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(54) REINFORCED CHEMICAL MECHANICAL PLANARIZATION BELT

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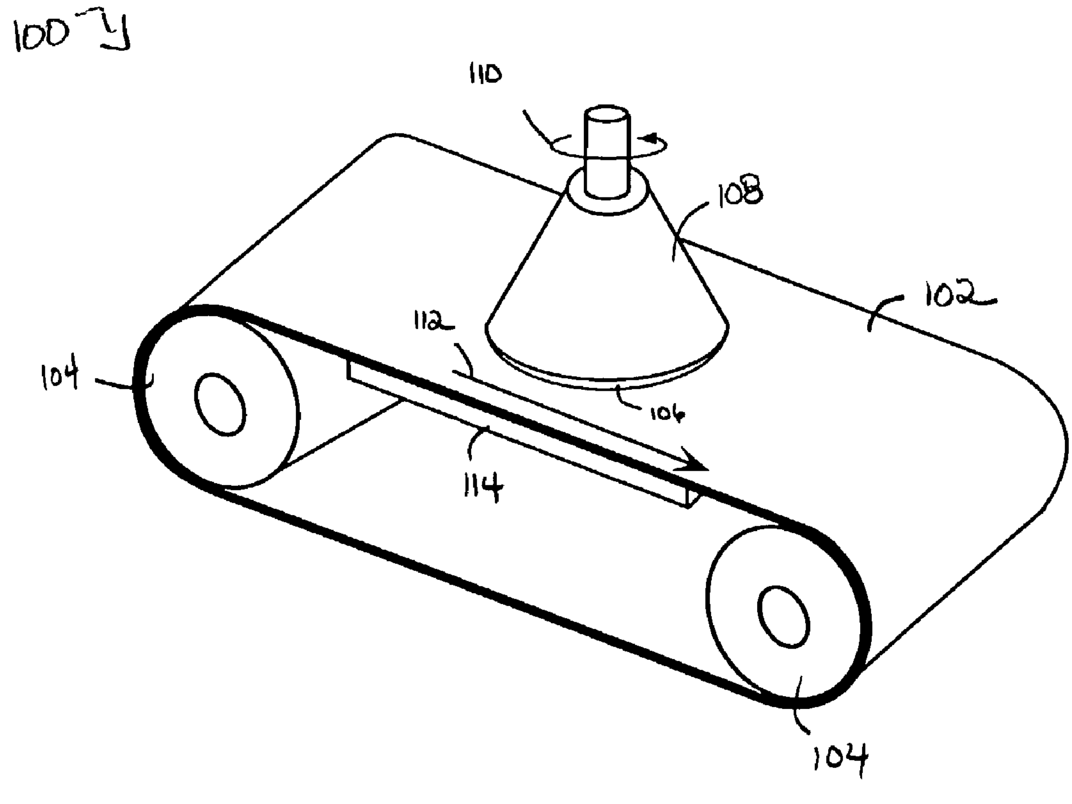
(57) **ABSTRACT**

A processing belt for use in chemical mechanical planarization (CMP), and methods for making the same, are provided. Embodiments of the processing belt include a polymeric material reinforced with a woven fabric or synthetic material encased between the polymeric material and an additional polymeric material layer to define the processing belt. The processing belt is fabricated so that the woven fabric forms a continuous loop and is positioned against a surface of the polymeric material. The additional polymeric material layer is applied over the woven fabric, permeating the woven fabric to bond to the polymeric material forming an integral structure of woven fabric reinforced polymeric material.



