

POLISHING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a polishing apparatus for polishing a platelike workpiece.

Description of the Related Art

In a polishing apparatus for polishing a platelike workpiece such as a semiconductor wafer to reduce the thickness of the platelike workpiece to a desired thickness, a polishing pad is brought into contact with the platelike workpiece and a slurry is supplied to a contact surface between the polishing pad and the platelike workpiece, thereby polishing the platelike workpiece. In Japanese Patent Laid-open No. 2005-203729, there has been proposed a polishing apparatus intended to finish the thickness of a platelike workpiece to a desired thickness, wherein past results of polishing are collected as a database to calculate optimum polishing conditions such as polishing time for the desired thickness of the platelike workpiece.

In Japanese Patent Laid-open No. 2011-224758, there has been proposed a polishing apparatus for measuring the thickness of a platelike workpiece after interruption of polishing, calculating optimum polishing conditions according to the results of measurement, and then perform

finish polishing according to the polishing conditions calculated above. Further, in Japanese Patent Laid-open No. 2012-189507, there has been proposed a measuring apparatus for measuring the thickness of a platelike workpiece by applying light to the platelike workpiece and next measuring the interference between light reflected from the upper surface of the platelike workpiece and light reflected from the lower surface of the platelike workpiece to thereby determine an optical path difference.

SUMMARY OF THE INVENTION

However, in the polishing apparatus for calculating optimum polishing conditions according to past results of polishing as described in Japanese Patent Laid-open No. 2005-203729, the thickness of the platelike workpiece is not always finished to a desired thickness and there is a possibility that insufficient polishing or excessive polishing may occur. Further, in the polishing apparatus for measuring the thickness of the platelike workpiece after interruption of polishing as described in Japanese Patent Laid-open No. 2011-224758, polishing must be interrupted every time the thickness of the platelike workpiece is measured, so that the productivity may be reduced. Further, in the measuring apparatus for measuring the thickness of the platelike workpiece by

using interference light during polishing as described in Japanese Patent Laid-open No. 2012-189507, the thickness measured may have an error and the thickness of the platelike workpiece cannot be accurately measured.

It is therefore an object of the present invention to provide a polishing apparatus which can accurately measure the thickness of a platelike workpiece during polishing and thereby polish the platelike workpiece until the thickness of the platelike workpiece becomes a desired thickness, so that the occurrence of insufficient polishing or excessive polishing can be prevented.

In accordance with an aspect of the present invention, there is provided a polishing apparatus including a chuck table for holding a platelike workpiece having an upper surface and a lower surface; polishing means having a rotatable polishing pad for polishing the platelike workpiece held on the chuck table; feeding means for moving the polishing means toward and away from the chuck table; slurry supplying means for supplying a slurry to a contact surface between the polishing pad and the platelike workpiece; thickness measuring means for measuring the thickness of the platelike workpiece in the condition where the platelike workpiece held on the chuck table is being polished by the polishing means; temperature measuring means for measuring the temperature of the platelike workpiece in the condition where the

platelike workpiece held on the chuck table is being polished by the polishing means; and a thickness correcting section for correcting the thickness measured by the thickness measuring means, according to the temperature measured by the temperature measuring means; the polishing means including a spindle, a mount connected to one end of the spindle for mounting the polishing pad thereon, and rotating means for rotating the spindle; the thickness measuring means including a light emitting section for emitting measurement light to the platelike workpiece held on the chuck table, a photodetecting section for detecting reflected light obtained by the reflection of the measurement light from the platelike workpiece, and a thickness calculating section for calculating an optical path difference between light reflected from the upper surface of the platelike workpiece and light reflected from the lower surface of the platelike workpiece, according to the reflected light detected by the photodetecting section, thereby calculating the thickness of the platelike workpiece; the temperature measuring means including a radiation thermometer for detecting infrared light radiated from the platelike workpiece, thereby measuring the temperature of the platelike workpiece, and a temperature storing section for storing the temperature measured by the radiation thermometer; the thickness

correcting section calculating the refractive index of the platelike workpiece at the temperature stored by the temperature storing section, according to the relation between the temperature and refractive index of the platelike workpiece, and next correcting the thickness calculated by the thickness calculating section, according to the refractive index calculated above; the platelike workpiece being polished as being measured the thickness of the platelike workpiece.

