

SUBSTRATE POLISHER AND POLISHING METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2017-031243, filed on February 22, 2017, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

[0001] The present invention relates to a substrate polisher and polishing method.

BACKGROUND ART

[0002] In recent years, a processing apparatus is used to perform a variety of types of processing on a process target object (for example, semiconductor substrate and other substrates or a variety of films formed on a surface of a substrate). An example of the processing apparatus may include a CMP (chemical mechanical polishing) apparatus for polishing or otherwise processing a process target object.

[0003] A CMP apparatus includes a polishing unit for polishing a process target object, a cleaning unit for cleaning and drying the process target object, a loading/unloading unit that transfers the process target object to the polishing unit and receives the process target object having been cleaned and dried by the cleaning unit, and other units. The CMP apparatus further includes a transport mechanism that transports the process target object in each of the polishing unit, the cleaning unit, and the loading/unloading unit. The CMP apparatus sequentially performs the polishing, cleaning, and drying with the process target object transported by the transport mechanism.

[0004] The precision requirement in each step in semiconductor device manufacture these days has already reached a level of several nanometers, and CMP is no exception. To satisfy the requirement, polishing and cleaning conditions are optimized in CMP. Even when optimum conditions are determined, however, there are inevitable changes in polishing

and cleaning performance due to variations in component control and changes in consumable materials over time. Further, there is also a variation in a semiconductor substrate itself, which is the process target object. There are, for example, pre-CMP variations in the thickness of a film formed on the process target object and in the shape of a device. These variations manifest themselves in the form of a variation in residual film and incomplete step elimination during CMP and after CMP and further in the form of a remaining film in polishing of a film that should be completely removed in the first place. These variations occur on a chip basis and across the chips on one substrate and further occur on a substrate basis and on a lot basis. At present, to cause each of these variations to be smaller than or equal to a certain threshold, remedies include controlling a polishing condition imposed on a substrate being polished and a substrate before polishing (for example, distribution of pressure applied onto substrate during polishing, number of revolutions of substrate holding stage, and slurry) and/or reworking (re-polishing) a substrate having any of the variations greater than the threshold.

[0005] However, since the aforementioned variation suppressing effect provided by setting a polishing condition is effective primarily in the radial direction of a substrate, it is difficult to adjust the variations in the circumferential direction of the substrate. Further, depending on the processing condition in the CMP process and the state of the layer below the film to be polished, the local on-substrate polishing amount distribution varies in some cases. Moreover, as for the control of the polishing distribution in the radial direction of a substrate in the CMP step, the device region on the substrate surface has been increasing from the viewpoint of improvement in the yield these days, and it is therefore necessary to adjust the polishing distribution even in a portion closer to the edge of the substrate. The influence of variations in the polishing pressure distribution and the amount of flow-in slurry, which is a polishing material, is greater in an edge portion of a substrate than at the center of the substrate and in the vicinity thereof. The polishing unit, which performs CPM, basically controls the polishing and cleaning conditions and performs reworking. In this process, a polishing pad is in contact with the entire surface of the substrate in many cases, and even in

a case where part of the polishing pad is in contact with the substrate, the area where the polishing pad is in contact with the substrate inevitably needs to be a large area from the viewpoint of maintaining the processing rate. In this situation, for example, in a case where a variation greater than a threshold occurs in a specific region of the substrate surface, the variation is corrected, for example, by reworking, but a portion that requires no reworking is undesirably polished due to the size of the contact area. As a result, it is difficult to correct the variation to a value smaller than or equal to a threshold required in the first place. It is therefore required to provide a method and an apparatus that has a configuration capable of controlling the polishing and cleaning states of a smaller region and allows control of the processing condition, reworking, and other types of re-processing to be performed on an arbitrary position on the substrate surface.

[0006] Fig. 20 shows a schematic configuration of an example of a partial polisher 1000 for polishing a process target object by using a polishing pad having a diameter smaller than the diameter of the process target object. The partial polisher 1000 shown in Fig. 20 uses a polishing pad 502 having a diameter smaller than the diameter of a substrate Wf, which is the process target object. The partial polisher 1000 includes a stage 400, on which the substrate Wf is placed, a polishing head 500, to which the polishing pad 502 for processing a processed surface of the substrate Wf is attached, an arm 600, which holds the polishing head 500, a processing liquid supply system 700 for supplying a processing liquid, and a conditioner 800 for conditioning (dressing) the polishing pad 502, as shown in Fig. 20. The overall action of the partial polisher 1000 is controlled by a controller 900. The partial polisher shown in Fig. 20 can partially polish the substrate by supplying the substrate with DIW (pure water), a cleaning chemical liquid, and a polishing liquid, such as slurry, from the processing liquid supply system 700 and rotating and pressing the polishing pad 502 against the substrate.

[0007] The polishing pad 502 has a dimension smaller than the dimension of the substrate Wf, as shown in Fig. 20. The diameter Φ of the polishing pad 502 is equal to or smaller than a film thickness/shape varying region, which is a target to be processed. For

example, the diameter Φ of the polishing pad 502 is smaller than or equal to 50 mm, or the diameter Φ ranges from 10 to 30 mm. Since the greater the diameter of the polishing pad 502, the smaller the ratio of the area of the polishing pad 502 to the area of the substrate, the rate at which the substrate is polished increases. On the other hand, conversely, the smaller the diameter of the polishing pad, the higher the precision in polishing performed on a desired processed region. The reason for this is that the smaller the diameter of the polishing pad, the smaller the unit processing area.

[0008] In the partial polisher 1000 shown in Fig. 20, to partially polish the substrate Wf, the polishing pad 502 is pressed against the substrate Wf with the polishing pad 502 rotated around an axis of rotation 502A. In this process, the arm 600 may be swung in the radial direction of the substrate Wf. Further, the stage 400 may be rotated around an axis of rotation 400A. The conditioner 800 includes a dressing stage 810, which holds a dresser 820. The dressing stage 810 is rotatable around an axis of rotation 810A. In the partial polisher 1000 shown in Fig. 20, the polishing pad 502 can be conditioned by pressing the polishing pad 502 against the dresser 820 and rotating the polishing pad 502 and the dresser 820. The partial polisher 1000 shown in Fig. 20 can partially polish an arbitrary region of the substrate Wf by causing the controller 900 to control the rotating speed of the stage 400, the rotating speed of the polishing pad 502, the force at which the polishing pad 502 is pressed, the swinging speed of the arm 600, the supply of the processing liquid from the processing liquid supply system 700, the processing period, and other factors.

CITATION LIST

PATENT LITERATURE

[0009] [PTL 1] United States Patent Application Publication No. 2015/0352686

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0010] In the partial polisher 1000 shown in Fig. 20, in which the diameter of the

polishing pad 502 is smaller than the diameter of the substrate Wf, which is the process target object, when the small-diameter polishing pad 502 is rotated at the same number of revolutions as that in a CMP apparatus using a large-diameter polishing pad, the linear speed in the region where the polishing pad 502 is in contact with the substrate Wf decreases, and in turn the polishing rate decreases. To achieve a polishing rate roughly equal to that in a CMP apparatus using a large-diameter polishing pad, the small-diameter polishing pad 502 needs to be rotated at a number of revolutions much greater than that in the large-diameter CMP apparatus. In this case, however, a larger amount of polishing liquid is undesirably discharged out of the polishing pad 502 because the polishing pad 502 is rotated at a higher speed, and it is therefore difficult to supply the polishing liquid to the surface where the polishing pad 502 is in contact with the substrate Wf, undesirably resulting in a decrease in the polishing rate in some cases.

[0011] Further, in the case where the disc-shaped polishing pad 502 shown in Fig. 20 is used, since the axis of rotation of the polishing pad 502 is perpendicular to the surface of the substrate Wf, a linear speed distribution is created in the radial direction of the polishing pad 502 when the polishing pad 502 is rotated and pressed against the substrate Wf. When a linear speed distribution is created in the radial direction of the polishing pad 502, a polishing rate distribution is created in the radial direction of the polishing pad 502. The polishing rate distribution increases a variation in the shape of a unit processed mark, which corresponds to the area where the polishing pad 502 is in contact with the substrate Wf, with respect to a predetermined shape. A large variation in the shape of the unit processed mark leads to a variation in a residual film after a processed region of the substrate Wf is polished. It is therefore preferable to reduce the variation in the shape of the unit processed mark. As a solution of the problem, there is a method for reducing the variation in the shape of the unit processed mark with respect to a predetermined shape by allowing a tolerance of the contact pressure or the linear speed of the polishing pad 502 on the surface where the polishing pad 502 is in contact with the substrate Wf. To add a mechanism for allowing the method to be performed, the polishing pad 502 needs to have a large size to some extent, and it is therefore

difficult to reduce the diameter of the polishing pad 502.

[0012] An object of the present application is to provide a partial polisher capable of reducing a variation in the shape of the unit processed mark with respect to a predetermined shape.

SOLUTION TO PROBLEM

[0013] [First form]

According to a first form, a polisher for locally polishing a substrate is provided. The polisher includes a polishing member having a processing surface that comes into contact with the substrate and is smaller than the substrate, a pressing mechanism for pressing the polishing member against the substrate, a first drive mechanism for imparting motion to the polishing member in a first motion direction parallel to a surface of the substrate, a second drive mechanism for imparting motion to the polishing member in a second motion direction perpendicular to the first motion direction and having a component parallel to the surface of the substrate, and a controller for controlling an action of the polisher. The polishing member is configured such that during polishing of the substrate, arbitrary points in a region that is in contact with the substrate make motion in the same first motion direction, and the controller is configured to control actions of the first and second drive mechanisms in such a way that the polishing member locally polishes the substrate. The polisher according to the first form not only allows the substrate to make motion in the first motion direction to polish the substrate with the polishing member pressed against the substrate but allows the polishing member to move in the second motion direction to reduce a variation in the shape of processed marks.

