OSCILLATING FIXED ABRASIVE CMP SYSTEM AND METHODS FOR IMPLEMENTING THE SAME

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to chemical mechanical polishing (CMP) systems and techniques for improving the performance and effectiveness of CMP operations. Specifically, the present invention relates to CMP systems that use a fixed abrasive polishing pad arranged in a web handling system.

2. Description of the Related Art

In the fabrication of semiconductor devices, there is a need to perform CMP operations, including polishing, buffing and wafer cleaning. Typically, integrated circuit devices are in the form of multi-level structures. At the substrate level, transistor devices having diffusion regions are formed. In subsequent levels, interconnect metallization lines are patterned and electrically connected to the transistor devices to define the desired functional device. As is well known, patterned conductive layers are insulated from other conductive layers by dielectric materials, such as silicon dioxide. As more metallization levels and associated dielectric layers are formed, the need to planarize the dielectric material increases. Without planarization, fabrication of additional metallization layers becomes substantially more difficult due to the higher variations in the surface topography. In other applications, metallization line patterns are formed in the dielectric material, and then metal CMP operations are performed to remove excess metallization.

In the prior art, CMP systems typically implement belt, orbital, or brush stations in which belts, pads, or brushes are used to scrub, buff, and polish one or both sides of a wafer. Slurry is used to facilitate and enhance the CMP operation. Slurry is most usually

introduced onto a moving preparation surface, *e.g.,* belt, pad, brush, and the like, and distributed over the preparation surface as well as the surface of the semiconductor wafer being buffed, polished, or otherwise prepared by the CMP process. The distribution is generally accomplished by a combination of the movement of the preparation surface, the movement of the semiconductor wafer and the friction created between the semiconductor wafer and the preparation surface.

Figure 1 illustrates an exemplary prior art CMP system 100. The CMP system 100 in Figure 1 is a belt-type system, so designated because the preparation surface is an endless belt 108 mounted on two drums 114 which drive the belt 108 in a rotational motion as indicated by belt rotation directional arrows 116. A wafer 102 is mounted on a carrier 104. The carrier 104 is rotated in direction 106. The rotating wafer 102 is then applied against the rotating belt 108 with a force F to accomplish a CMP process. Some CMP processes require significant force F to be applied. A platen 112 is provided to stabilize the belt 108 and to provide a solid surface onto which to apply the wafer 102. Slurry 118 composing of an aqueous solution such as NH_4OH or DI water containing dispersed abrasive particles is introduced upstream of the wafer 102. The process of scrubbing, buffing and polishing of the surface of the wafer is achieved by using an endless polishing pad glued to the belt 108. Typically, the polishing pad is composed of porous or fibrous materials and lacks fixed abrasive particles.

After the polishing pad polishes a limited number of wafers, the surface of the pad is conditioned and cleaned in order to remove the attached abrasive materials of the slurry and the particles removed from the wafer. Subsequent to cleaning and conditioning, the polishing pad will have a significant amount of particles that remain attached to the surface of the polishing pad causing the polishing pad to lose its effectiveness. The polishing pad also loses its effectiveness due to normal wear of the material itself. As a result, the polishing pad must be replaced in its entirety. The removal of the used polishing pad and its subsequent replacement with a new polishing pad is very time consuming and labor intensive. Additionally, the time needed to perform the replacement necessarily requires that the polishing system be taken off-line, which thus reduces throughput.

In view of the foregoing, a need therefore exists in the art for a chemical mechanical polishing system that will enable polishing surface layers of a wafer using a polishing pad that is less expensive to maintain and is more effectively serviced after its use degrades the effectiveness of the polishing.

SUMMARY OF THE INVENTION

Broadly speaking, the present invention fills these needs by providing an apparatus and related methods for efficiently polishing layer surfaces of a semiconductor wafer. Preferably, the CMP system is designed to implement a polishing pad strip that is less expensive to maintain and is more efficiently serviced after it loses its effectiveness to polish. In preferred embodiments, the polishing pad is a fixed abrasive polishing pad strip that is connected between a feed roll and a take-up. It should be appreciated that the present invention can be implemented in numerous ways, including as a process, an apparatus, a system, a device, or a method. Several inventive embodiments of the present invention are described below.