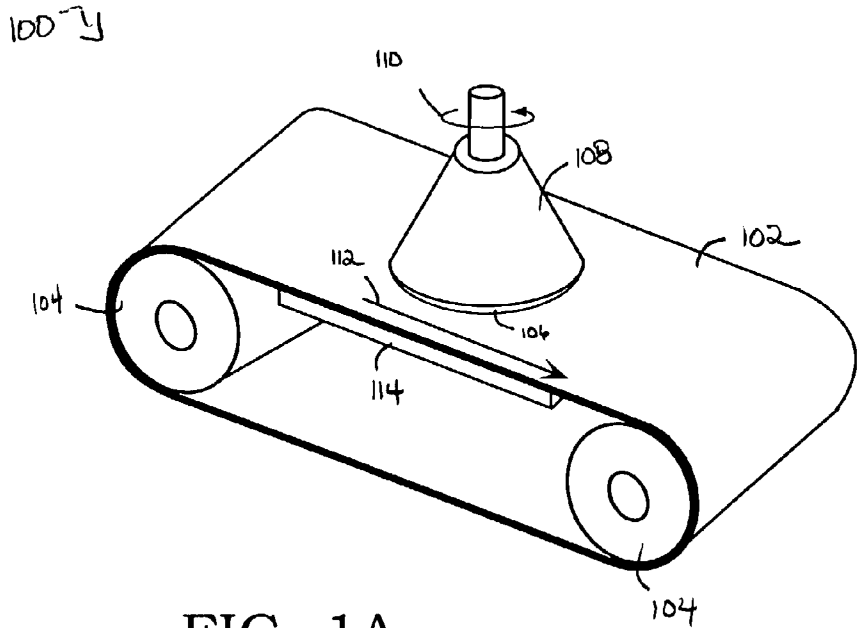


FIG. 1A

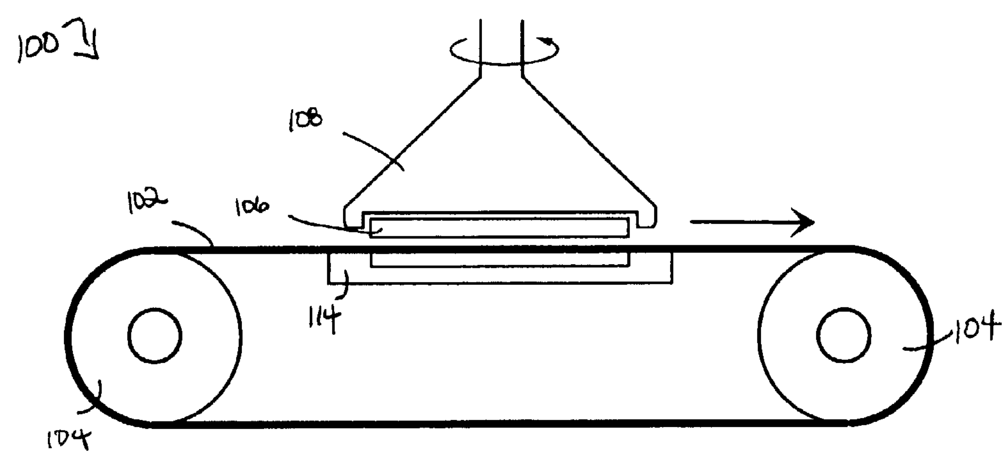


FIG. 1B

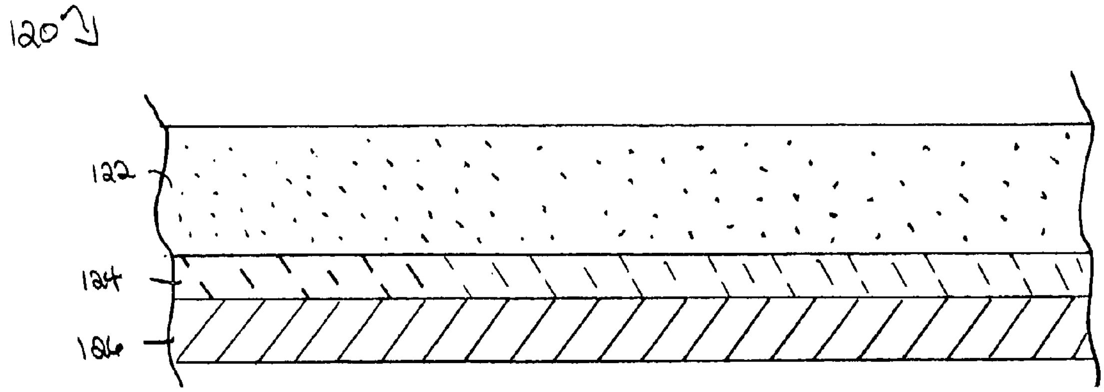


FIG. 2A

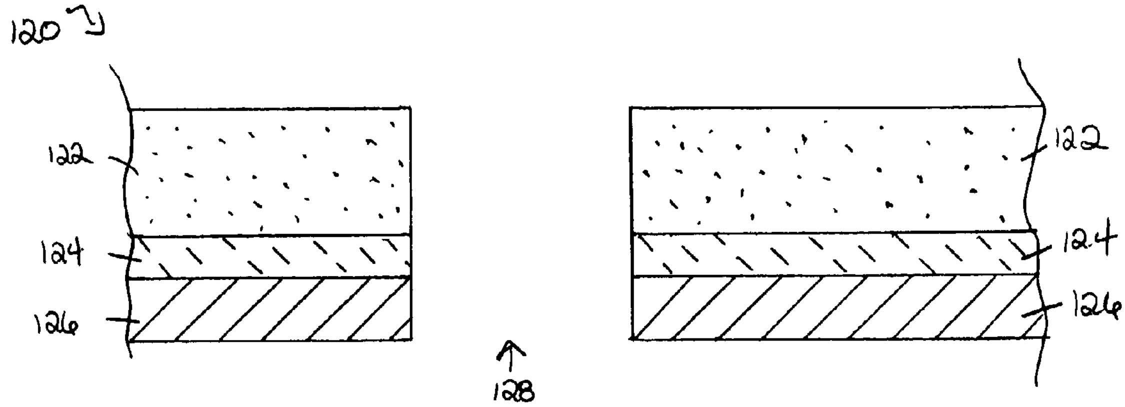


FIG. 2B

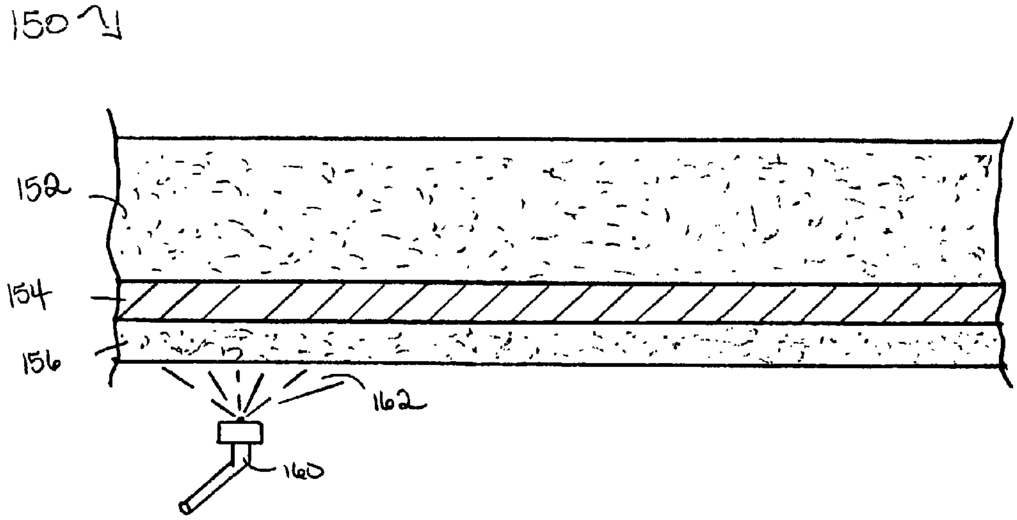


FIG 3A

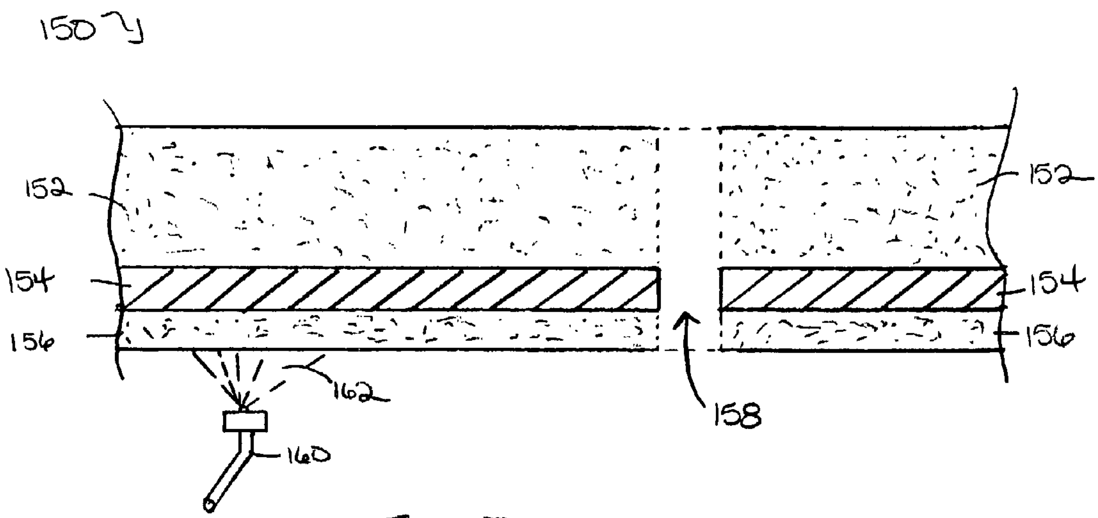


FIG 3B

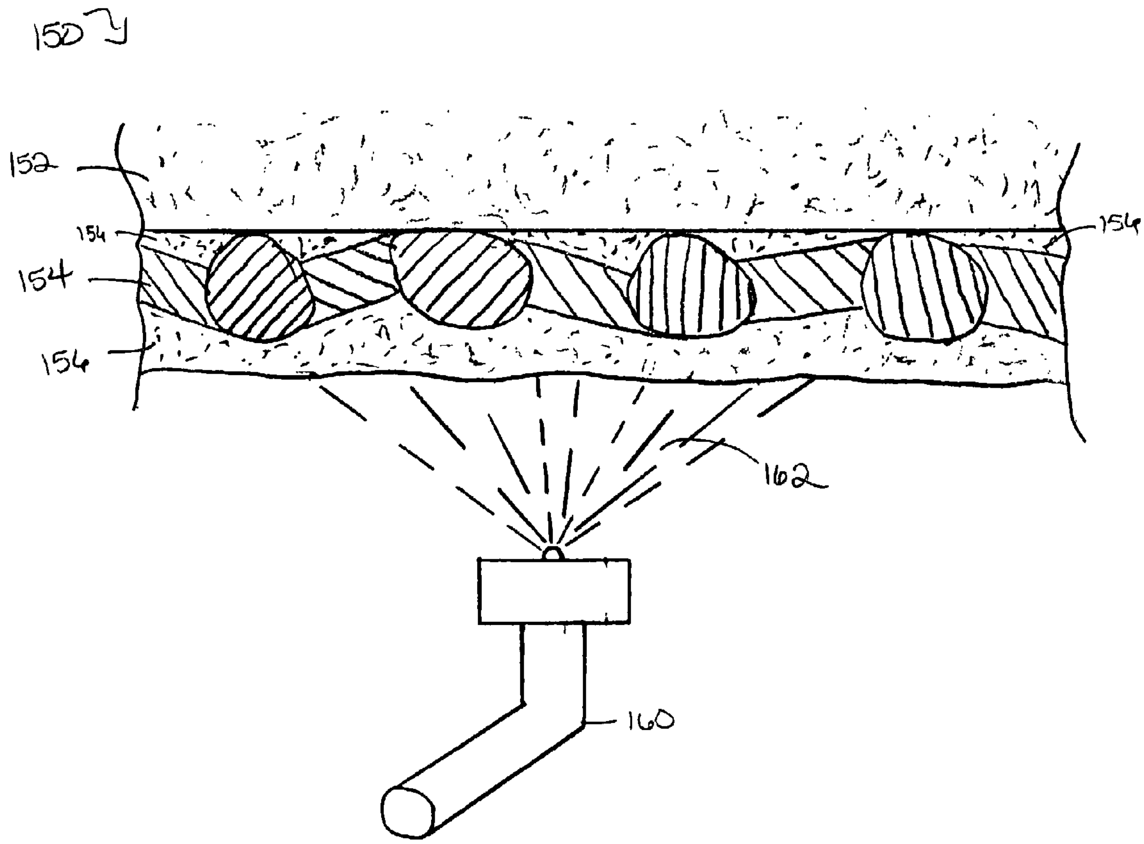


FIG. 4

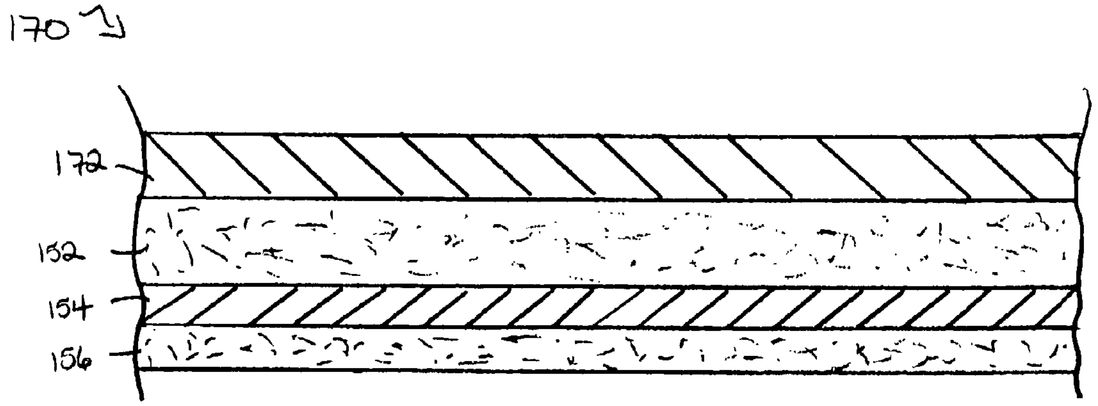


FIG. 5

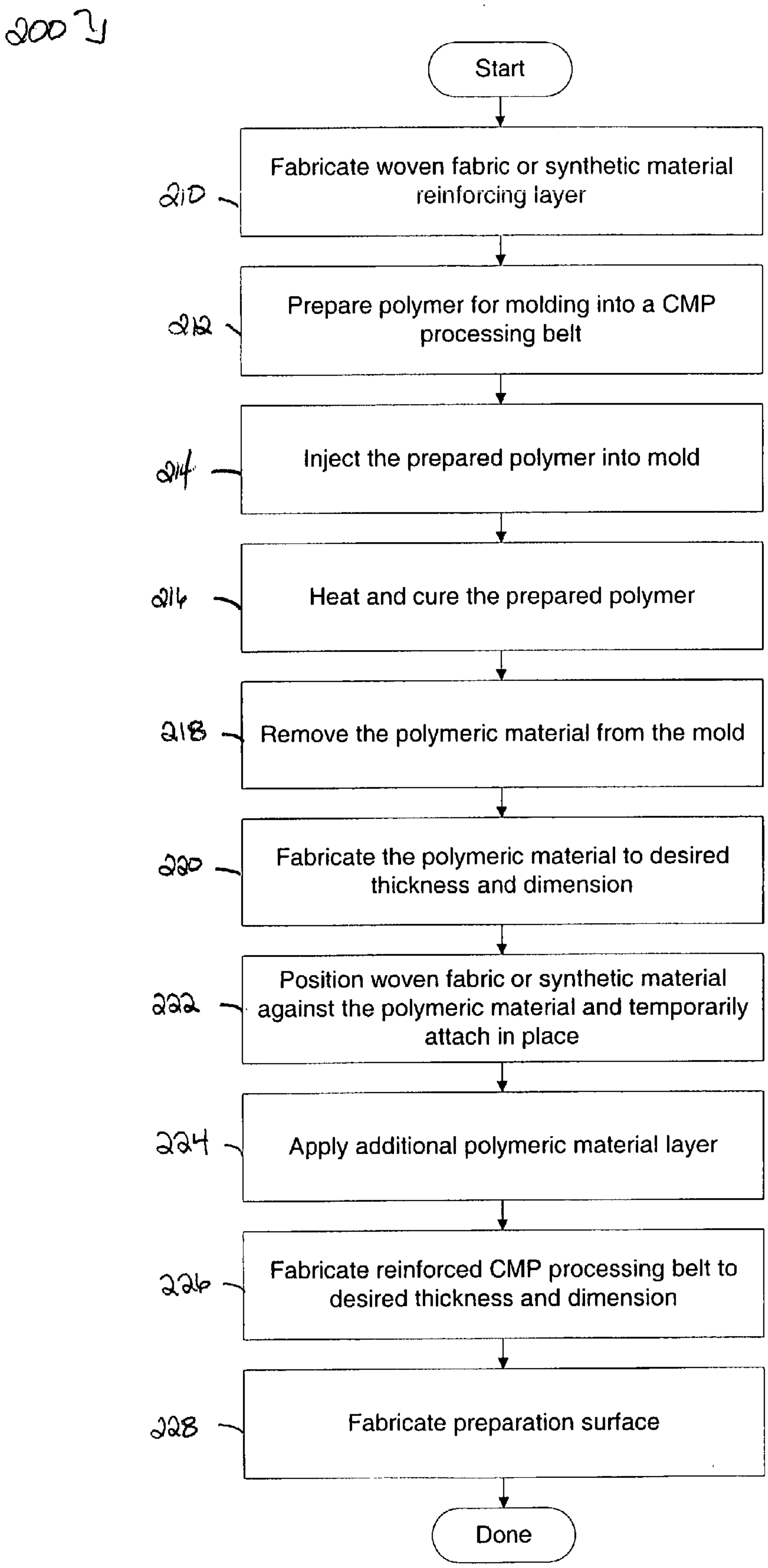

200
Start
210
Fabricate woven fabric or synthetic material reinforcing layer
212
Prepare polymer for molding into a CMP processing belt
214
Inject the prepared polymer into mold
216
Heat and cure the prepared polymer
218
Remove the polymeric material from the mold
220
Fabricate the polymeric material to desired thickness and dimension
222
Position woven fabric or synthetic material against the polymeric material and temporarily attach in place
224
Apply additional polymeric material layer
226
Fabricate reinforced CMP processing belt to desired thickness and dimension
228
Fabricate preparation surface
Done

FIG. 6

REINFORCED CHEMICAL MECHANICAL PLANARIZATION BELT

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to wafer preparation belts, and more specifically to the fabrication of belt materials used in chemical mechanical planarization apparatus.

[0003] 2. Description of the Related Art

[0004] In the fabrication of semiconductor devices, a plurality of layers are typically disposed over a substrate, and features are defined in and through the layers. A surface topography of the substrate or wafer can become irregular during fabrication processes, and an un-corrected irregularity increases with the addition of subsequent layers. Chemical Mechanical Planarization (CMP) has developed as a fabrication process utilized to planarize the surface of a semiconductor wafer, as well as to perform additional fabrication processes including polishing, buffing, substrate cleaning, etching processes, and the like.

