

REINFORCED CHEMICAL MECHANICAL PLANARIZATION BELT

BACKGROUND OF THE INVENTION**1. Field of the Invention**

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

2. Description of the Related Art

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.

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 are introduced to facilitate and enhance the planarization or other CMP process.

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 chemical and mechanical forces to planarize, scrub, polish, buff, clean, or otherwise process the surface of a semiconductor wafer having integrated circuits or other structures fabricated thereon.

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.

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 adds manufacturing costs to belt construction, such belts can be difficult to work with, and such belts are subject to structural failure at openings for end point detection systems, and due to break down of the bond between layers caused by normal use and aggravated by the typically wet CMP environment.

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. 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.

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

5 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.

10 In one embodiment, a belt for use in chemical mechanical planarization (CMP) processing is disclosed. The belt includes a polymeric material being cast into a continuous loop to define the belt, and a continuous mesh core embedded in the polymeric material. The continuous mesh core is defined as a more rigid inner core of the polymeric material.

15 In another embodiment, a belt for use in chemical mechanical planarization (CMP) processing is disclosed. The belt includes 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 is defined as a continuous loop within the polymeric material and the additional polymeric material layer.

20 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 reinforcing core of the present invention provides the necessary strength, support, and resilience without stacks of bonded layers subject to delamination or separation. The reinforcing core of the present invention is encased within the structure of the processing belt and is therefore integral to the belt structure. Polymeric material is cast around and through
25 the reinforcing core, or sprayed over and through the reinforcing core, resulting in a CMP processing belt of significantly increased lifetime in the CMP process.

30 Another benefit is the lower cost and ease of manufacture. Unlike typical prior art processing belts, one embodiment of the present invention includes a single inner mesh core around which the polymeric mass of the polishing belt is cast. In another embodiment, 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.

An additional benefit is the ability to readily integrate embodiments of the present invention with optical end point detection apparatus. The reinforcing core of the present invention provides for easy 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.

Yet another advantage and benefit is the plurality of options provided by the present invention for specific or specialty applications. Embodiments of the present invention can be easily implemented with preferential reinforcement according to specific circumstance or desired use.

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

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.

Figure 1A illustrates a typical linear belt CMP system.

Figure 1B shows a side view of the linear belt CMP system described in Figure 1A.

Figure 2A shows a cross section of a typical linear CMP processing belt.

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

Figure 3A is a cross section of a CMP processing belt in accordance with an embodiment of the present invention.

Figure 3B is a cross section of a CMP processing belt in accordance with another

embodiment of the present invention.

Figure 3C is a cross section of a CMP processing belt in accordance with yet another embodiment of the present invention.

5 Figure 4A is a cross section of a CMP processing belt in accordance with an embodiment of the present invention.

Figure 4B is a cross section of a CMP processing belt in accordance with an embodiment of the present invention.

10 Figure 5 shows a detail view of the application of the additional polymeric material layer described in reference to Figures 4A and 4B in accordance with one embodiment of the invention.

Figure 6 shows a cross section of a CMP processing belt in accordance with another embodiment of the present invention.

Figure 7 shows a detailed view of a mesh core in accordance with one embodiment of the present invention.

15 Figure 8A shows an embodiment of the mesh core constructed in an alternative grid or matrix pattern.

Figure 8B shows an embodiment of the mesh core constructed in an alternative grid or matrix pattern.

20 Figure 9A illustrates a detailed view of a mesh core in accordance with one embodiment of the present invention.

Figure 9B illustrates a detailed view of a mesh core in accordance with another embodiment of the present invention.

Figure 10A shows a method of fabricating a CMP processing belt in accordance with one embodiment of the present invention.

25 Figure 10B shows another embodiment of the casting mold of the present invention.

Figure 11 is a flow chart diagram illustrating the method operations for manufacturing a polymeric linear CMP processing belt in accordance with one embodiment of the present invention.

Figure 12A illustrates a section of a mesh core 154 as positioned within a linear CMP processing belt mold.

Figure 12B illustrates a mesh core support positioning a mesh core in accordance with one embodiment of the invention.

5 Figure 13A illustrates a polymeric linear CMP processing belt mold in accordance with one embodiment of the present invention.

Figure 13B illustrates a polymeric linear CMP processing belt mold in accordance with one embodiment of the present invention.