In one embodiment, a chemical mechanical polishing (CMP) apparatus is disclosed. The CMP apparatus includes a polishing pad strip defined between a first point and a second point. The first point is separate from the second point. Also included is a feed roll having a supply of the polishing pad strip, and the feed roll is configured to define a location of the first point. A take-up roll is further included and it is configured to collect at least a linear portion of the polishing pad strip.

In another embodiment, a chemical mechanical polishing (CMP) apparatus is disclosed. A first roller is situated at a first point and a second roller situated at a second point, such that the first point is separate from the second point. A polishing pad strip is also included and has a first end secured to the first roller and a second end secured to the second roller. The polishing pad strip is configured to provide a surface onto which a substrate to be polished is lowered. Preferably, the polishing pad strip is a fixed abrasive pad and is configured to receive chemicals or DI water so as to facilitate a removal of material from a surface of the substrate.

In still a further embodiment, a method for polishing a semiconductor wafer is disclosed. The method includes providing a polishing pad strip that is to be connected between a first point and a second point. The method then includes applying a tension to the polishing pad strip. Once the desired tension is applied, the polishing pad strip is oscillated between the first point and the second point. The semiconductor wafer is then applied to the oscillating polishing pad strip to commence the CMP process. The method can further include applying a chemical solution to the polishing pad strip before the applying of the semiconductor wafer. Furthermore, the method can include monitoring a linear velocity of the oscillating polishing pad strip, and controlling a setting of the linear velocity of the oscillating polishing pad strip. In addition, the method can include monitoring a tension of the polishing pad strip, and controlling a setting of the tension of the oscillating polishing pad strip.

The advantages of the present invention are numerous. Most notably, instead of a continuous belt polishing pad, a supply of polishing pad strip is provided between a feed roll and a take-up roll in a web handling arrangement. Thus, replacing used portions of the polishing pad strip with fresh portions of the polishing pad strip can be accomplished utilizing minimal effort and in significantly less amount of time. Furthermore, the re-supplying of the polishing pad strip can be achieved easily and expeditiously thereby minimizing the length of time needed to take the polishing system off-line thus having minimal effect on the throughput. Accordingly, the apparatus and the methods of the present invention provide for polishing surface layers of a wafer using a polishing pad that is less expensive to maintain and is more effectively serviced after its use degrades the effectiveness of the polishing.

Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, and like reference numerals designate like structural elements.

Figure 1 illustrates an exemplary prior art CMP system.

Figure 2A is a cross-sectional view of an oscillating CMP system, in accordance with one embodiment of the present invention.

Figure 2B is a cross-sectional view of an oscillating CMP system, illustrating the system's tension setting mechanism and velocity control mechanism, in accordance with another embodiment of the present invention.

Figure 2C is a cross-sectional view of an oscillating CMP system, illustrating the feed roll's design to hold an ample supply of the polishing pad strip, in accordance with yet another embodiment of the present invention.

Figure 2D-1 is a plan-view of an abrasive polishing pad strip, in accordance with yet another embodiment of the present invention.

Figure 2D-2 is a cross-sectional view of an abrasive polishing pad strip, revealing the plurality of posts containing a plurality of abrasive particles, in accordance with yet another embodiment of the present invention.

Figure 3A is a cross-sectional view of the CMP system in which the tension actuators are positioned to the right and to the left of the feed roll and the take-up roll, respectively, in accordance with yet another embodiment of the present invention.

Figure 3B is a cross-sectional view of the CMP system, depicting the system's tension setting and velocity control mechanisms, in accordance with yet another embodiment of the invention.

Figure 4A is a cross-sectional view of the CMP system in which the tension actuators are connected to the idler rollers, in accordance with yet another embodiment of the present invention.

