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(54) **METHODS AND APPARATUS TO CONTROL SUBSTRATE BEVEL AND EDGE POLISHING PROFILES OF FILMS**

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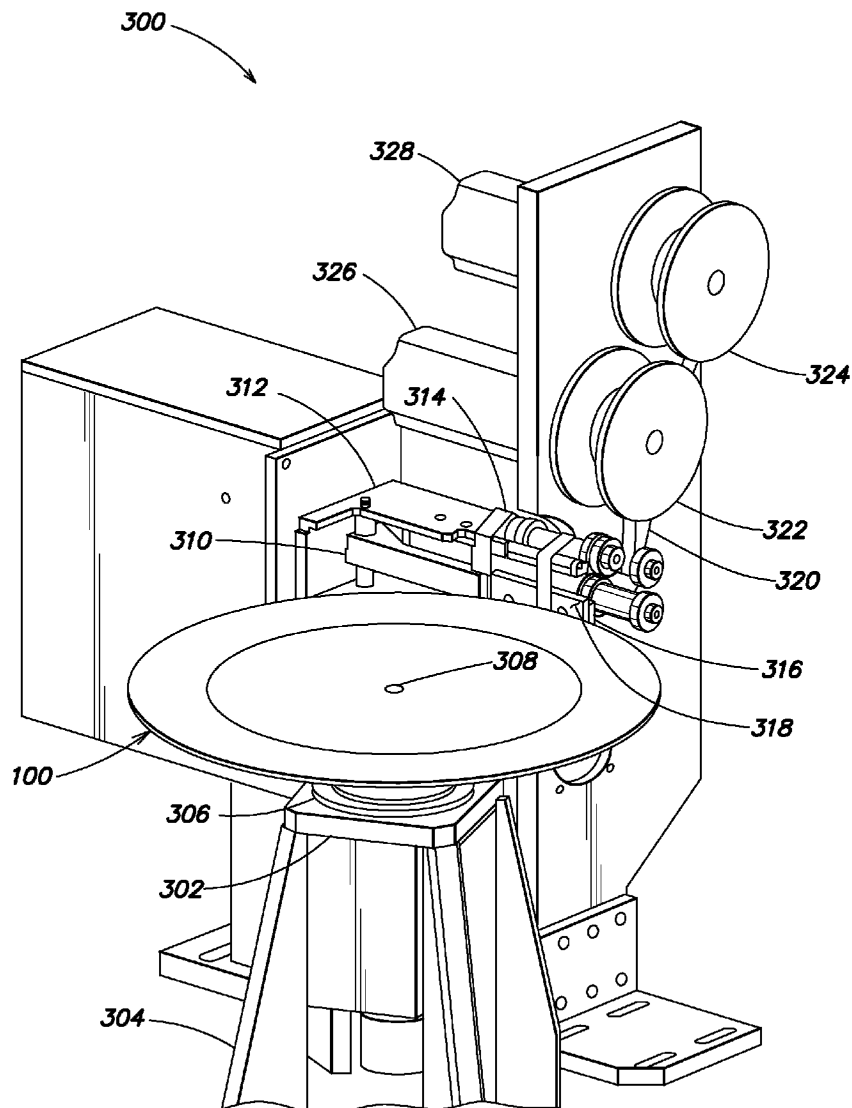
(57) **ABSTRACT**

Methods and apparatus are provided for polishing a film on an edge of a substrate. In some embodiments, a polishing head is provided having a backing plate adapted to press polishing material against a film on an edge of a substrate. The backing plate has a profiled portion adapted to provide a pre-set film profile. Numerous other aspects are provided.



