

Method for Operating a Double-Sided Processing Machine and Double-Sided Processing Machine

The invention relates to a method for operating a double-sided processing machine, in particular a double-sided polishing machine, which comprises a top working disk and a bottom working disk which can be rotated relative to each other by means of a rotary drive and between which a working gap for processing flat workpieces is formed.

The invention also relates to a double-sided processing machine, in particular a double-sided polishing machine, comprising a top working disk and a bottom working disk, between which a working gap for processing flat workpieces is formed, and comprising a rotary drive with which the top working disk and the bottom working disk can be rotated relative to each other.

In double-sided processing machines, for example double-sided polishing machines, flat workpieces such as semiconductor wafers are processed, for example polished, in a working gap formed between a top working disk and a bottom working disk. During processing, the working disks are rotated relative to each other by means of a rotary drive. The flat workpieces can be located, for example, in recesses of what are known as rotor disks which move along a circular path through the working gap during processing and in doing so rotate about their axis. The workpieces are thus guided along cycloidal paths through the working gap and processed. Very high surface qualities of the processed workpieces, in particular very high evenness, can be achieved with such double-sided processing machines. An important parameter for the processing quality is known to be the GBIR value (Global Backside Ideal Focal Plane Range).

During the in particular material-removing processing of the workpieces, what is known as slurry is often supplied to the working gap. For this purpose, the top working disk and/or the bottom working disk can have corresponding supply openings. It is also known, for example, to provide the top working disk and/or the bottom working disk with, for example, labyrinthine tempering channels through which a cooling liquid, for example water, is conducted during processing in order to keep the working disks at a specified operating temperature during a processing step. It is also known to measure the thickness of the processed workpieces, for example, at multiple radially distanced locations of the working gap, during a processing step and to terminate the processing step after a specified target thickness has been reached. For the thickness measurement, various sensors are known, for example, eddy current sensors or also optical sensors.

In practice, it has been shown that, in particular after a longer downtime of a double-sided processing machine, the processing result of the first processing runs performed after ending the downtime is not yet optimal. Thus, for example, a specified GBIR value is regularly only reached after multiple processing runs, wherein the number of the processing runs required for this seem to depend on the duration of the downtime of the double-sided processing machine. The workpieces processed during such processing runs until the specified quality criteria have been reached have a non-optimal processing result and are accordingly only usable for lower quality requirements, in particular not as what are known as prime wafers. If test workpieces are used for the processing runs required to reach the optimal processing quality, rejects can be avoided. However, this leads to a lower throughput of the processing machine and correspondingly higher costs.

Proceeding from the explained prior art, the object of the invention is to provide a method and a double-sided processing machine of the type explained above, with which the throughput can be increased compared to the prior art even after longer

downtime of the double-sided processing machine and the costs can be lowered accordingly.

The invention achieves the object with the independent claims 1 and 9. Advantageous embodiments are disclosed in the dependent claims, the description and the figures.

For a method of the type in question, the invention achieves the object in that, before a processing step for processing workpieces, at least the working disks are heated to an operating temperature by means of a heating apparatus in a heating step. For a double-sided processing machine of the type in question, the invention achieves the object in that a heating apparatus is provided for heating at least the working disks to an operating temperature in a heating step before a processing step for processing workpieces.

The double-sided processing machine can be, for example, a double-sided polishing machine. However, other double-sided processing machines are also conceivable, for example, double-sided grinding machines or double-sided lapping machines. The working disks can each have a working covering, for example a polishing pad. The flat workpieces can be, for example, semiconductor wafers. The top working disk can be fastened to a top support disk. Accordingly, the bottom working disk can be fastened to a bottom support disk. During processing of workpieces in the working gap formed between the working disks, they can be rotated relative to each other. A corresponding rotary drive is provided for this. For example, the working disks can be driven to rotate in opposite directions to each other.

The invention is based on the knowledge that the processing runs described above that are required in order to reach the specified processing quality correlate with a temperature of the working disks that is still too low at the beginning. In particular

after longer downtime, the working disks and if applicable the support disks can cool below the operating temperature. In the course of the processing runs described in the prior art, the working disks are then successively heated until they have reached their operating temperature and the specified processing results have thus been achieved. As also explained above, this procedure leads, however, to reduced throughput or respectively increased costs.