Figure 4B is a cross-sectional view of the CMP system, depicting the system's tension setting mechanism as well as velocity control mechanism, in accordance with yet another embodiment of the invention.

Figure 5A is a cross-sectional view of the CMP system in which the feed roll and take-up roll maintain and control both the tension exerted on the polishing pad strip as well as the linear velocity of the polishing pad strip, in accordance with yet another embodiment of the invention.

Figure 5B is a cross-sectional view of the CMP system, depicting the system's tension and velocity control mechanism, in accordance with yet another embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An invention for a CMP system, which enables efficient polishing of layer surfaces of a wafer is described. The CMP system preferably implements a polishing pad that is less expensive to maintain and is more efficiently serviced after it loses its effectiveness to polish. In preferred embodiments, the polishing pad is a fixed abrasive polishing pad. The fixed abrasive polishing pad is preferably provided as a polishing pad strip that is connected between a feed roll and a take-up. This configuration is referred to herein as a web handling arrangement. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be understood, however, to one skilled in the art, that the present invention may be practiced without some or all of these specific details. In other instances, well known process operations have not been described in detail in order not to unnecessarily obscure the present invention.

Figure 2A is a cross-sectional view of an oscillating CMP system 200, in accordance with one embodiment of the present invention. The CMP system 200 in Figure 2A includes a feed roll 212a positioned at a first point 211a. The feed roll 212a is configured to hold a roll of a polishing pad strip 202. A take-up roll 212b is positioned at a second point 211b, and is placed, in this embodiment, symmetrically across from the feed roll 212a and is configured to receive the polishing pad strip 202. The direct distance between the feed roll 212a and take-

up roll 212b is estimated to be about 20 inches. Of course, the distance between the feed roll 212a and take-up roll 212b may vary depending on the specific implementation. In this embodiment, each of the feed roll 212a and the take-up roll 212b is designed to contain an internal motor. Preferably, the internal motor is a servo drive, such as a direct drive servo. The internal motors are designed to allow the feed roll 212a and take-up roll 212b to reciprocate. The reciprocating motions of the feed roll 212a and take-up roll 212b cause the polishing pad strip to oscillate at a linear velocity ranging from about 140 feet per second to about 350 feet per second. The actual linear velocity selected for a polishing operation will also depend on the force at which a polishing head holding a wafer is applied to the polishing pad strip and the platen. The limits of the linear velocity and the force are generally calibrated using the well known Preston's Equation. According to Preston's Equation, Removal Rate = KpPV, where the removal rate of material is a function of Downforce (P) and Linear Velocity (V), with Kp being the Preston Coefficient, a constant determined by the chemical composition of the slurry (or fixed abrasive material and chemicals), the process temperature, and the pad surface, among other variables.

In this embodiment, tension actuators 214a and 214b are positioned directly below the feed roll 212a and take-up roll 212b, respectively. The tension actuators 214a and 214b are configured to controllably pull on the feed roll 212a and take-up roll 212b thereby causing the feed roll 212a and take-up roll 212b to exert tension on the polishing pad strip 202. It should be understood that each of the tension actuators can be any type of linear actuator. For instance, each tension actuator can be replaced with cylinders, coils, screws or linear motors.

Positioned above the feed roll 212a is a load cell roller 208a defined by a roller that measures the tension exerted on the polishing pad strip 202 on the side closest to intermediate point 207a (*e.g.*, left side). The load cell roller 208b is also defined by a roller that measures the tension exerted on the polishing pad strip 202 on the side closest to the intermediate point 207b (*e.g.*, right side). In this example, the load cell roller 208b is positioned symmetrically across from the load cell roller 208a and directly above the take-up roll 211b. Therefore, the polishing pad strip 202 is located on top of the load cell rollers 208a and 208b, and the load cell rollers 208a and 208b are configured to provide a location where the polishing pad strip 202 is caused to change angular orientation. For instance, the angular orientation may be about 90 degrees so that only the horizontal components of the forces applied on the load cell

rollers 208a and 208b are measured. An idler roller 210a defined by a roller fixed to a point is positioned between feed roll 212a and load cell roller 208a. Across from the idler roller 210a, is positioned an idler roller 210b. The idler rollers 210a and 210b are designed to support the polishing pad strip along a path that will ensure the 90-degree angle described above. Thus, the idler rollers 210a and 210b are further designed to allow the load cell rollers 208a and 208b to measure only the horizontal components of the forces applied on the load cell rollers 208a and 208b. The horizontal components of the applied forces are equivalent to the tension exerted on the polishing pad strip 202 on the left side and the right side of the polishing head 204.

