting it in a normal ultrasonic tub or in an ultrasonic tub filled with water having a temperature higher than ordinary temperature.

Furthermore, for the above embodiments, a case is described in which ultraviolet-setting resin 5 is used as a photoresetting resin. However, the present invention is not limited to the above case. It is also possible to use a thermosoftening ultraviolet-setting resin (not illustrated). In this case, it is possible to separate silicon wafer 6 from the fixed base 4 by grinding silicon wafer 6 and then heating the thermosoftening ultraviolet-setting resin (at approx. 20°C or higher) to decrease the adhesive strength of the resin.

Furthermore, for the above embodiments, a case is described in which silicon wafer 6 is applied as a thin flat workpiece. However, the present invention is not limited to the above case. The present invention can widely be applied to various thin flat workpieces including a hard disk substrate.

Furthermore, for the above embodiments, a case is described in

which a thin flat workpiece fixing method for grinding the workpiece is applied. However, the present invention is not limited to the above case. It is also possible to apply the present invention to a thin flat workpiece fixing method in various working processes such as cutting, lapping, polishing, and dicing.

Furthermore, for the second embodiment, a case is described in which a plurality of fine ceramic grains 12 are added to ultraviolet-setting resin 5. However, the present invention is not limited to the above case. It is also possible to use various types of granular or fibrous inorganic substances including granular glass and fibrous optical fiber in addition to ceramic grains 12.

Furthermore, for the third embodiment, a case is described in which polyester film 21 is used as an adhesive film. However, the present invention is not limited to the above case. It is also possible to use other various thin (thickness of 1 mm or less) film- or tape-like materials.

Furthermore, for the fourth embodiment, a case is described in which grease 31 is applied to the bottom of silicon wafer 6 in a striped pattern at a predetermined pitch. However, the present invention is not limited to the above case. It is also possible to apply grease 31 in other various patterns or apply an oily or gelled material such as liquid with a low or high viscosity in various patterns.

Furthermore, for the fifth embodiment, a case is described in which three support pins 41A to 41C are horizontally embedded in ultraviolet-setting resin 5 so as to support silicon wafer 6. However, the present invention is not limited to the above case. It is also

possible to use two support pins or four or more support pins and moreover use spherical, conical, cylindrical, pyramidal, or prismatic support pins.

In short, as long as silicon wafer 6 can be supported on top 4B of fixed base 4 so that the interval between silicon wafer 6 and the fixed base 4 is kept always constant, not only the material and shape of support pins but also the number of support pins and positions for arranging support pins on silicon wafer 6 are not restricted.

Furthermore, for the seventh embodiment, a case is described in which radial grooves 63G centering around through-hole 63H are formed on one side 63A of polyester film 63. However, the present invention is not limited to the above case. It is also possible to form radial grooves 63G into various shapes in stead of radial shape as long as they are formed on the whole of one side 63A of polyester film 63 and communicate with through-hole 63H.

Furthermore, for the ninth embodiment, a case is described in which uniaxial stage 82 is set between the frame 2 and fixed stage 4 as moving means. However, the present invention is not limited to the above case. It is also possible to set a biaxial stage (not illustrated) capable of moving in two dimensions along the surface direction of silicon wafer 6 instead of uniaxial stage 82.

As described above, the present invention makes it possible to fix a thin flat workpiece to one side of a base member without causing any strain in the workpiece and thus, increase the yield for working the workpiece and improve the quality and reliability of the workpiece by coating one side of a light-transmitting base member with a photosetting resin to form a photosetting resin layer, mounting the

workpiece on the photosetting resin layer, and thereafter applying rays from the other side of the base member to cure the photosetting resin layer.

While there has been described in connection with the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be aimed, therefore, to cover in the appended claims all such changes and modifications as fall within the true spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A thin flat workpiece fixing method comprising:
the first step of forming a photosetting resin layer by applying photosetting resin to one side of a light-transmitting base member and mounting a thin flat workpiece on said photosetting resin layer; and
the second step of curing said photosetting resin layer by applying rays to said layer from the other side of said base member.
2. The thin flat workpiece fixing method according to claim 1, wherein said photosetting resin is mixed with a plurality of granular or fibrous inorganic substances.
3. The thin flat workpiece fixing method according to claim 1, wherein said photosetting resin is water-soluble.
4. The thin flat workpiece fixing method according to claim 1, wherein said photosetting resin is thermosoftening.
5. The thin flat workpiece fixing method according to claim 1, wherein an adhesive film smaller than said workpiece is attached to the surface of said photosetting resin layer facing said workpiece in said first step.
6. The thin flat workpiece fixing method according to claim 1, wherein an oily or gelled substance is applied to the surface of said photosetting resin layer facing said workpiece in a predetermined



pattern in said first step.

7. The thin flat workpiece fixing method according to claim 1, wherein a predetermined number of pins are embedded in predetermined positions of said photosetting resin layer to support said workpiece by each of said pins in said first step.

