METHODS AND APPARATUS FOR USING A BEVEL POLISHING HEAD WITH AN EFFICIENT TAPE ROUTING ARRANGEMENT

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ABSTRACT
Apparatus and methods are provided to polish an edge of a substrate. The invention includes a polishing head, adapted to contact an edge of a substrate, wherein the polishing head includes one pair of front guide rollers and two pairs of back clamping rollers. Numerous other aspects are provided.
Select a Roll of Polishing Tape

Insert the Polishing Tape into the Polishing Head of the Bevel Cleaning System

Route Polishing Tape Between First Pair of Back Rollers

Route Polishing Tape around Outside of First Front Roller

Route Polishing Tape Over Backing Pad

Route Polishing Tape around Outside of Second Front Roller

Route Polishing Tape Between Second Pair of Back Rollers

Attach Polishing Tape to Take-Up Spool

FIG. 6
METHODS AND APPARATUS FOR USING A BEVEL POLISHING HEAD WITH AN EFFICIENT TAPE ROUTING ARRANGEMENT

[0001] The present application claims priority from U.S. Provisional Patent Application Ser. No. 60/939,350 filed May 21, 2007, entitled “METHODS AND APPARATUS FOR USING A BEVEL POLISHING HEAD WITH AN EFFICIENT TAPE ROUTING ARRANGEMENT” (Attorney Docket No. 11565/L) which is hereby incorporated herein by reference in its entirety for all purposes.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] The present application is related to the following commonly-assigned, co-pending U.S. patent applications, each of which is hereby incorporated herein by reference in its entirety for all purposes:


[0004] U.S. patent application Ser. No. 11/298,555, filed on Dec. 9, 2005, and entitled “METHODS AND APPARATUS FOR PROCESSING A SUBSTRATE” (Attorney Docket No. 10414);

[0005] U.S. patent application Ser. No. 11/693,695, filed on Mar. 29, 2007, and entitled “METHODS AND APPARATUS FOR POLISHING AN EDGE OF A SUBSTRATE” (Attorney Docket No. 10560);

[0006] U.S. Patent Application Ser. No. 60/939,351, filed May 21, 2007, entitled “METHODS AND APPARATUS FOR POLISHING A NOTCH OF A SUBSTRATE USING AN INFLATABLE POLISHING WHEEL” (Attorney Docket No. 10674/L);


[0008] U.S. Patent Application Ser. No. 60/939,343, filed May 21, 2007, entitled “METHODS AND APPARATUS TO CONTROL SUBSTRATE BEVEL AND EDGE POLISHING PROFILES OF EPITAXIAL FILMS” (Attorney Docket No. 11417/L);

[0009] U.S. Patent Application Ser. No. 60/939,219, filed May 21, 2007, entitled “METHODS AND APPARATUS FOR POLISHING A NOTCH OF A SUBSTRATE USING A SHAPED BACKING PAD” (Attorney Docket No. 11483/L);


[0015] U.S. Patent Application Ser. No. 60/939,228, filed May 21, 2007, entitled “METHODS AND APPARATUS FOR POLISHING A NOTCH OF A SUBSTRATE BY SUBSTRATE VIBRATION” (Attorney Docket No. 11952/L); and


FIELD OF THE INVENTION

[0017] The present invention relates generally to substrate processing, and more particularly to methods and apparatus for cleaning an edge of a substrate.

BACKGROUND OF THE INVENTION

[0018] Substrates are used in semiconductor device manufacturing. During processing, the edge of the substrate may become dirty, which may negatively affect the semiconductor devices. Conventional systems, which contact a substrate edge with an abrasive film to clean the edge, may not thoroughly clean the edge. For example, the abrasive tape or film may not sufficiently contact both bevels of the edge during cleaning. Additionally, the abrasive tape may run-off during the polishing process, especially when the tape is minimally tensioned. The inability to sufficiently clean the substrate may affect semiconductor device manufacturing throughput. Accordingly, improved methods and apparatus for cleaning an edge of a substrate are desired.

SUMMARY OF THE INVENTION

[0019] In aspects of the invention, an apparatus is provided for polishing an edge of a substrate. The apparatus comprises a polishing head, adapted to contact an edge of a substrate, wherein the polishing head includes one pair of front guide rollers and two pairs of back clamping rollers.