The invention is therefore based on the idea of providing an external heating apparatus or respectively an external heating source with which at least the top and bottom working disks are heated before a first processing step to prevent the heating runs described above. The external heating apparatus or respectively external heating source is in this case provided in addition to the components of the double-sided processing machine provided for the processing of the workpieces and is correspondingly not formed by processing workpieces in the working gap. As explained, during such processing, heat is also generated so that, after several heating runs, the working disks reach their operating temperature and the processing result thus meets the required criteria. However, according to the invention a heating apparatus is provided that is separate from this and that achieves a heating of the working disks even without processing workpieces in the working gap. In particular, during the heating step according to the invention, no workpieces to be processed are arranged in the working gap. The heating runs explained above are avoided. Accordingly, after the conclusion of the heating step, a processing step can directly follow, wherein the workpieces processed hereby already meet the target parameters in the first processing run. The throughput of the double-sided processing machine is increased accordingly and the costs are reduced. The operating temperature of the top working disk and the bottom working disk can be, for example, in a range between 20°C and 30°C, for example about 25°C.

In addition to the working disks, support disks holding the working disks, if provided, can of course also be heated to an operating temperature with the heating apparatus. This ensures that the working disks can hold their operating temperature at all times.

As explained, after the heating step one or more processing steps for processing workpieces in the working gap of the double-sided processing machine follow. The processing steps comprise in particular material-removing processing of the workpieces, for example, polishing, lapping, or grinding. As explained above, multiple workpieces can be mounted in a floating manner in recesses of what are known as rotor disks for this purpose. The rotor disks move, on one hand, along a circular path through the working gap and, on the other hand, rotate about their own axis. As a result, the workpieces move along cycloidal paths through the working gap, whereby an optimal processing result is achieved. The rotor disks can roll, for example, on sprockets on the inner and/or outer edge of the working gap.

The heating step can be controlled or respectively regulated, in particular initiated and terminated, by a control apparatus and/or a regulation apparatus of the double-sided processing machine. The regulation apparatus can use in particular the temperature of the heating source and the duration of the heating step as regulation parameters. When the working disks are rotated during the heating step, for example, the rotational speed of the working disks can also be used. Accordingly, the heating step can be controlled or respectively regulated by the control apparatus or respectively regulation apparatus.

According to one embodiment, a heated heating liquid is conducted into the working gap in the heating step. This can be, for example, water heated by means of a heating source. The heating liquid can have, for example, a somewhat higher temperature than the desired operating temperature, for example 5 to 10°C higher.

In a particularly practical manner, the heating liquid can be conducted into the working gap through supply openings for a slurry. As explained above, the top working disk and/or the bottom working disk can have such supply openings for slurry to be supplied to the working gap. The heating liquid can be conducted into the working gap through these, whereby at the same time a particularly even distribution of the heating liquid in the working gap is ensured. The supply openings are designed, for example, as axial bores in the top working disk and/or the bottom working disk.

During the heating step, the working disks can be rotated in the same direction of rotation, in particular in the same direction, further particularly with the same rotational speed, by means of a rotary drive. An even heating of the working disks, in particular of the entire radial extent of the working disks, and if applicable the support disks, can thereby be achieved, wherein the polishing pads are not influenced. However, it is also possible that the working disks are not rotated, meaning stay still, during the heating step.

The working disks can be held during the heating step by spacers between the working disks or by locking a mount of the top and/or the bottom working disk at a defined distance to each other. This achieves a particularly defined and effective heating of the working disks and if applicable the support disks. The top working disk and/or the bottom working disk can be settable in height by means of a corresponding mount in order to thus set the working gap in a defined manner. This setting can be used according to the previous exemplary embodiment in order to ensure a defined distance between the working disks during the heating step. To lock the working disks, for example, what are known as clamping shoes can be used. However, it is also possible to ensure the defined distance between the working disks by using suitable spacers between the working disks. The spacers can be held in the gap, for example, by setting

a narrower gap in the radially outer region of the working gap than in the radially inner region of the working gap.

According to another embodiment, heated heating liquid can be conducted in the heating step through tempering channels designed in the top working disk and/or in the bottom working disk. As also explained above, for example, top working disks and/or bottom working disks of double-sided processing machines have tempering channels, through which a cooling liquid, for example water, is conducted during workpiece processing in order to prevent an undesired heating of the working disks during processing. These, for example labyrinthine, tempering channels designed in the top working disk and/or the bottom working disk can be used in the previous embodiment in a particularly practical manner in that, during the heating step, a heating liquid heated in a defined manner is conducted through the tempering channels instead of a cooling liquid and thus the heating of the working disks is realized effectively. Of course, it would also be possible for corresponding tempering channels to be designed between the top working disk and a top support disk and/or between a bottom working disk and a bottom support disk. It would also be conceivable for corresponding tempering channels to be designed in a top support disk and/or a bottom support disk. Accordingly, the heated heating liquid can also be conducted through tempering channels designed in this manner.