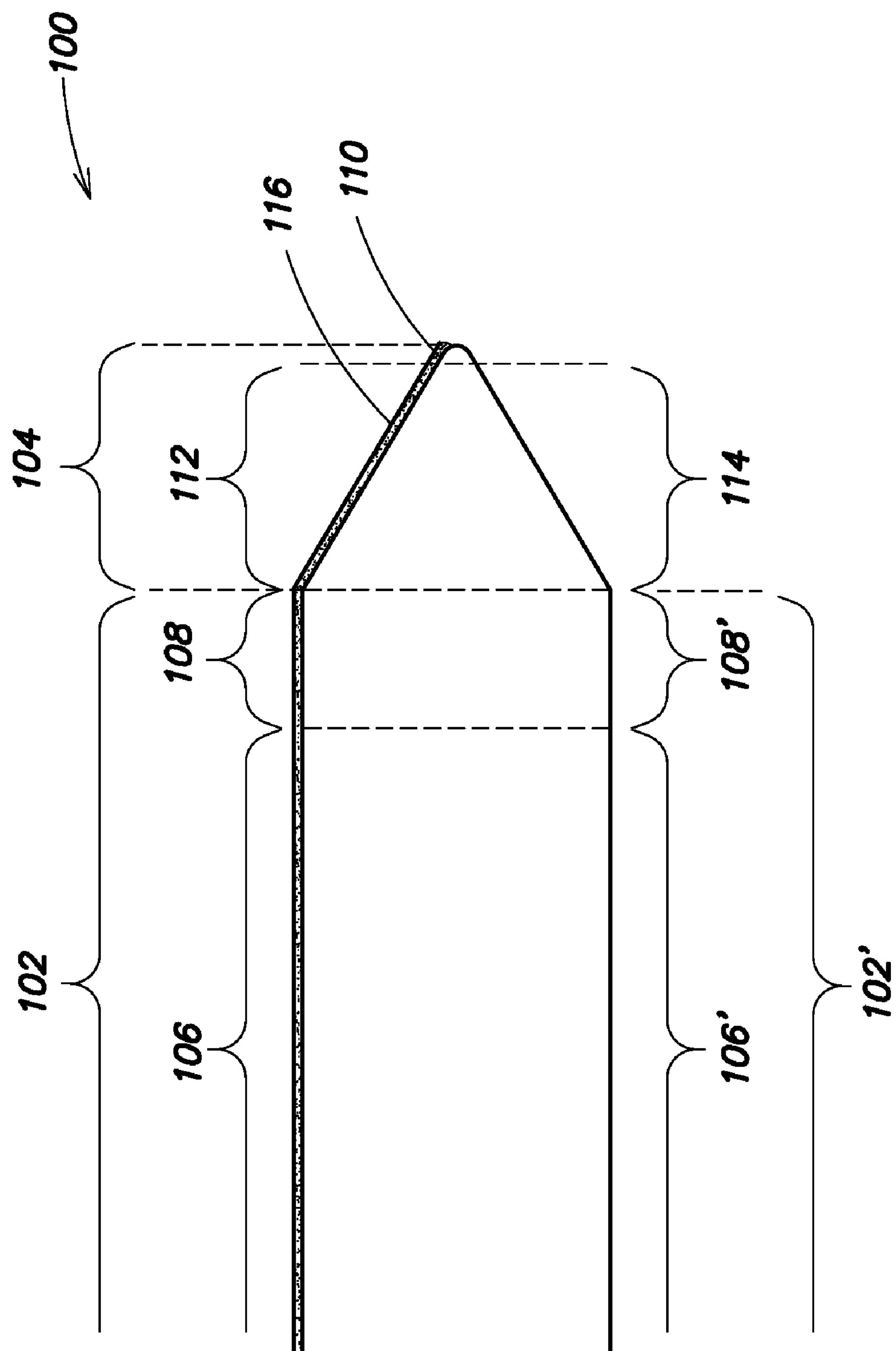


FIG. 1

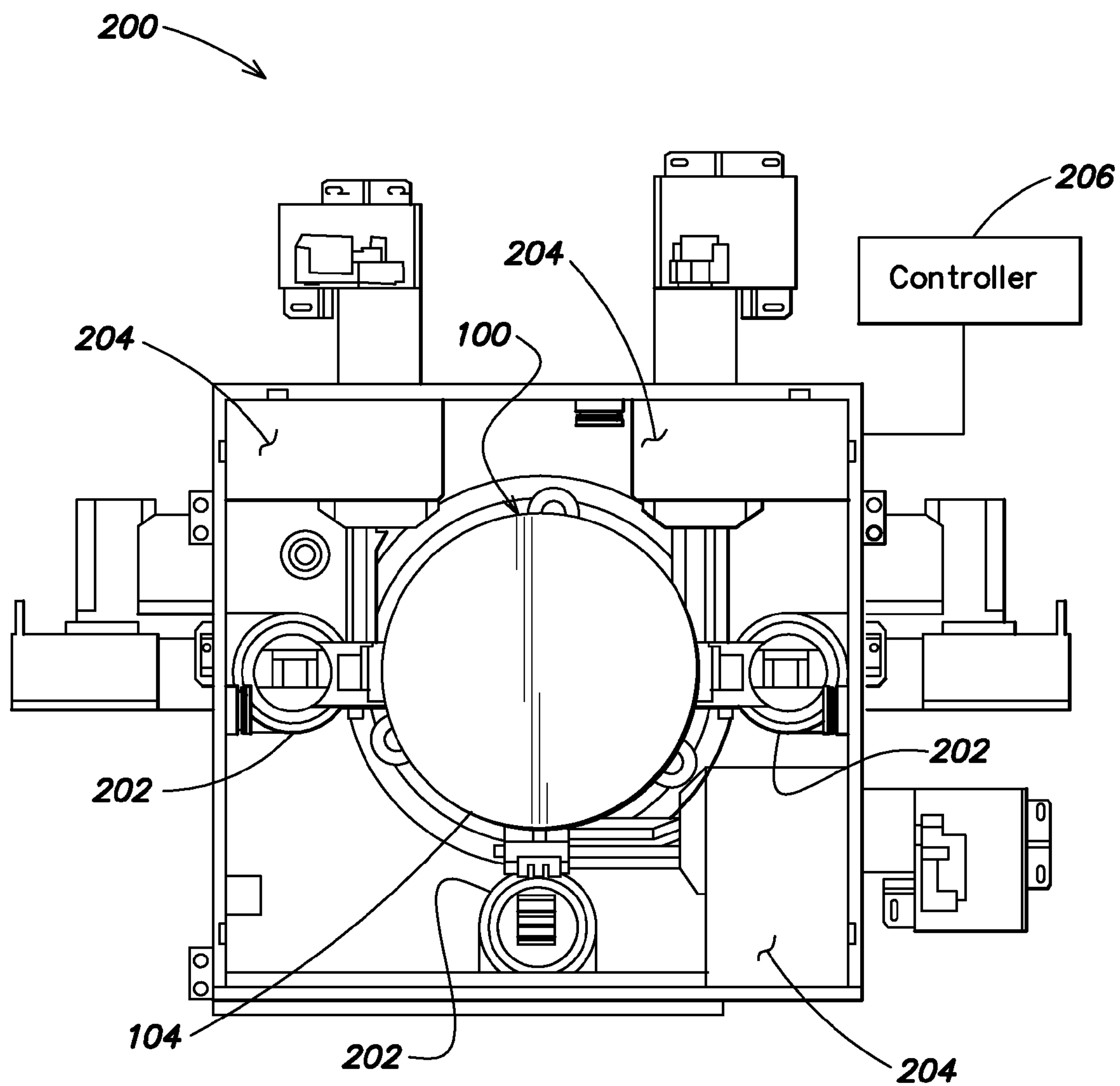


FIG. 2

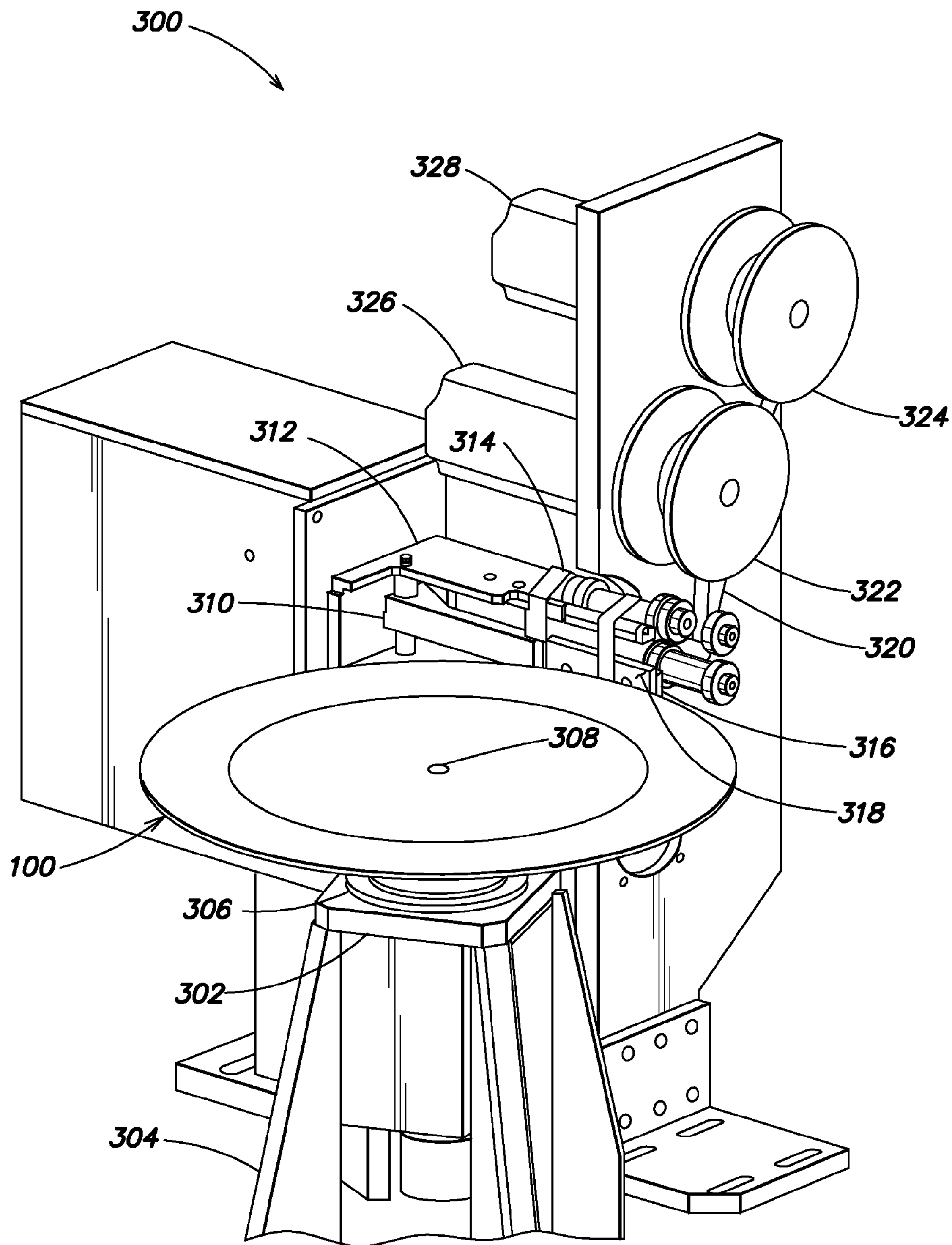


FIG. 3

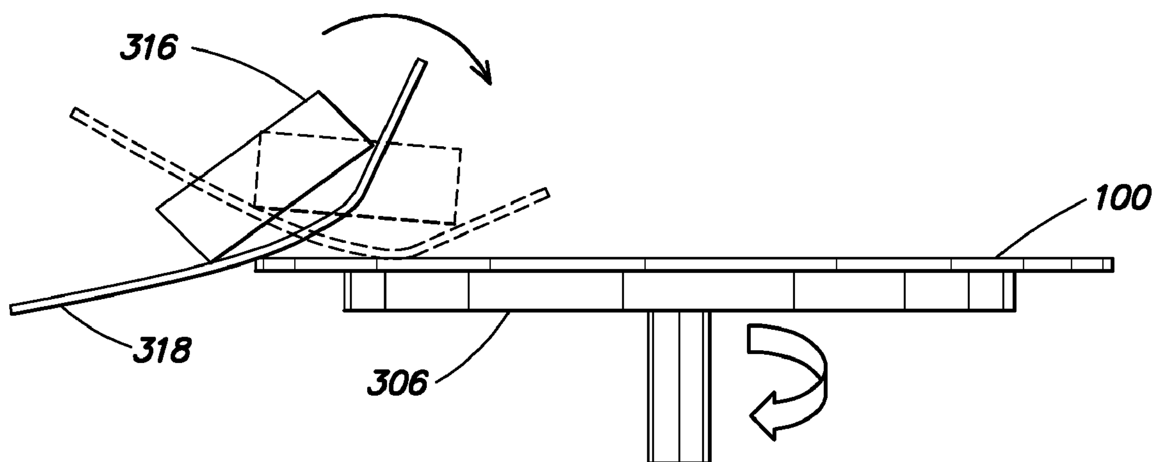


FIG. 4

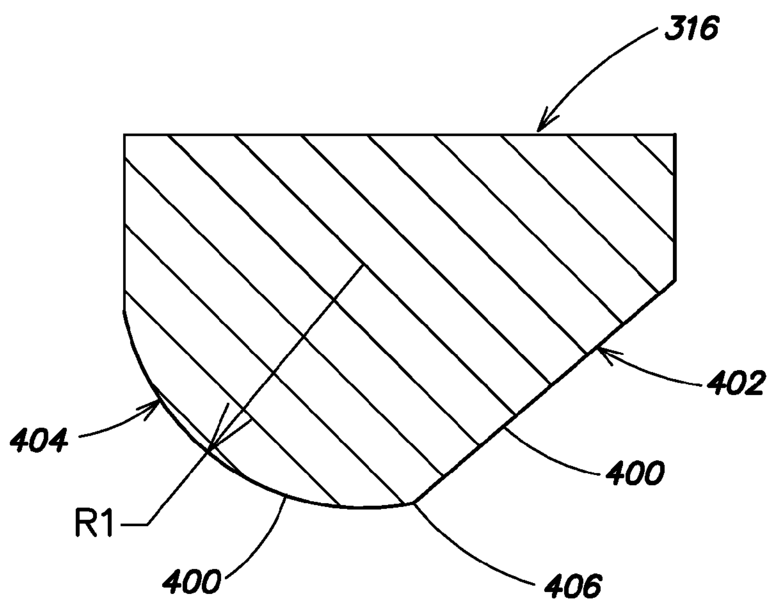


FIG. 5A

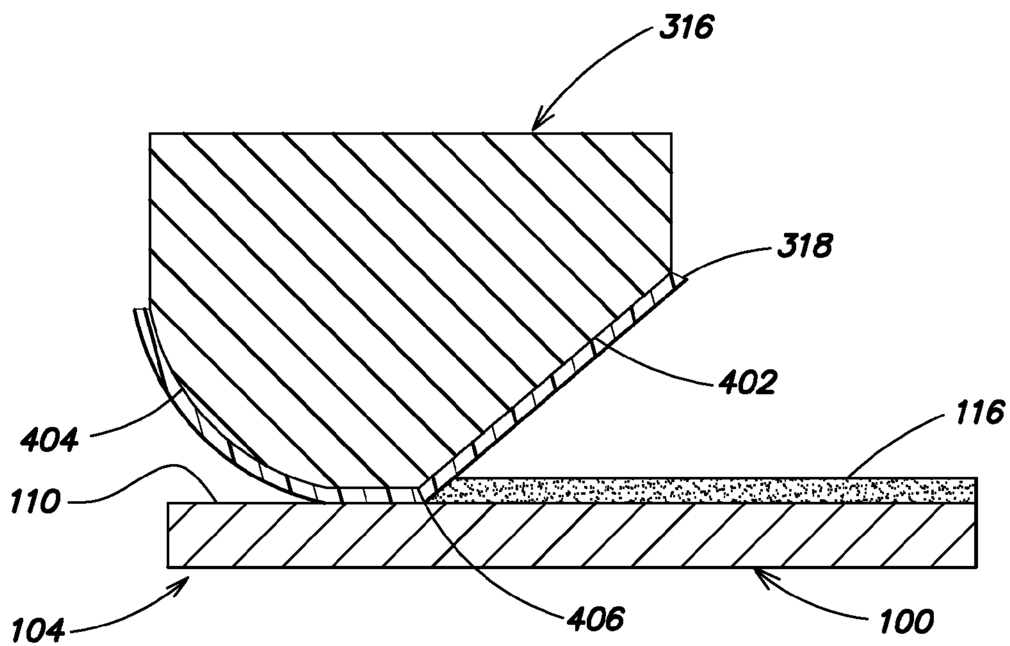


FIG. 5B

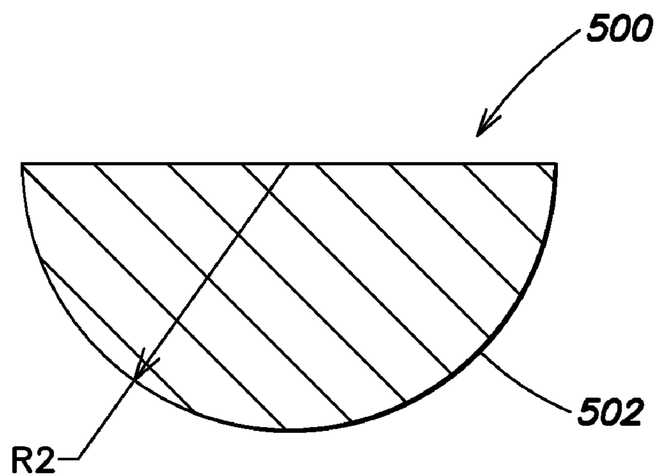


FIG. 6A

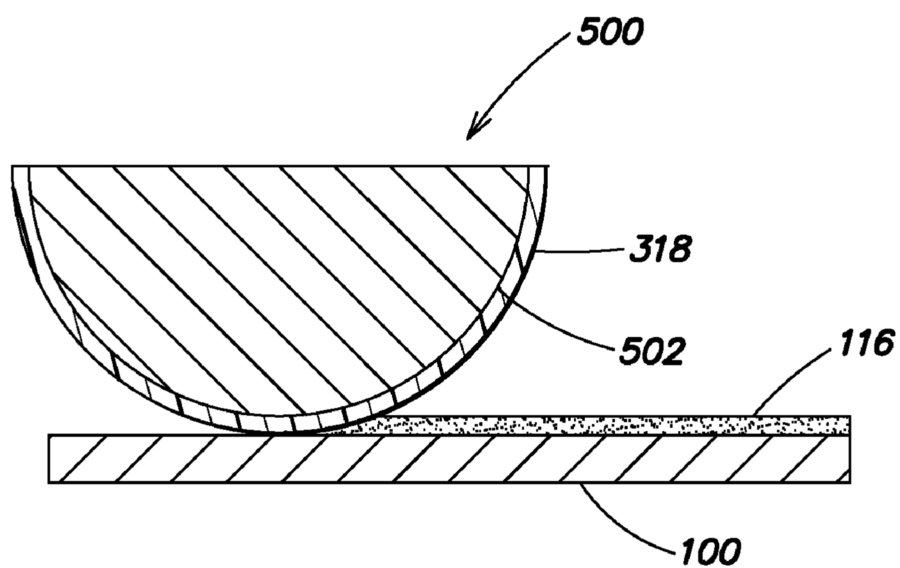


FIG. 6B

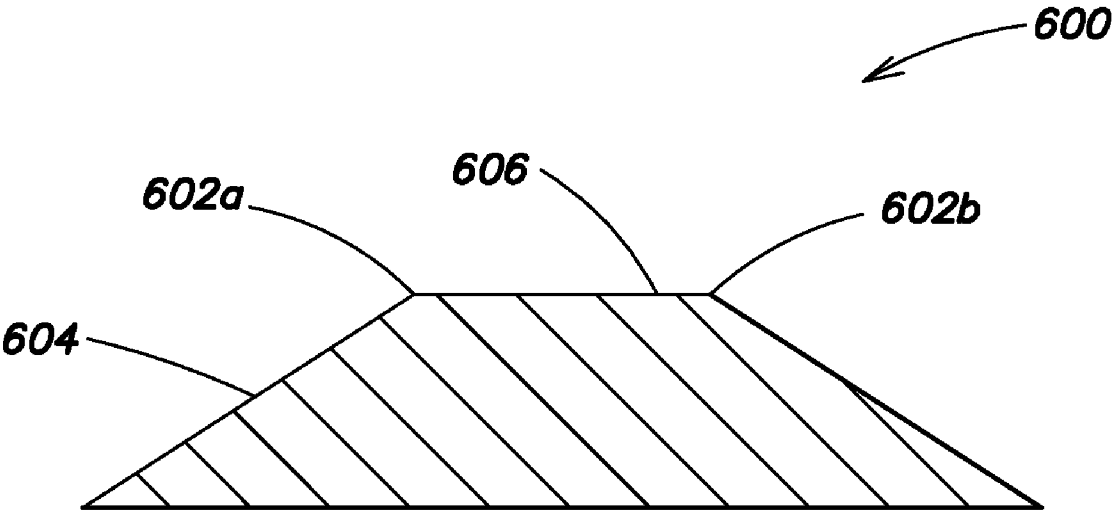


FIG. 7

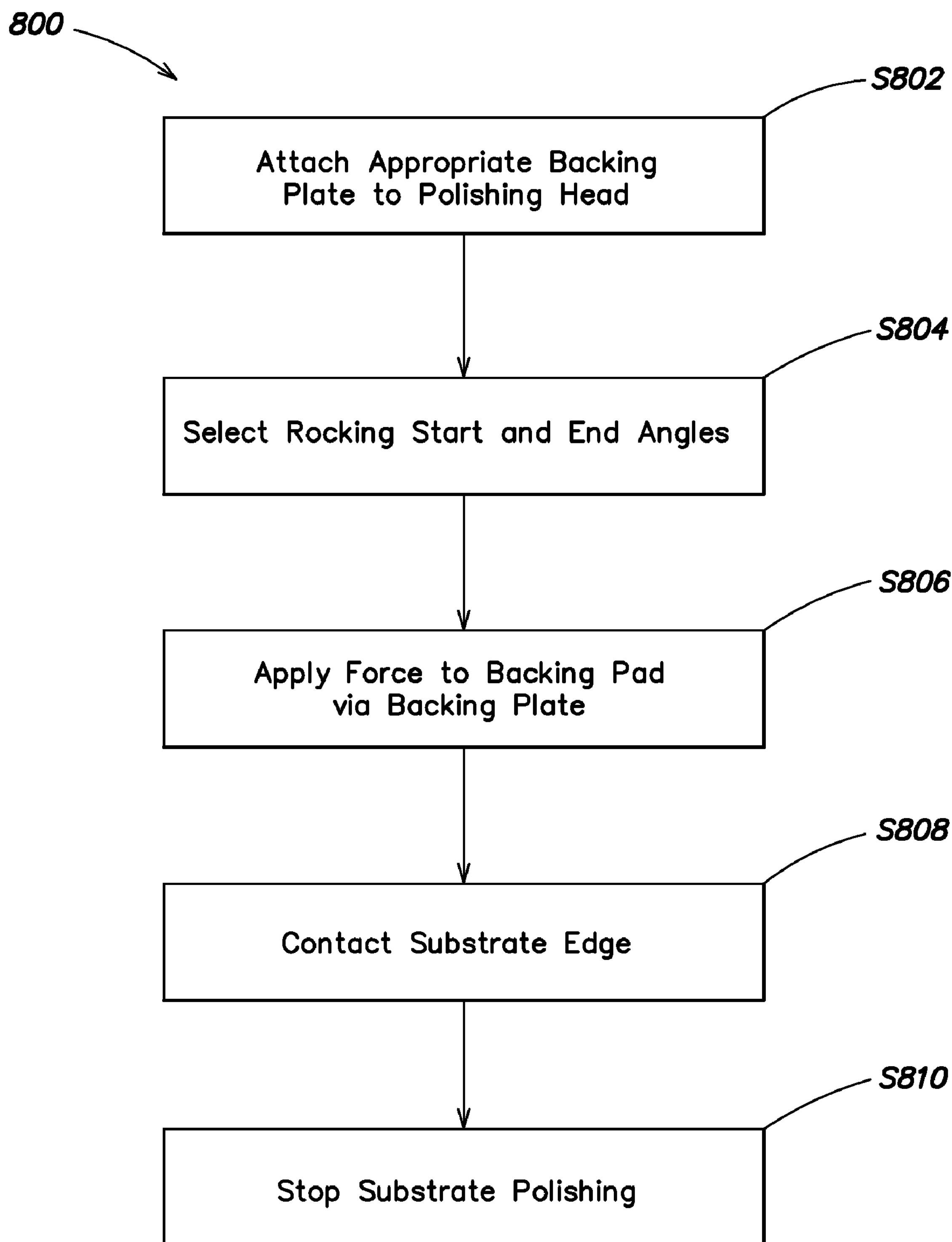


FIG. 8

METHODS AND APPARATUS TO CONTROL SUBSTRATE BEVEL AND EDGE POLISHING PROFILES OF FILMS

[0001] The present application claims priority from U.S. Provisional 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), which is hereby incorporated by reference herein in its entirety.

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:

[0003] U.S. patent application Ser. No. 11/299,295, filed on Dec. 9, 2005, and entitled "METHODS AND APPARATUS FOR PROCESSING A SUBSTRATE" (Attorney Docket No. 10121);

[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);

[0007] U.S. patent application Ser. No. 60/939,353, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR FINDING A SUBSTRATE NOTCH CENTER" (Attorney Docket No. 11244/L);

[0008] 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);

[0009] U.S. Patent Application Ser. No. 60/939,342, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR REMOVAL OF FILMS AND FLAKES FROM THE EDGE OF BOTH SIDES OF A SUBSTRATE USING BACKING PADS" (Attorney Docket No. 11564/L);