[0014] [Second form]

According to a second form, in the polisher according to the first form, the controller is configured to change a motion speed in the first motion direction during the polishing of the substrate.

[0015] [Third form]

According to a third form, in the polisher according to the first or second form, an amount of movement in the second motion direction is smaller than or equal to a length of a second-motion-direction component of a region where the polishing member is in contact with the substrate.

[0016] [Fourth form]

According to a fourth form, the polisher according to any one of the first to third forms further includes a third drive mechanism for moving the polishing member in a radial direction of the substrate.

[0017] [Fifth form]

According to a fifth form, the polisher according to any one of the first to fourth forms further includes a stage for holding the substrate and a fourth drive mechanism for imparting the motion to the stage.

[0018] [Sixth form]

According to a sixth form, in the polisher according to the fifth form that refers to the forth form, a speed of the polishing member motion produced by the second drive mechanism and directed in the second motion direction is greater than a speed of the polishing member motion produced by the third drive mechanism and a speed of the stage motion produced by the fourth drive mechanism relative to the polishing member.

[0019] [Seventh form]

According to a seventh form, in the polisher according to the sixth form, the stage motion is any one of rotary motion, angularly pivotal motion, and linear motion.

[0020] [Eighth form]

According to an eighth form, in the polisher according to any one of the first to seventh forms, the controller is configured to include a computation section that calculates a target polishing amount in a polished region of the substrate and control the polisher in accordance with the target polishing amount calculated by the computation section.

[0021] [Ninth form]

According to a ninth form, the polisher according to any one of the first to eighth

forms further includes a conditioning member for conditioning the polishing member.

[0022] [Tenth form]

According to a tenth form, the polisher according to the ninth form further includes a fifth drive mechanism that causes the conditioning member to make motion.

[0023] [Eleventh form]

According to an eleventh form, in the polisher according to the ninth form that refers to the fifth form, the conditioning member is disposed in a position outside the stage.

[0024] [Twelfth form]

According to a twelfth form, the polisher according to any one of the first to eleventh forms further includes a liquid supply nozzle for supplying a liquid onto the substrate.

[0025] [Thirteenth form]

According to a thirteenth form, in the polisher according to the twelfth form, the liquid contains at least one of a polishing agent, water, and a cleaning chemical liquid.

[0026] [Fourteenth form]

According to a fourteenth form, in the polisher according to any one of the first to thirteenth forms, the first drive mechanism is configured to rotate the polishing member.

[0027] [Fifteenth form]

According to a fifteenth form, in the polisher according to the fourteenth form, the polishing member has a disc-like shape.

[0028] [Sixteenth form]

According to a sixteenth form, in the polisher according to the fifteenth form, the disc-shaped polishing member is disposed such that a center axis thereof is parallel to the surface of the substrate.

[0029] [Seventeenth form]

According to a seventeenth form, in the polisher according to the fourteenth form, the disc-shaped polishing member is disposed such that a center axis thereof is not parallel to the surface of the substrate.

[0030] [Eighteenth form]

According to an eighteenth form, in the polisher according to the seventeenth form, when the first drive mechanism rotates the disc-shaped polishing member, a center axis of the rotation inclines with respect to the center axis of the disc-shaped polishing member.

[0031] [Nineteenth form]

According to a nineteenth form, in the polisher according to the fourteenth form, the polishing member has a columnar shape.

[0032] [Twentieth form]

According to a twentieth form, in the polisher according to the nineteenth form, the column-shaped polishing member is disposed such that a center axis thereof is parallel to the surface of the substrate.

[0033] [Twenty-first form]

According to a twenty-first form, in the polisher according to the fourteenth form, the polishing member has a spherical shape or a shape having part of a spherical shape.

[0034] [Twenty-second form]

According to a twenty-second form, in the polisher according to the twenty-first form, the second drive mechanism is configured to cause the polishing member to make swing motion around a point located outside the polishing member.

[0035] [Twenty-third form]

According to a twenty-third form, in the polisher according to any one of the first to thirteenth forms, the polishing member has a flat-plate-like shape.

[0036] [Twenty-fourth form]

According to a twenty-fourth form, in the polisher according to the twenty-third form, the flat-plate-shaped polishing member is disposed such that a surface thereof that comes into contact with the substrate inclines with respect to the surface of the substrate.

[0037] [Twenty-fifth form]

According to a twenty-fifth form, in the polisher according to the fourteenth form, the polishing member has a conical shape or a truncated conical shape, and the conical shape

or the truncated conical shape is disposed such that a center axis thereof is parallel to the surface of the substrate.

[0038] [Twenty-sixth form]

According to a twenty-sixth form, the polisher according to any one of the fourteenth to twenty-fifth forms, the second drive mechanism is configured to cause the polishing member to make linear motion or rotary motion on the substrate.

[0039] [Twenty-seventh form]

According to a twenty-seventh form, the polisher according to any one of the first to thirteenth forms, the polishing member includes a belt member, the first drive mechanism is configured to move the belt in a longitudinal direction thereof, and the second drive mechanism is configured to move the belt in a width direction thereof.

[0040] [Twenty-eighth form]

According to a twenty-eighth form, a substrate processing system is provided, the substrate processing system includes the polisher according to any one of the first to twenty-seventh forms, a cleaner for cleaning the substrate polished by the polisher, a dryer for drying the substrate cleaned by the cleaner, and a transporter for transporting the substrate among the polisher, the cleaner, and the dryer.

[0041] [Twenty-ninth form]

According to a twenty-ninth form, the substrate processing system according to the twenty-eighth form further includes a large-diameter polisher for polishing the substrate by using a polishing member having a processing surface that comes into contact with the substrate and is larger than the substrate.

[0042] [Thirtieth form]

According to a thirtieth form, the substrate processing system according to the twenty-eighth or twenty-ninth form further includes a state detecting section for detecting a state of the surface of the substrate before and/or after processing of the substrate.

[0043] [Thirty-first form]

According to a thirty-first form, in the substrate processing system according to

the thirtieth form, the state detecting section is configured to detect an across-substrate-surface distribution of at least one of a thickness of a film formed on the surface of the substrate, a step on the surface of the substrate, and signals corresponding to the thickness and the step.

BRIEF DESCRIPTION OF DRAWINGS

[0044] Fig. 1 is a schematic view showing the configuration of a partial polisher according to an embodiment;

Fig. 2 is a schematic view showing a mechanism according to the embodiment that allows a polishing head to hold a polishing pad;

Fig. 3 is a schematic view showing the configuration of the partial polisher according to an embodiment;

Fig. 4 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 5 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 6 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 7 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 8 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 9 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 10 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 11 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 12 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 13 shows a polishing belt member that is an example of a polishing member usable in place of the polishing pad in the partial polishers shown in Figs. 1 and 3;

Fig. 14 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 15 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 16 shows an example of the polishing pad usable in the partial polishers shown in Figs. 1 and 3;

Fig. 17 shows a drive mechanism that imparts swing motion to the polishing pad shown in Fig. 16;

Fig. 18A describes the amount of movement of the polishing pad according to an embodiment in a second motion direction;

Fig. 18B describes the amount of movement of the polishing pad according to the embodiment in the second motion direction;

Fig. 18C describes the amount of movement of the polishing pad according to the embodiment in the second motion direction;

Fig. 18D describes the amount of movement of the polishing pad according to the embodiment in the second motion direction;

Fig. 18E describes the amount of movement of the polishing pad according to the embodiment in the second motion direction;

Fig. 19A describes an effect of the movement of the polishing pad in the second motion direction and the movement of a substrate in a fourth motion direction on the polishing amount according to an embodiment;

Fig. 19B describes the effect of the movement of the polishing pad in the second motion direction and the movement of the substrate in the fourth motion direction on the polishing amount according to the embodiment;

Fig. 19C describes the effect of the movement of the polishing pad in the second motion direction and the movement of the substrate in the fourth motion direction on the polishing amount according to the embodiment;

Fig. 20 shows a schematic configuration of an example of a partial polisher for polishing a process target object by using a polishing pad having a diameter smaller than the diameter of the process target object;

Fig. 21A is a schematic view for describing an example of control of the polishing using the partial polisher according to the embodiment;

Fig. 21B is a schematic view for describing an example of control of the polishing using the partial polisher according to the embodiment;

Fig. 22A shows an example of a control circuit for processing information on the thickness of a film on a substrate and irregularities and height thereof according to an embodiment;

Fig. 22B shows a circuit diagram showing a substrate surface state detecting section separated from a partial polishing controller shown in Fig. 22A; and

Fig. 23 is a schematic view showing a substrate processing system according to an embodiment that incorporates any of the partial polishers.

DESCRIPTION OF EMBODIMENTS

[0045] Embodiments of a partial polisher according to the present invention will be described below with reference to the accompanying drawings. In the accompanying drawings, the same or similar elements have the same or similar reference characters, and in the description of each of the embodiments, no redundant description of the same or similar elements will be made in some cases. Further, the features shown in each of the embodiments are applicable also to the other embodiment to the extent that the features cause no contradiction.

[0046] Fig. 1 is a schematic view showing the configuration of a partial polisher 1000 according to an embodiment. The partial polisher 1000 is configured on a base

surface 1002, as shown in Fig. 1. The partial polisher 1000 may be configured as an independent single apparatus or may be configured as a module that is part of a substrate processing system 1100 including a large-diameter polisher 1200 using a large-diameter polishing pad along with the partial polisher 1000 (see Fig. 23). The partial polisher 1000 is installed in an enclosure that is not shown. The enclosure includes an exhaust mechanism that is not shown and is configured not to expose a polishing liquid and other components to the exterior of the enclosure during polishing.