Preferably, the polishing apparatus further includes control means for controlling the feeding means so that the temperature measured by the temperature measuring means becomes a set temperature preliminarily set, thereby moving the polishing means toward or away from the chuck table to change a pressure applied from the polishing pad to the platelike workpiece.

In the polishing apparatus according to the present invention, attention has been paid to the fact that the refractive index of the platelike workpiece changes with a change in temperature. That is, the refractive index of the platelike workpiece at the temperature measured by the temperature measuring means is first calculated, and the thickness calculated by the thickness calculating section is next corrected according to the refractive index calculated above. Accordingly, the thickness of the platelike workpiece can be accurately determined during

polishing. Since the thickness of the platelike workpiece can be accurately determined during polishing, the platelike workpiece can be polished until the thickness of the platelike workpiece becomes a desired thickness, so that the occurrence of insufficient polishing or excessive polishing can be prevented.

Further, the polishing pressure by the polishing pad can be controlled so that the temperature calculated by the temperature calculating section becomes a predetermined set temperature. For example, in the case that the set temperature is increased, a polishing speed can be increased. Conversely, in the case that the set temperature is decreased, the polished surface of the platelike workpiece can be cleaned. In this manner, the polishing conditions can be easily changed.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing a polishing apparatus according to a preferred embodiment of the

present invention;

FIG. 2 is a perspective view showing polishing means;

FIG. 3 is a schematic diagram showing thickness measuring means;

FIG. 4 is a sectional side view showing slurry supplying means; and

FIG. 5 is a graph showing the relation between the temperature and refractive index of a platelike workpiece.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a polishing apparatus 10 according to a preferred embodiment of the present invention. The polishing apparatus 10 includes a base 11, a chuck table 12 for holding a platelike workpiece, polishing means 13 for polishing the platelike workpiece held on the chuck table 12, feeding means 14 for moving the polishing means 13 toward and away from the chuck table 12 in the $\pm Z$ direction, thickness measuring means 15 for measuring the thickness of the platelike workpiece held on the chuck table 12, temperature measuring means 54 for measuring the temperature of the platelike workpiece held on the chuck table 12, a thickness correcting section 55 for correcting the thickness measured by the thickness measuring means 15 according to the temperature measured

by the temperature measuring means 54, and control means 17 for controlling the feeding means 14 and its associated parts.

The chuck table 12 has a holding surface 121 parallel to the XY plane. The holding surface 121 of the chuck table 12 is adapted to hold the platelike workpiece under suction. The chuck table 12 is rotatable to thereby allow the rotation of the platelike workpiece held on the holding surface 121 under suction. The polishing means 13 includes a mount 32 connected to the lower end of a spindle and a polishing pad 70 mounted on the lower surface of the mount 32. By rotating the spindle, the polishing pad 70 can be rotated.

The feeding means 14 includes a screw shaft 42 extending in the $\pm Z$ direction, a motor 41 for rotating the screw shaft 42, a moving member 43 threadedly engaged with the screw shaft 42, and a pair of guide members 44 (one of which being shown in FIG. 1) for guiding the moving member 43, whereby when the motor 41 is operated to rotate the screw shaft 42, the moving member 43 is guided by the guide members 44 to move the $\pm Z$ direction. The polishing means 13 is fixed to the moving member 43, so that the polishing means 13 is movable in the $\pm Z$ direction by the movement of the moving member 43.

In the condition where the platelike workpiece held on the chuck table 12 is rotated and the polishing pad 70

of the polishing means 13 is also rotated, the polishing means 13 is moved in the -Z direction by the feeding means 14 to bring the polishing surface (lower surface) of the polishing pad 70 into contact with the upper surface of the platelike workpiece, thereby polishing the platelike workpiece.

The thickness measuring means 15 includes a measuring section 51 for applying measurement light to the platelike workpiece and detecting reflected light from the platelike workpiece, and a thickness calculating section 53 for calculating the thickness of the platelike workpiece according to the reflected light detected by the measuring section 51.

The temperature measuring means 54 includes a radiation thermometer 541 for detecting infrared light radiated from the platelike workpiece to measure the temperature of the platelike workpiece, and a temperature storing section 542 for storing the temperature measured by the radiation thermometer 541. The thickness correcting section 55 functions to correct the thickness calculated by the thickness calculating section 53 according to the temperature stored by the temperature storing section 542.