[0010] U.S. 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);

[0011] U.S. Patent Application Ser. No. 60/939,344, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR USING A ROLLING BACKING PAD FOR SUBSTRATE POLISHING" (Attorney Docket No. 11566/L);

[0012] U.S. Patent Application Ser. No. 60/939,333, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR SUBSTRATE EDGE POLISHING USING A POLISHING ARM" (Attorney Docket No. 11567/L);

[0013] U.S. Patent Application Ser. No. 60/939,212, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR IDENTIFYING A SUBSTRATE EDGE PROFILE AND ADJUSTING THE PROCESSING OF THE SUBSTRATE ACCORDING TO THE IDENTIFIED EDGE PROFILE" (Attorney Docket No. 11695/L);

[0014] U.S. Patent Application Ser. No. 60/939,337, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR HIGH PERFORMANCE SUBSTRATE BEVEL AND EDGE POLISHING IN SEMICONDUCTOR MANUFACTURE" (Attorney Docket No. 11809/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

[0016] U.S. Patent Application Ser. No. 60/939,209, filed May 21, 2007, entitled "METHODS AND APPARATUS FOR CONTROLLING THE SIZE OF AN EDGE EXCLUSION ZONE OF A SUBSTRATE" (Attorney Docket No. 11987/L).

FIELD OF THE INVENTION

[0017] The present invention relates generally to substrate processing, and more particularly to methods and apparatus for controlling substrate edge film profiles.

BACKGROUND OF THE INVENTION

[0018] Substrates are used in electronic device manufacturing. During processing, a film may be deposited on the surface of a substrate. However, it may be undesirable to have this film on the edge of the substrate. As such, methods and apparatus adapted to partially or completely remove films from an edge of a substrate are desired.