[0047] The partial polisher 1000 includes a stage 400, which holds a substrate Wf in such a way that the substrate Wf faces upward, as shown in Fig. 1. In an embodiment, the substrate Wf can be placed on the stage 400 by a transporter that is not shown. The partial polisher 1000 shown in Fig. 1 includes four lift pins 402, which are movable upward and downward, around the stage 400, and in the state in which the lift pins 402 are lifted, the substrate Wf can be received from the transporter onto the four lift pins 402. After the substrate Wf is placed on the lift pins 402, the lift pins 402 are lowered to a position where the substrate is transferred to the stage 400, and the substrate Wf is temporarily placed on the stage. The substrate Wf can therefore be positioned within a restricted region inside the four lift pins 402. In a case where higher-precision positioning is required, however, a positioning mechanism 404, which is separately provided, may position the substrate Wf in a predetermined position on the stage 400. In the embodiment shown in Fig. 1, a positioning pin (not shown) and a positioning pad 406 allow the positioning of the substrate Wf. The positioning mechanism 404 includes the positioning pad 406, which can move the substrate Wf in the plane thereof. A plurality of positioning pins (not shown) are provided on the side opposite the positioning pad 406 with respect to the stage 400. In the state in which the substrate Wf is placed on the lift pins 402, the positioning pad 406 and the positioning pins can position the substrate Wf with the positioning pad 406 pressed against the substrate Wf. Once the substrate Wf is positioned, the substrate Wf is fixed onto the stage 400, and the lift pins 402 are then lowered, whereby the substrate Wf can be placed on the stage 400. The stage 400 can be configured to fix the substrate Wf onto the stage 400 by means, for example,

of on vacuum chucking. The partial polisher 1000 includes a detection section 408. The detection section 408 is intended to detect the position of the substrate Wf placed on the stage 400. For example, the detection section 408 can detect a notch or an orientation flat formed as part of the substrate Wf or the outer circumference of the substrate to detect the position of the substrate Wf on the stage 400. Using the position of the notch or the orientation flat as a reference allows identification of an arbitrary point on the substrate Wf, allowing partial polishing of a desired region. Further, since information on the position of the outer circumference of the substrate provides information on the position of the substrate Wf on the stage 400 (amount of shift with respect to ideal position, for example), the position to which a polishing pad 502 is moved may be corrected by a controller 900 based on the information. To detach the substrate Wf from the stage 400, the lift pins 402 are moved to the position where the substrate is received from the stage 400, and the vacuum chucking via the stage 400 is then deactivated. The lift pins 402 are then further lifted to move the substrate Wf to the position where the substrate is transferred to the transporter, and the transporter that is not shown can then receive the substrate Wf on the lift pins 402. The substrate Wf can then be transported by the transporter by the transporter to an arbitrary location for subsequent processing.

[0048] The stage 400 of the partial polisher 1000 includes a rotational drive mechanism 410 and is configured to be rotatable and/or angularly pivotable around an axis of rotation 400A. The term "rotation" means continuous rotation in a fixed direction, and the term "angular pivot" means motion in the circumferential direction over a predetermined angular range (including reciprocating motion). As another embodiment, the stage 400 may include a movement mechanism that imparts linear motion to the held substrate Wf.

[0049] The partial polisher 1000 shown in Fig. 1 includes a polishing head 500. The polishing head 500 holds the polishing pad 502. Fig. 2 is a schematic view showing the mechanism that allows the polishing head 500 to hold the polishing pad 502. The polishing head 500 includes a first holding member 504 and a second holding member 506, as shown in Fig. 2. The polishing pad 502 is held between the first holding member 504 and the

second holding member 506. The first holding member 504, the polishing pad 502, and the second holding member 506 each have a disc-like shape, as shown in Fig. 2. The diameter of each of the first holding member 504 and the second holding member 506 is smaller than the diameter of the polishing pad 502. Therefore, in the state in which the polishing pad 502 is held by the first holding member 504 and the second holding member 506, the polishing pad 502 is exposed beyond the edges of the first holding member 504 and the second holding member 506. The first holding member 504, the polishing pad 502, and the second holding member 506 each have an opening at the center thereof, and a rotary shaft 510 is inserted into the openings. One or more guide pins 508, which protrude toward the polishing pad 502, are provided on a surface of the first holding member 504 facing the polishing pad 502. On the other hand, through holes are provided in the positions on the polishing pad 502 that correspond to the guide pins 508, and recesses that receive the guide pins 508 are formed in a surface of the second holding member 506 facing the polishing pad 502. Therefore, when the rotary shaft 510 rotates the first holding member 504 and the second holding member 506, the holding members 504 and 506 can be rotated integrally with the polishing pad 502 with no slip thereof.

[0050] In the embodiment shown in Fig. 1, the polishing head 500 holds the polishing pad 502 in such a way that the side surface of the disc-like shape of the polishing pad 502 faces the substrate Wf. The polishing pad 502 does not necessarily have a disc-like shape. Other shapes of the polishing pad 502 will be described later. The partial polisher 1000 shown in Fig. 1 includes a holding arm 600, which holds the polishing head 500. The holding arm 600 includes a first drive mechanism for imparting motion to the polishing pad 502 in a first motion direction with respect to the substrate Wf. The motion in the "first motion direction" used herein is motion of the polishing pad 502 for polishing the substrate Wf and is a rotary motion of the polishing pad 502 in the partial polisher 1000 in Fig. 1. The first drive mechanism can therefore be formed, for example, of a typical motor. In the portion where the polishing pad 502 is in contact with the substrate Wf, since the polishing pad 502 moves in parallel to the surface of the substrate Wf (direction of tangent to polishing

pad 502, direction x in Fig. 1), the "first motion direction," which is actually the direction of rotary motion of the polishing pad 502, can be considered as the direction of a fixed straight line.

[0051] In the partial polisher 1000 shown in Fig. 20 described above, the polishing pad 502 has a disc-like shape, and the axis of rotation of the polishing pad 502 is perpendicular to the surface of the substrate W_f . A linear speed distribution is therefore created in the radial direction of the polishing pad 502, and a polishing rate distribution is in turn created in the radial direction of the polishing pad 502. In the partial polisher 1000 shown in Fig. 20, the polishing rate distribution increases a variation in the shape of a unit processed mark, which corresponds to the area where the polishing pad 502 is in contact with the substrate W_f , with respect to a predetermined shape. In the partial polisher 1000 shown in Fig. 1, however, the axis of rotation of the polishing pad 502 is parallel to the surface of the substrate W_f , and the linear speed is constant in the region where the polishing pad 502 is in contact with the substrate W_f . Therefore, in the partial polisher 1000 according to the embodiment in Fig. 1, in the region where the polishing pad 502 is in contact with the substrate W_f , the variation in the polishing rate resulting from the linear speed distribution is smaller than the variation in the partial polisher 1000 shown in Fig. 20. Therefore, in the partial polisher 1000 in Fig. 1, the variation in the shape of the unit processed mark with respect to a predetermined shape decreases. Further, in the partial polisher 1000 shown in Fig. 1, since the axis of rotation of the polishing pad 502 is parallel to the surface of the substrate W_f , the size of a region where the polishing pad 502 is in contact with the substrate W_f can be readily reduced to a very small size, unlike in the partial polisher 1000 shown in Fig. 20. When the size of the region where the polishing pad 502 is in contact with the substrate W_f can be reduced to a very small size, for example, increasing the diameter of the polishing pad 502 allows an increase in the relative linear speed between the polishing pad 502 and the substrate W_f , and the polishing rate can in turn be increased. The region where the polishing pad 502 is in contact with the substrate W_f is determined by the diameter and thickness of the polishing pad 502. As an example, any value of the diameter Φ of the polishing pad 502 ranging from about

50 to 300 mm and any value of the thickness of the polishing pad 502 ranging from about 1 to 10 mm may be used in combination.

[0052] As an embodiment, the first drive mechanism can change the rotational speed of the polishing pad 502 during polishing. Changing the rotational speed allows adjustment of the polishing rate. Therefore, even in a case where a large polishing amount is required in a processed region of the substrate Wf, the polishing can be efficiently performed. Further, for example, even in a case where the polishing pad 502 wears by a large amount during polishing and the diameter of the polishing pad 502 therefore changes, the adjustment of the rotational speed allows the polishing rate to be maintained. In the embodiment shown in Fig. 1, the first drive mechanism imparts rotary motion to the disc-shaped polishing pad 502, but in another embodiment, the polishing pad 502 can have another shape, and the first drive mechanism can be configured to impart linear motion to the polishing pad 502. It is noted that the linear motion includes a linear reciprocating motion.

[0053] The partial polisher 1000 shown in Fig. 1 includes a vertical drive mechanism 602 for moving the holding arm 600 in the direction perpendicular to the surface of the substrate Wf (direction z in Fig. 1). The vertical drive mechanism 602 can move the polishing head 500 and the polishing pad 502 along with the holding arm 600 in the direction perpendicular to the surface of the substrate Wf. The vertical drive mechanism 602 also functions as a pressing mechanism for pressing the polishing pad 502 against the substrate Wf when the substrate Wf is partially polished. In the embodiment shown in Fig. 1, the vertical drive mechanism 602 is a mechanism using a motor and a ball screw, but as another embodiment, the vertical drive mechanism 602 may be a drive mechanism using air pressure or liquid pressure or a drive mechanism using a spring. Further, as an embodiment, a drive mechanism for coarse motion and a drive mechanism for fine motion different from each other may be used as the vertical drive mechanism 602 for the polishing head 500. For example, the drive mechanism for coarse motion can be a drive mechanism using a motor, and the drive mechanism for fine motion, which presses the polishing pad 502 against the substrate Wf, can be a drive mechanism using an air cylinder. In this case, adjusting the air

pressure in the air cylinder while monitoring the pressing force exerted by the polishing pad 502 allows controlling the pressing force exerted by the polishing pad 502 on the substrate Wf. Conversely, an air cylinder may be used as the drive mechanism for coarse motion, and a motor may be used as the drive mechanism for fine motion. In this case, controlling the motor while monitoring the torque provided by the motor for fine motion allows controlling the pressing force exerted by the polishing pad 502 on the substrate Wf. A piezoelectric element may be used as another driver mechanism, and voltage applied to the piezoelectric element can be used to adjust the amount of movement. In the case where the vertical drive mechanism 602 is separated into the drive mechanism for coarse motion and the drive mechanism for fine motion, the drive mechanism for fine motion may be provided in a position where the holding arm 600 holds the polishing pad 502, that is, the front end of the holding arm 600 in the example in Fig. 1.

