

Device and Method for the Double-Sided Processing of Flat Work Pieces

The invention relates to a device for the double-sided processing of flat work pieces, comprising an upper working disc and a lower working disc, where the working discs between the working surfaces thereof facing each other, form a working gap for processing the work pieces, and where at least one of the working discs has a plurality of bores extending through the working surface for supplying a liquid working medium into the working gap. The invention also relates to a method for operating a device for the double-sided processing of flat work pieces, where the device has an upper working disc and a lower working disc, where the working discs between the working surfaces thereof facing each other form a working gap for processing the work piece, and where at least one of the working discs has a plurality of bores extending through the working surface for supplying a liquid working medium into the working gap.

Such devices and methods serve for double-sided polishing of semiconductor wafers, for example. For polishing, a polishing liquid is introduced as a working means into the working gap. For this purpose, a two disc polishing machine is known from the document DE 100 07 390 A1. The polishing disc described therein has a series of axis-parallel bores that are aligned with corresponding bores in the carrier disc supporting this polishing disc, and are connected to lines, via which a polishing means is supplied to the working surface of the polishing disc. The bores are provided in the upper working disc, wherein the polishing means is conveyed downward due to gravity into the polishing gap. Here one problem is that a uniform supply of polishing means in the working gap cannot always be guaranteed. In particular, a depletion of polishing means can result in regions of the polishing disc that are frequently traversed by workpieces during the processing. This can impact the polishing result.

Starting from the described prior art as a background, the object of the present invention is therefore to provide a device and a method of the initially named type, with which a sufficient supply of working medium in the working gap is guaranteed at any time.

This object is solved according to the invention by the subject matter of the independent claims 1 and 10. Advantageous embodiments are found in the dependent claims, the description and the drawings.

For a device of the initially named type, the objective of the invention is solved in that the bores for supplying the liquid are combined into several groups, where each group of bores is connected to a separate pressurized supply line for the working means, and where at least one pressure control apparatus is provided with which the pressure of the working means in the supply lines can be regulated separately from each other. For a method of the initially named type, the objective of the invention is solved in that the bores are combined into several groups, where each group of bores is supplied pressurized working means, and wherein the working means pressure of the working means supplied to each of the groups can be regulated separately from each other.

The processing according to the invention can remove material. The device can be a device for the double-sided polishing of flat workpieces. The working liquid can correspondingly be a polishing liquid. But other processing methods can also be considered, for example grinding or lapping. The work pieces to be processed according to the invention, for example coplanar processing, can be semiconductor wafers, for instance. The working discs can have, for example, a circular shape. The working gap can correspondingly also have a circular shape. A vertical drive shaft can be connected to one or both working discs. If the working discs are each supported by a carrier disc, this connection can be made by means of the carrier disc. At least one of these drive shafts can be driven by a suitable drive to rotate, so that the working disc connected to this drive shaft correspondingly rotates. The work pieces are processed between the working discs rotating relative to each other. The bores are provided in at least one of the working discs, for example the upper working disc. Naturally, such bores can also be provided in both working discs. Suitable pressure lines, for example pressure hoses or pressure pipes, which convey the working means to the working gap, can run through the bores of the working disc(s).