A polishing head 204 is designed to carry a wafer (not shown in the figure) and rotates in a rotation direction 205. A platen 206 is positioned horizontally between load cell rollers 208a and 208b. Platen 206 is configured to stabilize the polishing pad strip 202 and to provide a solid surface onto which to apply the polishing head 204. In some cases, it is possible to control the surface between the platen 206 and the polishing pad strip 202 to control the removal rate in different locations on the wafer. In one embodiment, the polishing pad strip 202 is a fixed abrasive polishing pad which has a polishing layer containing abrasive particles extended throughout the surface and the material thickness. As the polishing head 204 applies the wafer (not shown in the figure) against the polishing pad strip 202, the abrasive particles of the polishing pad strip 202 become loose thereby eliminating the necessity to use a slurry containing abrasive materials. Although a slurry containing abrasive particles is not required, a liquid solution (e.g., NH_4OH or DI water) is preferably used to facilitate the polishing process.

As depicted in the embodiment of Figure 2B, a certain portion of the supplied polishing pad strip 202 held in the feed roll 212a is fed around the load cell rollers 208a and 208b to the take-up roll 211b. After polishing a given number of wafers, the portion of the polishing pad strip 202 which came into contact with the wafers loses its effectiveness and must be replaced. The used portion of the polishing pad strip 202 is replaced by an unused portion of the polishing pad strip 202 by way of the feed roll 212a indexing the polishing pad strip 202, utilizing a programmable amount (e.g., enough to place a fresh portion of the polishing pad strip 202 over the platen 206). The indexing causes the used portions of the polishing pad strip 202 to be pushed farther and farther away from the polishing area. The

used portions of the polishing pad strip 202 are collected by the take-up roll 212b and will ultimately be discarded. Once the supply of the polishing pad strip 202 held in feed roll 212a is completely consumed, it can easily be replaced with a new roll of the polishing pad strip 202. The process of re-supplying the feed roll 212a with the polishing pad strip 202 is neither labor intensive nor time consuming. More importantly, the CMP machine will be off-line, if necessary, less frequently and for a significantly less amount of time thereby causing minimal effect on the throughput of the machine.

Also clearly shown in Figure 2B are the tension actuators 214a and 214b which are configured to controllably pull on the feed roll 212a and take-up roll 212b causing the feed roll 212a and take-up roll 212b to apply pressure to the polishing pad strip 202 at the first intermediate point 207a and the second intermediate point 207b, respectively. Due to normal wear, the polishing pad strip 202 can stretch, thereby causing the amount of tension exerted on the polishing pad strip 202 to reduce. This system is designed to maintain a desired tension by way of changing the amount of force the tension actuators 214a and 214b apply on the feed roll 212a and take-up roll 212b, respectively.

This task is achieved by the load cell roller 208a sending a tension feedback signal to an amplifier 222a, which is a part of a first tension-velocity controller 220a. Subsequently, a tension setting command, either supplied manually or automatically through a computerized device, is fed to the amplifier 222a. Thereafter, the amplifier 222a sends a tension output signal to a tension control device 226a, which is also a part of the tension-velocity controller 220a. Finally, the tension control device 226a sends a tension (TN) signal to the tension actuator 214a.

