Device and Method for Treatment of Substrate Surfaces

Specification

This invention relates to a device for treatment of a substrate treatment surface of a substrate, especially of a wafer, with a fluid, especially a liquid, by immersion of the substrate treatment surface into the fluid ~~as claimed in Claim 1~~ and a corresponding method ~~as claimed in Claim 11~~.

In the semiconductor industry the cleaning of the wafer surfaces plays a major part, one type of cleaning of wafer surfaces being wet chemical treatment which can also be used for stripping of polymers.

Generally the cleaning of the wafer surfaces takes place by means of liquids which are applied to the substrate surface, especially by liquid eddies, dripping, pouring, spraying, vapor deposition, etc. In doing so the substrate is often rotated or at the end of the liquid application the substrate is rotated to spin the liquid off the substrate.

There are often technical problems in that the wafers are becoming thinner and thinner, as a result of which damage can occur during rotation of the wafer and/or in the application of the liquid. The uniform application is also a major challenge so that the partially very expensive liquids for treatment of the wafer surface are uniformly and efficiently applied to the entire wafer surface. Furthermore wasting of the liquid should be avoided.

Moreover it is desirable for the cleaning step to take place within a time interval which is as short as possible.

EmbodimentsThe object of this invention discloseis therefore to devise a device which works as efficiently as possible and a corresponding method for treatment, especially cleaning, of a substrate treatment surface of a substrate in which uniform treatment with liquid consumption as low as possible can be ensured.

According to a first aspect, there is provided a device for treatment of a substrate treatment surface of a substrate with a fluid by immersion of the substrate treatment surface into the fluid, with the following features: - receiving means for receiving the fluid with an immersion opening and - immersion means for immersion of the substrate treatment surfaces through the immersion opening into the receiving means, - rotation means for rotation of the receiving means for at least predominant discharge of the fluid from the receiving means, characterized in that the immersion means have fixing means for fixing the substrate on one receiving surface which faces away from the substrate treatment surface.

According to a second aspect, there is provided a method for treatment of at least one substrate treatment surface of a substrate with a fluid with the following steps, especially following sequence: - fixing and receiving the substrate by means of immersion means on a receiving surface which facer away from the substrate treatment surface, - immersion of the substrate treatment surface(s) into the fluid which is held in a receiving means for receiving the fluid and - rotation of the receiving means for emptying the fluid out of the receiving means.

~~This object is achieved with the features of Claims 1 and 11. Advantageous developments of the invention are given in the dependent claims.~~ All combinations of at least two of the features given in the specification, the claims and/or the figures also fall within the framework of the invention. At the given value ranges values which lie within the indicated boundaries will also be considered disclosed as boundary values and will be claimed in any combination. To the extent features disclosed for the device can also be understood as features of the method, they should also be considered disclosed according to the method and vice versa.

Embodiments~~The idea~~ of the invention ~~is to~~ treat a substrate treatment surface with a fluid such that the substrate or the substrate treatment surface is immersed into a liquid which is provided in a tank, especially during rotation of the substrate treatment surface. The rotation can also take place at intervals while the substrate treatment surface is immersed in the fluid. As per an embodiment~~An important feature~~ of the invention, ~~is that~~ the especially trough-shaped tank can be rotated so that after one or more treatments of substrate treatment surfaces the fluid can be removed from the tank by rotation. Then the tank can be filled with a fresh fluid. Fluids can be especially liquids for wet chemical treatment. An embodiment of~~The configuration as claimed in~~ the invention enables a very uniform application to the substrate treatment surface and especially during rotation of the immersion means, extremely efficient action of the fluid on the substrate treatment surface. Furthermore an embodiment of this invention ensures an optimum use of the fluid and a very simple replacement of the fluid. Moreover, during the treatment of the

substrate treatment surface the minimum possible swirling or spraying of the fluid, especially none at all, takes place in the treatment space so that a very clean treatment is enabled.

Very thin wafers can also be attached to so-called film frames for fixing. As per embodiments of~~claimed in~~ the invention, all types of wafers and mountings with which wafers are fixed, whether for stabilization and/or transport, are disclosed. In the entire patent wafer is used as a synonym for individual wafers or for wafers on these mountings.