SUMMARY OF THE INVENTION

[0019] In aspects of the invention, an apparatus is provided for polishing a film on an edge of a substrate. The apparatus comprises a polishing head having a backing plate adapted to press polishing material against a film on an edge of a substrate, wherein the backing plate has a profiled portion adapted to provide a pre-set film profile during polishing.

[0020] In other aspects of the invention, a system for polishing a film on an edge of a substrate is provided. The system comprises a substrate support, adapted to support and rotate a substrate; a polishing head having a backing plate adapted to press polishing material against a film on an edge of a substrate, wherein the backing plate has a profiled portion adapted to provide a pre-set film profile during polishing; and a controller adapted to operate the movement of the polishing head.

[0021] In yet other aspects of the invention, a method for polishing a film on an edge of a substrate is provided. The method comprises selecting a rocking start angle and a rocking end angle for a profiled backing plate; contacting a film on an edge of a substrate with the backing plate; and rocking the backing plate against the film on the substrate edge during polishing.

[0022] In another aspect of the invention, a backing plate is provided that is adapted to press polishing material against a film on an edge of a substrate, wherein the backing plate has a profiled portion adapted to provide a pre-set film profile during polishing. Numerous other aspects are provided.

[0023] 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

[0024] FIG. **1** is a schematic illustration of a cross-section of a portion of a substrate.

[0025] FIG. **2** is a schematic plan view of an example embodiment of a system for polishing parts of a substrate according to the present invention.

[0026] FIG. **3** is a schematic perspective view depicting an embodiment of a polishing apparatus for polishing a substrate according to the present invention.

[0027] FIG. **4** is a schematic perspective view of an exemplary embodiment of a polishing apparatus including a backing plate according to the present invention.

[0028] FIG. **5**A is a schematic cross-sectional view depicting an example embodiment of a backing plate according to the present invention.

[0029] FIG. **5**B is an illustration of the backing plate shown in FIG. **5**A according to the present invention.

[0030] FIG. **6**A is a schematic cross-sectional view depicting an alternative example embodiment of a backing plate according to the present invention.

[0031] FIG. **6**B is an illustration of the backing plate shown in FIG. **6**A according to the present invention.

[0032] FIG. **7** is a schematic cross-sectional view depicting an additional example embodiment of a backing plate according to the present invention.

[0033] FIG. **8** is a flowchart describing the application of an example embodiment of the present invention.

