

PAD TEMPERATURE ADJUSTMENT MECHANISM FOR ADJUSTING TEMPERATURE OF POLISHING PAD, AND POLISHING DEVICE

TECHNICAL FIELD

[0001] The present invention relates to a pad temperature adjustment mechanism for adjusting the temperature of a polishing pad, and to a polishing device.

BACKGROUND ART

[0002] In a polishing device, especially a Chemical Mechanical Polishing (CMP) device, it is known that the level of uniformity of polishing may change depending on the temperature of the polishing surface. PTL1 (JP2011-136406A) discloses a substrate polishing device equipped with a pad temperature adjustment mechanism for adjusting the temperature of the polishing surface of a polishing pad.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: JP2011-136406A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] The polishing pad of a polishing device is a consumable article and must be exchanged periodically. Further, when it is not necessary to adjust the temperature of the polishing pad, it is preferable to enable the elimination of thermal contact between the polishing pad and the pad temperature adjustment mechanism. Thus, at least one object of the present invention is to provide a pad temperature adjustment mechanism which contributes to at least one of exchange of a polishing pad and elimination of thermal contact between a polishing pad and a pad temperature adjustment means.

SOLUTION TO PROBLEM

[0005] The present application discloses, as one embodiment, a pad temperature adjustment mechanism for adjusting the temperature of a polishing pad of a polishing device, the pad temperature adjustment mechanism including: a heat conduction part for conducting

heat between the heat conduction part and the polishing pad; an arm(s) that extends from the heat conduction part, wherein a distal end of the arm is formed in a tapered shape; an arm mount(s) for installing the arm, wherein an arm guide having a tapered groove shape corresponding to the shape of the arm is formed in the arm mount; and a falling prevention member for preventing the arm from falling out of the arm guide.

BRIEF DESCRIPTION OF DRAWINGS

[0006] Fig. 1 is a front surface view of a polishing device.

Fig. 2 is a front surface cross-section view of a pad temperature adjustment mechanism.

Fig. 3 is a front surface cross-section view of the pad temperature adjustment mechanism provided with an electrical heating/cooling mechanism.

Fig. 4A is a top surface view of a pad temperature adjustment mechanism.

Fig. 4B is a front surface cross-section view of the pad temperature adjustment mechanism.

Fig. 5 is a right side surface view of a vertical movement mechanism and an arm mount.

Fig. 6 is a front surface view of a heat conduction part and an arm.

Fig. 7 is a cross-section view of the arm mount at the position of the cross-section line indicated as A-A in Fig. 5.

Fig. 8A is a top surface view of a pad temperature adjustment mechanism.

Fig. 8B is a front surface partial cross-section view of the pad temperature adjustment mechanism.

Fig. 9 is a right side surface view of a vertical movement mechanism and an arm mount.

Fig. 10 is a left side surface view of a heat conduction part and an arm.

Fig. 11 is a front surface cross-section view of the arm mount and the vertical movement mechanism.

DESCRIPTION OF EMBODIMENTS

[0007]

<First Embodiment>

In a first embodiment, a configuration in which a pad temperature adjustment mechanism 140 is detachably attached by a fixing tool such as a bolt to a vertical movement mechanism 150 will be explained. Fig. 1 is a front surface view illustrating a polishing device 100 according to the present embodiment. Herein, Fig. 1 and the other drawings are schematic views. The size, position, shape, etc. of the parts illustrated in the drawings may differ from the size, position, shape, etc. in the actual device. In the following, the left-right direction in Fig. 1 will be referred to as the X-direction (with the right side of the paper surface of Fig. 1 as the positive side), the direction perpendicular to the paper surface in Fig. 1 will be referred to as the Y-direction (with the front side of the paper surface of Fig. 1 as the positive side), and the up-down direction in Fig. 1 will be referred to as the Z-direction (with top side of the paper surface of Fig. 1 as the positive side). The polishing device 100 in Fig. 1 is a so-called “rotary-type” CMP device. However, as long as it is a device in which the temperature adjustment of the polishing pad is necessary, the polishing device 100 may be a CMP device of a type other than the rotary type, and may be a polishing device other than a CMP device. The polishing device 100 in Fig. 1 includes: a polishing table 110; a polishing head 120; a discharge mechanism 130; a pad temperature adjustment mechanism 140; and a vertical movement mechanism 150. The polishing device 100 further includes a control part 160 for controlling each element.

[0008] The polishing device 100 includes the polishing table 110. A polishing pad 111 is detachably attached to the top surface of the polishing table 110. The polishing table 110 is rotatable in at least one direction by a motor or the like (not illustrated). The polishing table 110 in Fig. 1 is rotatable in the counter clockwise direction when viewed from above.

[0009] The polishing device 100 further includes the polishing head 120. The polishing head 120 is provided above the polishing table 110 so as to oppose the polishing table 110. A substrate 121 is detachably attached to the bottom surface of the polishing head 120. The polishing head 120 is rotatable in at least one direction by a motor or the like (not illustrated).

The polishing head 120 in Fig. 1 is rotatable in the counter clockwise direction (in the same direction as the rotation direction of the polishing table 110) when viewed from above.

Further, the polishing head 120 can be moved vertically by a head vertical movement mechanism (not illustrated).