[0005] In general, CMP processes involve the application of a substrate or wafer against a processing surface with a controlled pressure. Both the processing surface and the wafer are caused to rotate, spin, or otherwise move independently of one another to create a frictional force for planarization and to ensure the entire surface of the wafer is consistently and controllably processed. Typical CMP apparatus include linear belt processing systems in which a belt having a processing surface is supported between two or more drums or rollers which move the belt through a rotary path presenting a flat processing surface against which the wafer is applied. The wafer is typically supported and rotated by a wafer carrier, and a polishing platen is configured on the underside of the belt traveling in its circular path. The platen provides a stable surface over which the belt travels, and the wafer is applied to the processing surface of the belt against the stable surface provided by the platen. In some applications, abrasives in an aqueous solution known as slurry is introduced to facilitate and enhance the planarization or other CMP process.

[0006] Additional CMP apparatus include rotary CMP processing tools having a circular pad configuration for the processing surface, an orbital CMP processing tool similar to the circular CMP processing tool, a sub-aperture CMP processing tool, and other CMP processing systems providing a plurality of apparatus and configurations that, in general, utilize friction to planarize, scrub, polish, buff, clean, or otherwise process the surface of a semiconductor wafer having integrated circuits or other structures fabricated thereon.

[0007] In the linear belt CMP system, the belt and processing surface are typically fabricated to provide a stable structure to withstand the stresses of the belt and drum configuration, as well as a stable processing surface upon which precise and controllable planarization can occur. In addition to the stretching and contraction caused by the belt and processing surface traveling around the drums that drive the system, the belt and processing surface are typically in a wet environment from the liquid from slurry and rinsing operations. Belts and processing surfaces are typically constructed of a plurality of materials such as, by way of example, a stainless steel supporting layer, a cushioning layer, and one or more processing surface layers. The plurality of layers are joined by adhesives, bonding, stitching, and the like to form the continuous belt structure with an outwardly facing processing surface against which a wafer is applied in a CMP process.

[0008] The fabrication of linear belts in a plurality of layers as described provides the necessary support to substantially prevent the stretching of linear CMP belts, but such belts can be difficult to work with, and manufacturing costs associated with belt construction are increased. Some CMP processing belts include substantially polymer material without the additional layers described above. The substantially polymer material belts, however, tend to stretch and otherwise deform with continued use. Attempts to reinforce substantially polymer CMP processing belts have been largely unsuccessful, with functional belts substantially resulting in multi-layer processing belts as described above.

[0009] Linear belts used in linear belt CMP systems can be costly to manufacture, and can be time consuming to replace. Replacement of linear belts requires down time for the CMP system resulting in decreased through put and increased manufacturing costs. Multiple-layer linear belts can be subject to such failures as delamination or separation of the layers due to such factors as the contraction and stretching forces during use, and the breakdown of adhesives or other bonding techniques over time and accelerated in the wet CMP environment.

[0010] In view of the foregoing, what is needed are methods, processes, and apparatus to fabricate a linear CMP processing belt that is resilient to the stresses of use, is less likely to delaminate or otherwise separate, is economical and easy to manufacture, and is easy to work with in a plurality of CMP processing tools and environments.

SUMMARY OF THE INVENTION

[0011] Broadly speaking, the present invention fills these needs by providing a reinforced polymeric CMP processing belt. The present invention can be implemented in numerous ways, including as a process, an apparatus, a system, a device, or a method. Several embodiments of the present invention are described below.

[0012] In one embodiment, a processing belt for use in chemical mechanical planarization is disclosed. The processing belt includes a fabric belt and a polymeric material encasing the fabric belt to define the processing belt to be used in chemical mechanical planarization operations.

[0013] In another embodiment, a belt for use in chemical mechanical planarization processing is disclosed. The belt includes a polymeric material cast into a continuous loop to define the belt, and a reinforcing fabric embedded between the polymeric material and an additional polymeric material layer. The reinforcing fabric is defined as a continuous loop within the polymeric material and the additional polymeric material layer.

[0014] In yet another embodiment, a processing belt for use in chemical mechanical planarization is disclosed. The processing belt includes a continuous loop reinforcing woven fabric, a continuous loop polymeric material, and a continuous loop additional polymeric material layer. The continuous loop additional polymeric material layer is bonded to the continuous loop polymeric material encasing the continuous loop reinforcing woven fabric between the bonded materials to define the processing belt to be used in chemical mechanical planarization operations. The continuous loop reinforcing woven fabric is defined from one of kevlar, nylon, polyimide, and polyester.

[0015] In still a further embodiment, a method for fabricating a belt for use in chemical mechanical planarization is disclosed. The method includes forming a belt-shaped fabric, and providing a mold configured to form a belt-shaped structure. A polymeric material is formed in the mold, and the belt shaped fabric is attached to the formed polymeric material. The method further includes applying an additional polymeric material layer over the belt-shaped fabric. The additional polymeric material layer is applied over and through the belt-shaped fabric such that the belt-shaped fabric is encased between the polymeric material and the additional polymeric material layer. The polymeric material and the additional polymeric material layer are bonded together. Such bond can form a chemical bond, and can be adhered together as an essentially integral structure.

[0016] The advantages of the present invention are numerous. One notable benefit and advantage of the invention is significantly increased lifetime of the polymeric CMP processing belt in the CMP process. Unlike a typical linear CMP processing belt of prior art, the present invention provides the necessary strength, support, and resilience without stacks of bonded layers subject to delamination or separation. The reinforcement of the present invention can be chemically bonded, and is at least adhered to the processing belt in a manner so as to be integral to the belt structure. Polymeric material provides the supporting structure which is reinforced and may include a separately fabricated processing surface, resulting in a CMP processing belt of significantly increased lifetime in the CMP process.

[0017] Another benefit is the lower cost and ease of manufacture. Unlike typical prior art processing belts, the present invention includes a supporting and predominate structure of polymeric material. The plurality of layers, adhesives, stitches, or other bonding materials between the plurality of layers are eliminated without compromise of strength, support, and resilience. Reinforcing material is easily obtained, easy to work with, and easily applied to a surface of the polymeric processing belt.

[0018] An additional benefit is the ability to readily integrate embodiments of the present invention with optical end point detection apparatus. The reinforcing layer of the present invention provides for fabrication of optical "windows" for use with end point detection apparatus, and without compromise of necessary strength, support, and resilience. Further, integration of optical end point detection structures does not increase the likelihood of delamination or separation, or decrease the useable life of the processing belt.

[0019] Other 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

[0020] The present invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements.

[0021] **FIG. 1A** illustrates a typical linear belt CMP system.

[0022] **FIG. 1B** shows a side view of the linear belt CMP system described in **FIG. 1A**.

[0023] **FIG. 2A** shows a cross section of a typical linear CMP processing belt.

[0024] **FIG. 2B** shows the cross section of a typical linear CMP processing belt of **FIG. 2A** with an open section of belt for use with an in-situ optical end point detection system.

[0025] **FIG. 3A** is a cross section of a CMP processing belt in accordance with an embodiment of the present invention.

[0026] **FIG. 3B** is a cross section of a CMP processing belt in accordance with an embodiment of the present invention.

[0027] **FIG. 4** shows a detail view of the application of the additional polymeric material layer described in reference to **FIGS. 3A and 3B** in accordance with one embodiment of the invention.

[0028] **FIG. 5** shows a cross section of a CMP processing belt in accordance with another embodiment of the present invention.

[0029] **FIG. 6** is a flow chart diagram illustrating the method operations for manufacturing a reinforced polymeric CMP processing belt in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] An invention for a CMP processing belt and methods for making the same are disclosed. In preferred embodiments, the CMP processing belt includes a processing belt constructed of a polymeric material and reinforced with a woven fabric or synthetic material to define the processing belt to be used in CMP operations.

[0031] 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.