The control means 17 functions to control the polishing means 13 and the feeding means 14. For example, when the thickness of the platelike workpiece corrected

by the thickness correcting section 55 reaches a predetermined thickness, the control means 17 controls the feeding means 14 to move the polishing means 13 in the +Z direction and also control the polishing means 13 to stop the rotation of the polishing pad 70, thereby ending the polishing operation.

As shown in FIG. 2, the polishing means 13 includes a rotating shaft 31 extending in the $\pm Z$ direction, the mount 32 fixed to the lower end of the rotating shaft 31, a spindle 33 surrounding the rotating shaft 31, a motor 34 as rotating means for rotating the rotating shaft 31, and the polishing pad 70 mounted on the lower surface of the mount 32. The polishing pad 70 includes a disk-shaped member 71 and a polishing member 72 mounted on the lower surface of the disk-shaped member 71 and adapted to come into contact with the platelike workpiece for polishing it. The upper surface of the disk-shaped member 71 is mounted on the lower surface of the mount 32. Accordingly, the polishing pad 70 is mounted on the lower surface of the mount 32 in the condition where the polishing member 72 is oriented downward. The polishing surface (lower surface) of the polishing pad 70 mounted on the mount 32 is parallel to the XY plane and perpendicular to the rotating shaft 31. When the motor 34 as a drive source is operated to rotate the rotating shaft 31, the mount 32 and the polishing pad 70 mounted thereon are rotated

together by the rotation of the rotating shaft 31. Further, slurry supplying means 16 for supplying a slurry to the polishing surface of the polishing pad 70 is provided at the upper end of the rotating shaft 31.

The thickness measuring means 15 further includes a collimator lens 52 for collimating the measurement light radiated from the measuring section 51, in addition to the measuring section 51 and the thickness calculating section 53 shown in FIG. 1. As shown in FIG. 3, the measuring section 51 of the thickness measuring means 15 includes a light emitting section 511 for emitting measurement light 591 to a platelike workpiece 90, a mirror 512 for reflecting the measurement light 591 emitted from the light emitting section 511 in the -Z direction, a sensor head 513 for transmitting the measurement light 591, a diffraction grating 514 for separating reflected light 594 obtained by the reflection of the measurement light 591 from the platelike workpiece 90, and an image sensor 515 for detecting light 595 obtained by the diffraction grating 514.

The light emitting section 511 is provided by a superluminescent diode (SLD), for example, and the measurement light 591 emitted from the light emitting section 511 has a relatively large spectral width. The wavelength region of the measurement light 591 is selected to a transmission wavelength to the platelike

workpiece 90 according to the material of the platelike workpiece 90. For example, in the case that the material of the platelike workpiece 90 is silicon, light in the infrared region is used as the measurement light 591.

The measurement light 591 is separated into light 592 reflected from the upper surface 91 of the platelike workpiece 90 and light entering the platelike workpiece 90. At least a part of the light entering the platelike workpiece 90 is reflected from the lower surface 92 of the platelike workpiece 90 to produce reflected light 593. Accordingly, the reflected light 594 obtained by the reflection of the measurement light 591 from the platelike workpiece 90 is the combination of the reflected light 592 from the upper surface 91 of the platelike workpiece 90 and the reflected light 593 from the lower surface 92 of the platelike workpiece 90. The reflected light 592 and the reflected light 593 are different in optical path length and therefore different in phase. In the case that the phase of the reflected light 592 coincides with the phase of the reflected light 593, a resultant amplitude becomes large, whereas in the case that the phases of the reflected light 592 and the reflected light 593 are shifted from each other, a resultant amplitude becomes small. When the wavelength of light is different regardless of the same optical path difference, the phase difference becomes different, so

that the amplitude of the reflected light 594 is different according to wavelength. Accordingly, by analyzing the spectrum of the reflected light 594, the optical path difference between the reflected light 592 and the reflected light 593 can be determined to thereby calculate the thickness of the platelike workpiece 90.

The diffraction grating 514 functions to reflect the reflected light 594 in different directions according to wavelength, thereby separating the reflected light 594. The image sensor 515 is configured by linearly arranging a plurality of photodetecting portions, which function to detect the light 595 obtained by the reflection of the reflected light 594 from the diffraction grating 514. The angle of reflection of the reflected light 594 at the reflection point on the diffraction grating 514 is different according to the positions of the photodetecting portions of the image sensor 515. Accordingly, the photodetecting portions detect respective specific wavelength components of the reflected light 594. The image sensor 515 outputs a signal indicating the intensities of the specific wavelength components detected by the photodetecting portions. That is, the signal output from the image sensor 515 indicates the analytical result of the spectrum of the reflected light 594.