According to the invention, the plurality of provided bores is divided into several groups, for example two or more, groups. A pressurized supply line is associated with each of the groups. Thus, in the example mentioned a total of three or more pressurized supply lines can be provided. Specific working gap zones, for example can each be supplied with working means by a group of bores. The pressure of the working means is the pressure prevailing in the supply lines or bores filled with the working means. The pressure determines the flow rate of working fluid from the bores into the working gap. The invention makes it possible to separately regulate the pressure of the working means, and thus the flow of working means into the working gap for the individual supply lines, and thus for the individual groups of bores, or respectively working zones, supplied by these with working means. Thereby, the supply of working means, for example a polishing means, can be matched to the requirements of the process in a flexible manner. The flow of the working means can be regulated, for example depending on working parameters (guided by the working procedure). The zone, or respectively groups, can be divided so that the bores of one zone are subjected to substantially uniform operating conditions during the operation of the device. Thus, the bores of one working gap zone can be substantially traversed with uniform frequency by workpieces. The bores of one group can be assigned for instance in specific radial regions of the working gap. Thus, groups are formed of bores lying in a circular zones. By a common regulation of the pressure, and thus, the flow through the bores for the zone, the optimal supply of working fluid is guaranteed for the zone, or respectively the group. In particular, individually preset constant pressure of working means can be regulated for each supply line. Thereby, although the bores of different zones are subjected to different operating conditions, a constant polishing means supply is possible in the entire working gap. Naturally, more than one regulating apparatus can be provided, for example one per supply line, or respectively group of bores. However, it is also conceivable to provide a common regulating apparatus that regulates the pressure of working means in all the supply lines.

Thereby, according to the invention it is guaranteed that the working gap is uniformly and sufficiently supplied with working means at all times. In addition to optimizing the working results, the working means is also used more effectively so that the total

requirement of working means is reduced. Scratches or similar processing defects are reliably avoided. Also, relatively smooth polishing cloths can be used. If it is desired, the work piece can be rinsed off, for example through an upper working disc provided with the bores in that the pressure of the working means is sharply increased for a brief period. Thus, an undesired adhesion of the working piece while lifting the upper working disc at the end of the process is reliably avoided. It is also possible to intentionally vary the quantity of working means supplied to the working gap in order to cool regions with increased processing temperature, for example. This further optimizes the work result.

According to one embodiment that is particularly suitable to practice, the supply lines can each be connected to a common main pressure supply line and to the bores of the group. The main supply line is connected to a reservoir of working means, and can, for example, have a pump with which the working liquid is pumped through the main supply line to the individual supply lines. A pressure control unit is then disposed in each of the supply lines with which the pressure of the working means can be regulated in the respective supply line independently of the other supply lines. It is also possible to provide flow measuring apparatuses in the supply lines, the measuring signals thereof are connected to the corresponding flow regulating apparatuses which regulate the liquid flow based on the measured signal of the flow measuring apparatuses. The supply lines in a known manner, can be ring lines, or annular channels which are connected to a plurality of feed lines, for example feed tubes that run through the bores of the working disc. Such pressure-tight ring lines serve to supply a plurality of lines communicating therewith in a particularly simple and reliable manner. The common main pressure supply line, in turn can be guided through a vertical drive shaft assigned to the at least one working disc provided with the bores. The vertical drive shaft is driven by a drive, for example a motor. Thereby, the working disc connected to the drive shaft is rotated. Thus, a pressure-tight single channel rotary inlet is provided through the drive shaft in order to distribute the working means to the different supply lines. In an advantageous manner, only one main pressure supply line must be guided from the stationary machine housing into the rotating components. However, in this case it is necessary to provide an electrical control in the working disc for the

distribution of the main pressure supply line into the individual supply lines. In certain fields of application, this can be undesirable. Therefore, alternatively a multi-channel rotary inlet is also possible, with which the distribution into the individual supply line has already occurred before the drive shaft and a corresponding plurality of lines are guided through the drive shaft.

According to a further embodiment, the cross section of the bores, or the cross section of lines of liquid guided in the bores, can be reduced in the region of the end thereof opening into the working surface. The cross section can be reduced by more than 50%, for example. While working means flow out, such a reduction of the cross section in the region of the outlet into the working gap causes a back pressure to develop which guarantees that a minimum pressure is maintained in the supply line even when the means flows out freely. In particular, there is no breakdown of the pressure of the working means when individual or several outlet openings are uncovered. Unlike the prior art, the polishing means does not exit only through the bores that are free of work pieces, but rather can exit as a matter of principle from bores that are covered by work pieces. In particular, there is an outflow of liquid if the pressure in the supply line is equal to or greater than the specific working pressure in the working gap. By maintaining a specific pressure level in the supply lines, an outflow from all outlet openings is guaranteed.