[0032] **FIG. 1A** illustrates a typical linear belt CMP system **100**. A linear CMP processing belt **102** is positioned around two drums **104**. A wafer **106** for processing is attached to a wafer carrier **108** over the linear belt CMP system **100**. The wafer carrier **108** is caused to rotate **110** which causes the wafer **106** to rotate, and the drums **104**, also known as drive rollers **104**, rotate causing the linear CMP processing belt **102** to move in direction **112**. The rotating wafer carrier **108** having a wafer **106** attached thereto is applied against the linear CMP processing belt **102** which is moving around drums **104** in direction **112**. Platen

114 is positioned under linear CMP processing belt **102** opposite (e.g., on the opposite side of the linear CMP processing belt **102** from) the wafer carrier **108** with a wafer **106** attached. Platen **114** provides additional support in order for the wafer **106** to be applied against the linear CMP processing belt **102** with sufficient force to accomplish the desired planarization or other CMP process, as well as providing a flat surface for consistent, measurable processing. **FIG. 1B** shows a side view of the linear belt CMP system **100** just described.

[**0033**] As can be appreciated from **FIGS. 1A and 1B**, the linear CMP processing belt **102** is subjected to various stresses during operation of the linear belt CMP system **100**. By way of example, as a point on the linear CMP processing belt **102** travels around drums **104**, it is subjected to a stretching force, with the outer region or exterior surface of the linear CMP processing belt **102** subjected to greater stretching than the inner region or interior surface of the linear CMP processing belt. As the point on the linear CMP processing belt continues travel off of and away from the drums **104**, it is subjected to a contracting force as the belt straightens out and travels across the top or bottom of the linear belt CMP system **100** towards the next drum **104**. Further, the linear belt CMP processing system **100** subjects the linear CMP processing belt **102** to processing stresses such as the downward force of the wafer against the processing surface, the frictional contact between the rotating wafer **106** and the linear CMP processing belt **102**, and other such processing forces.

[**0034**] **FIG. 2A** shows a cross section of a typical linear CMP processing belt **120**. The exemplary linear CMP processing belt **120** includes three layers **122**, **124**, and **126**. The top polymeric layer **122** provides the processing surface against which the wafer **106** (see **FIGS. 1A, 1B**) is applied for CMP processing. A cushioning layer **124** is typically constructed between the processing surface polymeric layer **122** and the support or base layer **126**, and provides a cushioning transition layer between the processing surface polymeric layer **124**, and the rigid, hard support or base layer **126**. Typically, the support or base layer **126** is a solid stainless steel or other similar metal belt or band over which has been fabricated the cushioning layer **124** and polymeric processing surface layer **122**. The plurality of layers are typically joined by adhesives or other similar bonding of one layer to the next.

[**0035**] **FIG. 2B** shows the cross section of a typical linear CMP processing belt **120** of **FIG. 2A** with an open section **128** of belt for use with an in-situ optical end point detection (EPD) system. As can be appreciated in **FIG. 2B, a** section of the linear CMP processing belt **120** is removed, including the support or base layer **126**, the cushioning layer **124**, and the processing surface polymeric layer **122**. When an open section **128** is constructed in a linear CMP processing belt **120**, an open section **128** of sufficient size for optical EPD implementation is created in the linear processing belt **120**. Typically, sufficient size includes a small circular, oval or square section of the linear CMP processing belt **120** that varies in size according to the particular processing tool with a typical dimension of about 1.25 inches in length and about 0.75 inches in width, and therefore not an entire width of the linear CMP processing belt **120**, or of such a large size as to significantly weaken the structural integrity of the linear CMP processing belt **120**. Construction of the open section **128** for EPD use typically includes forming a hole or opening in the linear CMP processing belt **120** and through each of the processing surface polymeric layer **122**, the cushioning layer **124**, and the support or base layer **126**.

[**0036**] As described above, the stretching and contracting forces caused during normal use of the linear CMP processing system **100** (see **FIGS. 1A and 1B**) can cause delamination or separation in a linear CMP processing belt **120** such as exemplary belt illustrated in **FIG. 2A**. The effects of the stresses of normal wear are aggravated by the wet environment including the use of slurries, rinses, and the like. Structures such as the open section **128** illustrated in **FIG. 2B** can increase the likelihood for linear CMP processing belt **120** to suffer structural failure including delamination or separation due to the increased surface area subjected to stress, increased likelihood of exposure of the layer joints and adhesives or other bonds to the wet environment, structural weakening of the base or support layer **126** from the opening or openings created, and the like.

[**0037**] **FIG. 3A** is a cross section of a CMP processing belt **150** in accordance with an embodiment of the present invention. In the inventive CMP processing belt **150** shown in **FIG. 3A**, the CMP processing belt **150** is constructed substantially of a polymeric material **152** with a woven fabric or synthetic material reinforcing layer **154**, and an additional polymeric material layer **156** sprayed on, or otherwise applied, bonding the woven fabric or synthetic material reinforcing layer **154** to the polymeric material **152**. The polymeric material **152** can include any of a plurality of polymeric materials suitable for construction of CMP processing belts and surfaces, including polyurethane, polyester, PVC, polyacrylate, any of a plurality of epoxies, and the like.

[**0038**] In one embodiment, the woven fabric or synthetic material reinforcing layer **154** is a fabric of kevlar. In other embodiments, the fabric is constructed of synthetic materials such as synthetic fibers of nylon, polyimides, polyesters, and the like, and in some embodiments, the fabric is a combination of synthetic materials such as, by way of example, nylon material forming one direction of a weave, and polyester material forming another direction of the weave. In this manner, the most desirable properties of the particular synthetic such as strength, or rigidity, or elasticity, are selectively implemented along and across a CMP processing belt **150** according to particular processing needs.

[**0039**] In the embodiment illustrated in **FIG. 3A**, additional polymeric material layer **156** is shown bonding the woven fabric or synthetic material reinforcing layer **154** to the polymeric material **152**. The additional polymeric material layer **156** can include any of the plurality of polymers suitable for use in the construction of a CMP processing belt including polyurethane, polyester, PVC, polyacrylate, any of a plurality of epoxies, and the like.

[**0040**] As illustrated in **FIG. 3A**, one embodiment of the present invention includes the application of the additional polymeric material layer **156** by spraying **162** the desired polymer using polymer spray applicator **160**. The woven fabric or synthetic material reinforcing layer **154** is temporarily clamped, stapled, tacked, glued, or otherwise temporarily positioned (not shown in **FIG. 3A**) against the polymeric material **152**. Polymer spray applicator **160** is used to spray **162** the additional polymeric material layer **156** such that the additional polymeric material layer **156** is applied over the woven fabric or synthetic material reinforcing layer **154**, and also permeates the woven fabric or synthetic material reinforcing layer **154** forming a chemical bond, in one embodiment, between the polymeric material **152** and the additional polymeric material layer **156**. In one embodiment, the polymeric material **152** and the additional polymeric material layer **156** are fabricated from the same polymer. In alternative embodiments, the polymeric material **152** and the additional polymeric material layer **156** are fabricated of different polymers. The properties of polymers, however, provide for strong, permanent, and in some cases chemical bonding between the layers, effectively encasing the woven fabric or synthetic material reinforcing layer **154** within the bonded polymers **152, 156**.