10 Figure 14 is a flow chart diagram illustrating the method operations for manufacturing a reinforced polymeric CMP processing belt in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 An invention for a CMP processing belt and methods for making the same are disclosed. In preferred embodiments, the CMP processing belt includes a reinforcing mesh belt with a polymeric material encasing the mesh belt to define the processing belt, and 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.

20 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.

25 Figure 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 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
5 sufficient force to accomplish the desired planarization or other CMP process, as well as providing a flat surface for consistent, measurable processing. Figure 1B shows a side view of the linear belt CMP system 100 just described.

As can be appreciated from Figures 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
10 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 of the linear CMP processing belt 102 subjected to greater stretching than the inner region 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
15 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.

Figure 2A shows a cross section of a typical linear CMP processing belt 120. The
20 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 Figures 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
25 provides a cushioning transition layer between the processing surface polymeric layer 122, 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, casting of one layer over another, or other similar joining of one
30 layer to the next.

Figure 2B shows the cross section of a typical linear CMP processing belt 120 of

Figure 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 Figure 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
5 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 0.75 inches in width, and therefore not an entire width of the linear CMP
10 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.

15 As described above, the stretching and contracting forces caused during normal use of the linear CMP processing system 100 (see Figures 1A and 1B) can cause delamination or separation in a linear CMP processing belt 120 such as exemplary belt illustrated in Figure 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
20 illustrated in Figure 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.

25 Figure 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 Figure 3A, the CMP processing belt 150 is constructed substantially of a polymeric 152 material (also referred to herein as polymeric layer 152, and polymeric 152) with a stainless steel or other suitable material mesh core 154. In one embodiment, the mesh core 154 forms
30 an approximate core or center layer, and the polymeric 152 is cast around and through the mesh core 154. Examples of polymeric material used to cast the polymeric 152 of the CMP processing belt include polyurethanes, polyesters, PVC, polyacrylates, and epoxies. The

resulting structure is flexible and resilient to withstand the stretching and contraction stresses of use in a linear belt CMP system 100 (see Figures 1A and 1B), is cast as a single, integrated structure and therefore not subject to a high likelihood for delamination or separation, provides a stable surface for CMP processing, is easily integrated with optical EPD systems, is durable and long-lasting, and provides a plurality of advantages over the prior art.

In one embodiment of the present invention, the mesh core 154 provides an internal support analogous to the base or support layer 126 described in reference to Figures 2A and 2B. As described herein, a mesh core of the CMP processing belt is defined as a continuous loop, belt-shaped inner core. The continuous loop has no beginning and no end, and therefore is a belt- or band-shaped structure. Unlike the solid base or support layer 126 of Figures 2A and 2B, the mesh core 154 of the present invention provides the desired strength and support as an inner core, and due to its mesh design, is bonded and cast within the polymeric 152 to substantially reduce or essentially eliminate the likelihood of delamination or other separation that can result when polymeric is bonded or otherwise cast to a solid base or support layer 126 as illustrated in Figures 2A and 2B.

Figure 3B is a cross section of a CMP processing belt 150 in accordance with another embodiment of the present invention. In the embodiment illustrated in Figure 3B, the polymeric CMP processing belt 150 is reinforced with a mesh reinforcing layer 154. The mesh reinforcing layer 154 of Figure 3B is the same structure as the mesh core 154 shown in Figure 3A. The mesh reinforcing layer 154 is therefore a mesh layer of the CMP processing belt 150 having a continuous loop, belt-shaped structure. In one embodiment, the CMP processing belt 150 is essentially cast of polymeric 152, and the reinforcing mesh layer 154 is positioned against a bottom surface of the polymeric 152 material. The reinforcing mesh layer 154 is then bonded to the polymeric layer 152 by spraying 156 additional polymeric material 153, essentially forming an additional polymeric layer 153 and resulting in the reinforcing mesh layer 154 being a mesh core 154. In one embodiment, the additional polymeric layer 153 is the same material as the polymeric layer 152. In another embodiment, the additional polymeric layer 153 is a different material than the polymeric layer 152, according to process requirements and desires.

In one embodiment of the invention, an applicator 158 is used to spray 156, or otherwise apply, polymeric to the reinforcing mesh layer 154 positioned against a CMP

processing belt 150 that has been cast of polymeric 152. The additional polymeric 153 applied to the reinforcing mesh layer 154 and polymeric 152, in one embodiment, forms a continuous structure being of the same polymeric material as the polymeric layer 152 and flowing through and around the generally porous grid pattern of the reinforcing mesh layer 154.