Because the friction between the working coating of the working discs and the work pieces depends on the quantity of liquid, further, a measurement apparatus can be provided for measuring the torque applied by a rotary drive onto at least one vertical shaft connected to at least one of the working discs, where the control apparatus compares the torque measured by the measurement apparatus with a reference torque or a reference torque range, and in the case of a deviation of the measured torque from the reference torque or the reference torque range changes the pressure of the working means in at least a few of the supply lines such that the measured torque is again equal to the reference torque or lies within the reference torque range. Furthermore it can be provided that the control apparatus can compare the measured torque to a preset limit torque. If the measured torque falls below the limit torque, the control apparatus

reduces the pressure of the working means in at least a few of the supply lines such that the value of the measured torque is again above the limit torque. This design is based on the realization that in the event of an oversupply of working liquid in the working gap, the torque to be applied by the drive for reaching a predetermined rotational speed is drastically reduced, in a manner similar to aquaplaning. This leads to an undesired impairment of the work piece processing. Therefore, in such a case, the supply of working means is reduced by a pressure reduction in the supply lines until the torque again lies in the predetermined range. Naturally, the pressure can be changed in particular in all supply lines, in particular, the pressure can be reduced.

The bores can be combined into groups depending on how often they are covered by the work pieces to be processed during operation of the device. On this basis, the pressure of the working means in the supply lines of the groups can each be set higher, the more frequently the bores in the respective group are covered by the work pieces to be processed during operation of the device. Thus, for the different groups, there are various predetermined reference values for the respective supply line, where the reference pressure values are selected depending on the expected frequency of the bores being covered by the work pieces to be processed. According to the invention, carrier wheels can be provided in a known manner with at least one, in particular with a plurality of recesses, in which the work pieces to be processed are held afloat. The carrier wheels are driven to rotate in the working gap, wherein the work pieces held in the wheels are moved in the working gap along cycloidal tracks. This results in various dwell probabilities in the radial direction of the working gap during the processing of the work piece. Thus, the dwell probability of the work piece in the edge region of the working gap, and particularly at the inner edge, can be higher than in the center, for example. This fact is taken into consideration by the above-mentioned design. Thus, bores in specific ring zones of the working gap can be combined into one group, where each the ring zone is assigned a specific dwell probability for the work piece. The higher the dwell probability for one of the ring zones, or respectively group, also the greater the reference pressure of working means for the supply line assigned to this group. The control can occur in such a manner that overall the resulting distribution of the working means in the entire working gap is as homogeneous as possible.

The method according to the invention can be performed in particular using the device according to the invention. Correspondingly, the device is suited for performing the method according to the invention.

An exemplary embodiment of the invention is explained in the following in more detail using the drawings. They show schematically:

- Fig. 1 a vertical sectional view of a part of a device according to the invention,
- Fig. 2 an enlarged representation of a section from a view according to Fig. 1 according to a further example embodiment,
- Fig. 3 an enlarged representation of the section B from Fig. 2, and
- Fig. 4 a circuit diagram for illustrating the control according to the invention.

The same reference numbers refer to the same objects in the figures unless indicated otherwise. Figure 1 shows a sectional view of a device 10 according to the invention for the double-sided processing of flat work-pieces. The device in the example is a double-sided polishing machine for co-planar polishing of semiconductor wafers. The device in the example shown as three supply lines 36 coming from a polishing liquid reservoir, each of which are guided via a connection piece 22 and a multi-channel rotary inlet 18 through a vertical drive shaft 20 of the device. The polishing liquid can be conveyed out of the liquid reservoir through the supply line 36 by means of a pump, not shown in more detail in Figure 1. The supply lines 36 in the example shown form a respective ring line 36 with outlets to the respective group of bores. The supply lines 36 can be formed by supply hoses. Furthermore, pressure regulating apparatuses, not shown in more detail, can be provided that are each designed for the purpose of regulating the pressure of working means in one of the supply lines 36, as will be described in more detail below.