[**0041**] In one embodiment, the woven fabric or synthetic material reinforcing layer **154** forms a reinforcing layer of the CMP processing belt and therefore has the same continuous loop, belt-shaped structure as the polymeric material **152** of the CMP processing belt **150**. As described above, the fabrication of one embodiment of the present invention includes the temporary application of the woven fabric or synthetic material reinforcing layer **154** to the polymeric material **152** by such methods as clamping, stapling, tacking, the use of adhesives, and the like. As will be described in greater detail below in reference to **FIG. 4**, the woven fabric or synthetic material reinforcing layer **154** can be fabricated for and positioned against an interior surface of the polymeric material **152**, or the woven fabric or synthetic material reinforcing layer **154** can be fabricated for and positioned against an exterior surface of the polymeric material **152**. As used herein, an interior surface of the polymeric material **152** corresponds to an interior surface of the continuous loop, belt-shaped structure defining the CMP processing belt **150**. The interior surface of the CMP processing belt **150** is that surface in contact with the drums **104** (see **FIGS. 1A and 1B**) and the platen **114** (see **FIGS. 1A and 1B**). The exterior surface, therefore, is that surface having a processing surface and against which a wafer is applied for processing.

[**0042**] **FIG. 3B** is a cross section of a CMP processing belt **150** in accordance with an embodiment of the present invention. Similar to the CMP processing belt **150** illustrated in **FIG. 3A**, the CMP processing belt in **FIG. 3B** includes a polymeric material **152**, a woven fabric or synthetic material reinforcing layer **154**, and an additional polymeric material layer **156**. The woven fabric or synthetic material reinforcing layer **154** has been positioned against the polymeric material **152**, and the additional polymeric material layer **156** has been applied over the woven fabric or synthetic material reinforcing layer **154** by spraying **162** or otherwise applying the additional polymeric material layer **156** such that the applied polymer permeates the woven fabric or synthetic material reinforcing layer **154** and forms a strong and permanent bond between the polymeric material **152** and the additional polymeric material layer **156**, effectively encasing the woven fabric or synthetic material reinforcing layer **154** within the CMP processing belt **150**. In some embodiments, the bond formed is a chemical bond between the polymeric material **152** and the additional polymeric material layer **156**. The embodiment illustrated in **FIG. 3B** includes an EPD opening **158**, functioning as described above in reference to **FIG. 2B**.

[**0043**] In one embodiment, the EPD opening **158** is fabricated in the woven fabric or synthetic material reinforcing layer **154** prior to the positioning of the woven fabric or synthetic material reinforcing layer **154** against the polymeric material **152**. After the additional polymeric material layer **156** is applied, and the polymeric material **152** and the additional polymeric material layer **156** are bonded encasing the woven fabric or synthetic material reinforcing layer **154**. In one embodiment, the EPD opening **158** is fabricated in the CMP processing belt **150** by creating an opening through the additional polymeric material layer **156** and the polymeric material **152** aligned with and through the opening already created in the woven fabric or synthetic material reinforcing layer **154**. In some applications, a selected woven fabric or synthetic material is tough, strong, durable, and otherwise very difficult to cut or otherwise pierce in order to form an EPD opening. When the woven fabric or synthetic material is encased in polymeric material, the creation of an opening is extremely difficult, and therefore the opening is created prior to the positioning of the woven fabric or synthetic material reinforcing layer **154** against the polymeric material **152**.

[**0044**] In another embodiment, the polymeric material **152** and the additional polymeric material layer **156** are thinned (not shown in **FIG. 3B**) at the region in which the EPD opening **158** is defined through the woven fabric or synthetic material reinforcing layer **154**. In some implementations it is unnecessary to completely pierce through all of the polymeric material **152**, the woven fabric or synthetic material reinforcing layer **154** and the additional polymeric material layer **156**. Because the woven fabric or synthetic material reinforcing layer **156** has an EPD opening allowing for optical transmission through the reinforcing layer, the polymeric material **152** and the additional polymeric material layer **156** need only be thinned to allow optical transmission for EPD.

[**0045**] In other embodiments, the EPD opening **158** is fabricated by creating an opening in a fabricated CMP processing belt **150** through each of the integral polymeric material **152**, the woven fabric or synthetic material reinforcing layer **154**, and the additional polymeric material layer **156**. In an alternative embodiment, an EPD opening **158** can be fabricated in the polymeric material **152** during casting of the continuous loop, belt-shaped structure, and an opening can be created in the woven fabric or synthetic material reinforcing layer **154** prior to positioning against the polymeric material **152** during fabrication of the CMP processing belt **150**. The openings in the component layers are aligned when the woven fabric or synthetic material reinforcing layer **154** is positioned against the polymeric material **152**. The additional polymeric material layer **156** is applied, bonding the layers together and encasing the woven fabric or synthetic material reinforcing layer **154** forming the CMP processing belt **150**. The EPD opening **158** is then created by punching through the additional polymeric material layer **156** over the openings already created in the polymeric material **152** and the woven fabric or synthetic material reinforcing layer **154**.

[**0046**] **FIG. 4** shows a detail view of the application of the additional polymeric material layer **156** described in reference to **FIGS. 3A and 3B** in accordance with one embodiment of the invention. As described in reference to **FIGS. 3A and 3B**, the woven fabric or synthetic material reinforcing layer **154** is fabricated as a continuous loop, belt-shaped structure, and positioned against the polymeric material **152** which is also a continuous loop, belt-shaped structure. The woven fabric or synthetic material reinforcing layer **154** can be positioned against either an interior surface or an exterior surface of the polymeric material **152** according to desired implementation and use of the CMP processing belt **150**. In one embodiment, the woven fabric or synthetic material reinforcing layer **154** is fabricated from kevlar. In other embodiments, the woven fabric or synthetic material reinforcing layer **154** is fabricated of any of a plurality of fabrics or synthetic materials including polyesters, rayon, nylon, polyimides, mixtures of synthetics, and the like. The selected woven fabric or synthetic material is generally porous to allow for the additional polymeric material layer **156** to permeate the woven fabric or synthetic material such that the polymer(s) of the polymeric material **152** and the additional polymeric material layer **156** form a bond, effectively encasing the woven fabric or synthetic material reinforcing layer within the polymeric material **152** and the additional polymeric material layer **156** defining an integral structure CMP processing belt **150**. The integral structure thus formed is essentially not susceptible to delamination or separation of the layers typically used in the construction of some prior art CMP processing belts and surfaces.

[**0047**] As shown in **FIG. 4**, an embodiment of the present invention includes the application of the additional polymeric material layer **156** by spraying **162** polymeric material with a polymer spray applicator **160**. The applied polymer or polymeric material of the additional polymeric material layer **156** can be the same polymer or polymeric material as that defining polymeric material **152**, or in some embodiments, it can be a different polymer or polymeric material. In preferred embodiments, the selected polymers or polymeric materials have properties providing for the formation of a strong and permanent bond. In some embodiments, the bond formed is a chemical bond. Exemplary polymeric materials include polyurethane, polyester, PVC, polyacrylate, any of a plurality of epoxies, and the like. As can be appreciated in **FIG. 4**, the applied polymer permeates the woven fabric or synthetic material reinforcing layer **154**, forming the strong and permanent bond between the polymeric material **152** and the additional polymeric material layer **156**, and encasing the woven fabric or synthetic material reinforcing layer **154**. The resulting structure defines a reinforced CMP processing belt as an integrated structural unit.

[**0048**] **FIG. 5** shows a cross section of a CMP processing belt **170** in accordance with another embodiment of the present invention. In the embodiment illustrated in **FIG. 5**, the CMP processing belt **170** includes the polymeric material **152**, the woven fabric or synthetic material reinforcing layer **154**, and the additional polymeric material layer **156** as illustrated and described above in reference to **FIGS. 3A**, **3B**, and **4**. A processing surface layer **172** is cast, sprayed, or otherwise applied to the CMP processing belt **170** illustrated in **FIG. 5**. In the embodiments illustrated and described in **FIGS. 3A**, **3B**, and **4**, the polymeric material **152** defines the processing surface. In the embodiment illustrated in **FIG. 5, a** separate processing surface layer **172** is cast, sprayed, or otherwise fabricated over the polymeric material **152** to define the processing surface for the CMP processing belt **170**.