[0010] The substrate 121 will be polished by pressing the substrate 121 against the polishing pad 111 on the polishing table 110 and rotating at least one, preferably both, of the polishing table 110 and the polishing head 120.

[0011] The polishing device 100 further includes the discharge mechanism 130 for discharging a liquid such as polishing liquid, a chemical liquid, and/or a washing water toward the polishing surface. The discharge mechanism 130 in Fig. 1 includes a discharge pipe 132 that extends from a liquid supply source 131 provided near of the polishing table 110. The liquid supply source 131 may be a part that constitutes a portion of the polishing device 100. Additionally or alternatively, a liquid supply source 131 that is separate and independent from the polishing device 100 may be used. The discharge pipe 132 in Fig. 1 passes over the polishing table 110 and extends up to approximately the center portion of the polishing table 110. The polishing liquid is preferably discharged from the discharge pipe 132 during polishing of the substrate 121. The washing water is preferably discharged from the discharge pipe 132 during washing of the polishing pad 111 and/or the substrate 121. The number of the liquid supply source 131 and the discharge pipe 132 is not limited to one.

[0012] The polishing device 100 further includes the pad temperature adjustment mechanism 140 for adjusting the temperature of the polishing pad 111. The pad temperature adjustment mechanism 140 in Fig. 1 includes: a heat conduction part 141; an arm 142; and a heating/cooling mechanism 143. The heat conduction part 141 is provided on or above the polishing table 110, and is provided for conducting heat (for exchanging heat) between the heat conduction part 141 and the polishing pad 111. The arm 142 extends from the heat conduction part 141 toward the vertical movement mechanism 150. Further, the arm 142 is detachably fixed to the vertical movement mechanism 150. The heating/cooling mechanism 143 is a mechanism for heating and/or cooling the heat conduction part 141. The

heating/cooling mechanism 143 in Fig. 1 includes a heat medium flow passage 145 for a heat medium that is supplied from a heat medium source 144. The heat medium source 144 may be a part that constitutes a portion of the polishing device 100. Additionally or alternatively, a heat medium source 144 that is separate and independent from the polishing device 100 may be used. The heat medium that is supplied from the heat medium source 144 may be a heat medium for heating or a heat medium for cooling. As the heat medium, for example, water may be used. The heat medium source 144 may include a heater and/or a cooler (not illustrated) for heating and/or cooling the heat medium. Additionally or alternatively, the heat medium source 144 may be configured so as to retain a heat medium that has already been heated and/or cooled. The heat medium source 144 may include a pump (not illustrated) for flowing the heat medium toward the heat medium flow passage.

[0013] The heat medium flow passage 145 is provide to the inside of the heat conduction part 141. Therefore, the heat conduction part 141 is heated and/or cooled by flowing the heat medium from the heat medium source 144 to the heat medium flow passage 145. The number of the heat medium source 144 and the heat medium flow passage 145 is not limited to one. For example, as the heat medium source 144, a first heat medium source 144 that supplies hot water and a second heat medium source 144 that supplies cold water may be provided. If a plurality of the heat medium sources 144 are provided, one heat medium flow passage 145 may be connected to each heat medium source 144. The plurality of heat medium sources 144 may also share a single heat medium flow passage 145. Further, a plurality of heat medium flow passages 145 may be connected to one heat medium source 144.

[0014] In the case that a “raising mechanism (refer to PTL1)” for retracting the pad temperature adjustment mechanism 140 is added to the configuration of Fig. 1, the pad temperature adjustment mechanism 140 and the discharge mechanism 130 may collide during retraction of the pad temperature adjustment mechanism 140. Therefore, in the configuration of Fig. 1, it is difficult to exchange the polishing pad 111 and/or to eliminate thermal contact between the polishing pad 111 and the pad temperature adjustment mechanism 140 by using a “raising mechanism”. Note that, depending on the configuration

of the polishing device 100, a part other than the discharge mechanism 130 may collide with or interfere with the pad temperature adjustment mechanism 140.

[0015] Thus, the polishing device 100 in Fig. 1 includes the vertical movement mechanism 150 for vertically moving at least a portion of the pad temperature adjustment mechanism 140. More specifically, the vertical movement mechanism 150 is configured so as to vertically move at least the arm 142 and the heat conduction part 141. The vertical movement mechanism 150 is detachably fixed to the arm 142. In the example of Fig. 1, the arm 142 is fixed to the vertical movement mechanism 150 by a fixing tool 151. For the convenience of illustration, Fig. 1 illustrates the fixing tool 151 in a removed state. As an example of the fixing tool 151, mention may be made of a bolt. The vertical movement mechanism 150 may be configured to vertically move the heat medium source 144. Additionally or alternatively, the heat medium flow passage 145 may be formed from a flexible member (for example, bellows, or a tube that is at least partially made of an elastic body or flexible member (a tube made of rubber or resin, etc.)), and the vertical movement mechanism 150 may be configured so as not to vertically move the heat medium source 144.

[0016] When it is necessary to adjust the temperature of the polishing pad 111, the control part 160 controls the vertical movement mechanism 150 such that the heat conduction part 141 and the polishing pad 111 thermally contact each other. In other words, the vertical movement mechanism 150 lowers the heat conduction part 141 until the heat conduction part 141 contacts the polishing pad 111. In the state in which the heat conduction part 141 and the polishing pad 111 are in contact, the control part 160 controls the flow rate and/or temperature of the heat medium, and thereby the temperature of the polishing pad 111 is adjusted.