[0020] In other aspects of the invention, a system is provided for polishing an edge of a substrate. The system comprises a substrate support adapted to rotate a substrate; a polishing head adapted to contact an edge of a substrate, wherein the polishing head includes one pair of front rollers and two pairs of back rollers; and a controller adapted to operate the polishing of the edge of the substrate.

[0021] In yet other aspects of the invention, a method is provided for polishing an edge of a substrate. The method comprises rotating a substrate; contacting an edge of the substrate with a polishing head, wherein the polishing head includes one pair of front rollers and two pairs of back rollers; routing a polishing tape between the first pair of back rollers, around the first and second front rollers, and then between the second pair of back rollers, such that the length of polishing
tape between the first and second front rollers contacts and polishes the edge of the substrate.  

Other features and aspects of the present invention will become more fully apparent from the following detailed description, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a schematic illustration of a cross-section of a portion of a substrate.  

FIG. 2 is a perspective illustration depicting an example embodiment of an edge cleaning apparatus according to the present invention.  

FIG. 3 is a plan view depicting an example embodiment of an edge cleaning system according to the present invention.  

FIG. 4 is a perspective view of a polishing head according to the present invention.  

FIG. 5 is a schematic illustration of the polishing head of the bevel polishing module according to the present invention.  

FIG. 6 is a flowchart depicting the application of the polishing tape to an edge of a substrate according to the present invention.

DETAILED DESCRIPTION

The present invention provides improved methods, systems and apparatus for cleaning and/or polishing the edge of a substrate. The edge of a substrate may be polished by application of an abrasive polishing tape contacting the substrate edge (via a backing pad, in some embodiments) as the substrate is rotated or otherwise moved (e.g., oscillated). However, the polishing tape may run-off the polishing head, even when the apparatus is being operated with minimal tape tension values. According to the present invention, in some embodiments a polishing head is provided that may include a top plate, located in a plane opposite and parallel to a bottom plate. A pair of front guide rollers may be positioned between the top plate and the bottom plate. A first and second pair of back rollers may also be positioned between the top and bottom plates, and opposite each front roller. The back rollers may function to clamp the polishing tape that is routed between the rollers so that the polishing tape maintains alignment on the rollers without requiring tension along the length of the polishing tape. The front and back rollers may be arranged to route the polishing tape around or over the backing pad. In some embodiments, the space between the two back rollers in each pair of back rollers may be limited such that the polishing tape may be constrained in the lateral direction by the walls of the rollers. This may help to ensure that the tape does not run-off the polishing head, even when the apparatus is being operated with minimal tape tension values.

The present invention provides improved methods and apparatus for cleaning and/or polishing the edge of a substrate. With reference to FIG. 1, a substrate 100 may include two major surfaces 102, 102', and an edge 104. Each major surface 102, 102' of the substrate 100 may include a device region 106, 106' and an exclusion region 108, 108'. (Typically, however, only one of the two major surfaces 102, 102' will include a device region and an exclusion region.) The exclusion regions 108, 108' may serve as buffers between the device regions 106, 106' and the edge 104. The edge 104 of a substrate 100 may include an outer edge 110 and bevels 112, 114. The bevels 112, 114 may be located between the outer edge 110 and the exclusion regions 108, 108' of the two major surfaces 102, 102'. The present invention is adapted to clean and/or polish the outer edge 110 and at least one bevel 112, 114 of a substrate 100 without affecting the device regions 106, 106'. In some embodiments, all or part of the exclusion regions 108, 108' may be cleaned or polished as well.