[**0049**] The CMP processing belt **170** illustrated in **FIG. 5** is fabricated in order to optimize the processing surface in applications in which it is desirable to have a processing surface layer **172** of a different hardness than underlying polymeric material **152** or additional polymeric material layer **156**. As described above in reference to **FIG. 4**, the woven fabric or synthetic material reinforcing layer **154** can be positioned against either an interior surface of the polymeric material **152** or an exterior surface of the polymeric material **152**. In this manner, differing hardnesses of the layers can be combined to optimize the hardness of the processing surface layer **172** according to processing conditions and desires. In one embodiment, the polymeric material **152**, the woven fabric or synthetic material reinforcing layer **154** and the additional polymeric material layer **156** are fabricated as described above in reference to **FIGS. 3A**, **3B**, and **4**, and then the processing surface layer **172** is cast over the already fabricated layers to define the processing surface of CMP processing belt **170**. In other embodiments, the polymeric material **152**, the woven fabric or synthetic material reinforcing layer **154** and the additional polymeric material layer **156** are fabricated, and the processing surface layer **172** is sprayed over or otherwise applied over the fabricated layers to define the CMP processing belt **170**.

[**0050**] The embodiment of the CMP processing belt **170** illustrated in **FIG. 5** can also be utilized to control the thickness of the CMP processing belt **170** to meet performance requirements. A typical CMP processing belt **170**, **150**, in accordance with embodiments of the present invention as described above, ranges in thickness from about 80 mils to about 100 mils. In an embodiment of a CMP processing belt **170** according to the present invention, the thickness of the integral polymeric material **152**, the woven fabric or synthetic material reinforcing layer **154**, and the additional polymeric material layer **156** can be minimized to a range from about 20 mils to about 30 mils while retaining the desired strength and structural support properties. The overall thickness of the CMP processing belt **170** is then dependent upon the type and thickness of the processing surface layer **172**. By way of example, if a thicker CMP processing belt **170** is desired, any of the polymeric material **152**, the additional polymeric material layer **156**, and the processing surface layer **172** can be fabricated to a desired thickness to achieve design goals. In a similar manner, the thickness and composition of the layers **172**, **152**, **156**, can be adjusted to achieve desired hardness, rigidity, and the like according to processing conditions and desires.

[**0051**] **FIG. 6** is a flow chart diagram **200** illustrating the method operations for manufacturing a reinforced polymeric CMP processing belt in accordance with one embodiment of the present invention. The illustrated method begins with operation **210** in which the woven fabric or synthetic material reinforcing layer is fabricated. In one embodiment, the woven fabric or synthetic material reinforcing layer is fabricated of kevlar. In other embodiments, the woven fabric or synthetic material reinforcing layer is fabricated of nylon, rayon, polyester, polyimide, a mixed synthetic material, or any other desired fabric or synthetic material to provide the desired reinforcement of the fabricated CMP processing belt. Examples of desired reinforcement qualities include strength, durability, a decrease in the tendency of the CMP processing belt to stretch with continued, sustained use, flexibility for use in a linear CMP processing tool or system, and the like.

[0052] In one embodiment, the woven fabric or synthetic material reinforcing layer is fabricated to be positioned against an interior surface of the polymeric material of the fabricated CMP processing belt. In another embodiment, the woven fabric or synthetic material reinforcing layer is fabricated to be positioned against an exterior surface of the fabricated CMP processing belt. In method operation **210** the woven fabric or synthetic material reinforcing layer is fabricated according to the desired dimension and positioning in a continuous loop, belt-like structure. In one embodiment, EPD openings are fabricated in the woven fabric or synthetic material reinforcing layer during fabrication of the layer according to processing desires.

[0053] The method continues with operation **212** and the preparation of a polymer to be molded into a CMP processing belt. In one embodiment, a polymer or polymeric material is prepared for molding into a polymeric CMP processing belt utilizing a polymeric mold. A polymeric mold is typically used to cast a polymeric CMP processing belt as a continuous loop, belt-like structure by injecting a desired polymer or polymeric material into a mold or form of the desired shape and dimension. In one embodiment, method operation **212** includes the preparation of the polymer or polymeric material to be used to cast the polymeric material described above in reference to **FIGS. 3A, 3B, 4**, and **5**, and identified by reference numeral **152**. In one embodiment, the preparation of the polymer or polymeric material in method operation **212** includes the preparation for the polymeric material and for preparation of the polymer or polymeric material for the additional polymeric material layer described above and identified by reference numeral **156**.

[0054] Any desired polymer or polymeric material may be used in operation **212** according to the intended processing requirements. Generally, a flexible, durable, and tough material is desired for a linear CMP processing belt for effective wafer planarization without scratching. The selected polymer need not be fully elastic, and should not slacken or loosen with use. Different polymers may be selected to enhance certain features of the intended process. In one embodiment, the polymer may be polyurethane. In another embodiment, the polymer may be a urethane mixture that produces a processing surface of the completed polymeric CMP processing belt that is a microcellular polyurethane with a specific gravity of approximately 0.4-1.5 g/cm^2 and a hardness of approximately 2.5-90 shore D. Typically, a liquid resin and a liquid curative are combined to form the polyurethane mixture. In another embodiment, a polymeric gel may be utilized to form the polymeric material.

[0055] After operation **212**, the method proceeds to operation **214** in which prepared polymer is injected into the mold. In one embodiment, urethane or other polymer or polymeric material is dispensed into a hot cylindrical mold. In one embodiment, the injection of prepared polymer into a mold is to form the polymeric material identified by reference numeral **152** in the Figures described above.

[0056] In operation **216**, the prepared polymer is heated and cured. It should be understood that any type of polymer may be heated and cured in any way that would produce the physical characteristics desired in a finished polymeric CMP processing belt. In one embodiment, a urethane mixture is heated and cured for a predetermined time at a predetermined temperature to form a urethane processing surface. Curing times and temperatures suitable to the selected polymer or polymeric material, or to achieve specific desired properties may be followed. In just one example, thermoplastic materials are processed hot and then become set by cooling.

[0057] After operation **216**, the method advances to operation **218** and the polymeric material is de-molded by removing the belt from the mold. In one embodiment, the mold is a polymeric linear CMP processing belt molding container used to form the polymeric material to be reinforced with the woven fabric or other synthetic material reinforcing layer, and additional polymeric material to encase the woven fabric or synthetic material reinforcing layer within the polymeric structure of the CMP processing belt.

[0058] Then, in operation **220**, the polymeric material is fabricated to a desired thickness and dimension according to processing requirements. In one embodiment, the polymeric material is lathed to predetermined dimensions. In operation **220**, the polymeric material, in a molded continuous loop belt-shaped form, is cut to the desired thickness and dimensions for optimal linear CMP processing. In one embodiment, the polymeric CMP processing belt is lathed to a thickness ranging from about 0.02 inch to about 0.2 inch, with a preferred thickness of about 0.02 inch to about 0.05 inch, according to the CMP process for which the polymeric CMP processing belt is intended to be used.

[0059] The method proceeds with operation **222** in which the woven fabric or synthetic material reinforcing layer is positioned against polymeric material and temporarily attached. Methods of temporary attachment include clamping, stapling, tacking, use of adhesives, and the like in order to precisely position the woven fabric or synthetic material reinforcing layer against the polymeric material. In one embodiment, the woven fabric or synthetic material reinforcing layer is positioned against an interior surface of the polymeric layer. In another embodiment, the woven fabric or synthetic material reinforcing layer is positioned against an exterior surface of the polymeric material, according to processing and fabrication desires.