As shown in FIG. 2, the radiation thermometer 541

of the temperature measuring means 54 is located adjacent to the measuring section 51 above the rotating shaft 31.

The rotating shaft 31 of the polishing means 13 is formed as a straight pipe having a central through hole 311 axially extending in the $\pm Z$ direction. The polishing pad 70 also has a central circular through hole 73 extending in the $\pm Z$ direction. The through hole 73 of the polishing pad 70 mounted on the mount 32 is in communication with the through hole 311 of the rotating shaft 31. The measurement light radiated from the measuring section 51 propagates in the $-Z$ direction and passes through the through hole 311 of the rotating shaft 31 and the through hole 73 of the polishing pad 70 to reach the platelike workpiece held on the chuck table 12. The measurement light is reflected from the platelike workpiece and the resultant reflected light from the platelike workpiece propagates in the $+Z$ direction and passes through the through hole 73 of the polishing pad 70 and the through hole 311 of the rotating shaft 31 to reach the measuring section 51. The measurement light is collimated by the collimator lens 52, so that the thickness of the platelike workpiece can be measured.

In this manner, the thickness measuring means 15 measures the thickness of the platelike workpiece held on the chuck table 12 through the through hole 73 of the polishing pad 70 and the through hole 311 of the rotating

shaft 31. Further, the infrared light radiated from the platelike workpiece is also passed through the through holes 73 and 311 to reach the radiation thermometer 541. Accordingly, although the upper surface of the platelike workpiece is not exposed to the outside of the polishing pad 70, the thickness and temperature of the platelike workpiece can be measured. Further, the thickness of the platelike workpiece is measured by applying the measurement light to the platelike workpiece, and the temperature of the platelike workpiece is measured by detecting the infrared light radiated from the platelike workpiece. Accordingly, it is sufficient that each of the through holes 311 and 73 has a size (diameter) allowing the pass of light inside the slurry to be hereinafter described. That is, it is unnecessary to increase the size of the through holes 311 and 73, so that a reduction in polishing force can be prevented.

As shown in FIG. 4, the slurry supplying means 16 includes a cylindrical joint member 61 having a bottom 611, a slurry supply pipe 62 connected to a slurry source 80, and a slurry nozzle 63 connected to the slurry supply pipe 62, wherein a slurry 81 supplied from the slurry source 80 through the slurry supply pipe 62 is sprayed from the slurry nozzle 63 to the inside surface of the joint member 61. The bottom 611 of the joint member 61 has a central opening 612. The joint member 61 is fixed

to the upper end of the rotating shaft 31, so that it is rotatable by the rotation of the rotating shaft 31. The central opening 612 of the joint member 61 is in communication with the through hole 311 of the rotating shaft 31.

When the platelike workpiece 90 is placed on the holding surface 121 of the chuck table 12, a vacuum source 122 is operated to produce a suction force and thereby hold the platelike workpiece 90 on the holding surface 121 under suction. In this condition, the motor 34 shown in FIG. 2 is operated to rotate the rotating shaft 31 with the spindle 33 and thereby rotate the polishing pad 70. Further, the feeding means 14 shown in FIG. 1 is operated to lower the polishing means 13 and thereby bring the polishing member 72 of the polishing pad 70 into contact with the upper surface 91 of the platelike workpiece 90. In this preferred embodiment, the polishing pad 70 has a diameter larger than that of the platelike workpiece 90 as shown in FIG. 4, so that the polishing member 72 of the polishing pad 70 comes into contact with the whole of the upper surface 91 of the platelike workpiece 90.