According to one advantageous embodiment of the invention it is provided that the receiving means is made as an especially rotationally symmetrical trough, especially with one trough wall which is angled in the radial direction. The trough shape can be easily produced and can be easily rotated in a rotationally symmetrical configuration. An angled trough wall has the advantage that the discharge of the fluid is facilitated.

Here it is advantageous if the trough according to another advantageous embodiment has a peripheral edge which is curved against the trough shape and which projects especially over the rotation means for discharging the fluid to an especially ring-shaped fluid collection tank. In this way the fluid is routed in a controlled manner in the direction of the fluid collection tank, by rotation of the trough and the resulting drainage of the fluid over the curved peripheral edge, the peripheral edge advantageously ending in the fluid collection tank. Thus it is moreover ensured that the fluid does not come into contact with other components besides the substrate treatment surface, the receiving means and the fluid collection tank. Furthermore it is advantageous as per embodiments of~~claimed in~~ the invention if the fluid collection tank which is formed especially by a stator on its bottom, especially in at least one sunken region, preferably at the lowest point of the fluid collection tank, has at least one drain which is provided especially with a triggerable valve. Thus the fluid is routed on the

shortest path from the receiving means to the fluid collection tank and can be withdrawn from there via drains which are provided over the bottom of the fluid collection tank and in the bottom and especially can be treated for re-use.

To the extent the receiving means, especially solely in the region of the peripheral edge, can be fixed on the rotation means which is made especially as preferably rotationally symmetrical hollow bodies, the receiving means is interchangeable, for example in wear/fouling or abrasion or for adaptation of the fluid receiving volume. Fixing exclusively in the region of the peripheral edge enables a material-saving execution and moreover access to the receiving means from underneath, especially for a heating means which is described below.

A stator which is made especially as a preferably rotationally symmetrical hollow body for holding the rotation means which can rotate in the stator enables a space-saving and material-protective configuration of the device as claimed in embodiments of the invention.

Here as claimed in the invention it is advantageous if the device is made such that the rotation of the rotation means takes place along an especially ring-shaped guide segment which is located on the inner periphery of the stator, especially by means of a ball bearing between the guide segment and a corresponding guide segment of the rotation means. This execution leads to a stable configuration of the device so that a correspondingly high rotational speed and rapid discharge of the fluid from the receiving means are possible as claimed in embodiments of the invention.

According to another embodiment ofas ~~claimed in~~ the invention, there are heating means for temperature control of the fluid, especially in the form of a preferably rotatable heating body with a heating plate. The heating means can be located especially underneath the receiving means and/or within the rotation means. Via a corresponding control apparatus the heating means can be moved

into its operating position and accordingly the rotation of the heating means can be controlled. Rotation of the heating means as claimed in embodiments of the invention causes homogenization of the temperature exposure along the receiving means. An equidistant arrangement of the heating plate or of the surface of the heating plate facing the receiving means also contributes to this. The position of the heating plate to the bottom of the especially trough-shaped (trough) receiving means can preferably be monitored and adjusted. The optimum distance between the bottom of the trough (receiving means) and the top of the heating plate is smaller than 1 cm, preferable smaller than 1 mm, more preferably smaller than 300 µm, most preferably smaller than 100 µm, most preferably of all smaller than 50 µm. The space between the heating plate and the trough as claimed in embodiments of the invention can also be flushed with a gas which preferably has good heat convection properties in order to transport the heat optimally from the heating plate to the trough. The gas can be introduced either via nozzles (not shown) which project into the intermediate space or which are located in the heating plate. Since the heating plate can be pivotally mounted, the contact between the top of the heating plate and the bottom of the trough in a relative rotation of the two components should preferably be prevented. If relative rotation between the heating plate and trough does not take place, making contact of the surface of the heating plate with the bottom of the trough for faster heat transfer or for preheating is conceivable. It is also conceivable for the shaft on which the heating plate sits to be coupled via a coupling (not shown) to the hollow shaft on which the trough lies and thus effects the centrifugal process which is described below by the rotation of the trough.