DETAILED DESCRIPTION

[0034] The present invention provides improved methods and apparatus for polishing the edge of a substrate. In the present application, the term "polish" is used to mean wearing away of a layer of film deposited on the substrate. The wearing away may be partial, such that a thinner layer of film remains or may be complete, such that no film remains. The present invention provides a backing plate having a shape that substantially matches a desired film shape to remain at the substrate edge. Backing plates having different shapes may be used, depending on the desired film profile. The backing plate may also be rocked against the film to achieve the desired film profile. In some embodiments, the backing plate may press a backing pad against the film on the substrate to optimize film removal.

[0035] 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 substrate **100** may have a film **116** deposited on at least one major surface **102** and the edge **104**, including at least one bevel **112** and the outer edge **110** during processing. The present invention is adapted to 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.

[0036] FIG. **2** is a perspective view depicting an exemplary embodiment of a substrate polishing system **200** according to the present invention. The system **200** of FIG. **2** may be adapted to polish a substrate **100**, including, for example, the substrate edge **104**. In an edge polishing process, the substrate edge **104** may be polished to remove defects or contaminants, to reduce film thickness and more generally to improve surface uniformity.

[0037] The system **200** shown herein includes three polishing heads **202** which, in turn, may each be part of a plurality of polishing apparatus **204** for cleaning and polishing the above-mentioned parts of the substrate **100**. Any number and type of polishing heads **202** may be used in any practicable combination. The apparatus **204** may be supported by a frame. The frame may be constructed from any practicable materials such as aluminum, stainless steel, etc. In addition, in such multi-head embodiments, each head **202** may use a differently contoured backing plate **316** (FIG. **3**) (e.g., parallel or perpendicular to the backing plate rocking plane, different shaped cut-off joints, different widths for the flat region, etc.). Any number of heads **202** may be used concurrently, individually, and/or in any sequence. The heads **202** 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 polishing heads **202** (and backing pads and/or polishing tape described further below) to polish different portions of the substrate edge **104**. The substrate **100** may be stationary or rotate as it is polished.

[0038] In some embodiments, one or more of the heads **202** may be adapted to be oscillated or moved (e.g., be 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 any suitable means so as to polish different portions of the substrate **100**. In some embodiments, one or more of the heads **202** may continuously oscillate around or along the rotating edge **104** of the substrate **100**. Different heads **202** may be used for different substrates **100**, different types of substrates **100**, or different polishing operations.

[0039] As shown herein, substrate polishing may be performed using one or more polishing apparatuses **204**. In one or more embodiments, a plurality of polishing apparatuses **204** may be employed, in which each polishing apparatus **204** may have similar or different characteristics and/or mechanisms. In the latter case, particular polishing apparatuses **204** may be employed for specific operations. For example, one or more of a plurality of polishing apparatuses **204** may be adapted to perform relatively rough polishing and/or adjustments while another one or more of the plurality of polishing apparatus **204** may be adapted to perform relatively fine polishing and/or adjustments. Polishing apparatuses **204** 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 **204** may be located in a single chamber or module, as shown herein, or alternatively, one or more polishing apparatuses 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 **100** between the chambers so that polishing apparatuses **204** in the separate chambers may be used in series or otherwise.

[0040] The system **200** may also include a programmed and/or user operated controller **206**. The controller **206** may direct the operation and movement of the one or more heads **202**, as well as the other system components, as will be further described below.

[0041] FIG. **3** is a schematic perspective view of an embodiment of a polishing apparatus **300** for polishing a substrate edge **104**. The polishing apparatus **300** may include a substrate driver **302** (e.g., a servomotor, gear, belt, chain, etc.), which may be mounted on a pedestal **304**. A support **306** (e.g., a vacuum chuck) may be coupled (e.g., rigidly) to a shaft (not shown) of the substrate driver **302**. The support **306** may support a substrate **100**, for example. The substrate driver **302** may rotate the substrate **100**, via the support **306**, about a center **308** of the substrate **100** or another suitable axis. The substrate driver **302** may be connected to a substrate driver control unit (not shown) and/or the controller **206**, which may control the angular displacement, angular velocity, and/or angular acceleration of the substrate **100**. The polishing apparatus **300** may further include a polishing arm **310** aligned in the horizontal plane approximately tangential to the edge **104** (shown in FIG. **1**) of the substrate **100** and supported by a frame **312**. In other embodiments, the polishing arm **310** may be aligned differently, for example, vertically or at an angle with respect to the horizontal plane. The polishing arm **310** may include a polishing head section **314** ('head'). The polishing head **314** may include a backing plate **316**. A backing pad **318**, for example, may cover the backing plate **316**. In some embodiments the backing pad **318** may include an abrasive surface adapted to polish the substrate edge **104**. The backing pad **318** may also be used to further lower the local pressure on the substrate **100** and increase the conformity of the backing plate **316** to a particular film profile. The backing plate **316** may be moved toward or away from the substrate **100** by an actuator (e.g., hydraulic actuator, pneumatic actuator, servomotor, etc.) (not shown). In some embodiments, polishing tape **320**, may wrap around the polishing head **314**, and over the backing plate and pad **316**, **318**, and be tensioned between spools **322**, **324**. The spools **322**, **324** may be driven by spool drivers **326**, **328** (e.g., servomotors), respectively. The spool drivers **326**, **328**, may be indexed to precisely control the amount of the polishing tape **320** that is advanced over the polishing head **314** from, for example, spool **322** to spool **324** in order to polish the substrate edge **104**. In other embodiments, a polishing pad or other polishing material may be employed in place of the polishing tape **320**.

[0042] In some embodiments, the backing pad **318** may be pushed against the substrate **100**, via the backing plate **316**, with an amount of force ranging from about 0.5 lbs. to about 2.0 lbs. Other amounts of force may be used. The backing pad **318** may be soft and/or include or develop contours to conform with a desired film profile. The tight contact between the backing pad **318** and the substrate edge **104** combined with the particular rotation speed of the substrate **100**, may provide relative movement between the backing pad **318** and the substrate edge **104**, resulting in polishing of the film **116** deposited on the substrate edge **104**.

[0043] In some embodiments, the substrate **100** may contact the backing pad **318** for about 15 to 150 seconds depending on the resiliency of the pad selected, the rate of rotation, and/or the amount of polishing required. More or less time may be used. Depending on the amount of force applied by the actuator and the resiliency of the pad selected, for example, a controlled amount of pressure may be applied to the film **116**. Other parameters may be used to control the applied pressure.

[0044] The backing pad **318** may be made of material such as, for example, an acetal resin (e.g., Delrin® manufactured by DuPont Corporation), PVDF, polyurethane closed cell foam, silicon rubber, etc. Other suitable materials may be used. Such materials may have resilience or an ability to conform that is a function of the thickness or density of the pad. The material may be selected based upon its resilience. The desired resilience may be selected based upon the type of polishing required. In some embodiments, the backing pad **318** may have an adjustable amount of ability to conform to the substrate's edge **104**, such as by including an inflatable bladder.