On the other hand, the slurry supplying means 16 is operated to spray the slurry 81 from the slurry nozzle 63. The slurry 81 sprayed to the inside surface of the joint member 61 is subjected to a centrifugal force by the

rotation of the joint member 61 and introduced from the central opening 612 of the joint member 61 into the through hole 311 of the rotating shaft 31. The slurry 81 introduced into the through hole 311 of the rotating shaft 31 is subjected to a centrifugal force by the rotation of the rotating shaft 31 and accordingly flows down along the inner surface of the through hole 311 of the rotating shaft 31. The slurry 81 reaches the lower end of the through hole 311 of the rotating shaft 31 and then further flows down along the inner surface of the through hole 73 of the polishing pad 70 due to a centrifugal force by the rotation of the polishing pad 70. Thereafter, the slurry 81 is discharged from the lower end of the through hole 73 and supplied to the space between the polishing surface (lower surface) of the polishing member 72 of the polishing pad 70 and the upper surface 91 of the platelike workpiece 90 held on the chuck table 12. The slurry 81 supplied to the space between the polishing pad 70 and the platelike workpiece 90 is subjected to a centrifugal force by the rotation of the chuck table 12 and accordingly spread radially outward of the platelike workpiece 90. Accordingly, the slurry 81 is spread over the space between the upper surface 91 of the platelike workpiece 90 and the polishing member 72 of the polishing pad 70, thereby polishing the upper surface 91 of the platelike workpiece

90.

In this manner, the slurry 81 is supplied along the inner surface of the through hole 311 of the rotating shaft 31 due to the centrifugal force by the rotation of the rotating shaft 31, so that a passage for allowing the pass of light is defined along the center (axis) of the through hole 311. Similarly, the slurry 81 is further supplied along the inner surface of the through hole 73 of the polishing pad 70 due to the centrifugal force by the rotation of the polishing pad 70, so that a passage for allowing the pass of light is defined along the center (axis) of the through hole 73. Accordingly, the measurement light radiated from the thickness measuring means 15 can pass through the through holes 311 and 73 to reach the platelike workpiece 90, and the infrared light radiated from the platelike workpiece 90 can pass through the through holes 73 and 311 to reach the radiation thermometer 541. Further, since the slurry 81 that has reached the polishing surface is spread radially outward of the platelike workpiece 90 by the centrifugal force, a central portion of the platelike workpiece 90 to be irradiated with the measurement light is not influenced by the slurry 81. That is, the slurry 81 is not waved at this central portion of the platelike workpiece 90. Accordingly, the thickness of the platelike workpiece 90 can be accurately measured.

In the condition where the platelike workpiece 90 held on the chuck table 12 is being polished by the polishing means 13, the thickness calculating section 53 shown in FIG. 1 performs any processing such as Fourier transform to the signal output from the image sensor 515 shown in FIG. 3, thereby calculating the optical path difference between the light 592 and the light 593. The optical path difference between the light 592 and the light 593 is twice the thickness d of the platelike workpiece 90. Accordingly, the thickness calculating section 53 calculates the thickness d of the platelike workpiece 90 from the optical path difference calculated above.

The wavelength of light changes according to the refractive index of a substance in which the light is transmitted. That is, when light having a wavelength λ in a vacuum enters a substance having an absolute refractive index n , the wavelength λ changes to λ/n in this substance. Accordingly, when the refractive index of the platelike workpiece 90 is different regardless of the same optical path difference, the phase difference becomes different. As a result, the relation between the spectral distribution of interference light detected by the photodetecting portions of the image sensor 515 and the thickness of the platelike workpiece 90 changes according to the refractive index of the platelike

workpiece 90. The thickness calculating section 53 calculates the thickness of the platelike workpiece 90 on the assumption that the refractive index of the platelike workpiece 90 is a refractive index n preset according to the material of the platelike workpiece 90.

However, the refractive index of a substance changes according to temperature. At starting the polishing operation, the temperature of the platelike workpiece 90 is an ordinary temperature (e.g., 20°C). To the contrary, after the polishing operation proceeds to some degree, the temperature of the platelike workpiece 90 is increased to 60°C, for example, by a processing heat due to the friction of the slurry 81 supplied to the contact surface between the platelike workpiece 90 and the polishing pad 70. It was found that a change in refractive index due to such a temperature rise causes a problem that the thickness of the platelike workpiece during polishing cannot be accurately measured by a measuring apparatus using interference light. Accordingly, by taking a change in refractive index due to a temperature rise into consideration, the thickness of the platelike workpiece during polishing can be accurately measured.

In the condition where the platelike workpiece 90 held on the chuck table 12 is being polished by the polishing means 13, the radiation thermometer 541 detects

the infrared light radiated from the surface of the platelike workpiece 90 and calculates the temperature of the platelike workpiece 90 according to a spectral distribution of the infrared light detected above. The radiation thermometer 541 detects the infrared light radiated from a position near the reflection point where the measurement light 591 emitted from the light emitting section 511 of the thickness measuring means 15 is reflected from the platelike workpiece 90. Accordingly, the radiation thermometer 541 measures the temperature of the platelike workpiece 90 at a position where the thickness measuring means 15 measured the thickness of the platelike workpiece 90.