[0060] In method operation **224**, additional polymeric material is applied to form the additional polymeric material layer and encase the woven fabric or synthetic material reinforcing layer within the polymeric structure of the fabricated CMP processing belt. In one embodiment, the additional polymeric material is applied by spraying the additional polymeric material over the woven fabric or synthetic material reinforcing layer. In another embodiment, the polymeric material with temporarily attached woven fabric or synthetic material reinforcing layer is positioned in a mold and the additional polymeric material is cast over the woven fabric or synthetic material reinforcing layer. However the additional polymeric material layer is applied, the polymer or polymeric material permeates the woven fabric or synthetic material and bonds with the polymeric material, encasing the woven fabric or synthetic material reinforcing layer to define an integral structure of the reinforced CMP processing belt.

[0061] The method continues with operation **226** in which the reinforced polymeric CMP processing belt, including the polymeric material, the woven fabric or synthetic material reinforcing layer, and the additional polymeric material layer as an integral structure, is fabricated into the desired thickness and dimension for the reinforced CMP processing belt. In one embodiment, the fabrication includes lathing, trimming, and the like to achieve the desired thickness and surface quality. If the polymeric linear CMP processing belt is an embodiment with EPD openings, one embodiment of operation **226** includes piercing, thinning and clearing of the polymeric regions at the EPD openings fabricated in the woven fabric or synthetic material reinforcing layer as described above. In one embodiment of fabrication of a CMP processing belt in accordance with the present invention, the mold or form used in method operation **214** includes structural definition of EPD openings within the mold or form. The woven fabric or synthetic material reinforcing layer is positioned in method operation **222** with fabricated EPD openings aligned with the structures defined in the polymeric material, and in operation **226**, the final thinning or piercing of the EPD openings is accomplished as desired.

[**0062**] In one embodiment of method operation **226**, the reinforced polymeric CMP processing belt is fabricated to a desired thickness and dimension according to processing requirements. In one embodiment, the integral polymeric material is lathed to predetermined dimensions. In one embodiment, the reinforced polymeric CMP processing belt is lathed to a thickness ranging from about 0.02 inch to about 0.2 inch, with a preferred thickness of about 0.07 inch to about 0.12 inch, according to the CMP process for which the polymeric CMP processing belt is intended to be used.

[**0063**] In one embodiment of method operation **226**, edges of the reinforced polymeric CMP processing belt are trimmed, and the reinforced polymeric CMP processing belt is cleaned and prepared for use. In one embodiment, the polymeric linear CMP processing belt is 90-110 inches in length, 8-16 inches wide and 0.020-0.2 inches thick. It is therefore suitable for use in the Teres™ linear polishing apparatus manufactured by Lam Research Corporation.

[**0064**] In one embodiment, the fabrication of the integral structure reinforced polymeric CMP processing belt to the desired thickness and dimension completes the fabrication of a reinforced CMP processing belt, and the method is done. In one embodiment, the method includes additional method operation **228** in which a desired preparation surface is fabricated. In the fabrication of the preparation surface of method operation **228** grooves are formed on a processing surface of the reinforced polymeric CMP processing belt in accordance with one embodiment of the invention. In another embodiment, the grooves may be formed during molding by providing a suitable pattern on the inside of the mold. In one embodiment, the raw casting is turned and grooved on a lathe to produce a smooth polishing surface with square shaped grooves. In another embodiment, a separate polymer or polymeric material processing surface is applied to the reinforced CMP processing belt, the polymer(s) or polymeric material bonding to the reinforced CMP processing belt as an additional integral structure. Embodiments of additional processing surfaces include surfaces providing a different hardness than the underlying layers of the reinforced polymeric CMP processing belt, desired surface texturing, and the like. If the additional method operation **228** is accomplished, the reinforced polymer CMP processing belt is completed upon fabrication and preparation of the processing surface, and the method is done.

[**0065**] 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. 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:

1. A processing belt for use in chemical mechanical planarization (CMP), comprising:

a fabric belt; and

a polymeric material encasing the fabric belt to define the processing belt to be used in CMP operations.

2. The processing belt of claim 1, wherein the fabric belt forms a continuous loop within the polymeric material.

3. The processing belt of claim 1, wherein the fabric belt is defined of kevlar.

4. The processing belt of claim 3, further comprising openings in the fabric belt, the openings being configured to be suitable for optical transmissions through the opening in the fabric.

5. The processing belt of claim 4, wherein the polymeric material is made thinner at the opening in the fabric.

6. The processing belt of claim 1, wherein the fabric belt is defined of a synthetic material including polyester, polyimide, nylon, rayon, and PVC.

7. A belt for use in chemical mechanical planarization (CMP) processing, comprising:

a polymeric material being cast into a continuous loop to define the belt; and

a reinforcing fabric embedded between the polymeric material and an additional polymeric material layer, the reinforcing fabric being defined as a continuous loop within the polymeric material and the additional polymeric material layer.

8. The belt of claim 7, wherein the polymeric material includes polyurethane, polyester, PVC, polyacrylate, and epoxy.

9. The belt of claim 7, wherein the additional polymeric material layer is defined by one of polyurethane, polyester, PVC, polyacrylate, and epoxy.

10. The belt of claim 7, wherein the reinforcing fabric is defined as a woven and porous structure.

11. The belt of claim 7, further comprising openings fabricated in the reinforcing fabric, the openings being suitable for optical transmissions through the reinforcing fabric.

12. The belt of claim 11, wherein the polymeric material and the additional polymeric material layer are made thinner at the openings in the reinforcing fabric.

13. The belt of claim 7, wherein the reinforcing fabric is defined from kevlar.

14. The belt of claim 7, wherein the reinforcing fabric is defined of a synthetic fiber including nylon, polyester, polyimide, rayon, and PVC.

15. The belt of claim 7, further comprising:

a processing surface defined over the polymeric material, the polymeric material being a first polymeric material and the processing surface being defined from a second polymeric material bonded to the first polymeric material.

16. A processing belt for use in chemical mechanical planarization (CMP), comprising:

a continuous loop reinforcing woven fabric;

a continuous loop polymeric material; and

a continuous loop additional polymeric material layer bonded to the continuous loop polymeric material and encasing the continuous loop reinforcing woven fabric between the continuous loop polymeric material and the continuous loop additional polymeric material layer to define the processing belt to be used in CMP operations,

wherein the continuous loop reinforcing woven fabric is defined from one of kevlar, nylon, polyimide, and polyester.

17. The processing belt of claim 16, wherein the continuous loop reinforcing woven fabric includes openings that allow optical transmission to pass through the continuous loop reinforcing fabric.

18. The processing belt of claim 17, wherein the continuous loop polymeric material and the continuous loop additional polymeric material encasing the continuous loop reinforcing woven fabric are thinner at the openings than the continuous loop polymeric material and the continuous loop additional polymeric material encasing the continuous loop reinforcing woven fabric in regions other than at the openings.

19. A method for fabricating a belt for use in chemical mechanical planarization (CMP), comprising:

forming a belt-shaped fabric;

providing a mold configured to form a belt-shaped structure;

forming a polymeric material in the mold;

attaching the belt shaped fabric to the formed polymeric material; and

applying an additional polymeric material layer over the belt-shaped fabric, the applying being over and through the belt-shaped fabric such that the belt-shaped fabric is encased between the polymeric material and the additional polymeric material layer, the polymeric material and the additional polymeric material layer being bonded together.

20. The method of claim 19, further comprising:

defining a polymeric processing surface over the polymeric material.

21. The method of claim 19, wherein the forming a belt-shaped fabric includes forming openings through the belt-shaped fabric through which optical transmissions can pass.

22. The method of claim 19, wherein the belt-shaped fabric is formed of kevlar.

23. The method of claim 19, wherein the polymeric material includes polyurethane, polyester, PVC, polyacrylate, and epoxy.

24. The method of claim 19, wherein the additional polymeric material layer is defined of one of polyurethane, polyester, PVC, polyacrylate, and epoxy.

25. The method of claim 19, wherein the polymeric material and the additional polymeric material layer encasing the belt-shaped fabric are chemically bonded together.

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