[0054] The partial polisher 1000 shown in Fig. 1 includes a lateral drive mechanism 620 for moving the holding arm 600 in the lateral direction (direction y in Fig. 1). The lateral drive mechanism 620 can move the polishing head 500 and the polishing pad 502 along with the arm 600 in the lateral direction. The lateral direction (direction y) is a second motion direction perpendicular to the first motion direction described above and parallel to the surface of the substrate. The partial polisher 1000 can therefore further homogenize the shapes of the processed marks on the substrate Wf by moving the polishing pad 502 in the first motion direction (direction x) to polish the substrate Wf and causing the polishing pad 502 to make motion in the second motion direction (direction y) perpendicular to the first motion direction at the same time. As described above, in the partial polisher 1000 shown in Fig. 1, in the region where the polishing pad 502 is in contact with the substrate Wf, the linear speed is constant. However, if the state in which the polishing pad 502 is in contact with the substrate is not uniform due to unevenness of the shape and material of the polishing pad 502, the shape of each processed mark on the substrate Wf varies, particularly, the polishing rate varies in the direction perpendicular to the first motion direction on the surface where the polishing pad 502 is in contact with the substrate Wf.

However, causing the polishing pad 502 during polishing to make motion in the direction perpendicular to the first motion direction allows reduction in the polishing variation, whereby the shapes of the processed marks can be more homogenized. In the embodiment shown in Fig. 1, the vertical drive mechanism 602 is a mechanism using a motor and a ball screw. In the embodiment shown in Fig. 1, the lateral drive mechanism 620 is configured to move the holding arm 600 by moving the vertical drive mechanism 602 as a whole. The second motion direction is not necessarily exactly perpendicular to the first motion direction but may be a direction having a component perpendicular to the first motion direction. Also in the latter case, the effect of homogenizing the shapes of the processed marks can be provided.

[0055] The partial polisher 1000 according to the embodiment shown in Fig. 1 includes a polishing liquid supply nozzle 702. The polishing liquid supply nozzle 702 is fluidly connected to a supply source 710 (see Fig. 20), which supplies the processing liquid, for example, slurry. In the partial polisher 1000 according to the embodiment shown in Fig. 1, the polishing liquid supply nozzle 702 is held by the holding arm 600. The polishing liquid can therefore be efficiently supplied only to a polished region on the substrate Wf via the polishing liquid supply nozzle 702.

[0056] The partial polisher 1000 according to the embodiment shown in Fig. 1 includes a cleaning mechanism 200 for cleaning the substrate Wf. In the embodiment shown in Fig. 1, the cleaning mechanism 200 includes a cleaning head 202, a cleaning member 204, a cleaning head holding arm 206, and a rinse nozzle 208. The cleaning member 204 is a member for cleaning the partially polished substrate Wf with the rotated cleaning member 204 being in contact with the substrate Wf. The cleaning member 204 can be formed of a PVA sponge as an embodiment. The cleaning member 204 can instead include a cleaning nozzle for achieving mega-sonic cleaning, high-pressure water cleaning, or two-fluid cleaning in place of or in addition to the PVA sponge. The cleaning member 204 is held by the cleaning head 202. The cleaning head 202 is held by the cleaning head holding arm 206. The cleaning head holding arm 206 includes a drive mechanism for rotating the cleaning

head 202 and the cleaning member 204. The drive mechanism can be formed, for example, of a motor. The cleaning head holding arm 206 further includes a swing mechanism for swinging the cleaning head 202 and the cleaning member 204 in the plane of the substrate Wf. The cleaning mechanism 200 includes the rinse nozzle 208. The rinse nozzle 208 is connected to a cleaning liquid supply source that is not shown. The cleaning liquid can, for example, be pure water or a chemical liquid. In the embodiment in Fig. 1, the rinse nozzle 208 may be attached to the cleaning head holding arm 206. The rinse nozzle 208 includes a swing mechanism for swinging the rinse nozzle in the plane of Wf with the rinse nozzle 208 held by the cleaning head holding arm 206.

[0057] The partial polisher 1000 according to the embodiment shown in Fig. 1 includes a conditioner 800 for conditioning the polishing pad 502. The conditioner 800 is disposed in a position outside the stage 400. The conditioner 800 includes a dressing stage 810, which holds a dresser 820. In the embodiment in Fig. 1, the dressing stage 810 is rotatable around an axis of rotation 810A. In the partial polisher 1000 in Fig. 1, the polishing pad 502 can be conditioned by pressing the polishing pad 502 against the dresser 820 and rotating the polishing pad 502 and the dresser 820. As another embodiment, the dressing stage 810 may be configured to make linear motion (including reciprocating motion) instead of rotary motion. In the partial polisher 1000 in Fig. 1, the conditioner 800 is primarily used to condition the polishing pad 502 after completion of partial polishing at a certain point on the substrate Wf but before partial polishing at the following point or on the following substrate. The dresser 820 can be formed, for example, as (1) a diamond dresser having a surface onto which diamond particles are fixed in an electrodeposition process, (2) a diamond dresser having a surface which comes into contact with the polishing pad and on which diamond abrasive grains are entirely or partially placed, (3) a brushed dresser having a surface which comes into contact with the polishing pad and on which resin brushes are entirely or partially placed, or (4) any of the dressers described above or an arbitrary combination thereof.

[0058] The partial polisher 1000 according to the embodiment shown in Fig. 1 includes a second conditioner 850. The second conditioner 850 is intended to condition the polishing

pad 502 during polishing of the substrate Wf with the polishing pad 502. The second conditioner 850 can therefore be called an in-situ conditioner. The second conditioner 850 is held by the holding arm 600 in the vicinity of the polishing pad 502. The second conditioner 850 includes a movement mechanism for moving a conditioning member 852 in the direction in which the conditioning member 852 is pressed against the polishing pad 502. In the embodiment in Fig. 1, the conditioning member 852 is held in the vicinity of the polishing pad 502 but separate from the polishing pad 502 in the direction x and is configured to be movable by the movement mechanism in the direction x. The conditioning member 852 is configured to be capable of making rotary motion or linear motion by means of a drive mechanism that is not shown. Therefore, in the course of polishing of the substrate Wf with the polishing pad 502, the polishing pad 502 can be conditioned during the polishing of the substrate Wf by pressing the conditioning member 852 in rotary motion or any other motion against the polishing pad 502.

[0059] In the embodiment shown in Fig. 1, the partial polisher 1000 includes the controller 900. The variety of drive mechanisms of the partial polisher 1000 are connected to the controller 900, and the controller 900 can control the action of the partial polisher 1000. The controller includes a computation section that calculates a target polishing amount in a polished region of the substrate Wf. The controller 900 is configured to control the polisher in accordance with the target polishing amount calculated by the computation section. The controller 900 can be configured by installing a predetermined program in a typical computer including a storage device, a CPU, an input/output mechanism, and other components.

[0060] In an embodiment, the partial polisher 1000 may include, although not shown in Fig. 1 or 3, a state detecting section 420 (see Figs. 22A and 23B, for example) for detecting the state of the polished surface of the substrate Wf. The state detecting section can be a Wet-ITM (in-line thickness monitor) 420 by way of example. The Wet-ITM 420 can detect (measure) the distribution of the thickness of a film formed on the substrate Wf (or distribution of information on film thickness) by moving a noncontact detection head, which is present above the substrate Wf, across the entire surface of the substrate Wf. As the state

detecting section 420, a detector based on an arbitrary method other than the Wet-ITM can instead be used. For example, as a usable detection method, a noncontact detection method, such as a known eddy-current type or optical type, can be used. Still instead, a contact-type detection method may be employed. As the contact-type detection method, for example, a detection head including a probe through which current can flow is prepared, and the surface of the substrate Wf is scanned with the probe which is in contact with the substrate Wf and through which current is caused to flow. Electrical resistance detection that allows detection of a membrane resistance distribution can thus be employed. As another contact detection method, a step detection method can also be employed. In the step detection method, the surface of the substrate Wf is scanned with a probe that is in contact with the surface of the substrate Wf, and the upward and downward motion of the probe is monitored to detect the distribution of irregularities across the surface. In each of the contact-type and noncontact-type detection methods, a detected output is the film thickness or a signal corresponding to the film thickness. In the optical detection, the amount of light projected onto the surface of the substrate Wf and reflected off the surface may be detected. In addition to this, a film thickness difference may be identified based on a difference in color tone of the surface of the substrate Wf. To detect the thickness of a film on the substrate Wf, it is desirable to detect the film thickness with the substrate Wf rotated and the detector swung in the radial direction of the substrate Wf. As a result, information on the film thickness across the entire surface of the substrate Wf and information on a step and other surface states can be obtained. Further, use of the position of a notch or an orientation flat detected with the detection section 408 as a reference allows data on the film thickness and other factors to be related not only to the radial position but to the circumferential position, whereby a distribution of the film thicknesses and steps on the substrate Wf or singles relating thereto can be obtained. Further, when partial polishing is performed, the actions of the stage 400 and the holding arm 600 can be controlled based on the positional data.