[0045] In one or more embodiments, the polishing tape **320** and/or the backing pad **318** may be made from and/or include many different materials, such as aluminum oxide, silicon oxide, silicon carbide, etc. Other materials may also be used. In some embodiments, abrasives used may range from about 0.5 microns up to about **3** microns in size, although other sizes may be used. Different widths of polishing tape **320** ranging from about 0.2 inches to about 1.5 inches may be used, although other polishing tape widths may be used. In one or more embodiments, the polishing tape **320** may be about 0.002 to about 0.02 inches thick and withstand about 1 to 5 lbs. in tension. Other tapes having different thicknesses and tensile strengths may be used. The spools **322**, **324** may have a diameter of approximately 1 inch and be capable of holding about **500** inches of polishing tape **320** or may be a diameter of approximately 3 inches and be capable of holding about 30,000 inches of polishing tape. Other spool dimensions may be used. The spools **322**, **324** may be constructed from materials such as polyurethane, polyvinyl difluoride (PVDF), etc. Other materials may also be used.

[0046] In some embodiments, as the substrate **100** rotates, the polishing head **314** may rock around the substrate edge **104** to polish the entire edge **104**. In operation, this may be achieved by angularly translating the head **314** and consequently, the backing plate **316** and backing pad **318** 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. In some embodiments, the head **314** may be adapted to continuously or intermittently oscillate between the various positions. The head **314** may be moved by drivers (not shown) under the direction of the controller **206** (FIG. **2**). Alternatively, the head **314** 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 **314** is oscillated (as described above) as well as rotated circumferentially around the substrate **100**.

[0047] In some embodiments, the substrate **100** may be rotated in a horizontal plane. The substrate edge **104** may be aligned with, or normal to, the backing pad **318** (and backing plate **316**) and/or polishing head **314**. In additional or alternative embodiments, the substrate **100** may be rotated in a vertical plane, another non-horizontal plane, and/or be moved between different planes of rotation. The substrate **100** may

be rotated at a rate ranging from about 50 to 300 RPM, for example, although other rates may be used.

[0048] Additionally or alternatively, the present invention may include facilities (e.g., a spray nozzle or bar) to deliver fluids to the substrate edge **104** being polished. In some embodiments, one or more channels may be provided, to direct chemicals or water to the substrate edge **104** to assist in the polishing and/or to wash away particles resulting from the polishing. The chemicals may be sprayed directly onto the substrate **100**, at the substrate/backing pad interface, and/or may be applied to and/or through the backing pad **318**. In some embodiments, sonic (e.g., megasonic) nozzles may be used to deliver sonicated fluids to the substrate edge **104** to supplement the cleaning. The fluids may be sprayed from either or both sides of the substrate **100** and the present invention may employ gravity or suction to cause the runoff not to contaminate or contact other parts of the substrate **100** or apparatus of the invention. Further, energy (e.g., megasonic energy) may be applied to the substrate edge **104** via fluid carrying such energy.

[0049] As described above, in some embodiments, the controller **206** (e.g., a programmed computer, a programmed processor, a gate array, a logic circuit, an embedded real time processor, etc.) may control the driver(s) used to rotate the substrate **100** and the actuator used to push the backing plate **316** and backing pad **318** against the film **116** on the substrate edge **104**. Note that the controller **206** may be coupled (e.g., electrically, mechanically, pneumatically, hydraulically, etc.) to each of a plurality of actuators. Likewise, operation of the fluid channels may also be under the direction of the controller **206**. Under direction of the controller **206**, various fluids may be selectively delivered to the backing pad **318** and/or the substrate edge **104** via the fluid channels. The controller **206** may be adapted to receive feedback signals from driver(s) and/or actuator(s) that indicate the amount of energy being exerted to drive the substrate **100** (e.g., rotate a vacuum chuck holding the substrate **100**) and/or actuate the actuator to push the backing plate **316** and therefore backing pad **318**, respectively. These feedback signals may be employed to determine when a particular layer of film **116** has been removed and/or whether a sufficient amount of polishing has occurred.

[0050] Turning to FIG. **4**, a schematic perspective view of a backing plate **316** according to the present invention is provided. As described above, the driver **302** may cause the substrate support **306** to rotate the substrate **100**, as indicated by the directional arrow or in the opposite direction. As the substrate **100** rotates, the backing plate **316** may contact and press the backing pad **318** (and/or polishing tape or a polishing pad) against the substrate edge **104**, as indicated by the directional arrow, dotted line of the backing pad and backing plate, thereby creating a particular film profile. In some embodiments the backing pad **318** may conform, or be conformable, to the shape of the backing plate **316**, and be affixed thereto. In other embodiments, as shown herein, the backing pad **318** may not conform to the shape of the backing plate **316**, per se, but the direction and force of the movement of the backing plate **316** against the backing pad **318** may create the desired film profile in accordance with the shape of the backing plate **316**.

[0051] Turning to FIG. **5**A, a schematic cross sectional view of an exemplary backing plate **316** according to the present invention is depicted. The backing plate **316** may rock in a particular pre-set plane, including between a rocking start angle and an end angle, further described below. The backing plate **316** may have a surface **400** adapted to contact the backing pad **318** (FIG. **3**) and/or polishing tape or a polishing pad. In the embodiment shown herein, the backing plate **316** may further include a profiled portion having a first flat region **402** and a second curved region **404**. The surface **400** of the curved region **404** of the backing plate **316** adapted to contact the backing pad **318** and/or polishing tape or a polishing pad, may have a spherical shape parallel with the backing plate rocking plane, for example. The curved region **404** may have a radius of R**1**. The radius (R**1**) of the backing plate **316** may range from 5 mm to infinity (a flat surface), for example. Other suitable radius values may be used. The radius R**1** may be selected to provide process optimization flexibility for polishing different types of films on the substrate **100**. A cut-off joint **406** may be positioned at the conjunction of the flat region **402** and the curved region **404**. The width of the cut-off joint **406** may range from 0 to 50 mm, for example. Other suitable widths may be used. The width of the cut-off joint may provide another control over the width of the substrate edge **104** being polished.

[0052] Turning to FIG. **5**B, an illustration of the backing plate **316** shown in FIG. **5**A is provided. As is further depicted in FIG. **5**B, the shape of the cut-off joint **406**, may provide control over the profile of the film **116** on the substrate edge **104**. The polishing profile may be the shape created when the film **116** is removed, as further described below. In addition, by choosing rocking start and end angles in combination with the radius R**1** of the curved region **404**, the width of the substrate edge **104** being polished is controlled. The film **116** may be partially or completely removed as per pre-set profiles from 0 to 50 mm from the substrate outer edge **110**, for example. Other suitable removal areas may be used.

[0053] As described above, the cut-off joint **406** may be positioned at the conjunction of the flat region **402** and the curved region **404**. The curved region **404** may contact the major (or top) surface **102** of the substrate edge **104**. As shown herein, the curved region **404** may completely remove the film **116** from that portion of the major surface **102**. The flat region **402** may also contact the film **116** on the major surface **102** of the substrate edge **104**, but may only partially remove the film **116**. The use of the cut-off joint **406** may create a sharp angled profile in the film **116** at the location where the curved region **404** and flat region **402** made contact with the film **116**. The shape of the cut-off joint **406** may provide control over the profile of the film edge.