In a like manner, an amplifier 222b, which is a part of a tension-velocity controller 220b receives a tension feedback (FB) signal from load cell roller 208b. Subsequently, a tension setting command, either supplied manually or automatically through a computerized device, is fed to the amplifier 222b. Thereafter, the amplifier 222b sends a tension (TN) output signal to a tension control device 226b, which is also a part of the tension-velocity controller 220b. Finally, the tension control device 226b sends a tension signal to the tension actuator 214a. Depending on the tension signals received from the tension-velocity controllers 220a and 220b, the tension actuators 214a and 214b may or may not exert additional force on

the feed roll 212a and take-up roll 212b so as to achieve a desired tension (e.g., either higher or lower).

Once the desired tension is exerted on the polishing pad strip 202, the internal motors located inside the feed roll 212a and take-up roll 212b will cause the feed roll 212a and take-up roll 212b to reciprocate, synchronously, thereby causing the polishing pad strip 202 to oscillate at a linear velocity. In one embodiment, to achieve optimum performance, the linear velocity of the polishing pad strip 202 should be maintained within the range of about 140 ft/sec and about 350 ft/sec. Thus, the linear velocity of the polishing pad strip 202 should be measured frequently by the feed roll 212a and take-up roll 212b. Besides measuring the velocity of the polishing pad strip 202, the feed roll 212a and take-up roll 212b control and change, if necessary, the velocity of the polishing pad 202 so as to maintain a desired velocity.

As an example, the feed roll 212a initially sends out a velocity feedback to a Proportional, Integral and Derivative (PID) 224a, which is a part of the tension-velocity controller 220a. Then, a velocity setting command, either supplied manually or automatically using a computerized device, is fed to the PID 224a. Finally, the PID 224a sends out a velocity signal to the feed roll 212a.

Similarly, the take-up roll 212b sends out a velocity feedback to a Proportional, Integral and Derivative (PID) 224b, which is a part of the tension-velocity controller 220b. Then, a velocity setting command, either supplied manually or by way of a programmable machine, is fed to the PID 224b. Finally, the PID 224b sends out a velocity signal to the take-up roll 212b. The velocity signals received by the feed roll 212a and the take-up roll 212b are the determinative factors as to whether the feed roll 212a and take-up roll 212b must maintain or change the rate of reciprocating. Although the tension-velocity controllers 220a and 220b have been illustrated using exemplary electronics, it should be understood that the electronics and control signals can be processed using any other suitable well known processing techniques (e.g., software/hardware combinations). For instance, the PID electronics can be substituted with other circuitry that can process and control the signals as may be desired.

As clearly evident from the embodiment of Figure 2C, the feed roll 212a is designed to hold an ample supply of the polishing pad strip 202. Utilizing minimal effort, the feed roll 212a can be re-supplied with the fresh polishing pad strip 202 thereby having minimum effect on the throughput of the CMP machine.

Figure 2D-1 depicts one of many types of the polishing pad strip 202, which has a fixed abrasive polishing layer. The approximate thickness of this type of polishing pad strip 202 ranges from about 0.004 inch to about 0.010 inch. Embedded and extended through out the surface of this type of polishing pad strip 202 are several three-dimensional protrusions, which are defined as posts 202'. The cross-sectional view of the polishing pad strip 202, as shown in Figure 2D-2, reveals that each post 202' contains a plurality of abrasive particles having an approximate size in the range from about 40 micrometer and about 200 micrometer.

Another embodiment of the present invention is shown in Figure 3A wherein the tension actuator 314a is positioned to the right of the feed roll 212a. In a like manner, the tension actuator 314b is situated to the left of the take-up roll 212b. In this embodiment, by respectively pulling on the feed roll 212a and take-up roll 212b, the tension actuators 314a and 314b will cause the feed roll 212a and take-up roll 212b to controllably exert tension on the polishing pad strip 202.

For example, in the embodiment of Figure 3B, the tension actuators 314a and 314b control the amount of tension exerted on the polishing pad strip 202. This is achieved by the load cell roller 208a sending out a tension feedback to the tension/velocity controller 220a, which in turn, after internally processing the tension feedback, sends a tension signal to the tension actuator 314a. Similarly, the load cell roller 208b sends out a tension feedback to the tension/velocity controller 220b. Once the tension/velocity controller 220b processes the tension feedback, internally, it sends a tension signal to the tension actuator 314b. Depending on the tension signals received, if necessary, the tension actuators 314a and 314b, may change the amount of force each of them exerts on the feed roll 212a and take-up roll 212b so as to achieve a desired tension.