[0061] The state detecting section 420 described above is connected to the controller 900, and a signal detected by the state detecting section 420 is processed by the controller 900.

The controller 900 for the detector of the state detecting section 420 may use the same hardware as that used by the controller 900 that controls the actions of the stage 400, the polishing head 500, and the holding arm 600 or may use another piece of hardware. In the case where the controller 900 that controls the actions of the stage 400, the polishing head 500, and the holding arm 600 and the controller 900 for the detector use different pieces of hardware, hardware resources used in the polishing of the substrate Wf can be different from hardware resources used in the detection of the state of the surface of the substrate Wf and the subsequent signal processing, whereby the processing can be performed at high speed as a whole.

[0062] The timing when the state detecting section 420 performs the detection can be a timing before polishing of the substrate Wf, during the polishing, and/or after the polishing. In a case where the state detecting section 420 is independently incorporated, the detecting operation before the polishing, after the polishing, and even during the polishing but between adjacent polishing actions does not interfere with the action of the holding arm 600. It is, however, noted that when the thickness of a film on the substrate Wf is detected during the processing of the substrate Wf and concurrently with the processing performed by the polishing head 500, the state detecting section 420 performs the scanning in accordance with the action of the holding arm 600 to minimize a temporal delay of the thickness of a film on the substrate Wf being processed or a signal relating to the film thickness. In the present embodiment, the state detecting section 420 is incorporated in the partial polisher 1000 to detect the state of the surface of the substrate Wf. Instead, in a case where the polishing performed by the partial polisher 1000 takes time, for example, the detecting section may be disposed as a detection unit external to the partial polisher 1000 from the viewpoint of productivity. For example, as for ITM, Wet-ITM is effective in measurement during the processing, whereas in the acquisition of the film thickness or a signal corresponding thereto before or after the processing, the ITM is not necessarily required to be incorporated in the partial polisher 1000. The ITM may be disposed in a position outside the partial polisher module, and the measurement may be performed when the substrate Wf is placed in or

removed from the partial polisher 1000. Further, the polishing end point in each polished region of the substrate Wf may be determined based on the film thickness or signals relating to the film thickness, irregularities, and height acquired by the state detecting section 420.

[0063] Fig. 21A is a schematic view for describing an example of control of the polishing using the partial polisher 1000 according to the embodiment. Fig. 21A is a schematic view of the substrate Wf viewed from above and shows an example in which portions Wf-1, where the film thickness is greater than the film thickness in the other portion Wf-2, are randomly formed. It is assumed in Fig. 21A that the polishing pad 502 has a roughly rectangular unit processed mark 503. The size of the unit processed mark 503 corresponds to the area where the polishing pad 502 is in contact with the substrate Wf. As shown in Fig. 21A, it is assumed that the portions Wf-1, where the film thickness is greater than the film thickness in the other portion Wf-2, are randomly formed on the processed surface of the substrate Wf. In this case, the controller 900 can cause the drive mechanism that drives the stage 400 to cause the substrate Wf to make angularly pivotal motion so that the polishing amount in each of the portions Wf-1, where the film on the substrate Wf is thicker, is greater than the polishing amount in the other portion Wf-2. For example, the controller 900 can grasp the position of each of the portions Wf-1, where the film on the substrate Wf is thicker, with respect to a notch, an orientation flat, or a laser marker on the substrate Wf and use the drive mechanism that drives the stage 400 to cause the substrate Wf to make angularly pivotal motion in such a way that the position falls within the range over which the polishing head 500 swings. Specifically, the partial polisher 1000 shown in Figs. 1 and 3 includes the detection section 408, which detects at least one of the notch, the orientation flat, and the laser marker on the substrate Wf, moves the polishing head 500 in the radial direction to a polishing position calculated based on the detected notch, orientation flat, or laser marker and the surface state distribution of the substrate Wf detected by the state detecting section 420, and rotates the substrate Wf on the stage 400 by an arbitrary predetermined angle. The controller 900 only needs to polish Wf-1 in a case where the Wf-2 region has a desired film thickness. In a case where both Wf-1 and

Wf-2 are polished to achieve a desired film thickness, the polishing head 500 can be controlled such that when each of the portions Wf-1, where the film on the substrate Wf is thicker, falls within the range over which the polishing head 500 swings, the number of revolutions of the polishing head 500 is greater than the number of revolutions in the other portion Wf-2. Further, the controller 900 can control the polishing head 500 in such a way that when each of the portions Wf-1, where the film on the substrate Wf is thicker, is located within the range over which the polishing head 500 swings, the force exerted by the polishing pad 502 is greater than the force in the other portion Wf-2. Further, the controller 900 can control the swing speed of the holding arm 600 in such a way that the polishing period (period for which polishing pad 502 stays) for which each of the portions Wf-1, where the film on the substrate Wf is thicker, is located within the range over which the polishing head 500 swings is longer than the polishing period in the other portion Wf-2. Further, the controller 900 can perform control so as to rotate the polishing head 500 with the stage 400 being stationary in the position where the polishing pad 502 is above each of the portions Wf-1, where the film on the substrate Wf is thicker, to polish only the portion Wf-1, where the film on the substrate Wf is thicker. As a result, the partial polisher 1000 can polish the polished surface into a flat surface by using the controller 900.

[0064] Fig. 21B is a schematic view for describing an example of control of the polishing using the partial polisher 1000. Fig. 21B is a schematic view of the substrate Wf viewed from above and shows an example in which a portion Wf-1, where the film thickness is greater than in the other portions Wf-2, is concentrically formed. It is assumed in Fig. 21B that the polishing pad 502 has the roughly rectangular unit processed mark 503. The size of the unit processed mark 503 corresponds to the area where the polishing pad 502 is in contact with the substrate Wf. As shown in Fig. 21B, it is assumed that the portion Wf-1, where the film thickness is greater than in the other portions Wf-2, is concentrically formed on the processed surface of the wafer Wf. In this case, the controller 900 performs polishing by rotating the stage 400 and moving the holding arm 600 in the radial direction of the substrate Wf at the same time. In a case where the Wf-2 regions have a desired film

thickness, only the Wf-1 region of the substrate Wf is polished. In a case where both Wf-1 and Wf-2 are polished to achieve a desired film thickness, the number of revolutions of the polishing head 500 can be controlled to be greater in Wf-1 than in Wf-2. Further, the controller 900 can control the polishing head 500 in such a way that the force exerted by the polishing pad 502 is greater in Wf-1 than in Wf-2. Further, the controller 900 can control the swing speed of the holding arm 600 in such a way that the polishing period (period for which polishing pad 502 stays) in Wf-1 is longer in Wf-1 than in Wf-2. As a result, the controller 900 allows the polished surface of the wafer Wf to be polished into a flat surface.

[0065] Fig. 22A shows an example of a control circuit for processing information on the thickness of a film on the substrate Wf and irregularities and height thereof according to an embodiment. First, a partial polishing controller combines a polishing process recipe set via an HMI (human machine interface) with parameters to determine a basic partial polishing process recipe. In this process, the partial polishing process recipe and the parameters may be downloaded from a HOST to the partial polisher 1000. A recipe server then combines the basic partial polishing process recipe with polishing process information on a process job to produce a basic partial polishing process recipe for each substrate Wf to be processed. The partial polishing recipe server combines the partial polishing process recipe for each substrate Wf to be processed, substrate surface shape data stored in a partial polishing database, and, further, data on the substrate surface shape and other factors relating to similar substrates and obtained after past partial polishing and polishing rate data on each parameter in a polishing condition acquired in advance with one another to produce a partial polishing process recipe on a substrate basis. At this point, the substrate surface shape data stored in the partial polishing database may be data on the substrate Wf measured by the partial polisher 1000 or may be data downloaded in advance from the HOST to the partial polisher 1000. The partial polishing recipe server transmits the partial polishing process recipe via the recipe server or directly to the partial polisher 1000. The partial polisher 1000 partially polishes the substrate Wf in accordance with the received partial polishing process recipe.

[0066] Fig. 22B shows a circuit diagram showing the substrate surface state detecting

section separated from the partial polishing controller shown in Fig. 22A. It can be expected by separating the substrate surface state detecting section, which handles a large amount of data, from the partial polishing controller that the data processing load on the partial polishing controller is reduced and the period for creating the process job and the processing period required for the generation of a partial polishing process recipe can be shortened, whereby the overall throughput of the partial polishing module can be improved.

[0067] Fig. 3 is a schematic view showing the configuration of the partial polisher 1000 according to an embodiment. The partial polisher 1000 shown in Fig. 3 differs from the partial polisher 1000 shown in Fig. 1 in terms of the arrangement of the polishing pad 502, the lateral drive mechanism 620, the cleaning mechanism 200, the conditioner 800, and the second conditioner 850. In the embodiment in Fig. 1, the first motion direction of the polishing pad 502 is so defined as to coincide with the direction x, whereas in the embodiment shown in Fig. 3, the first motion direction of the polishing pad 502 is so defined as to coincide with the direction y. Further, in the embodiment in Fig. 1, the lateral drive mechanism 620 is configured to move the holding arm 600 in the direction y, whereas in the embodiment in Fig. 3, the lateral drive mechanism 620 is configured to move the holding arm 600 in the direction x. In the embodiment in Fig. 1, the second conditioner 850 is so disposed as to be separate from the polishing pad 502 in the direction x, whereas in the embodiment in Fig. 3, the second conditioner 850 is so disposed as to be separate from the polishing pad 502 in the direction y and configured to be capable of moving the conditioning member 852 in the direction y. As described above, in the embodiment in Fig. 1, the first motion direction, in which the polishing pad 502 makes motion to polish the substrate Wf, coincides with the direction x, and the second motion direction, which is perpendicular to the first motion direction and parallel to the surface of the substrate, coincides with the direction y. On the other hand, in the embodiment in Fig. 3, the first motion direction, in which the polishing pad 502 makes motion to polish the substrate Wf, coincides with the direction y, and the second motion direction, which is perpendicular to the first motion direction and parallel to the surface of the substrate, coincides with the direction x. The other

configurations of the partial polisher 1000 in Fig. 3 can be the same as those of the partial polisher 1000 shown in Fig. 1 and will therefore not be described.