8. The thin flat workpiece fixing method according to claim 1, wherein

said rays are applied so as to pass through an opening with a predetermined diameter of a first mask which is set to the other side of said base member and on which said opening is formed at a position corresponding to the center of said workpiece and thereby, a portion of said photosetting resin layer corresponding to said opening is cured and thereafter,

the whole of said photosetting resin layer is cured by removing said first mask and applying said rays to the layer in said second step.

9. The thin flat workpiece fixing method according to claim 1, wherein

an adhesive film which is smaller than said workpiece and on whose surface facing said workpiece a groove with a predetermined pattern is formed is attached to the surface of said photosetting resin layer facing said workpiece in said first step, and

said workpiece is mounted on said adhesive film and thereafter, said rays are applied from the other side of said base member while



applying a predetermined negative pressure through said base member and said photosetting resin so as to communicate with said groove in said second step.

10. The thin flat workpiece fixing method according to claim 1, wherein

said rays are applied so as to pass through a rectangular opening of a second mask which is set to the other side of said base member and on which said opening with a major side longer than the diameter of said workpiece is formed and said base member is moved in a predetermined surface direction, and thereby a portion of said photosetting resin layer corresponding to said opening is cured in accordance with movement of said base member in said second step.

11. The thin flat workpiece fixing method according to claim 1, wherein

said rays are applied through a third mask set to the other side of said base member and having an opening whose diameter can be increased or decreased about a position corresponding to the center of said workpiece and the diameter of said opening is slowly increased starting with the diameter of 0, and thereby a portion of said photosetting resin corresponding to said opening is cured in said second step.

12. The thin flat workpiece fixing method according to claim 11, wherein

said base member is rotated about a position corresponding to



the center of said workpiece along the surface direction while applying said rays in said second step.

13. A thin flat workpiece fixing system comprising:
a light-transmitting base member;
a photosetting resin layer formed by applying a photosetting resin to one side of said base member; and
a light source set to the other side of said base member;

wherein

said workpiece is mounted on said photosetting resin layer and thereafter, rays are applied from said light source to cure said photosetting resin layer.

14. The thin flat workpiece fixing system according to claim 13, wherein said photosetting resin is mixed with a plurality of granular or fibrous inorganic substances.

15. The thin flat workpiece fixing system according to claim 13, wherein said photosetting resin is water-soluble.

16. The thin flat workpiece fixing system according to claim 13, wherein said photosetting resin is thermosoftening.

17. The thin flat workpiece fixing system according to claim 13, wherein an adhesive film smaller than said workpiece is attached to the surface of said photosetting resin layer facing said workpiece.



18. The thin flat workpiece fixing system according to claim 13, wherein an oily or gelled substance is applied to the surface of said photosetting resin layer facing said workpiece in a predetermined pattern.

19. The thin flat workpiece fixing system according to claim 13, wherein a predetermined number of pins are embedded in predetermined positions of said photosetting resin layer to support said workpiece by each of said pins.

20. The thin flat workpiece fixing system according to claim 13, wherein

a first mask which is set to the other side of said base member and at whose position corresponding to the center of said workpiece an opening with a predetermined diameter is formed is included, and

a portion of said photosetting resin corresponding to said opening is cured by applying said rays from said light source so as to pass through the opening of said first mask and thereafter, the whole of said photosetting resin layer is cured by removing said first mask and applying said rays from said light source.

21. The thin flat workpiece fixing system according to claim 13, wherein

an adhesive film which is attached to the surface of said photosetting resin layer facing said workpiece and smaller than said workpiece and on whose surface facing said workpiece a groove with a predetermined pattern is formed and negative pressure means for



supplying a predetermined negative pressure to said groove through said base member and said photosetting resin are included, and

said rays are applied from said light source while supplying said negative pressure to said groove by said negative pressure means after mounting said workpiece on said adhesive film.

22. The thin flat workpiece fixing system according to claim 13, wherein

a second mask which is set to the other side of said base member and on which a rectangular opening whose major side is longer than the diameter of said workpiece and moving means for moving said base member in a predetermined surface direction are included, and

a portion of said photosetting resin layer corresponding to said opening is cured in accordance with movement of said base member by said moving means' moving said base member in a predetermined surface direction while applying said rays from said light source so as to pass through the opening of said second mask.

23. The thin flat workpiece fixing system according to claim 13, wherein

a third mask set to the other side of said base member and having an opening whose diameter can be increased or decreased about a position corresponding to the center of said workpiece is included, and

a portion of said photosetting resin corresponding to said opening is cured by slowly increasing the diameter of the opening of said third mask starting with the diameter of 0 while applying said



rays from said light source through said third mask.

24. The thin flat workpiece fixing system according to claim 23,
wherein

rotating means for rotating said base member about a position
corresponding to the center of said workpiece along the surface
direction is included, and

said rotating means rotates said base member while applying
said rays from said light source.