[0017] When it is not necessary to adjust the temperature of the polishing pad 111, the control part 160 controls the vertical movement mechanism 150 so that the heat conduction part 141 and the polishing pad 111 no longer thermally contact each other. In other words, the vertical movement mechanism 150 raises the heat conduction part 141 until the heat conduction part 141 no longer contacts the polishing pad 111. Additionally or alternatively,

when it is not necessary to adjust the temperature of the polishing pad 111, control of the heat medium by the control part 160 may be stopped.

[0018] When it is necessary to exchange the polishing pad 111, the control part 160 controls the vertical movement mechanism 150 so that a sufficient gap is formed between the heat conduction part 141 and the polishing pad 111. In other words, the vertical movement mechanism 150 raises the heat conduction part 141 until a sufficient gap is formed between the heat conduction part 141 and the polishing pad 111. When it is necessary to exchange the polishing pad 111, a user may release the fixation by the fixing tool 151 and remove the pad temperature adjustment mechanism 140. The pad temperature adjustment mechanism 140 which has been removed may be stored outside of the polishing device 100. Within the polishing device 100, a mechanism for storing the pad temperature adjustment mechanism 140 which has been removed may be provided. By raising the heat conduction part 141 or removing the heat conduction part 141, the space necessary for exchanging the polishing pad 111 can be secured. In order to facilitate the peeling of the polishing pad 111 from the polishing table 110, the top surface of the polishing table 110 is preferably coated with a material having a low coefficient of friction (for example, Teflon).

[0019] Configuring the pad temperature adjustment mechanism 140 to be detachable is advantageous in that it becomes easy to clean the pad temperature adjustment mechanism 140, especially the heat conduction part 141. The polishing liquid may adhere or become fixed to the pad temperature adjustment mechanism 140, especially to the heat conduction part 141, and thus the ease of cleaning is important.

[0020] The pad temperature adjustment mechanism 140 will now be explained in detail using Fig. 2. Fig. 2 is a front surface cross-section view of the pad temperature adjustment mechanism 140. Fig. 2 also illustrates the vertical movement mechanism 150 that is connected to the pad temperature adjustment mechanism 140.

[0021] The heat medium flow passage 145 in Fig. 2 is configured to supply the heat medium from the heat medium source 144, and to collect the heat medium that was supplied. By configuring the heat medium flow passage 145 as shown in Fig. 2 so as to circulate the

heat medium within the heat conduction part 141, the heat conduction part 141 can be stably heated and/or cooled. The heat medium collected by the heat medium flow passage 145 may be heated and/or cooled for reuse, or may be discarded. The heat medium flow passage 145 preferably occupies at least 30% of the volume of the heat conduction part 141, more preferably at least 40% of the volume, and most preferably at least 50% of the volume.

[0022] An uneven structure 200 is preferably formed on the bottom surface of the heat conduction part 141, i.e. on the portion of the heat conduction part 141 that contacts the polishing pad 111. If the bottom surface of the heat conduction part 141 is completely flat, the heat conduction part 141 may become adhered to the polishing pad 111 due to the surface tension of the liquid (the polishing liquid or the washing water, etc.) between the heat conduction part 141 and the polishing pad 111. On the other hand, if the bottom surface of the heat conduction part 141 is completely flat, the heat can be efficiently conducted. Further, if the bottom surface of the heat conduction part 141 is completely flat, there are no recesses, and thus byproducts generated by the polishing do not accumulate in such recesses. In addition, if a heat conduction part 141 having no recesses is used, the flow of the polishing liquid does not become disturbed due to the polishing liquid passing through the recesses.

[0023] Instead of configuring the bottom surface of the heat conduction part 141 to be flat, providing the uneven structure 200 to the bottom surface of the heat conduction part 141 can prevent adhesion of the heat conduction part 141 to the polishing pad 111. Further, by providing the uneven structure 200, chattering between the heat conduction part 141 and the polishing pad 111 can be prevented. It is preferable to determine whether to configure the bottom surface of the heat conduction part 141 to be flat or to provide the uneven structure 200 to the bottom surface of the heat conduction part 141 upon taking into account the degree of adhesion of the heat conduction part 141, the heat conduction efficiency from the heat conduction part 141, and the like. In the case that the uneven structure 200 is provided, the region to which the uneven structure 200 is provided and the specific structure of the uneven structure 200 are appropriately determined based on the necessary heat conduction efficiency and the like.

[0024] The polishing device 100 preferably includes a sensor 210 for detecting that the arm 142 and the vertical movement mechanism 150 are correctly fixed to each other. The sensor 210 may be controlled by the control part 160 (not illustrated in Fig. 2). In Fig. 2, as the sensor 210, a proximity sensor is provided between the arm 142 and the vertical movement mechanism 150. As another example, a microswitch, an optical sensor, and a camera, etc. can be used. Due to the sensor 210, the substrate 121 can be prevented from being polished in a state in which the pad temperature adjustment mechanism 140 has been removed or a state in which the pad temperature adjustment mechanism 140 is not correctly attached.