Figure 3C is a cross section of a CMP processing belt 150 in accordance with yet another embodiment of the present invention. In the embodiment illustrated in Figure 3C, the polymeric CMP processing belt 150 is reinforced with a mesh reinforcing layer 154. The mesh reinforcing layer 154 of Figure 3C is the same structure as the mesh core 154 shown in Figures 3A and 3B. In the embodiment illustrated in Figure 3C, the CMP processing belt 150 is essentially cast of polymeric 152 encasing the mesh core 154 similar to the CMP processing belt 150 illustrated in Figure 3A. A processing surface layer 155 is then cast, in one embodiment, over the polymeric 152 encasing the mesh core 154. In another embodiment, the processing surface layer is sprayed on using an applicator as described above in reference to Figure 3B. The CMP processing belt 150 illustrated in Figure 3C can be utilized where processing conditions are optimized using materials in which the processing surface layer 155 is of a different hardness than polymeric layer 152. Both the processing surface layer 155 and the polymeric layer 152 can be of polymeric materials and therefore securely bonded. Additionally, when processing conditions warrant, processing surface layer 155 can be cast or otherwise applied and include one or more individual layers, only one of which is illustrated in Figure 3C. A processing surface layer 155 consisting of more than a single layer of polymeric material can be used to implement differing hardness layers in a CMP processing belt 150 to achieve desired processing surface properties, for example, a cushioning layer beneath the process surface.

Figure 4A is a cross section of a CMP processing belt 160 in accordance with an embodiment of the present invention. In the inventive CMP processing belt 160 shown in Figure 4A, the CMP processing belt 160 is constructed substantially of a polymeric material 162 with a woven fabric or synthetic material reinforcing layer 164, and an additional polymeric material layer 166 sprayed on, or otherwise applied, bonding the woven fabric or synthetic material reinforcing layer 164 to the polymeric material 162. The polymeric material 162 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.

In one embodiment, the woven fabric or synthetic material reinforcing layer 164 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 160 according to particular processing needs.

In the embodiment illustrated in Figure 4A, additional polymeric material layer 166 is shown bonding the woven fabric or synthetic material reinforcing layer 164 to the polymeric material 162. The additional polymeric material layer 166 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.

As illustrated in Figure 4A, one embodiment of the present invention includes the application of the additional polymeric material layer 166 by spraying the desired polymer using polymer spray applicator 158. The woven fabric or synthetic material reinforcing layer 164 is temporarily clamped, stapled, tacked, glued, or otherwise temporarily positioned (not shown in Figure 4A) against the polymeric material 162. Polymer spray applicator 158 is used to spray the additional polymeric material layer 166 such that the additional polymeric material layer 166 is applied over the woven fabric or synthetic material reinforcing layer 164, and also permeates the woven fabric or synthetic material reinforcing layer 164 forming a chemical bond, in one embodiment, between the polymeric material 162 and the additional polymeric material layer 166. In one embodiment, the polymeric material 162 and the additional polymeric material layer 166 are fabricated from the same polymer. In alternative embodiments, the polymeric material 162 and the additional polymeric material layer 166 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 164 within the bonded polymers 162, 166.

In one embodiment, the woven fabric or synthetic material reinforcing layer 164 forms a reinforcing layer of the CMP processing belt and therefore has the same continuous

loop, belt-shaped structure as the polymeric material 162 of the CMP processing belt 160. 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 164 to the polymeric material 162 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 Figure 5, the woven fabric or synthetic material reinforcing layer 164 can be fabricated for and positioned against an interior surface of the polymeric material 162, or the woven fabric or synthetic material reinforcing layer 164 can be fabricated for and positioned against an exterior surface of the polymeric material 162. As used herein, an interior surface of the polymeric material 162 corresponds to an interior surface of the continuous loop, belt-shaped structure defining the CMP processing belt 160. The interior surface of the CMP processing belt 160 is that surface in contact with the drums 104 (see Figures 1A and 1B) and the platen 114 (see Figures 1A and 1B). The exterior surface, therefore, is that surface having a processing surface and against which a wafer is applied for processing.