The device 10 in a known manner additionally has a circular upper and lower carrier disc and a circular upper and respectively lower working disc respectively connected to the upper and lower carrier disks. Fig. 1 merely shows the upper carrier disc 38 and the upper working disc 40 connected thereto. The upper carrier disc 38 is circular shaped in

design. The device 10 has a lower carrier disc and working disc, both not represented, that are largely symmetrical in design to the upper carrier disc 38 and working disc 40. The working disks define a circular working gap in between the circular working surfaces that face each other, of which one the working surface of the upper working disk 40 is shown in Fig. 1 with reference number 46. The fundamental design of such a double-side polishing machine with upper and lower working disks is known from, and described in the document, DE 100 07 390 A1, for example.

As is further seen in Fig. 1, a plurality of axial bores 48 is provided through the working disc 40 each of which aligns with corresponding bores 50 in the upper carrier disc 38. Pressure pipes 52 extend through each of the bores. Fig. 1 further show that the circular supply lines 36 are each connected to the upper openings of the pressure pipes 52.

The design of the bores 48, 50, and respectively pressure pipes 52, will be explained in more detail based on the enlarged representations shown in the Figures 2 and 3. In contrast to the example embodiment according to Figure 1, in the example embodiment according to Fig. 2 and 3, a larger number of supply lines 36, bores 48, 50, and pressure pipes 52 are provided. Beyond that, the example embodiments are the same. Figures 2 and 3 show that the pressure pipes 52 are respectively connected at the upper end thereof via a connector 54 to the ring lines 36. The pressure pipes 52 are plastic for example. A metal sleeve 58 is inserted into each of the bores 50, or respectively 48, in the upper carrier disc 38, or respectively the upper working disc 40. The pressure pipe 52 in the region of the end thereof opening into the working surface 46 is sealed with respect to the sleeve 58. As further seen in Fig. 3, the pressure pipes 52 at the lower end thereof has a significant reduction 62 in cross section of more than 50%. Thus, the outlet opening 64 of the pressure pipe 52 has a significantly smaller diameter than the main region 66 of the pressure pipe 52.

As seen in particular in the Figures 1 and 2, bores 48, 50 are disposed at different radial distances to the working disc and carrier disc. The upper working disc, and therefore also the upper carrier disk supporting it, have multiple circular series of axial bores

running through the working disk 40 and the carrier disc 38 at different radial distances to the central axis of rotation running through the vertical drive shaft 20. The bores of a radial distance are combined respectively into a group, and are supplied with polishing means from a ring line 36.

The function of the device according to the invention will be explained again in more detail using the schematic circuit diagram shown in Fig. 4. Polishing means is conveyed in the supply lines 36 from a reservoir of polishing means, not shown, via a non-return valve 70 connected to the pump 68. From there, the polishing means is further conveyed to the pressure regulating apparatuses 35. In addition, a two-way valve 72 is respectively located in the supply lines 36 for switching on and off the supply circuits supplied through the supply lines 36. The pressure of polishing means in each of the ring lines 36 can be separately regulated to a specific value using the pressure control apparatuses 35. Additionally, a flow meter 74 is located in each of the supply lines 36. Such regulation, or respectively flow control, is known to the person skilled in the art, and therefore is not explained here in more detail. The workpieces to be processed can be held in carrier wheels in a known manner, for example, such that they move along a cyclical track in the working gap. In the process, there are different dwell probabilities of the workpiece in the working gap. In particular, the different radial groups of bores in the upper working disc 40 are covered with different frequency by workpieces during operation. This can be taken into consideration according to the invention in that the radial region of bores that are expected to be covered more frequently, can be pressurized through the ring lines 36 assigned thereto and the corresponding pressure regulating apparatus 35 at a higher working pressure.