[0025] A heating/cooling mechanism 143 of another configuration may also be used. Fig. 3 is a front surface cross-section view of the pad temperature adjustment mechanism 140 provided with an electrical heating/cooling mechanism 143. The heating/cooling mechanism 143 in Fig. 3 includes a heater 300 and a cooler 310. The heater 300 and the cooler 310 are provided to the inside of the heat conduction part 141. Further, the heater 300 and the cooler 310 are connected to a power source 320. The power source 320 may be a part that constitutes a portion of the polishing device 100. Additionally or alternatively, a power source 320 that is separate and independent from the polishing device 100 may be used. The heating/cooling mechanism 143 may include only the heater 300 or only the cooler 310.

[0026] A heating/cooling mechanism 143 in which the configuration of Fig. 2 and the configuration of Fig. 3 are combined may also be used. For example, a heating/cooling mechanism 143 including the heat medium flow passage 145, which is connected to the heat medium source 144 that supplies cold water, and the heater 300 can be used.

[0027]

<Second Embodiment>

In a second embodiment, a configuration in which the heat conduction part 141 can be easily attached/detached will be explained. This embodiment will be explained referring to Figs. 4, 5, and 6. Fig. 4 illustrates a pad temperature adjustment mechanism 140 according to the present embodiment. Fig. 4A is a top surface view of the pad temperature adjustment

mechanism 140. Fig. 4B is a front surface cross-section view of the pad temperature adjustment mechanism 140. Fig. 4B also illustrates a vertical movement mechanism 150. Fig. 5 is a right side surface view of the vertical movement mechanism 150 and an arm mount 400 according to the present embodiment. Fig. 6 is a front surface view of a heat conduction part 141 and an arm 142 according to the present embodiment. The arrangement pattern of the heating/cooling mechanism 143 on the inside of the heat conduction part 141 shown in Fig. 4 is one example, and any other arrangement pattern may be used.

[0028] The pad temperature adjustment mechanism 140 according to the present embodiment includes the heat conduction part 141 and two arms 142, as well as the arm mount 400. The arm mount 400 is fixed to the vertical movement mechanism 150. The arm mount 400 is provided for installing (mounting) the arms 142. The arm mount 400 is provided with arm guides 410 in a number (two in this embodiment) corresponding to the number of arms 142. The user can insert the arms 142 into the arm mount 400 along the arm guides 410, and can pull out the arms 142 from the arm mount 400. The arm guides 410 according to the present embodiment have a groove-shaped structure. The number of arms 142 is not limited to two, and one arm or three or more arms may be used. The number of arm guides 410 is preferably the same as the number of arms 142. However, the number of arm guides 410 may be different than the number of arms 142.

[0029] Each arm 142 is installed in the arm mount 400 by a plunger 420. When the arm 142 has been inserted into the arm mount 400, a pin of the plunger 420 is engaged with a plunger hole 430 provided to the arm 142. The number, size, position, etc. of the plunger 420 and the plunger hole 430 may be designed as appropriate. Each arm 142 is preferably provided with a plunger guide 440 for guiding the pin of the plunger 420 to the plunger hole 430. The plunger guide 440 in the present embodiment is a groove that becomes shallower approaching the plunger hole 430.

[0030] The user inserts the arms 142 along the arm guides 410 until the pins of the plungers 420 engage with the plunger holes 430, and thereby the heat conduction part 141 is attached to the vertical movement mechanism 150. The arms 142 may be inserted

automatically by some kind of conveyance mechanism. In the present embodiment, the heat conduction part 141 can be easily attached to the vertical movement mechanism 150 without requiring the labor of screwing or the like.

[0031] The plungers 420 may be configured such that the engagement between the pin of the plunger 420 and the plunger hole 430 can be released by, for example, pulling the head part of the plunger 420. The heat conduction part 141 is removed from the vertical movement mechanism 150 by pulling out the arms 142 from the arm mount 400 in a state in which the engagement between the pins of the plungers 420 and the plunger holes 430 has been released. In order to maintain the state in which the engagement between the pins of the plungers 420 and the plunger holes 430 has been released, the plungers 420 preferably include a lock mechanism. In the present embodiment, the heat conduction part 141 can be easily removed from the vertical movement mechanism 150 without requiring the labor of unscrewing or the like.

[0032] Each arm 142 is preferably provided with a handle 450 for facilitating the insertion and pulling out of the arm 142. The handle 450 may be provided to the heat conduction part 141 as long as it does not obstruct the polishing of the substrate 121 and the temperature adjustment of the polishing pad 111. The arm mount 400 is preferably provided with a spring 460 for assisting in the pulling out of the arms 142. The spring 460 may be provided to each arm 142. The spring 460 is provided so as to push the arms 142 in the direction in which the arms 142 are pulled out (toward the positive side in the X-direction in Fig. 4). The user can easily pull out the arms 142 due to the pushing force generated by the spring 460. For the convenience of illustration, the spring 460 is illustrated in a contracted state.