Once the desired tension is set for the polishing pad strip 202, the synchronous reciprocation of the feed roll 212a and take-up roll 212b start thereby causing the polishing pad strip 202 to oscillate at a linear velocity. In one embodiment, the linear velocity of the polishing pad strip 202 may be measured frequently or at set times. Depending upon the measurements, adjustments can be made to the tension that is controlled by the feed roll 212a and take-up roll 212b. The feed roll 212a and take-up roll 212b each send out a velocity feedback to the tension/velocity controllers 220a and 220b, respectively. Then, after internally processing the velocity feedbacks, the tension/velocity controllers 220a and

220b, each sends out a velocity signal to the feed roll 212a and take-up roll 212b. Depending on the velocity signals received, if necessary, the feed roll 212a and take-up roll 212b may change the rate of reciprocating, thus fixing a new linear velocity for the polishing pad strip 202.

The embodiment of Figure 4A depicts an oscillating CMP system 200b that is similar to the embodiment of Figure 2A, with the exception that the tension actuators 414a and 414b are positioned outside the idler rollers 210a and 210b. In this embodiment, the tension actuators are configured to pull on the idler rollers 210a and 210b so as to cause the idler rollers 210a and 210b to exert tension on the polishing pad strip 202.

In this case, there will be points in time when the vertical portions of the polishing pad strip 202 will not be at a 90 degree angle relative to the polishing region (e.g., where the platen 206 is located) of the polishing pad strip 202. Nevertheless, the tension can be controllably adjusted to a correct desired level. It should therefore be understood that it is not necessary to have the vertical and horizontal portions of the polishing pad strip 202 at a 90 degree angle at all times so long as the polishing pad strip 202 provides the desired optimum polishing condition at the location where polishing is to be performed on the wafer surfaces.

As shown in the embodiment of Figure 4B, the load cell roller 208a sends out a tension feedback to the tension/velocity controller 220a. After internally processing the tension feedback, the tension/velocity controller 220a sends out a tension signal to the tension actuator 414a. Similar signals are also exchanged between the load cell roller 208b, tension/velocity controller 220b and tension actuator 414b.

Once each of the tension actuators 414a and 414b respectively receive a tension signal from 220a and 220b, depending on the tension signals received, tension actuators may, if necessary, change the force by which they exert tension on the polishing pad strip 202. After achieving the desired tension, the feed roll 212a and take-up roll 212b start reciprocating, preferably synchronously, causing the polishing pad strip to oscillate at a desired linear velocity. Similar to the embodiments of Figures 2B and 3B, the feed roll 212a and take-up roll 212b maintain and if necessary, change the velocity of the oscillation of the polishing pad strip 202.

Figure 5A depicts an oscillating CMP system 200c wherein the feed roll 212a and take-up roll 212b maintain and control both the tension exerted on the polishing pad strip 202 as well as the linear velocity of the polishing pad 202. Accordingly, the tension actuators have completely been eliminated from the CMP system 200c.

As illustrated in Figure 5B, in a CMP system 200c', the load cell roller 208a sends a tension feedback to an amplifier 322a that is part of the tension-and-velocity controller 320a. Thereafter, a tension setting command, supplied either manually or automatically through a computerized device, is fed to the amplifier 322a. Then, the amplifier 322a sends a tension output signal to a tension and velocity control device 326a.

Thereafter, a velocity feedback is sent from feed roll 212a to a PID 324a also positioned within the tension-and-velocity controller 320a. In a subsequent operation, a velocity setting command, supplied either manually or by way of a programmable machine, is fed to the PID 324a. Then, the PID 324a sends a velocity output signal to the tension and velocity control 326a. After receiving the tension output signal and the velocity output signal, the tension and velocity control 326a sends out a tension and velocity signal to the feed roll 212a.