[0068] Fig. 4 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 4 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 4 has a disc-like shape. The center axis of the disc-shaped polishing pad 502 in Fig. 4 is parallel to the surface of the substrate Wf. The axis of rotation 502A of the polishing pad 502 in Fig. 4 coincides with the center axis thereof. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0069] Fig. 5 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 5 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 5 has a columnar shape. A polishing pad may instead be disposed on the surface where a base having a columnar shape is in contact with the substrate Wf. The material of the polishing pad may be the material used to form a commercial CMP pad. The center axis of the column-shaped polishing pad 502 in Fig. 5 is parallel to the surface of the substrate Wf. The axis of rotation 502A of the polishing pad 502 in Fig. 5 coincides with the center axis thereof. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0070] Fig. 6 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 6 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 6 has a roughly quadrangular flat-plate-like

cross-sectional shape. A polishing pad may instead be disposed on the surface where a base having a flat-plate-like shape is in contact with the substrate Wf (side surface). The material of the polishing pad may be the material used to form a commercial CMP pad. The flat-plate-shaped polishing pad 502 in Fig. 6 is so held by the polishing head 500 that one of the surfaces of the flat-plate-like shape comes into contact with the substrate Wf in parallel thereto. The polishing pad 502 in Fig. 6 is configured to make reciprocating motion in the direction parallel to the substrate Wf (first motion direction) with the polishing pad 502 being in contact with the substrate Wf. Further, the polishing pad 502 in Fig. 6 is configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0071] Fig. 7 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 7 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 7 has a disc-like shape. A polishing pad may instead be disposed on the surface where a base having a disc-like shape is in contact with the substrate Wf (side surface). The material of the polishing pad may be the material used to form a commercial CMP pad. The center axis of the disc-shaped polishing pad 502 in Fig. 7 inclines with respect to the surface of the substrate Wf. The center axis of the polishing pad 502 inclines by an angle θ with respect to a straight line parallel to the surface of the substrate Wf, as shown in Fig. 7. The axis of rotation 502A of the polishing pad 502 in Fig. 7 coincides with the center axis thereof. Since the center axis of the polishing pad 502 in Fig. 7 inclines with respect to the substrate Wf, only part of the side surface of the disc-shaped polishing pad 502 comes into contact with the substrate Wf, so that the area where the polishing pad 502 is in contact with the substrate Wf is smaller than, for example, the contact area in the case shown in Fig. 4, whereby the size of the unit processed mark 503 can be further reduced. Further, the polishing pad 502 shown in Fig. 7 is configured to be capable of making rotary motion in the first motion direction relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first

motion direction and parallel to the surface of the substrate Wf.

[0072] Fig. 8 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 8 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 8 has a roughly quadrangular flat-plate-like cross-sectional shape. A polishing pad may instead be disposed on the surface where a base having a flat-plate-like shape is in contact with the substrate Wf. The material of the polishing pad may be the material used to form a commercial CMP pad. The flat-plate-shaped polishing pad 502 in Fig. 8 is held by the polishing head 500 such that one of the edges of the flat-plate-like shape comes into contact with the substrate Wf. In other words, a surface of the flat-plate-shaped polishing pad 502 facing the substrate Wf inclines by an angle θ with respect to the surface of the substrate Wf, as shown in Fig. 8. The polishing pad 502 in Fig. 8 is configured to make reciprocating motion in the direction parallel to the substrate Wf (first motion direction) with the polishing pad 502 being in contact with the substrate Wf. The first motion direction is, for example, the direction of an edge of the polishing pad 502 that is in contact with the substrate Wf. Further, the polishing pad 502 in Fig. 8 is configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0073] Fig. 9 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 9 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 9 has a conical shape. A polishing pad may instead be disposed on the surface where a base having a conical shape is in contact with the substrate Wf. The material of the polishing pad may be the material used to form a commercial CMP pad. The center axis of the cone-shaped polishing pad 502 in Fig. 9 is parallel to the surface of the substrate Wf. The axis of rotation 502A of the polishing pad 502 in Fig. 9 coincides with the center axis thereof. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction

(direction perpendicular to plane of view of Fig. 9) relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0074] Fig. 10 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 10 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 10 has a truncated conical shape. The center axis of the truncated-cone-shaped polishing pad 502 in Fig. 10 is parallel to the surface of the substrate Wf. A polishing pad may instead be disposed on the surface where a base having a truncated conical shape is in contact with the substrate Wf. The material of the polishing pad may be the material used to form a commercial CMP pad. The axis of rotation 502A of the polishing pad 502 in Fig. 10 coincides with the center axis thereof. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction (direction perpendicular to plane of view of Fig. 10) relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0075] Fig. 11 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 11 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 11 has a spherical shape. A polishing pad may instead be disposed on the surface where a base having a spherical shape is in contact with the substrate Wf. The material of the polishing pad may be the material used to form a commercial CMP pad. The axis of rotation 502A of the sphere-shaped polishing pad 502 in Fig. 11 is parallel to the surface of the substrate Wf. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0076] Fig. 12 shows an example of the polishing pad 502 usable in the partial polishers

1000 shown in Figs. 1 and 3. It is noted that Fig. 12 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 12 is so shaped as to have part of a spherical shape. Instead, a base so shaped as to have part of a spherical shape may be used, and a polishing pad may be disposed on the surface where the base is in contact with the substrate Wf. The material of the polishing pad may be the material used to form a commercial CMP pad. The axis of rotation 502A of the polishing pad 502 in Fig. 12 is parallel to the surface of the substrate Wf. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0077] Fig. 13 shows a polishing belt member 502B, which is an example of a polishing member usable in place of the polishing pad 502 in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 13 shows only the polishing belt member 502B, a polishing belt support member 520 for causing the polishing belt member 502B to come into contact with the substrate Wf, and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing belt member 502B is made, for example, of the material used to form a commercial CMP pad. The polishing belt member 502B in Fig. 13 is movable in the longitudinal direction thereof. That is, the first motion direction coincides with the longitudinal direction of the polishing belt member 502B. The polishing belt member 502B in Fig. 13 may be movable only toward one side of the longitudinal direction thereof or toward both sides of the longitudinal direction. The polishing belt member 502B in Fig. 13 is configured to be movable along with the polishing belt support member 520 in the second motion direction perpendicular to the longitudinal direction and parallel to the surface of the substrate Wf.

[0078] Fig. 14 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 14 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of

illustration. The polishing pad 502 in Fig. 14 has a disc-like shape, as in the case of the polishing pad 502 shown in Fig. 4. The center axis of the disc-shaped polishing pad 502 in Fig. 14 is parallel to the surface of the substrate Wf. The axis of rotation 502A of the polishing pad 502 in Fig. 14 coincides with the center axis thereof. As described above, the polishing pad 502 can make rotary motion to move in the first motion direction relative to the substrate Wf. Unlike the embodiment shown in Fig. 4, the polishing pad 502 in Fig. 14 is configured to be capable of rotary motion and/or angularly pivotal motion around the point where the polishing pad 502 is in contact with the substrate Wf.

[0079] Fig. 15 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 15 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 15 has a disc-like shape. The axis of rotation 502A of the polishing pad 502 in Fig. 15 is parallel to the surface of the substrate Wf. The center axis of the disc-shaped polishing pad 502 in Fig. 15, however, inclines with respect to the surface of the substrate Wf. It can also be said that the axis of rotation 502A of the polishing pad 502 inclines by a predetermined angle θ with respect to the center axis of the polishing pad 502. Since the axis of rotation 502A of the polishing pad 502 in Fig. 15 inclines with respect to the center axis thereof, rotating the polishing pad 502 results in movement of the region where the polishing pad 502 is in contact with the substrate Wf. As a result, the polishing pad 502 in Fig. 15 can provide an effect similar to the effect provided by rotating the polishing pad 502 shown in Fig. 4 and causing the polishing pad 502 to make reciprocating motion in the second motion direction (direction of axis of rotation 502A in embodiment in Fig. 4).

[0080] Fig. 16 shows an example of the polishing pad 502 usable in the partial polishers 1000 shown in Figs. 1 and 3. It is noted that Fig. 16 shows only the polishing pad 502 and the substrate Wf in a simplified manner and the other configurations are omitted for clarity of illustration. The polishing pad 502 in Fig. 16 is so shaped as to have part of a spherical shape, as in the case of the polishing pad 502 shown in Fig. 12. The axis of rotation 502A

of the polishing pad 502 in Fig. 16 is parallel to the surface of the substrate Wf. As described above, the polishing pad 502 is configured to be capable of making rotary motion in the first motion direction (direction perpendicular to plane of view of Fig. 16) relative to the substrate Wf and further configured to be movable in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf. In the embodiment in Fig. 16, however, unlike the embodiment in Fig. 12, the movement in the second motion direction is achieved by swing motion of the polishing pad 502 around a pivotal point 522A separate from the polishing pad 502 and located thereabove. Fig. 17 shows a drive mechanism that imparts swing motion to the polishing pad 502 shown in Fig. 16. The polishing pad 502 is fixed to a rotary shaft 510, as shown in Fig. 17. The rotary shaft 510 is driven and rotated with a motor and a belt. The polishing pad 502 is held along with the rotary shaft 510 by a swinging polishing pad support member 522, as shown in Fig. 17. The swinging polishing pad support member 522 can impart, with the aid of a motor, rotary motion around the pivotal point 522A. The center axis of rotation of the swinging polishing pad support member 522 is configured to be perpendicular to the center axis of rotation of the polishing pad 502. The swing motion can therefore impart motion in the second motion direction perpendicular to the first motion direction and parallel to the surface of the substrate Wf.