[0033] A coupling element (in this case two coupling elements) 470 is provided to the arm mount 400. In the illustrated example, the heat medium source 144 and the heat medium flow passage 145 are detachably connected by the coupling elements 470 for fluid. When attaching the heat conduction part 141, the distal ends of the heat medium flow passage 145 are inserted into the coupling elements 470. In the case that the heat medium is a fluid, the

heat medium flow passage 145 and the coupling elements 470 are preferably sealed by a one-touch joint, an O-ring, a metal seal, etc. In the case that the heat medium is a fluid, a check valve (not illustrated) may be provided to each coupling element 470. Additionally or alternatively, the check valve may be provided to a part other than the coupling elements 470, such as the distal ends of the heat medium flow passage 145. By providing a check valve, fluid remaining within the parts can be prevented from flowing to the outside when the heat medium source 144 and the heat medium flow passage 145 have been disconnected. When an electrical part(s) is used as the heating/cooling mechanism 143, i.e. when the heating/cooling mechanism 143 includes the heater 300 and/or the cooler 310, coupling element(s) 470 for electric wiring may be used. The coupling element(s) 470 facilitate the separation of the heat medium source 144 and the heat medium flow passage 145, and thus the heat conduction part 141 can be easily removed. Additionally or alternatively, the heat medium source 144 and the heat medium flow passage 145 can be connected by a piping or wiring that is expandable and/or flexible.

[0034] Depending on the shape of the arm guides 410, the arms 142 may be inserted into the arm guides 410 in a tilted state and/or a state in which the arms 142 are shifted in the up-down/left-right direction in Fig. 5 (Y-direction and/or Z-direction). Therefore, the heat medium flow passage 145 may be inserted into the coupling elements 470 in a tilted state and/or a state in which the heat medium flow passage 145 is shifted in the up-down/left-right direction. If the amount of tilting and/or the amount of shifting is large, the heat medium source 144 and the heat medium flow passage 145 may not be able to be appropriately connected.

[0035] Thus, in the present embodiment, a gap is provided between each coupling element 470 and the arm mount 400. Fig. 7 is a cross-section view of the arm mount 400 at the position of the cross-section line indicated as A-A in Fig. 5. The coupling element 470 shown in Fig. 7 shall be explained as a fluid coupling element. The coupling element 470 has a T-shaped cross-section shape, and a first through hole 700 for passing a fluid is provided to the center of the coupling element 470. The arm mount 400 is provided with a second

through hole 710 for inserting the small-diameter part (the portion corresponding to the vertical bar of the T) of the coupling element 470. Once the small-diameter part of the coupling element 470 has been inserted into the second through hole 710, a stopper 720 (a retaining ring or a clamp, etc.) is attached to the small-diameter part of the coupling element 470. The diameter of the second through hole 710 is determined such that a gap exists between the second through hole 710 and the small-diameter part of the coupling element 470. Specifically, the diameter of the second through hole 710 (indicated as “ D_{hole} ” in Fig. 7) can be set to be greater by at least 0.1 mm, at least 1 mm, at least 5 mm, at least 10 mm, or at least 20 mm than the diameter of the small-diameter part of the coupling element 470 (indicated as “ D_{cpl} ” in Fig. 7). The diameter of the second through hole 710 is preferably set to be smaller than the diameter of the large-diameter part of the coupling element 470 so that the coupling element 470 does not fall out from the second through hole 710.

[0036] Further, the distance between the portion of the large-diameter part of the coupling element 470 that can contact the arm guide 410 and the stopper 720 (indicated as “ l ” in Fig. 7) is determined so as to be greater than the thickness of the portion of the arm guide 410 in which the second through hole 710 is provided (indicated as “ t ” in Fig. 7).

Specifically, the distance between the portion of the large-diameter part of the coupling element 470 that can contact the arm guide 410 and the stopper 720 can be set to be longer by at least 0.1 mm, at least 1 mm, at least 5 mm, at least 10 mm, or at least 20 mm than the thickness of the portion of the arm guide 410 in which the second through hole 710 is provided.

[0037] According to the configuration shown in Fig. 7, the gap provided between the coupling elements 470 and the arm mount 400 absorbs tilting and/or up-down/left-right shifting of the heat medium flow passage 145. Therefore, even if the heat medium flow passage 145 is inserted into the coupling elements 470 in a tilted state and/or a state in which the heat medium flow passage 145 is shifted in the up-down/left-right direction, the heat medium source 144 and the heat medium flow passage 145 can be appropriately connected. Further, the gap provided between the coupling elements 470 and the arm mount 400 also

serves as a clearance (a play) for thermal expansion of the coupling elements 470 and/or the arm mount 400.

[0038] In particular, in the case that the heat medium is a fluid and the connection between the coupling elements 470 and the heat medium flow passage 145 is inappropriate, leakage of the fluid may occur. Further, in the case that each coupling element 470 is provided with a check valve and the connection between the coupling elements 470 and the heat medium flow passage 145 is inappropriate, the check valve may inhibit the flow of the heat medium. A sensor (not illustrated) may be provided near the coupling elements 470 in order to confirm that the coupling elements 470 and the heat medium flow passage 145 are appropriately connected.

[0039] In the configuration of the second embodiment, the vertical movement mechanism 150 does not necessarily have to be provided. However, the vertical movement mechanism 150 is preferably provided in order to facilitate the removal of the heat conduction part 141, to facilitate the exchange of the polishing pad 111, and to separate the heat conduction part 141 from the polishing pad 111 when temperature adjustment is unnecessary.

[0040] In the configuration of the second embodiment as well, the polishing pad 111 can be exchanged and/or thermal contact between the heat conduction part 141 and the polishing pad 111 can be eliminated without using a “raising mechanism (refer to PTL1)”.