Similarly, a tension feedback and a velocity feedback are respectively fed to an amplifier 322b and a PID 324b, which are part of the tension-and-velocity controller 320b. Then, a tension setting command is fed to the amplifier 322b, which in turn, sends out a tension output signal to a tension and velocity control 326b, which is also a part of the tension-and-velocity controller 320b. Next, a velocity setting command is fed to the PID 324b, which subsequently sends out a velocity command signal to the tension and velocity control 326b. After receiving the tension output signal and the velocity output signal, the tension and velocity control 326b sends out a tension and velocity signal to the take-up roll 212b.

Depending on the tension and velocity signals received by the feed roll 212a and take-up roll 212b, the feed roll 212a and take-up roll 212b may, if necessary, each rotate inwardly in the direction (TA) so as to adjust the tension exerted on the polishing pad strip 202 to a desired level. Once the tension applied to the polishing pad strip 202 is set to a desired level, the feed roll 212a and take-up roll 212b start, preferably, a synchronous reciprocation thereby causing the polishing pad to oscillate at a linear velocity under the

polishing head 204. Thus, in this embodiment, similar to some of the embodiments, the feed roll 212a and take-up roll 212b can change, if necessary, the velocity of the polishing pad 202 so as to maintain a desired velocity for optimum polishing performance.

Although the foregoing invention has been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications may be practiced within the scope of the appended claims. For example, embodiments described herein have been primarily directed toward wafer polishing, however, it should be understood that the polishing operations are well suited for precision polishing of any type of substrate. Accordingly, the present embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalents of the appended claims.

What is claimed is:

CLAIMS

1. A chemical mechanical polishing (CMP) apparatus, comprising:

a polishing pad strip defined between a first point and a second point, the first point being separate from the second point;

a feed roll having a supply of the polishing pad strip, and the feed roll defining the first point; and

a take-up roll configured to collect at least a linear portion of the polishing pad strip.

2. A chemical mechanical polishing (CMP) apparatus as recited in claim 1, wherein the feed roll and the take-up roll are configured to reciprocate so that the polishing pad strip oscillates at a programmable rate at least partially between the first point and the second point.

3. A chemical mechanical polishing (CMP) apparatus as recited in claim 2, wherein the programmable rate defines a linear velocity for the polishing pad strip in a direction between the first point and the second point as well as between the second point and the first point.

4. A chemical mechanical polishing (CMP) apparatus as recited in claim 1, further comprising:

a first tension actuator connected to the feed roll; and

a second tension actuator connected to the take-up roll.

5. A chemical mechanical polishing (CMP) apparatus as recited in claim 4, wherein the first tension actuator is configured to controllably pull on the feed roll so as to apply tension to the polishing pad strip, and wherein the second tension actuator is configured to controllably pull on the take-up roll so as to apply tension to the polishing pad strip.

6. A chemical mechanical polishing (CMP) apparatus as recited in claim 5, further comprising:

a first load cell roller;

a second load cell roller, the first load cell roller being defined at a first intermediate point and the second load cell roller being defined at a second intermediate point, the first intermediate point and the second intermediate point being located under and supporting the polishing pad strip and between the first point and the second point.

7. A chemical mechanical polishing (CMP) apparatus as recited in claim 6, further comprising:

a platen defined under the polishing pad strip in a location defined between the first intermediate point and the second intermediate point, the platen is configured to provide support for receiving a polishing head that is to be applied to the polishing pad strip, the polishing head is designed to hold a semiconductor wafer to be polished.

8. A chemical mechanical polishing (CMP) apparatus as recited in claim 6, further comprising:

a first idler roller positioned between the first point and the first intermediate point, the first idler roller configured to maintain a constant positional velocity for the polishing pad strip at a tangential interface with the first intermediate point defined by the first load cell roller; and

a second idler roller positioned between the second point and the second intermediate point, the second idler roller configured to maintain a constant positional velocity for the polishing pad at a tangential interface with the second intermediate point defined by the second load cell roller.