Figure 4B is a cross section of a CMP processing belt 160 in accordance with an embodiment of the present invention. Similar to the CMP processing belt 160 illustrated in Figure 4A, the CMP processing belt in Figure 4B includes a polymeric material 162, a woven fabric or synthetic material reinforcing layer 164, and an additional polymeric material layer 166. The woven fabric or synthetic material reinforcing layer 164 has been positioned against the polymeric material 162, and the additional polymeric material layer 166 has been applied over the woven fabric or synthetic material reinforcing layer 164 by spraying 156 or otherwise applying the additional polymeric material layer 166 such that the applied polymer permeates the woven fabric or synthetic material reinforcing layer 164 and forms a strong and permanent bond between the polymeric material 162 and the additional polymeric material layer 166, effectively encasing the woven fabric or synthetic material reinforcing layer 164 within the CMP processing belt 160. In some embodiments, the bond formed is a chemical bond between the polymeric material 162 and the additional polymeric material layer 166. The embodiment illustrated in Figure 4B includes an EPD opening 168, functioning as described above in reference to Figure 2B.

In one embodiment, the EPD opening 168 is fabricated in the woven fabric or synthetic material reinforcing layer 164 prior to the positioning of the woven fabric or synthetic material reinforcing layer 164 against the polymeric material 162. After the additional polymeric

material layer 166 is applied, and the polymeric material 162 and the additional polymeric material layer 166 are bonded encasing the woven fabric or synthetic material reinforcing layer 164. In one embodiment, the EPD opening 168 is fabricated in the CMP processing belt 160 by creating an opening through the additional polymeric material layer 166 and the polymeric material 162 aligned with and through the opening already created in the woven fabric or synthetic material reinforcing layer 164. 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 164 against the polymeric material 162.

In another embodiment, the polymeric material 162 and the additional polymeric material layer 166 are thinned (not shown in Figure 4B) at the region in which the EPD opening 168 is defined through the woven fabric or synthetic material reinforcing layer 164. In some implementations it is unnecessary to completely pierce through all of the polymeric material 162, the woven fabric or synthetic material reinforcing layer 164 and the additional polymeric material layer 166. Because the woven fabric or synthetic material reinforcing layer 164 has an EPD opening allowing for optical transmission through the reinforcing layer, the polymeric material 162 and the additional polymeric material layer 166 need only be thinned to allow optical transmission for EPD.

In other embodiments, the EPD opening 168 is fabricated by creating an opening in a fabricated CMP processing belt 160 through each of the integral polymeric material 162, the woven fabric or synthetic material reinforcing layer 164, and the additional polymeric material layer 166. In an alternative embodiment, an EPD opening 168 can be fabricated in the polymeric material 162 during casting of the continuous loop, belt-shaped structure, and an opening can be created in the woven fabric or synthetic material reinforcing layer 164 prior to positioning against the polymeric material 162 during fabrication of the CMP processing belt 160. The openings in the component layers are aligned when the woven fabric or synthetic material reinforcing layer 164 is positioned against the polymeric material 162. The additional polymeric material layer 166 is applied, bonding the layers together and encasing the woven fabric or synthetic material reinforcing layer 164 forming the CMP processing belt 160. The EPD opening 168 is then created by punching through the additional polymeric material layer

166 over the openings already created in the polymeric material 162 and the woven fabric or synthetic material reinforcing layer 164.

Figure 5 shows a detail view of the application of the additional polymeric material layer 166 described in reference to Figures 4A and 4B in accordance with one embodiment of the invention. As described in reference to Figures 4A and 4B, the woven fabric or synthetic material reinforcing layer 164 is fabricated as a continuous loop, belt-shaped structure, and positioned against the polymeric material 162 which is also a continuous loop, belt-shaped structure. The woven fabric or synthetic material reinforcing layer 164 can be positioned against either an interior surface or an exterior surface of the polymeric material 162 according to desired implementation and use of the CMP processing belt 160. In one embodiment, the woven fabric or synthetic material reinforcing layer 164 is fabricated from kevlar. In other embodiments, the woven fabric or synthetic material reinforcing layer 164 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 166 to permeate the woven fabric or synthetic material such that the polymer(s) of the polymeric material 162 and the additional polymeric material layer 166 form a bond, effectively encasing the woven fabric or synthetic material reinforcing layer within the polymeric material 162 and the additional polymeric material layer 166 defining an integral structure CMP processing belt 160. 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.