[0041]

<Third Embodiment>

In the configuration explained in the second embodiment, it is necessary to provide a clearance between the arms 142 and the arm guides 410 in order to insert the arms 142 into the arm guides 410. Further, it is also necessary to provide a clearance between the pins of the plungers 420 and the plunger holes 430. The clearances between these parts causes rattling of the arms 142. Rattling of the arms 142 may lead to a shift in the position at which the heat conduction part 141 contacts the polishing pad 111, and may make it difficult to accurately adjust the temperature of the polishing pad 111. In particular, if the heat

conduction part 141 shifts in the radial direction (X-direction) of the polishing table 110, the area of the polishing pad 111 which is intended to contact the heat conduction part 141 may no longer contact the heat conduction part 141.

[0042] In addition, abrasion powder may be produced if the arms 142 and the arm guides 410 rub against each other during the insertion and pulling out of the arms 142. Such abrasion powder can ride the flow of a gas and/or liquid in the polishing device 100, eventually reaching the polishing pad 111. Abrasion powder on the polishing pad 111 may cause abnormal polishing of the substrate 121. Further, abrasion powder which has adhered to the substrate 121 may cause abnormalities in the process(es) after the substrate polishing. Moreover, abrasion of the arms 142 and/or the arm guides 410 may cause a deterioration in the slidability between the arms 142 and the arm guides 410, and this can lead to difficulties in the insertion and pulling out of the arms 142.

[0043] If the clearance between the parts is decreased in order to reduce rattling of the arms 142, it is conceivable that arms 142 and the arm guides 410 will strongly rub against each other. Conversely, if the clearance between the parts is increased in order to reduce the abrasion between the arms 142 and the arm guides 410, it is believed that rattling of the arms 142 will increase.

[0044] Thus, in the third embodiment, a configuration for reducing the rattling of the arms 142 and/or the abrasion between the arms 142 and the arm guides 410 will be explained referring to Figs. 8, 9, and 10. Fig. 8 illustrates a pad temperature adjustment mechanism 140 according to the present embodiment. Fig. 8A is a top surface view of the pad temperature adjustment mechanism 140. Fig. 8B is a front surface partial cross-section view of the pad temperature adjustment mechanism 140 (the heat medium source 144, the vertical movement mechanism 150, and the arm mount 400 are illustrated in cross-section, and the heat conduction part 141 and the arms 142 are illustrated in non-cross-section). Fig. 8B also illustrates the vertical movement mechanism 150. Fig. 9 is a right side surface view of the vertical movement mechanism 150 and the arm mount 400 according to the present embodiment. Fig. 10 is a left side surface view of the heat conduction part 141 and arms 142

according to the present embodiment.

[0045] The third embodiment shares common features with the second embodiment in that the arms 142 are configured such that they can be inserted into the arm guides 410. Meanwhile, the shapes of the arms 142 and the arm guides 410 in the third embodiment differs from the shapes thereof in the second embodiment.

[0046] As is best illustrated in Fig. 8B, the distal end of at least one of the arms 142 (in this illustrated example, both of the two arms) according to the present embodiment is formed in a tapered shape. More specifically, the top part of the distal end, which is the end that is spaced apart from the heat conduction part 141, of each arm 142 is formed in a tapered shape. Herein, “the distal end of the arm 142” can be rephrased as “the portion of the arm 142 that is inserted into the arm guide 410”. Additionally or alternatively, the bottom part of the arm 142 may be formed in a tapered shape. However, the bottom part of the arm 142 preferably has a non-tapered shape in order to prevent the arm 142 from accidentally falling out. The shape of the arm guide 410 corresponds to the shape of the arm 142. In other words, the arm guide 410 is formed in a tapered groove shape. The taper angle of the arm 142 and the arm guide 410 may be any angle, and can be set to, for example, an angle from 10 degrees to 45 degrees. The taper angle may be an angle less than 10 degrees, and may be an angle greater than 45 degrees. The taper angle is preferably determined such that length of the tapered portion of the arm 142 is longer than the length of the portion of the arm 142 that is inserted into the arm guide 410.

[0047] In the present embodiment, a falling prevention member 810 is provided in order to install the arms 142 in the arm guides 410 of the arm mount 400, i.e. in order to prevent the arms 142 from falling out from the arm guides 410. Specifically, as the falling prevention member 810, a hook 811 is provided to the arm 142, and a fastener 812 is provided to the arm mount 400. In the illustrated example, one set of the hook 811 and the fastener 812 is provided, but two or more sets of the hook 811 and the fastener 812 can be used. When the hook 811 and the fastener 812 are engaged with each other, the arms 142 are pressed to the arm mount 400, and thus the arms 142 are prevented from falling out. Additionally or

alternatively, the fastener 812 may be provided to the arm 142 and the hook 811 may be provided to the arm mount 400. As a further additional or alternative example, instead of the hook 811 and the fastener 812, other elements such as a spring, a plunger, a pin, a bolt, a nut, a wire, and/or a string, etc. can be used. The falling prevention member 810 may be a member that prevents the arms 142 from falling out using an electromagnetic force generated by a permanent magnet or an electromagnet, etc. Further, the falling prevention member 810 may be provided at an arbitrary location, for example, the fastener 812 may be provided to the vertical movement mechanism 150.