9. A chemical mechanical polishing (CMP) apparatus as recited in claim 6, further comprising:

a first tension-velocity controller;

a second tension-velocity controller, each of the first and second tension-velocity controller being configured to receive a tension feedback signal, a tension setting command,

a velocity feedback signal, and a velocity setting command, and each of the first and second tension-velocity controller being configured to output a velocity setting signal and a tension setting signal.

10. A chemical mechanical polishing (CMP) apparatus as recited in claim 9, wherein each of the first and second tension-velocity controller includes a tension control for setting each of the first tension actuator and the second tension actuator, respectively.

11. A chemical mechanical polishing (CMP) apparatus as recited in claim 3, further comprising:

a first tension-and-velocity controller;

a second tension-and-velocity controller, each of the first and second tension-and-velocity controller being configured to receive a tension feedback signal, a tension setting command, a velocity feedback signal, and a velocity setting command, and each of the first and second tension-and-velocity controller being configured to output a tension-and-velocity setting signal.

12. A chemical mechanical polishing (CMP) apparatus as recited in claim 11, wherein each of the first and second tension-and-velocity controller includes a tension and velocity control for setting each of the feed roll and the take-up roll, respectively.

13. A chemical mechanical polishing (CMP) apparatus as recited in claim 1, wherein the polishing pad strip is made from a fixed abrasive material.

14. A chemical mechanical polishing (CMP) apparatus as recited in claim 1, wherein the polishing pad strip, the feed roll and the take-up roll define a web handling arrangement.

15. A chemical mechanical polishing (CMP) apparatus as recited in claim 1, further comprising:

a first load cell roller;

a second load cell roller, the first load cell roller being defined at a first intermediate point and the second load cell roller being defined at a second intermediate point, the first intermediate point and the second intermediate point being located under and supporting the polishing pad strip and between the first point and the second point;

a first idler roller positioned between the first point and the first intermediate point; and

a second idler roller positioned between the second point and the second intermediate point.

16. A chemical mechanical polishing (CMP) apparatus as recited in claim 15, further comprising:

a first tension actuator connected to the first idler roller; and

a second tension actuator connected to the second idler roller.

17. A chemical mechanical polishing (CMP) apparatus, comprising:

a first roller situated at a first point and a second roller situated at a second point, the first point being separate from the second point; and

a polishing pad strip having a first end secured to the first roller and a second end secured to the second roller.

18. A chemical mechanical polishing (CMP) apparatus as recited in claim 17, further comprising:

a first tension actuator connected to the first roller and a second tension actuator connected to the second roller, the first and second tension actuators being configured to apply a controlled tension to the polishing pad strip.

19. A chemical mechanical polishing (CMP) apparatus as recited in claim 17, further comprising:

a first idler roller; and

a second idler roller, the first and second idler rollers being positioned between the first roller and the second roller.

20. A chemical mechanical polishing (CMP) apparatus as recited in claim 19, further comprising:

a first tension actuator connected to the first idler roller and a second tension actuator connected to the second idler roller, the first and second tension actuators being configured to apply a controlled tension to the polishing pad strip.

21. A method for polishing a semiconductor wafer, comprising:

providing a polishing pad strip connected between a first point and a second point;

applying a tension to the polishing pad strip;

oscillating the polishing pad strip between the first point and the second point; and

applying the semiconductor wafer to the oscillating polishing pad strip.

22. A method for polishing a semiconductor wafer as recited in claim 21, further comprising:

applying a chemical solution to the polishing pad strip before the applying of the semiconductor wafer.

23. A method for polishing a semiconductor wafer as recited in claim 21, wherein the polishing pad strip is a fixed abrasive pad.

24. A method for polishing a semiconductor wafer as recited in claim 21, further comprising:

monitoring a linear velocity of the oscillating polishing pad strip; and

controlling a setting of the linear velocity.

25. A method for polishing a semiconductor wafer as recited in claim 21, further comprising:

monitoring a tension of the polishing pad strip; and

controlling a setting of the tension.