[0081] In each of the partial polishers 1000 according to the embodiment described above, the first drive mechanism allows the polishing pad 502 for polishing the substrate Wf to make motion in the first motion direction. The first motion direction is the direction in which the polishing pad 502 moves in the region where the polishing pad 502 is in contact with the substrate Wf. For example, in the case where the polishing pad 502 has a disc-like shape and makes rotary motion, the first motion direction of the polishing pad 502 is the direction of a tangent to the polishing pad 502 in the region where the polishing pad 502 is in contact with the substrate Wf. Further, in each of the partial polisher 1000 according to the embodiment described above, the lateral drive mechanism 620 allows the polishing pad 502 to make motion in the second motion direction having a component perpendicular to the

first motion direction and parallel to the substrate Wf. Causing the polishing pad 502 to make motion in the second motion direction during the polishing of the substrate Wf as described above allows a further uniform shape of processed marks on the substrate Wf. The polishing pad 502 can be moved by an arbitrary amount in the second motion direction during the polishing, and the amount of movement in the second motion direction can be determined from a variety of points of view.

[0082] Figs. 18A to 18E describe the amount of movement of the polishing pad 502 in the second motion direction. Fig. 18A shows the same disc-shaped polishing pad 502 shown in Fig. 4, and the axis of rotation 502A and the center axis of the polishing pad 502 are parallel to the surface of the substrate Wf and coincide with each other. Consider a case where the disc-shaped polishing pad 502 shown in Fig. 18A is rotated to make motion in the first motion direction and the polishing pad 502 is further caused to make reciprocating motion in the second motion direction perpendicular to the first motion direction. Fig. 18B shows the polishing amount in the case where the polishing pad 502 shown in Fig. 18A is caused to make reciprocating motion in the second motion direction. The upper portion of Fig. 18B is a schematic view of the substrate Wf viewed from above and schematically shows unit processed marks 503 formed on the substrate Wf. The size of each of the unit processed marks 503 corresponds to the area where the polishing pad 502 is in contact with the substrate Wf. In the case of the disc-shaped polishing pad 502 shown in Fig. 18A, the unit processed marks 503 each have a roughly square shape or a roughly oblong shape. In the case of the sphere-shaped polishing pad 502 shown in Fig. 11 and other figures, the unit processed marks 503 each have a circular shape. The graph in the lower portion of Fig. 18B is a graph showing the polishing amount in the case where the polishing pad 502 shown in Fig. 18A is rotated and caused to make reciprocating motion at a constant speed in the second motion direction. In Fig. 18B, the amount of movement in the second motion direction is greater than the width of each of the unit processed marks 503 in the second motion direction (thickness of disc-shaped polishing pad 502). In the case where the polishing pad 502 is rotated at a constant speed and caused to make reciprocating motion in the second motion

direction at a constant speed, the polishing amount at each point on the substrate Wf is proportional to the period for which the polishing pad 502 stays on the substrate Wf, and Fig. 18B shows the polishing amount. Fig. 18C is similar to Fig. 18B, but the amount of movement of the polishing pad 502 in the second motion direction is equal to the width of each of the unit processed marks 503 in the second motion direction. Fig. 18D is similar to Fig. 18B, but the amount of movement of the polishing pad 502 in the second motion direction is smaller than the width of each of the unit processed marks 503 in the second motion direction. Fig. 18E is similar to Fig. 18B, but the amount of movement of the polishing pad 502 in the second motion direction is further smaller than the width of each of the unit processed marks 503 in the second motion direction in Fig. 18D. As described above, the amount of movement of the polishing pad 502 in the second motion direction may be set as appropriate in accordance with a necessary polishing amount. A large amount of movement of the polishing pad 502 in the second motion direction results in enlargement of the shape of a processed mark in the second motion direction and is therefore unsuitable for partial polishing of a local region in some cases. On the other hand, a small amount of movement of the polishing pad 502 in the second motion direction reduces the effect of reducing the variation in the polishing amount in the second motion direction and causes the distribution of the polishing amount in the second motion direction to have too sharp an edge portion in some cases. As an example, to reduce the size of the shape of a processed mark with the variation in the polishing amount in the second motion direction reduced, the amount of movement of the polishing pad 502 in the second motion direction can be set at a value smaller than or equal to the second-motion-direction length of the region where the polishing pad 502 is in contact with the substrate Wf.

[0083] In some of the embodiments of the partial polisher 1000 according to the present disclosure, the movement mechanism for allowing the stage 400, which holds the substrate Wf, to make rotary motion and/or linear motion, can be provided, as described above. The substrate Wf can therefore be moved during polishing of the substrate Wf. The direction of the movement of the substrate Wf is referred to as a fourth motion direction in the following

description. In this case, the speed at which the stage 400 moves the substrate Wf in the fourth motion direction is preferably set to be smaller than the moving speed of the polishing pad 502 in the second motion direction. The reason for this is that the motion of the polishing pad 502 in the second motion direction is intended to reduce a variation in the polishing amount to achieve a uniform shape of processed marks. Figs. 19A to 19C describe an effect of the movement of the polishing pad 502 in the second motion direction and the movement of the substrate Wf in the fourth motion direction on the polishing amount. Fig. 19A shows a polishing pad 502 similar to the disc-shaped polishing pad 502 shown in Fig. 4, and the axis of rotation 502A and the center axis of the polishing pad 502 are parallel to the surface of the substrate Wf and coincide with each other. Consider a case where the disc-shaped polishing pad 502 shown in Fig. 19A is rotated to make motion in the first motion direction and the polishing pad 502 is further caused to make reciprocating motion in the second motion direction perpendicular to the first motion direction. The description will be made with reference to a case where the stage 400 moves the substrate Wf in the fourth motion direction that coincides with the first motion direction. Upper portions of Figs. 19B and 19C each show the trajectory of the unit processed mark 503, which is formed on the substrate Wf by the polishing pad 502, on the substrate Wf in the situation described above. Lower portions of Figs. 19B and 19C each show a graph illustrating the polishing amount of the substrate Wf in the fourth motion direction. Fig. 19B shows a case where the speed of the substrate Wf in the fourth motion direction is greater than the speed of the polishing pad 502 in the second motion direction. In the case where the speed in the fourth motion direction is greater, the substrate Wf undesirably moves at a greater speed in the fourth motion direction than the speed of the polishing pad 502 that makes reciprocating motion in the second motion direction, resulting in an unevenness of the polishing amount in the fourth motion direction, as shown in Fig. 19B. Further, in the case where the speed in the fourth motion direction is greater, the motion in the second motion direction does not provide a large degree of effect of reducing the variation in the polishing amount. Fig. 19C shows a case where the speed of the substrate Wf in the fourth motion direction is smaller than the

speed of the polishing pad 502 in the second motion direction. In the case where the speed in the fourth motion direction is smaller, the reciprocating motion in the second motion direction causes the polishing pad 502 to pass through each point on the substrate Wf multiple times, whereby the unevenness of the polishing amount in the fourth motion direction decreases, as shown in Fig. 19C. Figs. 19A to 19C have been described with reference to the case where the motion in the fourth motion direction is achieved by the substrate Wf moved by the stage 400, but the motion in the fourth motion direction may be achieved by the polishing pad 502 moved relative to the substrate Wf in a direction different from the second motion direction. That is, the fourth motion direction used herein only needs to be a direction in which the polishing pad 502 and the substrate Wf are caused to move relative to each other in a direction different from the second motion direction described above.

[0084] Figs. 19A to 19C have been described with reference to the case where the motion in the fourth motion direction differs from the motion in the second motion direction. Instead, for example, the fourth motion direction may coincide with the second motion direction. For example, in the partial polisher 1000 shown in Fig. 1, the first motion direction of the polishing pad 502 is so defined as to be perpendicular to the circumference of the substrate Wf. In a case where polished regions distributed along the circumference of the substrate Wf are polished in this state, the stage 400 is rotated or caused to angularly pivot. In this case, the fourth motion direction of the stage 400 is perpendicular to the first motion direction of the polishing pad 502 and coincides with the second motion direction. In this case, the motion mechanism that produces the motion in the fourth motion direction may also serve as the motion mechanism that produces the motion in the second motion direction. In the partial polisher 1000 shown in Fig. 1, the first motion direction of the polishing pad 502 is so defined as to be perpendicular to the circumferential direction of the substrate Wf but only needs to have a vertical motion direction corresponding to the second motion direction and may be so defined as to incline by a constant angle, for example, 45°, with respect to the circumferential direction of the substrate Wf, that is, the fourth motion

direction.

[0085] Fig. 23 is a schematic view showing a substrate processing system 1100 according to an embodiment, which incorporates the partial polisher 1000. The substrate processing system 1100 includes the partial polisher 1000, a large-diameter polisher 1200, a cleaner 1300, a dryer 1400, the controller 900, and a transport mechanism 1500, as shown in Fig. 23. The partial polisher 1000 in the substrate processing system 1100 can be the partial polisher 1000 having any of the features described above. The large-diameter polisher 1200 is a polisher that polishes a substrate by using a polishing pad having an area greater than the area of the substrate Wf, which is a target to be polished. The large-diameter polisher 1200 can be formed of a known CMP apparatus. The cleaner 1300, the dryer 1400, and the transport mechanism 1500 can also be each an arbitrary known apparatus. The controller 900 can be configured to control the entire action of the substrate processing system 1100 as well as the action of the partial polisher 1000 described above. In the embodiment shown in Fig. 23, the partial polisher 1000 and the large-diameter polisher 1200 are incorporated in one substrate processing system 1100. Therefore, combining the partial polishing performed by the partial polisher 1000, overall polishing of the substrate Wf performed by the large-diameter polisher 1200, and detection of the state of the surface of the substrate Wf performed by the state detecting section allows a variety of types of polishing. In the partial polishing performed by the partial polisher 1000, only part of the surface of the substrate Wf instead of the entire surface thereof can be polished, or in the polishing of the entire surface of the substrate Wf performed by the partial polisher 1000, the polishing condition can be changed in part of the surface of the substrate Wf and the polishing can be performed in accordance with the changed polishing condition.