[0048] According to the configuration of the third embodiment, if the arms 142 are not completely inserted into the arm guides 410, the arms 142 and the arm guides 410 will not rub against each other much. Therefore, according to the configuration of the third embodiment, the generation of abrasion powder can be reduced. Further, a deterioration in the slidability can be prevented by reducing the abrasion. In addition, since the arms 142 and the arm guides 410 are configured in a tapered shape, the arms 142 can be easily inserted and pulled out.

[0049] When the arms 142 are completely inserted into the arm guides 410, the tapered surface of the arms 142 and the tapered surface of the arm guides 410 contact each other. In other words, when the arms 142 are completely inserted into the arm guides 410, the clearance in the X-direction between the arms 142 and the arm guides 410 is substantially zero (excluding clearance that is generated by the effects of manufacturing errors, assembly errors, warping of the parts, deterioration over time, and differences in the coefficient of thermal expansion, etc.). Thus, rattling in the X-direction of the arms 142 is reduced. Therefore, according to the configuration of the third embodiment, the heat conduction part 141 can be positioned with high accuracy.

[0050] More preferably, at least one of the arms 142 is formed in a dovetail tenon shape as is best illustrated in Fig. 10. The term “dovetail tenon shape” as used herein includes a “half-dovetail tenon shape”. Further, as is best illustrated in Fig. 9, the arm guide 410 for the dovetail tenon-shaped arm is preferably formed in a dovetail groove shape. The term

“dovetail groove shape” as used herein includes a “half-dovetail groove shape”. Rattling in the Y-direction of the arms 142 is reduced by the dovetail tenon structure and the dovetail groove structure. Unlike the illustrated example, a plurality of the arms 142 and the arm guides 410 may be configured in a dovetail tenon shape or a dovetail groove shape. The angle of the dovetail tenon and the dovetail groove may be any angle, and can be set to, for example, 45 degrees or 60degrees.

[0051] An alternative example of the present embodiment is shown in Fig. 11. Fig. 11 is a front surface cross-section view of the arm mount 400 and the vertical movement mechanism 150. However, for the convenience of illustration, the coupling elements 470 are not illustrated. In the example of Fig. 11, the arm guide 410 is configured in an overall tapered groove shape by a groove 1100, which is rectangular when viewed from the front surface, and a block 1110, which has a trapezoidal shape when viewed from the front surface. The block 1110 is at least partially positioned on the inside of the rectangular groove 1100. In the example of Fig. 11, the block 1110 is entirely positioned on the inside of the rectangular groove 1100. The block 1110 is fixed by a fixing tool 1120 such as a bolt. Further, at least one of the fixation position and the fixation angle of the block 1110 is adjustable. By moving the fixation position of the block 1110 in the X-direction, the insertion length of the arm 142 can be adjusted, and thus the position of the heat conduction part 141 can be adjusted. By changing the fixation angle of the block 1110, the taper angle of the arm guide 410 can be adjusted according to the angle of the tapered portion of the heat conduction part 141. An arm guide 410 that has a tapered groove shape and a dovetail groove shape can be configured by the rectangular groove 1100 and the block 1110.

[0052] Several embodiments of the present invention have been explained above, but these embodiments of the invention are for the purpose of facilitating the understanding of the present invention, and are not intended to limit the present invention. Further, the matters explained in a certain embodiment can be applied to another embodiment as long as they do not contradict each other. For example, the uneven structure 200 and/or the sensor 210, etc. explained in the first embodiment can be applied to the second embodiment or the third

embodiment. Similarly, the plunger 420 and/or the spring 460, etc. explained in the second embodiment can be applied to the third embodiment.

[0053] The present invention may be modified or improved without departing from the gist of the invention, and the present invention obviously includes equivalents thereof. Further, the constituent elements described in the scope of the claims and the specification may be arbitrarily combined or eliminated within a scope in which the above-described problems can be at least partially solved or a scope in which the effects can be at least partially achieved.

[0054] The present application discloses, as one embodiment, a pad temperature adjustment mechanism for adjusting the temperature of a polishing pad of a polishing device, the pad temperature adjustment mechanism including: a heat conduction part for conducting heat between the heat conduction part and the polishing pad; an arm(s) that extends from the heat conduction part, wherein a distal end of the arm is formed in a tapered shape; an arm mount(s) for installing the arm, wherein an arm guide having a tapered groove shape corresponding to the shape of the arm is formed in the arm mount; and a falling prevention member for preventing the arm from falling out of the arm guide.

[0055] This pad temperature adjustment mechanism may achieve, as one example, an effect in which rattling of the arm and/or abrasion between the arm and the arm guide can be reduced. Further, this pad temperature adjustment mechanism may achieve, as one example, an effect in which rattling of the arm in the X-direction can be reduced.

[0056] The present application further discloses, as one embodiment, a pad temperature adjustment mechanism including a plurality of arms and arm mounts, wherein at least one of the plurality of arms is formed in a dovetail tenon shape, and the arm guide for the dovetail tenon-shaped arm is formed in a dovetail groove shape.

[0057] This pad temperature adjustment mechanism may achieve, as one example, an effect in which rattling of the arm in the Y-direction can be reduced.