As shown in FIG. 2, an example of an edge polishing apparatus 200 is depicted. The apparatus 200 may include a base or frame 202 that includes a head 204 which supports a length of polishing tape 201. The polishing tape 201 may be tensioned between front and back rollers 210, 212, and further supported by a backing pad 203. The backing pad 203 may be mounted to the head 204 via an actuator (e.g., a pneumatic slide, hydraulic ram, servo motor driven pusher, etc.) (not shown). The edge polishing apparatus 200 of FIG. 2 also may include a vacuum chuck 205 coupled to a driver 208 (e.g., motor, gear, belt, chain, etc.). Unlike some embodiments which may include one or more drive rollers (not shown) and guide rollers (not shown) that are adapted to rotate the substrate 100 such that the substrate edge 104 is rotated against the polishing tape 201, an advantage of using the vacuum chuck 205 may be that the vacuum chuck 208 does not need to contact the substrate edge 104 being polished. Thus, the potential of particles accumulating on drive rollers and being re-deposited on the substrate edge 104 is eliminated. The need to clean rollers also is eliminated. Further, the possibility of rollers damaging or scratching the substrate edge 104 may also be eliminated. By holding the substrate 100 in the vacuum chuck 205, high speed rotation without significant vibration may be achieved.

The polishing tape 201 may be supplied to the head 204 by a set of spools including a supply spool 209 and a take-up spool 211. The spools 209, 211 may be driven by one or more drivers 213, 215 (e.g., servo motors) which may provide an indexing capability to allow a specific amount of unused polishing tape 201 to be advanced or continuously fed to the substrate edge 104, and/or a tensioning capability to allow the polishing tape 201 to be stretched taught and to apply pressure to the substrate edge 104.

The front and back rollers 210, 212 may be adapted to apply a variable amount of tension to the polishing tape 201, and thereby the substrate edge 104, so as to attain precise control over an edge polishing process which may be used to compensate for different edge geometries and changes in the substrate 100 as material is removed from the substrate edge 104.

The substrate 100 may contact the abrasive tape 201 for about 15 to about 150 seconds depending on the type of tape used, the grit of the tape, the rate of rotation, the amount of polishing required, etc. More or less time may be used. The contact between the backing pad 203, and hence polishing tape 201, and the substrate edge 104 combined with the particular rotation speed of the substrate 100, may provide relative movement between the polishing tape 201 and the substrate edge 104, resulting in the substrate edge 104 being polished. Depending on the amount of force applied by the actuator, the resiliency of the pad selected, the amount of inflation of an inflatable pad, and/or the amount of tension on the polishing tape, a controlled amount of pressure may be applied to polish the substrate edge 104. Thus, the present invention may provide precise control of an edge polish process, which may be used to compensate for different edge
geometries and changes in the substrate 100 as material is removed from the substrate edge 104.

[0036] The substrate 100 may be rotated in a horizontal plane. The edge 104 of the substrate 100 may be aligned with, or normal to, the polishing tape 201, pad 203 and/or polishing head 204. In additional or alternative embodiments, the substrate 100 may be rotated in a vertical plane, other non-horizontal plane, and/or be moved between different planes of rotation.

[0037] FIG. 3 is a plan view depicting another example embodiment of an edge cleaning system 300 according to the present invention. FIG. 3 depicts an edge polishing system 300 including three heads 304, each attached to a polishing apparatus 303. The polishing apparatuses 303 shown herein, include features similar to the polishing apparatuses 200 described above with respect to FIG. 2. As suggested by FIG. 2 and FIG. 3, any number and type of heads 304 may be used in any practicable combination. Substrate [edge/notch] polishing may be performed using one or more polishing apparatuses 303. In one or more embodiments, a plurality of polishing apparatuses 303 may be employed, in which each polishing apparatus may have similar or different characteristics and/or mechanisms. In the latter case, particular polishing apparatuses 303 may be employed for specific operations. For example, one or more of a plurality of polishing apparatuses 303 may be adapted to perform relatively rough/coarse polishing and/or adjustments while another one or more of the plurality of polishing apparatuses may be adapted to perform relatively fine polishing and/or adjustments. Polishing apparatuses 303 may be used in sequence so that, for example, a rough polishing procedure may be performed initially and a fine polishing procedure may be employed subsequently to make adjustments to a relatively rough polish as needed or according to a polishing recipe. The plurality of polishing apparatuses 303 may be located in a single chamber or module, as shown herein, or alternatively, one or more polishing apparatuses 303 may be located in separate chambers or modules. Where multiple chambers are employed, a robot or another type of transfer mechanism may be employed to move substrates between the chambers so that polishing apparatuses in the separate chambers may be used in series or otherwise.