[0054] Turning to FIG. **6**A, another exemplary embodiment of a backing plate **500** according to the present invention is provided. In the embodiment shown herein, a surface **502** of a backing plate **500** has a smooth spherical shape or profile. Unlike the backing plate **316** of FIG. **5**A, the spherical shape of the backing plate **500** shown herein may be perpendicular to the backing plate rocking plane, and may have a radius of R**2**. The perpendicular orientation may allow a backing pad **318** (and/or polishing tape and/or polishing pad) contact with the backing plate surface **502** at all times during the polishing, for example. The value of R**2** may range from 50 mm to 500 mm, for example, depending on the backing plate, polishing tape and/or polishing pad properties. Other suitable values may be used. The smooth curvature change of the surface **502** of the backing plate **500** may also provide for a smooth film profile. By varying the cut-off joint **406** shape from a sharp corner (FIG. **5**A) to a smooth curvature change (FIG. **6**A), the profile of film **116** may have a sharp or gradually-diminished edge.

[0055] The backing plate **316**, **500** may be made of a plurality of materials, such as metal and plastic, for example. Other suitable materials may be used. The type of material used to form the backing plate **316**, **500** may depend on the type of film **116** being polished. For example, when the film **116** is hard, like silicon nitride, the backing plate **316**, **500**, may be made of hard materials, such as metal or the like, to improve the polishing efficiency. On the other hand, a soft film **116**, such as an amorphous carbon film, for example, may require the use of a backing plate **316**, **500** made from plastic materials to prevent damage to the substrate **100**. In some embodiments, the backing pad **318** surface may be further covered by a cushion to further lower the local pressure, and increase conformity to the desired film profile.

[0056] Turning to FIG. **6**B, an illustration of the backing plate **500** shown in FIG. **6**A is provided. As shown herein, the surface **502** of the backing plate **500** has a smooth spherical shape. Thus, unlike the sharp angled profile of the film **116** formed with the cut-off joint **406**, shown in FIG. **5**B, the film **116** profile created with the smooth backing plate **500** is smooth and shows a smooth curvature change and gradually diminished edge.

[0057] Turning to FIG. **7**, a schematic cross-sectional view of another example embodiment of a backing plate **600** according to the present invention is depicted. The backing plate **600** shown herein may include two cut-off joints **602***a*, **602***b*. Other backing plate **600** shapes may be used. As shown herein, a top surface of the backing plate **604** may have a flat region **606**, delineated between the cut-off joints **602***a* and **602***b*. The flat region **606** may have a length or width ranging from about 0 to 50 mm, for example. Other suitable lengths may be used. A smaller flat region **604** may result in a larger local pressure on the film **116** and substrate edge **104** (FIG. **1**). The smaller flat region **604** may also facilitate the alignment of the backing plate **600** (and therefore alignment of a backing pad, polishing tape or polishing pad) with the substrate edge **104**. A larger flat region **604** width may result in a more efficient usage of the backing pad **318**, polishing tape and/or polishing pad, as a larger surface area may contact the film **116** and substrate edge **104**. The different benefits associated with a larger and smaller flat region **604** may provide flexibility in optimizing the process according to targeting particular films and desired film profiles.

[0058] Turning to FIG. **8**, a flowchart is provided depicting an exemplary method **800** for polishing the substrate edge **104**. The appropriate backing plate **316** is selected and attached, or coupled, to the polishing head **314** in step S**802**. An appropriate backing plate may be the backing plate **316** used to create a particular desired film profile. The rocking start and end angles are selected in step S**804**. As described above, the rocking start and end angles may indicate a path of movement of the backing pad **316**. For example, if the rocking start angle is zero degrees, and the rocking end angle is 15 degrees, the backing plate **316** rocks in a path from zero to 15 degrees as it contacts the film **116**. The backing plate **316** contacts and applies a force to the backing pad **318**, polishing tape and/or polishing pad in step S**806**. The backing plate **316** contacts the substrate edge **104** via the backing pad **318**, polishing tape and/or polishing pad in step S**808** (e.g., while the substrate rotates) to create the particular film **116** profile. The contact may be via a rocking motion, as indicated by the rocking start and end angles. The polishing stops when the pre-set film profile is created in step S**810**.

[0059] 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 describe 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).

[0060] 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.

[0061] 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. For instance, other backing plates with other profiles may be used (e.g., elliptical, hexagonal, or other profiles). 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 a film on an edge of a substrate comprising:

a polishing head having:

a backing plate adapted to press polishing material against a film on an edge of a substrate, wherein the backing plate has a profile portion adapted to provide a pre-set film profile during polishing of the substrate.

2. The apparatus of claim **1** wherein the profile portion is smooth.

3. The apparatus of claim **2** wherein the profile portion is adapted to provide a gradual curvature to the film profile.

4. The apparatus of claim **1** wherein the profile portion is formed by a flat region and a curved region.

5. The apparatus of claim **4** wherein the flat region and the curved region are conjoined at a cut-off joint.

6. The apparatus of claim **5** wherein the cut-off joint is adapted to provide a sharp and angled film profile.

7. The apparatus of claim **1** wherein the backing plate is adapted to rock about the substrate edge.

8. A system for polishing a film on an edge of a substrate comprising:

a substrate support, adapted to support and rotate a substrate;

a polishing head having:

a backing plate adapted to press polishing material against a film on an edge of a substrate, wherein the backing plate has a profile portion adapted to provide a pre-set film profile during polishing of the substrate; and

a controller adapted to operate the movement of the polishing head.

9. The system of claim **8** wherein the profile portion is smooth.

10. The system of claim **9** wherein the profile portion is adapted to provide a gradual curvature to the film profile.

11. The system of claim **8** wherein the profile portion is formed by a flat region and a curved region.

12. The system of claim **11** wherein the flat region and the curved region are conjoined at a cut-off joint.

13. The system of claim **12** wherein the cut-off joint is adapted to provide a sharp and angled film profile.

14. The system of claim **8** wherein the backing plate is adapted to rock about the substrate edge.

15. The system of claim **14** wherein the controller is adapted to control the rocking of the backing plate.

16. The system of claim **15** wherein the backing plate is adapted to rock in a path between a rocking start angle and a rocking end angle.

17. The system of claim **8** further comprising a backing pad adapted to conform to the shape of the backing plate.

18. A method for polishing a film on an edge of a substrate comprising:

selecting a rocking start angle and a rocking end angle for a profiled backing plate;

contacting a film on an edge of a substrate with the backing plate and a polishing material; and

rocking the backing plate against the film on the substrate edge during polishing.

19. An apparatus for polishing a film on an edge of a substrate comprising:

a backing plate adapted to press polishing material against a film on an edge of a substrate, wherein the backing plate has a profile portion adapted to provide a pre-set film profile during polishing of the substrate.

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