[0086] A partial polishing method carried out by the substrate processing system 1100 will be described. First, the state of the surface of the substrate Wf, which is the polishing target object, is detected. The surface state is, for example, information on the thickness of a film formed on the substrate Wf and irregularities of the surface (such as position, size, and height) and can be detected by the state detecting section 420 described

above. A polishing recipe is then created in accordance with the detected state of the surface of the substrate Wf. The polishing recipe is formed of a plurality of process steps. Parameters in the steps, for example, in the partial polisher 1000 include the processing period, the contact pressure or load exerted by the polishing pad 502 on the substrate Wf and the dresser 820 disposed on the dressing stage 810, the number of revolutions of the polishing pad 502 and the substrate Wf, the movement pattern and moving speed of the polishing head 500, the selection and flow rate of the polishing pad processing liquid, the number of revolutions of the dressing stage 810, and the polishing end point detection condition. Further, in the partial polishing, it is necessary to determine the action of the polishing head 500 on the substrate Wf based on the information on the thickness and irregularities of a film on the substrate Wf acquired by the state detecting section 420 described above. For example, as for the period for which the polishing head 500 stays in each polished region of the substrate Wf, examples of the parameters involved in the determination described above may include target values corresponding to a desired film thickness and a desired state of the irregularities and a polishing rate in the polishing condition described above. The polishing rate, which varies depending on the polishing condition, may be stored as a database in the controller 900 and may be automatically calculated when a polishing condition is set. In this case, a polishing rate for each basic parameter may be acquired in advance and stored as a database. The period for which the polishing head 500 stays on the substrate Wf can be calculated from the information on the parameters and the acquired thickness and irregularities of the film on the substrate Wf. Further, as will be described later, since the order of the pre-measurement, partial polishing, overall polishing, and cleaning varies depending on the state of the substrate Wf and the processing liquid to be used, the transport order of the components described above may be set. Further, a condition under which data on the thickness and irregularities of a film on the substrate Wf are acquired may be set. In a case where the state of the processed Wf does not reach an acceptable level, as will be described later, the polishing is required to be performed again. A processing condition (such as number of repetitions of re-polishing) in this case may be set. Partial polishing and

overall polishing are then performed in accordance with the created polishing recipe. In the present example and other examples described later, the substrate Wf can be cleaned at an arbitrary timing. For example, in a case where the processing liquid used in the partial polishing differs from the processing liquid used in the overall polishing, and contamination of the processing liquid in the partial polishing is not negligible in the overall polishing, the substrate Wf may be cleaned after each of the partial polishing and the overall polishing to prevent the contamination. Conversely, in a case where the same processing liquid is used or in a case where the contamination of the processing liquid is negligible, the substrate Wf may be cleaned after both the partial polishing and the overall polishing are performed.

[0087] The embodiments of the present invention have been described based on some examples. The inventive embodiments described above are intended to allow easy understanding of the present invention and are not intended to limit the present invention. The present invention can be changed and improved to the extent that the changes or improvements do not depart from the substance of the present invention and of course encompasses equivalents of the present invention. The components described in the claims and the specification can be arbitrarily combined with one another or any of the components can be omitted to the extent that at least part of the object described above is achieved or at least part of the effects is provided.

REFERENCE SIGNS LIST

[0088]	200	Cleaning mechanism
	208	Rinse nozzle
	400	Stage
	410	Rotational drive mechanism
	420	Stage detecting section
	500	Polishing head
	502	Polishing pad
	503	Unit processed mark

600	Holding arm
602	Vertical drive mechanism
620	Lateral drive mechanism
700	Processing liquid supply system
800	Conditioner
850	Second conditioner
852	Conditioning member
900	Controller
1000	Partial polisher
502B	Polishing belt member
Wf	Substrate

WHAT IS CLAIMED IS:

1. A polisher for locally polishing a substrate, the polisher comprising:
 - a polishing member having a processing surface that comes into contact with the substrate and is smaller than the substrate;
 - a pressing mechanism for pressing the polishing member against the substrate;
 - a first drive mechanism for imparting motion to the polishing member in a first motion direction parallel to a surface of the substrate;
 - a second drive mechanism for imparting motion to the polishing member in a second motion direction perpendicular to the first motion direction and having a component parallel to the surface of the substrate; and
 - a controller for controlling an action of the polisher,wherein the polishing member is configured such that during polishing of the substrate, arbitrary points in a region that is in contact with the substrate make motion in the same first motion direction, and
 - the controller is configured to control actions of the first and second drive mechanisms in such a way that the polishing member locally polishes the substrate,
 - wherein an amount of movement in the second motion direction is smaller than or equal to a length of a second-motion-direction component of a region where the polishing member is in contact with the substrate.
2. The polisher according to claim 1,
 - wherein the controller is configured to change a motion speed in the first motion direction during the polishing of the substrate.
3. The polisher according to any one of claims 1 to 2,
 - further comprising a third drive mechanism for moving the polishing member in a

radial direction of the substrate.

4. The polisher according to any one of claims 1 to 3,
further comprising a stage for holding the substrate; and
a fourth drive mechanism for imparting the motion to the stage.
5. The polisher according to claim 4 that refers to claim 3,
wherein a speed of the polishing member motion produced by the second drive
mechanism and directed in the second motion direction is greater than a speed of the
polishing member motion produced by the third drive mechanism and a speed of the stage
motion produced by the fourth drive mechanism relative to the polishing member.
6. The polisher according to claim 5,
wherein the stage motion is any one of rotary motion, angularly pivotal motion,
and linear motion.
7. The polisher according to any one of claims 1 to 6,
wherein the controller is configured to include a computation section that
calculates a target polishing amount in a polished region of the substrate and control the
polisher in accordance with the target polishing amount calculated by the computation
section.
8. The polisher according to any one of claims 1 to 7,
further comprising a conditioning member for conditioning the polishing
member.
9. The polisher according to claim 8,
further comprising a fifth drive mechanism that causes the conditioning member

to make motion.

10. The polisher according to claim 8 that refers to claim 4,
wherein the conditioning member is disposed in a position outside the stage.
11. The polisher according to any one of claims 1 to 10,
further comprising a liquid supply nozzle for supplying a liquid onto the
substrate.
12. The polisher according to claim 11,
wherein the liquid contains at least one of a polishing agent, water, and a cleaning
chemical liquid.
13. The polisher according to any one of claims 1 to 12,
wherein the first drive mechanism is configured to rotate the polishing member.
14. The polisher according to claim 13,
wherein the polishing member has a disc-like shape.
15. The polisher according to claim 14,
wherein the disc-shaped polishing member is disposed such that a center axis
thereof is parallel to the surface of the substrate.
16. The polisher according to claim 13,
wherein the disc-shaped polishing member is disposed such that a center axis
thereof is not parallel to the surface of the substrate.
17. The polisher according to claim 16,

wherein when the first drive mechanism rotates the disc-shaped polishing member, a center axis of the rotation inclines with respect to the center axis of the disc-shaped polishing member.

18. The polisher according to claim 13,
wherein the polishing member has a columnar shape.
19. The polisher according to claim 18,
wherein the column-shaped polishing member is disposed such that a center axis thereof is parallel to the surface of the substrate.
20. The polisher according to claim 13,
wherein the polishing member has a spherical shape or a shape having part of a spherical shape.
21. The polisher according to claim 20,
wherein the second drive mechanism is configured to cause the polishing member to make swing motion around a point located outside the polishing member.
22. The polisher according to any one of claims 1 to 12,
wherein the polishing member has a flat-plate-like shape.
23. The polisher according to claim 22,
wherein the flat-plate-shaped polishing member is disposed such that a surface thereof that comes into contact with the substrate inclines with respect to the surface of the substrate.
24. The polisher according to claim 13,

wherein the polishing member has a conical shape or a truncated conical shape,
and

the conical shape or the truncated conical shape is disposed such that a center axis thereof is parallel to the surface of the substrate.

25. The polisher according to any one of claims 13 to 24,
wherein the second drive mechanism is configured to cause the polishing member to make linear motion or rotary motion on the substrate.

26. The polisher according to any one of claims 1 to 12,
wherein the polishing member includes a belt member, and
the first drive mechanism is configured to move the belt in a longitudinal direction thereof, and the second drive mechanism is configured to move the belt in a width direction thereof.

27. A substrate processing system comprising:
the polisher according to any one of claims 1 to 26;
a cleaner for cleaning the substrate polished by the polisher;
a dryer for drying the substrate cleaned by the cleaner; and
a transporter for transporting the substrate among the polisher, the cleaner, and the dryer.

28. The substrate processing system according to claim 27,
further comprising a large-diameter polisher for polishing the substrate by using a polishing member having a processing surface that comes into contact with the substrate and is larger than the substrate.

29. The substrate processing system according to claim 27 or 28,

further comprising a state detecting section for detecting a state of the surface of the substrate before and/or after processing of the substrate.

30. The substrate processing system according to claim 29,
wherein the state detecting section is configured to detect an
across-substrate-surface distribution of at least one of a thickness of a film formed on the
surface of the substrate, a step on the surface of the substrate, and signals corresponding to
the thickness and the step.