[0038] In addition, in such multi-head embodiments, each head 304 may use a differently configured or type of polishing tape 201 (e.g., different grits, materials, tensions, pressures, etc.). Any number of heads 304 may be used concurrently, individually, and/or in any sequence. The heads 304 may be disposed in different positions and in different orientations (e.g., aligned with the substrate edge 104, normal to the substrate edge 104, angled relative to the substrate edge 104, etc.) to allow the tape 201 to polish different portions of the edge 104 of the substrate 100.

[0039] In some embodiments, one or more of the heads 304 may be adapted to be oscillated or moved (e.g., angularly translated about a tangential axis of the substrate 100 and/or circumferentially relative to the substrate 100) around or along the substrate edge 104 by the frame 202 so as to polish different portions of the substrate edge 104. Different heads 304 may be used for different substrates 100 or different types of substrates.

[0040] As further described below, the system 300 may further include a controller 306, (e.g., a programmed computer, a programmed processor, a microcontroller, a gate array, a logic circuit, an embedded real time processor, etc.), which may control the driver(s) used to rotate the substrate 100 and/or the actuator(s) used to push the polishing pad(s) 203 against the substrate edge 104. Note that the controller 306 may be coupled (e.g., electrically, mechanically, pneumatically, hydraulically, etc.) to each of a plurality of actuators. Likewise, the controller 306 may be adapted to receive feedback signals from one or more drivers and/or actuators, that indicate the amount of energy being exerted to rotate the substrate 100 (e.g., rotate a vacuum chuck holding the substrate 100) and/or actuate the actuator(s) to push the polishing pad(s) 203 against the substrate 100. These feedback signals may be employed to determine when a particular layer of film has been removed and/or whether a sufficient amount of polishing has occurred.

[0041] Turning to FIG. 4, an exemplary polishing head 400 for use with the polishing tape 201, shown in FIG. 5, to clean the edge 104 of the substrate 100 is provided. The surface of the polishing tape 201 in contact with the substrate edge 104 may include an abrasive material to expedite the polishing. In one or more embodiments, the polishing tape 206 may be made from one or more different materials including, for example, aluminum oxide, silicon oxide, silicon carbide, etc. Other materials may also be used. In some embodiments, the abrasive particles forming the abrasive material may range from about 0.5 microns up to about 5 microns in size, although other sizes may be used. Different widths of tape ranging from about 0.2 inches to about 1.5 inches may be used (although other widths may be used). In one or more embodiments, the polishing tape 201 may be about 0.002 inches to about 0.02 inches thick, and be able to withstand about 1 to about 5 lbs. of tension in embodiments that use a pad, and from about 3 to about 8 lbs. of tension in embodiments without a pad. Other tapes having different thicknesses and strengths may be used. The supply and take-up spools 209, 211 (FIG. 2) may be approximately 1 inch to approximately 4 inches in diameter, held up to approximately 5000 inches of polishing tape 201, and may be constructed from any practicable materials such as polyurethane, polyvinylidene fluoride (PVDF), etc. Other materials may be used. The supply and take-up spools 209, 210 may also have other dimensions and hold other amounts of polishing tape 201.

[0042] The polishing head 400 may include a top plate 402, located in a plane opposite and parallel to a bottom plate 404. A pair of front rollers 406a, 406b may be positioned between the top plate 402 and the bottom plate 404, such that the front rollers 406a, 406b are able to rotate in a plane perpendicular, or alternatively, substantially perpendicular to the top and bottom plates 402, 404. In other words, the axis of rotation may be perpendicular (or substantially so) to the horizontal plane of the top and bottom plates 402, 404, and therefore the plane of rotation may be parallel to the top and bottom plates 402, 404. A first and second pair of back rollers 408a and 408b may be positioned between the top and bottom plates 402, 404 and oppose each front roller 406a and 406b, respectively, and may rotate in the same rotational orientation as the front rollers 406.

[0043] The rollers may be designed for maximum diameter to reduce friction. The rollers may be made of a plastic bearing material including but not limited to PTFE and PEEK.