CLAIMS

1. A device for the double-sided processing of flat work pieces, comprising an upper working disc (40) and a lower working disc, wherein the working discs (40) between the working surfaces (46) thereof facing each other, form a working gap for processing the work pieces, and wherein at least one of the working discs (40) has a plurality of bores (48) extending through the working surface (46) for supplying a liquid working medium into the working gap, characterized in that the bores (48) are combined into several groups, wherein each group of bores (48) is connected to a separate pressurized supply line (36) for the working means, and wherein at least one pressure control apparatus (35) is provided with which the pressure of the working means in the supply lines (36) can be regulated separately from each other.
2. The device according to claim 1, characterized in that the supply lines (36) can each be connected to a common main pressure supply line and to the bores (48) of one group.
3. The device according to claim 2, characterized in that the common main pressure supply line is guided through a vertical drive shaft (20) assigned to the at least one working disk (40) provided with the bores (48).
4. The device according to claim 2, characterized in that the supply lines (36) are guided through a vertical drive shaft (20) assigned to the at least one working disk (40) provided with the bores (48).
5. The device according to one of the preceding claims, characterized in that the cross section of the bores (48), or the cross section of lines (52) of liquid guided in the bores (48), are reduced in the region of the end thereof opening into the working surface (46).

6. The device according to one of the preceding claims, further characterized by a measurement apparatus for measuring the torque applied by a rotary drive onto at least one vertical shaft (20) connected to the at least one of the working discs, wherein the control apparatus (35) compares the torque measured by the measurement apparatus with a reference torque or a reference torque range, and in the case of a deviation of the measured torque from the reference torque or the reference torque range changes the pressure of the working means in at least a few of the supply lines (36) such that the measured torque is again equal to the reference torque or lies within the reference torque range.
7. The device according to claim 6, characterized in that the control device (35) compares the measured torque with a predetermined limit torque, and that if the measured torque fall below the limit torque, the control apparatus (35) reduces the pressure of the working means in at least a few of the supply lines (36) such that the value of the measured torque is again above the limit torque.
8. The device according to one of the preceding claims, characterized in that the bores (48) are combined into groups depending on how often the bores (48) are covered by work pieces to be processed during operation of the device (10).
9. The device according to claim 8, characterized in that the control apparatus (35) sets the pressure of working means in the supply lines (36) of the group depending on how frequently the bores (48) of a respective group are to be covered by work pieces to be processed during operation of the device (10).
10. A method for operating a device for the double-sided processing of flat work pieces, wherein the device has an upper working disc (40) and a lower working disc, wherein the working discs (40) between the working surfaces (46) thereof facing each other form a working gap for processing the work piece, and wherein at least one of the working discs (40) has a plurality of bores (48) extending through the working surface (46) for supplying a liquid working medium into the working gap,

characterized in that the bores (48) are combined into several groups, wherein each group of bores (48) is pressurized with working means, and wherein the working means pressure of the working means supplied to each of the groups (48) can be regulated separately from each other.

11. The method according to claim 10, characterized in that the torque applied by a rotary drive onto at least one vertical drive shaft (20) connected to at least one of the working disks, is measured, and the the torque measured by the measurement apparatus with a reference torque or a reference torque range, and in the case of a deviation of the measured torque from the reference torque or the reference torque range changes the pressure of the working means in at least a few of the supply lines such that the measured torque is again equal to the reference torque or lies within the reference torque range.
12. The method according to claim 11, characterized in that the measured torque is compared to a predetermined limit torque, and that if the measured torque falls below the limit torque, the pressure of the working means of the working means supplied to at least a few groups is reduced so that the measured torque is again above the limit torque.
13. The method according to one of the claims 10 to 12, characterized in that the bores (48) are combined into groups depending on how often the bores (48) are to be covered by the work pieces to be processed during operation of the device.
14. The method according to claim 13, characterized in that the pressure of working means of the working means supplied to the groups is set depending on how frequently the bores (48) of a respective group are to be covered by the work pieces to be processed during operation of the device.