[0058] The present application further discloses, as one embodiment, a pad temperature adjustment mechanism wherein a heating/cooling mechanism is provided to the inside of the

heat conduction part. The present application further discloses, as one embodiment, a pad temperature adjustment mechanism wherein the heating/cooling mechanism includes a heat medium flow passage for flowing a heat medium, and the arm mount is provided with a coupling element that is connected to the heat medium flow passage when the arm is installed in the arm mount.

[0059] The pad temperature adjustment mechanism and the heating/cooling mechanism are explained in detail in the content disclosed above.

[0060] The present application further discloses, as one embodiment, a pad temperature adjustment mechanism wherein the coupling element is provided so that a gap is formed between the coupling element and the arm mount.

[0061] This pad temperature adjustment mechanism may achieve, as one example, an effect in which it becomes easier to appropriately connect the heat medium source and the heat medium flow passage.

[0062] The present application further discloses, as one embodiment, a pad temperature adjustment mechanism wherein the heating/cooling mechanism includes a heater and/or a cooler.

[0063] Another example of the heating/cooling mechanism is explained in the content disclosed above.

[0064] The present application further discloses, as one embodiment, a pad temperature adjustment mechanism wherein the arm guide having a tapered groove shape is formed by a rectangular groove and a block that is at least partially positioned on the inside of the rectangular groove, wherein a fixation position and/or a fixation angle of the block is adjustable.

[0065] This pad temperature adjustment mechanism may achieve, as one example, an effect in which the insertion length of the arm and/or the taper angle of the arm guide can be adjusted.

[0066] The present application further discloses, as one embodiment, a polishing device including: a polishing table to which a polishing pad is attached; a polishing head that is

provided above the polishing table so as to oppose the polishing table; and the pad temperature adjustment mechanism disclosed in the present specification. The present application further discloses, as one embodiment, a polishing device that further includes a vertical movement mechanism for vertically moving the pad temperature adjustment mechanism.

[0067] A polishing device including the pad temperature adjustment mechanism disclosed in the present specification is explained in detail in the content disclosed above.

[0068] The present application further discloses, as one embodiment, a polishing device wherein a surface of the polishing table to which the polishing pad is attached is coated with a material having a low coefficient of friction.

[0069] This polishing device may achieve, as one example, an effect in which it becomes easier to peel the polishing pad away from the polishing table.

REFERENCE SIGNS LIST

[0070]

100...polishing device

110...polishing table

111...polishing pad

120...polishing head

121...substrate

130...discharge mechanism

131...liquid supply source

132...discharge pipe

140...pad temperature adjustment mechanism

141...heat conduction part

142...arm

143...heating/cooling mechanism

144...heat medium source

145...heat medium flow passage

150...vertical movement mechanism

151...fixing tool

160...control part

200...uneven structure

210...sensor

300...heater

310...cooler

320...power source

400...arm mount

410...arm guide

420...plunger

430...plunger hole

440...plunger guide

450...handle

460...spring

470...coupling element

700...first through hole

710...second through hole

720...stopper

810...falling prevention member

811...hook

812...fastener

1100...rectangular groove

1110...block

1120...fixing tool

WHAT IS CLAIMED IS:

1. A pad temperature adjustment mechanism for adjusting a temperature of a polishing pad of a polishing device, the pad temperature adjustment mechanism comprising:
 - a heat conduction part for conducting heat between the heat conduction part and the polishing pad;
 - an arm that extends from the heat conduction part, wherein a distal end of the arm is formed in a tapered shape;
 - an arm mount for installing the arm, wherein an arm guide having a tapered groove shape corresponding to the shape of the arm is formed in the arm mount; and
 - a falling prevention member for preventing the arm from falling out of the arm guide.
2. The pad temperature adjustment mechanism according to claim 1 comprising a plurality of arms and arm mounts,
 - wherein at least one of the plurality of arms is formed in a dovetail tenon shape, and
 - the arm guide for the dovetail tenon-shaped arm is formed in a dovetail groove shape.
3. The pad temperature adjustment mechanism according to claim 1 or 2, wherein a heating/cooling mechanism is provided to the inside of the heat conduction part.
4. The pad temperature adjustment mechanism according to claim 3, wherein the heating/cooling mechanism comprises a heat medium flow passage for flowing a heat medium supplied from a heat medium source, and
 - the arm mount is provided with a coupling element that is connected to the heat medium flow passage when the arm is installed in the arm mount.

5. The pad temperature adjustment mechanism according to claim 4, wherein the coupling element is provided so that a gap is formed between the coupling element and the arm mount.
6. The pad temperature adjustment mechanism according to any one of claims 3 to 5, wherein the heating/cooling mechanism comprises a heater and/or a cooler.
7. The pad temperature adjustment mechanism according to any one of claims 1 to 6, wherein the arm guide having a tapered groove shape is formed by:
 - a rectangular groove; and
 - a block that is at least partially positioned on the inside of the rectangular groove,wherein a fixation position and/or a fixation angle of the block is adjustable.
8. A polishing device comprising:
 - a polishing table to which a polishing pad is attached;
 - a polishing head that is provided above the polishing table so as to oppose the polishing table; and
 - the pad temperature adjustment mechanism according to any one of claims 1 to 7.
9. The polishing device according to claim 8, further comprising a vertical movement mechanism for vertically moving the pad temperature adjustment mechanism.
10. The polishing device according to claim 8 or 9, wherein a surface of the polishing table to which the polishing pad is attached is coated with a material having a low coefficient of friction.