[0044] Turning to FIG. 5, an top view schematic illustration of the polishing head 400 (with top plate 402 removed for clarity), shown above in FIG. 4. Of the bevel polishing module is depicted. The front and back rollers 406a, 406b, & 408a, 408b may be arranged to route the polishing tape 201 (not
shown in FIG. 4, but see FIG. 5) around the backing pad 203. The arrangement of rollers 406a, 406b, 408a, 408b may accurately align the tape 201 around the backing pad 203. In some embodiments, the back rollers 408a, 408b may be self-locking. In some embodiments, the space between the two back rollers 408a in the first pair and 408b in the second pair of back rollers may be very limited. Thus, the polishing tape 201 routed through each of the first and second pairs of back rollers 408a and 408b may be constrained in the lateral direction by the walls of the rollers 408a, 408b. This may help to ensure that the tape 201 does not run-off the polishing head 400, even when the apparatus is being operated with minimal tape tension values. Other back roller 408a, 408b orientations may be used.

In some embodiments, the back rollers 408a, 408b may be disposed so close together that the back rollers 408a, 408b effectively clamp the polishing tape 201 and prevent the polishing tape 201 from moving along the longitudinal dimension of the back rollers 408a, 408b and consequently prevent the polishing tape 201 from moving along the longitudinal dimension of the front rollers 406a, 406b as well as prevent the polishing tape 201 from slipping off the backing pad 203. In other words, without having to rely on high tension applied to the polishing tape 201 along the length of the polishing tape 201 (i.e., in the longitudinal dimension of the polishing tape 201) to keep the polishing tape 201 aligned on the front rollers 406a, 406b and the backing pad 203, the present invention facilitates maintaining the alignment of the polishing tape 201 on the front rollers 406a, 406b and the backing pad 203 by using two pairs of back rollers 408a, 408b which each clamp the polishing tape 201 on either side of the front rollers 406a, 406b which allows the polishing tape 201 to move through the polishing head 400 but not move laterally off the rollers towards the top plate 402 or bottom plate 404.

In some embodiments, the front rollers 406a, 406b may be placed close to the backing pad 203 (e.g., disposed so as to guide the polishing tape 201 out to a plane that is almost co-planar with the backing pad 203) to reduce the amount of displacement of the polishing tape 201 by the backing pad 203 needed to make the polishing tape 201 contact the edge 104 of the substrate 100. Other front roller orientations may be used. The front and back roller 406a, 406b, 408a, 408b arrangement may reduce the effect of the polishing tape 201 tension on the backing pad 203. In some embodiments (e.g., embodiments that use a roller backing pad 203), the front rollers 406a, 406b may be removed, and the polishing tape 201 may be routed just over the backing pad 203.

In some embodiments, the spool of polishing tape 201 mounted to the head 400 may be driven by one or more drivers 213, 215, e.g., servo motors (FIG. 2). The drivers 213, 215 may provide both an indexing capability to allow a specific amount of unused polishing tape 201 to be advanced or continuously fed to the substrate edge 104, and a tensioning capability to allow the polishing tape 201 to be stretched taught and to apply pressure to the substrate edge 104. Alternatively or additionally, the abrasive side of the polishing tape 201 may be pressed against the substrate edge 104 using the backing pad 203, mounted to the head 400 and pushed by an actuator and/or by inflation of an inflatable pad. In embodiments described herein, the polishing head 400 may rock around the edge 104 of the substrate 100 to polish the entire substrate edge 104. The angle of rocking may include, for example, plus or minus 90 degrees. Other suitable rocking angles may be used. In operation, the rocking motion may be achieved by angularly translating the head 400 and consequently, a portion of polishing tape 201 in contact with, and contoured to, the edge 104 of the substrate 100 around an axis that is tangential to the outer edge 110 of the substrate 100 as the substrate 100 is rotated. For example, the polishing head 400 may start polishing at the upper bevel 112, adjust to polish the outer edge 110 and then adjust again to polish the lower bevel 114. While the polishing head 400 rocks about the edge 104, the entire substrate 100 may be rotated such that the entire circumferential edge 104 of the substrate 100 may be polished. The substrate 100 may be rotated by a, vacuum chuck or driver rollers, as described above. Other suitable substrate rotation devices may be used. In some embodiments, the head 400 may be adapted to continuously or intermittently oscillate between various positions. As described above, the head 400 may be moved by drivers (not shown) under the direction of a programmed or user operated controller 306. Alternatively, the head 400 may be fixed and or only adjusted while the substrate 100 is not being rotated. In yet other embodiments, the substrate 100 may be held fixed while the head 400 is oscillated (as described above) as well as rotated circumferentially around the substrate 100. The front and back roller 406a, 406b, 408a, 408b arrangement may ensure that the contact between the tape 201 and the substrate 100 is consistent at any angle during the rotation of the head 400.