In this manner, the temperature of the platelike workpiece 90 is measured by detecting the infrared light radiated from the platelike workpiece 90. That is, the temperature of the platelike workpiece 90 can be measured without the touch to the platelike workpiece 90. Accordingly, the temperature of the platelike workpiece 90 can be measured in real time even during polishing of the platelike workpiece 90.

The radiation thermometer 541 repeatedly measures the temperature of the platelike workpiece 90 at given intervals during polishing of the platelike workpiece 90 by the polishing means 13. While the measurement light 591 is being emitted from the light emitting section 511

of the thickness measuring means 15 toward the platelike workpiece 90, the reflected light 594 is also detected by the radiation thermometer 541, so that the temperature of the platelike workpiece 90 cannot be accurately measured. To avoid this problem, the radiation thermometer 541 measures the temperature of the platelike workpiece 90 with any timing shifted from the timing of measurement of the thickness of the platelike workpiece 90 by the thickness measuring means 15. As a result, the temperature of the platelike workpiece 90 can be accurately measured.

The temperature storing section 542 functions to store the temperature measured by the radiation thermometer 541. The thickness correcting section 55 functions to correct the thickness calculated by the thickness calculating section 53, according to the temperature stored by the temperature storing section 542. For example, the thickness correcting section 55 corrects the thickness calculated by the thickness calculating section 53 with the timing of measurement of the thickness of the platelike workpiece 90 by the thickness measuring means 15, by using the temperature just measured by the temperature measuring means 54 at the previous time. This temperature just measured by the temperature measuring means 54 at the previous time is stored by the temperature storing section 542.

Accordingly, although the timing of measurement of the thickness of the platelike workpiece 90 by the thickness measuring means 15 is different from the timing of measurement of the temperature of the platelike workpiece 90 by the temperature measuring means 54, the thickness calculated by the thickness calculating section 53 can be corrected.

FIG. 5 shows the relation between the temperature T of the platelike workpiece 90 and the refractive index n' of the platelike workpiece 90. As apparent from FIG. 5, there is a predetermined relation between the temperature T and the refractive index n' , depending upon the material of the platelike workpiece 90. This relation between the temperature T and the refractive index n' is preliminarily stored in the thickness correcting section 55. For example, the thickness correcting section 55 preliminarily stores a coefficient in a relationship equation expressing the relation between the temperature T and the refractive index n' or preliminarily stores a table showing the relation between the temperature T and the refractive index n' .

The thickness correcting section 55 calculates the refractive index n' at the temperature T measured by the temperature measuring means 54, according to the preliminarily stored relation between the temperature T and the refractive index n' . Further, the thickness

correcting section 55 corrects the thickness d calculated by the thickness measuring means 15, according to the refractive index n' calculated above. More specifically, the refractive index n preset in the thickness calculating section 53 is divided by the refractive index n' calculated above to obtain a correction factor α ($= n/n'$). This correction factor α is next multiplied by the thickness d calculated by the thickness calculating section 53 to obtain a corrected thickness d' ($= \alpha \cdot d$).

The control means 17 controls the feeding means 14 according to the thickness d' corrected by the thickness correcting section 55. For example, when the thickness d' reaches a desired thickness preliminarily set, the control means 17 stops the polishing operation.

In this manner, the platelike workpiece 90 is polished as measuring the thickness of the platelike workpiece 90 in real time. Further, when the thickness measured reaches a desired thickness, the polishing operation is stopped, so that the occurrence of insufficient polishing or excessive polishing can be prevented. Further, by taking into consideration a change in refractive index caused by a temperature rise of the platelike workpiece 90 due to a processing heat, the thickness of the platelike workpiece 90 can be accurately measured.

Preferably, the control means 17 controls the

feeding means 14 so that the temperature T measured by the temperature measuring means 54 becomes a set temperature T_0 preliminarily set, thereby moving the polishing means 13 toward or away from the chuck table 12 to change a pressure applied from the polishing pad 70 to the platelike workpiece 90. When the polishing means 13 is moved toward the chuck table 12 in the $-Z$ direction during polishing, the polishing pad 70 is strongly pressed on the platelike workpiece 90 to thereby increase the polishing pressure. As a result, the processing heat due to friction is increased to cause an increase in temperature of the platelike workpiece 90. Conversely, when the polishing means 13 is moved away from the chuck table 12 in the $+Z$ direction during polishing, the polishing pressure is decreased. As a result, the processing heat due to friction is decreased to cause a decrease in temperature of the platelike workpiece 90.