Instead of the heating plate, an ultrasonic head is also conceivable which travels in contact with the bottom of the trough and injects acoustic waves into the liquid of the trough in order for example to accelerate cleaning processes. A combination of ultrasonic head and heating plate is

also conceivable. If the injection of the ultrasonic waves into the liquid should be possible without direct contact of the surface of the ultrasonic head with the bottom of the trough via the gas space, this is likewise to be disclosed here.

It is furthermore advantageous if the immersion means have especially rotatable fixing means for fixing the substrate on one receiving surface which faces away from the substrate treatment surface and by rotation of the substrate during treatment of the substrate treatment surface, therefore in a state immersed in the fluid, the treatment which is generally associated with a chemical reaction is clearly accelerated. The rotation can also take place at intervals. Furthermore the rotation of the fixing means as claimed in embodiments of the invention can be used for centrifuging of fluid which is adhering to the substrate after treatment, therefore in one position above the fluid. To the extent the centrifuging takes place a short distance above the fluid surface, as little fluid as possible is wasted since most of the fluid drips or is centrifuged into the receiving means. To the extent fluid is centrifuged over the edge of the receiving means, it is automatically collected in the collection tank. The return of the fluid into the receiving means is further optimized by the rotational velocity being reduced especially to zero as the substrate is moved out of the fluid and only then is slowly increased.

According to another advantageous embodiment of the invention it is provided that the immersion means has flushing means for flushing of a flushing surface which remains outside the substrate treatment surface and outside the receiving surface, using a flushing fluid. This avoids the fluid for treatment of the substrate treatment surface acting on regions other than the substrate treatment surface on the substrate. The flushing fluid can be especially an inert gas so that mixing with the fluid for treatment of the substrate is avoided or prevented. The flushing fluid can also be

liquids. It is decisive that during the cleaning process of the front of the wafer, the cleaning substance of the trough cannot wet the back of the wafer or can do so only in very small amounts.

In the aspect of the method as claimed in the invention, according to one advantageous embodiment it is provided that the rotation means is rotated in a stator for holding the rotation means, the rotation of rotation means taking place along an especially ring-shaped guide segment which is located on the inner periphery of the stator, especially by means of a ball bearing between the guide segment and a corresponding guide segment of the rotation means.

According to the method it can furthermore be provided that the temperature of the fluid will be controlled by heating means for temperature control at least during the immersion of the substrate treatment surface.

To the extent at least during the immersion of the substrate treatment surface a flushing of a flushing surface which remains outside the substrate treatment surface and a receiving surface which faces away from the substrate treatment surface takes place, contamination or exposure of the substrate outside the substrate treatment surface is avoided or prevented.

According to the method it is furthermore advantageously provided that the substrate treatment surface will be rotated by fixing means for holding the substrate at least during the immersion. In this way treatment is accelerated.

The construction as claimed in embodiments of the invention also allows the changing of the chemicals in the trough between the use of different wafers and/or during the fixing of an individual wafer. Very often the surface of a wafer is to be treated in sequence with different chemicals. The wafer remains fixed in this method. The trough is filled especially sequentially with the individual chemicals. Before using a new chemical the old one is centrifuged out of the trough by the centrifuging process

as claimed in embodiments of the invention. It is also conceivable to use the trough as a mixing container for chemicals in order to obtain a corresponding new chemical. Between the use of different chemicals it can be provided as claimed in embodiments of the invention that the trough be cleaned with a detergent. The detergent in this case is also considered a chemical, but is preferably not brought into contact with the wafer.

Other advantages, features and details of the invention will become apparent from the following description of preferred exemplary embodiments and using the drawings.

Figure 1 shows a schematic cross sectional view of one embodiment of the device as claimed in the invention and

Figure 2 shows an exploded depiction of the schematic view according to Figure 1.

The same components or components with the same function are identified in the figures with the same reference numbers.

In the embodiment of the invention which is shown in Figures 1 and 2, the device consists essentially of five main components, especially a stator 12, a rotation means 13 which can be rotated relative to the stator 12 and a receiving means 5 which can be fixed on the rotation means 13. Furthermore a heating means 16 can be extended and retracted in a heating space 15 which is formed by the rotation means 13 and the receiving means 5, along one axis D of rotation. Another important component is the immersion means 19 which is used for immersion of a substrate 9 which is held on fixing means 22 into a fluid 8 which is provided in the receiving means 5. For this purpose the immersion means 19 is made to be able to move along the axis D of rotation.