Further, the polishing tape 201 may be mounted on the head 400 in a continuous loop and/or the polishing tape 201 may be continuously (or intermittently) advanced to polish and/or increase the polishing effect on the substrate edge 104. For example, the advancement of the tape 201 may be used to create and/or enhance the polishing motion. In some embodiments the tape 201 may be oscillated back and forth to polish and/or enhance the polishing effect on a stationary or rotating substrate 100. In some embodiments, the tape 201 may be held stationary during polishing. Further, the tape 201 tension and/or force may be varied based on various factors including, for example, the angle and/or position of the polishing tape 201, the polishing time, the materials used in the substrate, the layer being polished, the amount of material removed, the speed at which the substrate is being rotated, the amount of current being drawn by the driver rotating the substrate, etc. Any combination of the above described polishing motions and/or methods may be used to achieve the desired practice.

These methods provide additional control over the edge polish process which can be used to compensate for geometry and changes in the material being removed as the tape 201 is rotated/moved about, or relative to, the substrate edge 104.

FIG. 6 is a flowchart depicting an exemplary method 600 for loading polishing tape 201 for use in a bevel polishing system 300. In step 602, an appropriate polishing tape 201 is selected. The type of polishing tape selected may vary depending on, for example, a particular abrasiveness, liquid chemicals being used, tape durability, polishing process etc. In step 604, the spool of polishing tape 201 is inserted in the bevel polishing system 300. In some embodiments, the system 300 may include a supply spool 209 of tape for supplying polishing tape and a take-up spool 211 for receiving the used polishing tape. The supply spool 209 of polishing tape 201 may be inserted in the supply spool location of the system 300. Then the polishing tape 201 may be routed between the first pair of back rollers 408a in step 606. Routing the polishing tape 201 between the two rollers forming each pair of back rollers 408a and 408b, may prevent, or lessen, lateral movement of the polishing tape 201, which may disrupt the
polishing process. The polishing tape 201 may then be routed around the outside of the first front roller 406a in step S608. Then the polishing tape 201 may be routed over the backing pad 203, and around the outside of the second front roller 406b in steps S610 and S612, respectively. The portion of the polishing tape 201 over the backing pad 203 may be pressed by the backing pad 203 onto the edge 104 of the substrate 100. The rotation of the substrate 100, as well as the movement of the polishing tape 201 against the edge 104 of the substrate 100, is how the substrate edge 104 may be polished. In step S614, the polishing tape 201 may then be routed between the second pair of back rollers 408b. The loose end of the polishing tape 201 is then affixed to the take-up spool 211 in step S616. After cleaning one or more substrates 100, the portion of the polishing tape 201 employed for such cleaning may become worn. Therefore, the take-up spool 211 may be driven to draw the polishing tape 201 by a fixed amount from the supply spool 209 towards the take-up spool 211. In this manner, an unused portion of the polishing tape 201 may be provided between the take-up spool 211 and the supply spool 209. The unused portion of the polishing tape 201 may be employed to subsequently clean one or more other substrates 100 in a manner similar to what described above. Consequently, a new portion of polishing tape 201 may be replaced with an unused portion with little or no impact on substrate processing throughput. In some embodiments, the polishing tape 201 may be considered to be “worn,” for example, after being applied to a predetermined number of substrates. The type of polishing being performed may impact the predetermined number of substrates, for example. In alternative embodiments, the polishing tape 201 may be considered “worn” after the size or number, for example, of abrasive particles/materials has decreased by a particular amount. This determination may be made by the controller 306 after receiving feedback from sensors, for example.