For example, in the case that the temperature T measured by the temperature measuring means 54 is lower than the set temperature T_0 , the control means 17 moves the polishing means 13 in the $-Z$ direction to increase the polishing pressure, thereby increasing the temperature of the platelike workpiece 90. Conversely, in the case that the temperature T measured by the temperature measuring means 54 is higher than the set temperature T_0 , the control means 17 moves the polishing

means 13 in the +Z direction to decrease the polishing pressure, thereby decreasing the temperature of the platelike workpiece 90. Thusly, the temperature of the platelike workpiece 90 can be maintained at a substantially constant temperature.

Every time the thickness calculating section 53 calculates the thickness of the platelike workpiece 90, the thickness correcting section 55 corrects the thickness calculated by the thickness calculating section 53. Accordingly, the thickness of the platelike workpiece during polishing can be managed without a reduction in polishing efficiency.

The control means 17 may change the set temperature T_0 according to processing conditions. For example, in the case of intending to increase a processing speed, the control means 17 increases the set temperature T_0 . Accordingly, the polishing pressure is increased to cause an increase in processing speed. Further, in the case of intending to clean the polished surface, the control means 17 decreases the set temperature T_0 . Accordingly, the polishing pressure is decreased to clean the polished surface. In this manner, the processing conditions can be changed by monitoring the processing temperature.

Further, in the case that the polishing pad is smaller in diameter than the platelike workpiece and the upper surface of the platelike workpiece is therefore

exposed to the outside of the polishing pad during polishing, the measurement light from the thickness measuring means may be applied to an exposed portion of the platelike workpiece exposed to the outside of the polishing pad, thereby measuring the thickness of the platelike workpiece. In this case, the through hole of the rotating shaft of the polishing means and the through hole of the polishing pad may not be formed.

The present invention is not limited to the details of the above described preferred embodiment. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A polishing apparatus comprising:

a chuck table for holding a platelike workpiece having an upper surface and a lower surface;

polishing means having a rotatable polishing pad for polishing said platelike workpiece held on said chuck table;

feeding means for moving said polishing means toward and away from said chuck table;

slurry supplying means for supplying a slurry to a contact surface between said polishing pad and said platelike workpiece;

thickness measuring means for measuring the thickness of said platelike workpiece in the condition where said platelike workpiece held on said chuck table is being polished by said polishing means;

temperature measuring means for measuring the temperature of said platelike workpiece in the condition where said platelike workpiece held on said chuck table is being polished by said polishing means; and

a thickness correcting section for correcting the thickness measured by said thickness measuring means, according to the temperature measured by said temperature measuring means;

said polishing means including

a spindle,

a mount connected to one end of said spindle
for mounting said polishing pad thereon, and

rotating means for rotating said spindle;

said thickness measuring means including

a light emitting section for emitting
measurement light to said platelike workpiece held on
said chuck table,

a photodetecting section for detecting
reflected light obtained by the reflection of said
measurement light from said platelike workpiece, and

a thickness calculating section for
calculating an optical path difference between light
reflected from the upper surface of said platelike
workpiece and light reflected from the lower surface of
said platelike workpiece, according to said reflected
light detected by said photodetecting section, thereby
calculating the thickness of said platelike workpiece;

said temperature measuring means including

a radiation thermometer for detecting
infrared light radiated from said platelike workpiece,
thereby measuring the temperature of said platelike
workpiece, and

a temperature storing section for storing
the temperature measured by said radiation thermometer;

said thickness correcting section calculating the
refractive index of said platelike workpiece at the

temperature stored by said temperature storing section, according to the relation between the temperature and refractive index of said platelike workpiece, and next correcting the thickness calculated by said thickness calculating section, according to said refractive index calculated above;

said platelike workpiece being polished as being measured the thickness of said platelike workpiece.

2. The polishing apparatus according to claim 1, further comprising

control means for controlling said feeding means so that the temperature measured by said temperature measuring means becomes a set temperature preliminarily set, thereby moving said polishing means toward or away from said chuck table to change a pressure applied from said polishing pad to said platelike workpiece.