According to another embodiment, at least the working disks can be heated to an operating temperature in the heating step by means of an electrical heating apparatus, in particular by means of at least one electrical heating mat. Such an electrical heating apparatus, for example, an electrical heating mat, can be designed, for example, in the top working disk and/or the bottom working disk, in a top support disk and/or a bottom support disk and/or between a top working disk and a top support disk and/or a bottom

working disk and a bottom support disk. By means of such an electrical heating apparatus, a particularly fast and defined heating of the working disks can be realized.

According to another embodiment, the temperature of the top working disk and/or the bottom working disk can be measured during the heating step, and the heating step can be terminated after the operating temperature has been reached, as determined by the temperature measurement. For this purpose, temperature sensors, for example, can be designed in the top working disk and/or the bottom working disk which measure the temperature of the top working disk and/or the bottom working disk during the heating step. If the temperature sensors detect that the operating temperature has been reached, the heating step can be terminated. The heating step can be terminated automatically after the operating temperature detected in this way has been reached. The temperature measurement values of corresponding temperature sensors can be applied for this purpose to a control and/or regulation apparatus and the control and/or regulation of the heating step can be based on them accordingly.

The double-sided processing machine according to the invention can be designed to perform the method according to the invention. Accordingly, the method according to the invention can be performed with a double-sided processing machine according to the invention.

An exemplary embodiment of the invention is explained in greater detail below based on figures. Schematically:

Figure 1 shows a double-sided processing machine according to the invention in a sectional view, and

Figure 2 shows a diagram to explain the method according to the invention.

The same reference signs refer to the same objects in the figures unless indicated otherwise.

The double-sided processing machine shown in Figure 1, in which it can be, for example, a double-sided polishing machine, has an annular top working disk 10 and a likewise annular bottom working disk 12. Between the working disks 10, 12, an annular working gap 14 is formed in which flat workpieces, for example, semiconductor wafers, can be processed, for example polished. As explained, the workpieces can be mounted in a floating manner in recesses of what are known as rotor disks. The rotor disks can be moved along a circular path through the working gap 14 and in doing so rotate about their own axis. For this purpose, the rotor disks can roll, for example, on sprockets on the inner and/or outer edge of the working gap 14. This is known per se and is therefore not explained in more detail.

The top working disk 10 is fastened to a top support disk 16, and the bottom working disk 12 is fastened to a bottom support disk 18. During processing of workpieces in the working gap 14, the top support disk 16 and the bottom support disk 18, and with them the top working disk 10 and the bottom working disk 12, are rotated relative to each other about an axis of rotation 20 by means of a rotary drive which is not shown in more detail. For example, the working disks 10, 12 or respectively the support disks 16, 18 can be driven to rotate in opposite directions.

In Figure 1, various further components of the top and bottom working disks 10, 12 are shown, wherein they are shown only for one of the working disks 10, 12 for reasons of clarity. It should be understood that the corresponding components, described in more detail in the following, can be designed in both working disks 10, 12.

In the example shown, the top working disk 10 has supply lines 22 for supplying a slurry to the working gap 14. The supply lines 22 each have supply openings 23 opening into the working gap 14. In addition, in Figure 1 distance sensors 24, for example, eddy current sensors 24, are provided in the top working disk 10 and measure the distance to the workpieces to be processed and thus their thickness at different radial locations of the working gap 14 during workpiece processing. In Figure 1, multiple temperature sensors 26 are also designed in the top working disk 10, which sensors measure the temperature at least of the top working disk 10 in particular during a heating step but also, for example, during a processing step. As explained, temperature sensors can also be provided in the bottom working disk 12. The same applies to the top support disk 16 and the bottom support disk 18. In the example shown, the measurement results from the temperature sensors 26 are applied to a control and/or regulation apparatus 28 of the double-sided processing machine. This controls or respectively regulates the operation of the double-sided processing machine, including a heating step still to be explained in the following.

A heating element 30 is also shown schematically in the bottom working disk 12. The heating element 30 can be, for example, an electrical heating element 30, for example an electrical heating mat 30. However, the heating element 30 can also be a, for example, labyrinthine arrangement of tempering channels 30 through which heated heating liquid is conducted in a heating step, as will also be explained below. The heating element 30 can in turn also be designed in the top working disk 10. The same applies to the top support disk 16 and the bottom support disk 18.

In the method according to the invention, before a processing step for processing workpieces in the working gap 14, the temperature of the top working disk 10 and the bottom working disk 12 is first brought to a specified operating temperature in a

heating step. This can be controlled or respectively regulated by the control and/or regulation apparatus 28. For example, heated heating liquid can be conducted into the working gap 14 in the heating step through the supply lines 22 and the supply openings 23. The working disks 10, 12 and the support disks 16, 18 can be rotated in the working gap 14 during the supply of the heating liquid. During the heating step, the working disks 10, 12 can be held at a defined distance from each other, for example by locking a mount of the top working disk 10 and/or of the bottom working disk 12. The temperature sensors 26 can detect when the specified operating temperature has been reached. The control and/or regulation apparatus 28 can then terminate the heating step. Subsequently, workpieces can be processed in one or more processing steps, in particular material-removing processing, for example, polishing, lapping, or grinding.