[0050] It should be understood that the inventive edge polishing apparatus described herein may be employed in apparatuses other than those adapted for bevel and edge polishing and/or removal of films on substrates. Further, as will be apparent to those of ordinary skill in the art, the apparatus described herein may be employed to polish and/or remove films on an edge of a substrate supported in any orientation (e.g., horizontal, vertical, diagonal, etc).

[0051] Further, it should be understood that although only examples of cleaning a round substrate are disclosed, the present invention could be modified to clean substrates having other shapes (e.g., a glass or polymer plate for flat panel displays). Further, although processing of a single substrate by the apparatus is shown above, in some embodiments, the apparatus may process a plurality of substrates concurrently.

[0052] The foregoing description discloses only exemplary embodiments of the invention. Modifications of the above disclosed apparatus and methods which fall within the scope of the invention will be readily apparent to those of ordinary skill in the art. Accordingly, while the present invention has been disclosed in connection with exemplary embodiments thereof, it should be understood that other embodiments may fall within the spirit and scope of the invention, as defined by the following claims.

The invention claimed is:
1. An apparatus for polishing an edge of a substrate, the apparatus comprising:
   a polishing head, adapted to contact an edge of a substrate, wherein the polishing head includes at least one front roller adapted to guide a polishing tape and at least one pair of back rollers adapted to maintain an alignment of the polishing tape.

2. The apparatus of claim 1 wherein the front and back rollers are adapted to rotate.

3. The apparatus of claim 1 wherein the polishing head includes a pad.

4. The apparatus of claim 3 wherein the polishing head is adapted to guide the polishing tape over the pad.

5. The apparatus of claim 4 wherein the pad is adapted to press the polishing tape to contact the edge of the substrate.

6. The apparatus of claim 4 wherein the polishing tape is routed between a first pair of back rollers, around a first front roller and a second front roller, and then between a second pair of back rollers.

7. The apparatus of claim 6 wherein a length of polishing tape between the first and second front rollers is adapted to contact the edge of the substrate.

8. The apparatus of claim 1 wherein the back rollers are self-locking.

9. The apparatus of claim 6 wherein the polishing tape is constrained from slipping off the pad by the back rollers.

10. A system for polishing an edge of a substrate, the system comprising:
   a substrate support adapted to rotate a substrate;
   a polishing head adapted to contact an edge of a substrate, wherein the polishing head includes one pair of front rollers and two pairs of back rollers;
   a controller adapted to operate the polishing of the edge of the substrate.

11. The system of claim 10 wherein the polishing head includes a polishing tape.

12. The system of claim 11 wherein the polishing head is adapted to contact the edge of the substrate with the polishing tape.

13. The system of claim 12 wherein the polishing head is adapted to contact the edge of the substrate with the polishing tape.

14. The system of claim 12 wherein the polishing tape is routed between the first pair of back rollers, around the first and second front rollers, and then between the second pair of back rollers.

15. The system of claim 14 wherein the length of polishing tape between the first and second front rollers contacts the edge of the substrate.

16. The system of claim 12 wherein the controller is adapted to incrementally advance the polishing tape to the polishing head.

17. The system of claim 14 wherein the polishing tape is constrained in the lateral direction by the back rollers.

18. The system of claim 11 wherein the front and back rollers are adapted to rotate.

19. The system of claim 11 wherein the polishing head is adapted to rock about the edge of the substrate.

20. A method for polishing an edge of a substrate comprising:
   rotating a substrate;
   contacting an edge of the substrate with a polishing head, wherein the polishing head includes one pair of front rollers and two pairs of back rollers;
   routing a polishing tape between the first pair of back rollers, around the first and second front rollers, and then between the second pair of back rollers, such that the length of polishing tape between the first and second front rollers contacts and polishes the edge of the substrate.
21. The method of claim 20 further comprising: advancing the polishing tape in increments.
22. The method of claim 20 further comprising: advancing the polishing tape continuously.
23. The method of claim 20 further comprising: constraining the polishing tape in the lateral direction between each pair of back rollers.

24. The method of claim 20 further comprising: pressing the polishing tape against the edge of the substrate via a pad.
25. The method of claim 20 further comprising: rocking the polishing head about the edge of the substrate.