In this exemplary embodiment the fixing means 22 is a component of the immersion means 19 and is attached by webs 19s to them on one immersion side 19e on a body 19r of revolution

~~amended~~ Claims

1. A device for treatment of a substrate treatment surface (9o) of a substrate (9) with a fluid (8) by immersion of the substrate treatment surface (9o) into the fluid (8), with the following features:

- receiving means (5) for receiving the fluid (8) with an immersion opening (5e) and
- immersion means (19) for immersion of the substrate treatment surfaces (9o) through the immersion opening (5e) into the receiving means (5),
- rotation means (13) for rotation of the receiving means (5) for at least predominant discharge of the fluid (8) from the receiving means (5),

characterized in that the immersion means (19) have fixing means (22) for fixing the substrate (9) on one receiving surface (9a) which faces away from the substrate treatment surface (9o).

2. The device as claimed in Claim 1, wherein the receiving means (5) is made as an especially rotationally symmetrical trough, especially with one trough wall (5w) which is angled in the radial direction.

3. The device as claimed in Claim 2, wherein the trough has a peripheral edge (5r) which is curved against the trough shape and which projects especially over the rotation means (13) for discharging the fluid (8) to an especially ring-shaped fluid collection tank (21).

4. The device as claimed in Claim 3, wherein the fluid collection tank (21) which is formed especially by a stator (12) on its bottom (21b), especially in at least one sunken region (21a), preferably at the lowest point of the fluid collection tank (21), has at least one drain (6) which is provided especially with a triggerable valve.

5. The device as claimed in claim 1 or 2, wherein the receiving means (5), especially solely in the region of the peripheral edge (5r), can be fixed on the rotation means (13) which is made especially as preferably rotationally symmetrical hollow bodies (4).

6. The device as claimed in one of Claims 4 or 5, wherein there is a stator (12) which is made especially as a preferably rotationally symmetrical hollow body for holding the rotation means (13) which can rotate in the stator (12).

7. The device as claimed in Claim 6, wherein the device is made such that the rotation of the rotation means (13) takes place along an especially ring-shaped guide segment (12f) which is located on the inner periphery of the stator (12), especially by means of a ball bearing (3) between the guide segment (12f) and a corresponding guide segment (13f) of the rotation means (13).

8. The device as claimed in claim 1 or 2, wherein there are heating means (16) for temperature control of the fluid (18), especially in the form of a preferably rotatable heating body (18) with a heating plate (17).

9. The device as claimed in claim 1 or 2, wherein the immersion means (19) has flushing means (11) for flushing of a flushing surface (9s) which remains outside the substrate treatment surface (9o) and the receiving surface (9a), using a flushing fluid.

10. A method for treatment of at least one substrate treatment surface (9o) of a substrate (9) with a fluid (8) with the following steps, especially following sequence:

- fixing and receiving the substrate (9) by means of immersion means (19) on a receiving surface (9a) which facer away from the substrate treatment surface (9o),
- immersion of the substrate treatment surface(s) into the fluid (8) which is held in a receiving means (5) for receiving the fluid (8) and

- rotation of the receiving means (5) for emptying the fluid out of the receiving means (5).

11. The method as claimed in Claim 10, wherein a rotation means (13) held to be able to rotate in a stator (12), the rotation of rotation means (13) taking place along an especially ring-shaped guide segment (12f) which is located on the inner periphery of the stator (12), especially by means of a ball bearing (3) between the guide segment (12f) and a corresponding guide segment (13f) of the rotation means (13).

12. The method as claimed in one of Claims 10 or 11, wherein the temperature of the fluid (8) is controlled by heating means (16) for temperature control at least during the immersion of the substrate treatment surface (9o).

13. The method as claimed in one or more of Claims 10 or 11, wherein during the immersion of the substrate treatment surface (9o) a flushing of a flushing surface (9s) which remains outside a substrate treatment surface (9o) and outside a receiving surface (9a) which faces away from the substrate treatment surface (9o) takes place.

14. The method as claimed in one or more of Claims 10 or 11, wherein the substrate treatment surface (9o) is rotated by fixing means (22) for receiving the substrate (9) at least during the immersion.