Alternatively or additionally, heated heating liquid can be conducted through the tempering channels 30 in the heating step and the temperature of the working disks 10, 12 can thereby be heated to the specified operating temperature. It is further possible alternatively or additionally to heat at least the working disks 10, 12 to the operating temperature in the heating step by means of the electrical heating apparatus 30, in particular the heating mat 30. Detecting the operating temperature and the corresponding termination of the heating step can take place, as explained above, by the control and/or regulation apparatus 28. The control and/or regulation apparatus 28 can use the temperature of the supplied heating liquid, the heating output of the electrical heating apparatus 30 and the duration of the heating step as control and/or regulation parameters. When the working disks 10, 12 are rotated, the rotational speed of the working disks 10, 12 can also be used.

Figure 2 shows a diagram with results of a heating according to the prior art and according to the invention. The GBIR value is shown normalized in each case over

the number of heating runs of the double-sided processing machine. The curve 32 refers to the case in which the double-sided processing machine was not operated for three nights and days at room temperature and then was used to process workpieces in processing steps without a heating step according to the invention. It is shown that three heating runs were required in order to reach a specified GBIR value, which should be as close to 1 as possible in the normalized version.

The curve 34 describes a case corresponding to the curve 32, wherein the double-sided processing machine stood idle, however, for only one night at room temperature. Here, the number of required heating runs until the desired GBIR value is reached is shortened to one run. However, a corresponding throughput loss or respectively a corresponding cost increase is still registered.

The curve 36 shows the results for a double-sided processing machine which has stood idle for one night at room temperature and in which a heating step according to the invention was performed before the first processing step (run one). The curve 36 shows that the first processing run here already has the desired GBIR value. Corresponding throughput loss or respectively corresponding cost increases could be avoided.

List of Reference Signs

10	Top working disk
12	Bottom working disk
14	Working gap
16	Top support disk
18	Bottom support disk
20	Axis of rotation
22	Supply lines
23	Supply openings
24	Distance sensors
26	Temperature sensors
28	Control and/or regulation apparatus
30	Heating element
32	Curve
34	Curve
36	Curve

Claims

1. A method for operating a double-sided processing machine, in particular a double-sided polishing machine, which comprises a top working disk (10) and a bottom working disk (12) which can be rotated relative to each other by means of a rotary drive and between which a working gap (14) for processing flat workpieces is formed, characterized in that, before a processing step for processing workpieces, at least the working disks (10, 12) are heated to an operating temperature by means of a heating apparatus (30) in a heating step.
2. The method according to claim 1, characterized in that a heated heating liquid is conducted into the working gap (14) in the heating step.
3. The method according to claim 2, characterized in that the heating liquid is conducted into the working gap (14) through supply openings (23) for a slurry.
4. The method according to any of the preceding claims, characterized in that the working disks (10, 12) are rotated in the same direction of rotation by means of the rotary drive during the heating step.
5. The method according to any of the preceding claims, characterized in that the working disks (10, 12) can be held during the heating step by spacers between the working disks (10, 12) or by locking a mount of the top and/or the bottom working disk (10, 12) at a defined distance from each other.
6. The method according to any of the preceding claims, characterized in that heated heating liquid can be conducted in the heating step through tempering channels (30) designed in the top working disk (10) and/or in the bottom working disk (12).

7. The method according to any of the preceding claims, characterized in that at least the working disks (10, 12) can be heated to an operating temperature in the heating step by means of an electrical heating apparatus (30), in particular at least one electrical heating mat (30).
8. The method according to any of the preceding claims, characterized in that the temperature of the top working disk (10) and/or the bottom working disk (12) is measured during the heating step, and that the heating step is terminated after the operating temperature has been reached.
9. A double-sided processing machine, in particular a double-sided polishing machine, comprising a top working disk (10) and a bottom working disk (12), between which a working gap (14) for processing flat workpieces is formed, and comprising a rotary drive with which the top working disk (10) and the bottom working disk (12) can be rotated relative to each other, characterized in that a heating apparatus (30) is provided for heating at least the working disks (10, 12) to an operating temperature in a heating step before a processing step for processing workpieces.
10. The double-sided processing machine according to claim 9, characterized in that it is designed to perform the method according to any of claims 1 to 8.