As shown in Figure 5, an embodiment of the present invention includes the application of the additional polymeric material layer 166 by spraying 156 polymeric material with a polymer spray applicator 158. The applied polymer or polymeric material of the additional polymeric material layer 166 can be the same polymer or polymeric material as that defining polymeric material 162, 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 Figure 5, the applied polymer permeates the woven fabric or synthetic

material reinforcing layer 164, forming the strong and permanent bond between the polymeric material 162 and the additional polymeric material layer 166, and encasing the woven fabric or synthetic material reinforcing layer 164. The resulting structure defines a reinforced CMP processing belt as an integrated structural unit.

5 Figure 6 shows a cross section of a CMP processing belt 170 in accordance with another embodiment of the present invention. In the embodiment illustrated in Figure 6, the CMP processing belt 170 includes the polymeric material 162, the woven fabric or synthetic material reinforcing layer 164, and the additional polymeric material layer 166 as illustrated and described above in reference to Figures 4A, 4B, and 5. A processing surface layer 172 is
10 cast, sprayed, or otherwise applied to the CMP processing belt 170 illustrated in Figure 6. In the embodiments illustrated and described in Figures 4A, 4B, and 5, the polymeric material 162 defines the processing surface. In the embodiment illustrated in Figure 6, a separate processing surface layer 172 is cast, sprayed, or otherwise fabricated over the polymeric material 162 to define the processing surface for the CMP processing belt 170.

15 The CMP processing belt 170 illustrated in Figure 6 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 162 or additional polymeric material layer 166. As described above in reference to Figure 5, the woven fabric or synthetic material reinforcing layer 164 can be positioned against either an interior surface
20 of the polymeric material 162 or an exterior surface of the polymeric material 162. 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 162, the woven fabric or synthetic material reinforcing layer 164 and the additional polymeric material layer 166 are fabricated as described above in
25 reference to Figures 4A, 4B, and 5, 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 162, the woven fabric or synthetic material reinforcing layer 164 and the additional polymeric material layer 166 are fabricated, and the processing surface layer 172 is sprayed over or otherwise applied over the fabricated layers to
30 define the CMP processing belt 170.

The embodiment of the CMP processing belt 170 illustrated in Figure 6 can also be

utilized to control the thickness of the CMP processing belt 170 to meet performance requirements. A typical CMP processing belt 170, 160, 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 162, the woven fabric or synthetic material reinforcing layer 164, and the additional polymeric material layer 166 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 162, the additional polymeric material layer 166, 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, 162, 166, can be adjusted to achieve desired hardness, rigidity, and the like according to processing conditions and desires.

Further, in the embodiment of a CMP processing belt 150 in accordance with the embodiments illustrated in Figures 3A, 3B, and 3C, a desired thickness is obtained by adjusting any of the polymeric 152, additional polymeric 153 and processing surface 155 layers as described above. In one embodiment, the overall thickness of the CMP processing belt 150 is then dependent upon the type and thickness of the processing surface layer 155. If a thicker CMP processing belt is desired, the polymeric layer 152 with the embedded mesh core 154 can be made as thick as desired to achieve the desired thickness for the CMP processing belt.

Looking more closely at structures of the embodiments of the present invention illustrated in Figures 3A, 3B, and 3C, Figure 7 shows a detailed view of a mesh core 154 in accordance with one embodiment of the present invention. In the illustrated embodiment, the mesh core 154 is configured in a grid arrangement. As described herein, a grid defines the mesh structure of the inner mesh core 154, and a grid is alternatively defined as a matrix. Vertical members 174a and horizontal members 174b are arranged to form a perpendicular grid as illustrated. In one embodiment, the mesh core 154 is constructed by adhering, bonding, welding, soldering, or otherwise affixing the vertical members 174a and the horizontal members 174b. As will be described in greater detail in reference to Figures 8A and 8B, the mesh core 154 is not limited to vertical members 174a and horizontal members

174b, but grid members 174 (illustrated in Figure 7 as 174a and 174b) which can be in any desired orientation or grid pattern according to the processing environment, desires, specifications, and the like.

Each joint 176 between grid members 174a, 174b, is fixed in one embodiment in order to allow for discontinuities in the grid as will be described in greater detail below in reference to Figures 8A and 8B. In another embodiment, the grid or matrix is constructed by weaving, braiding, intertwining, or otherwise forming a grid of inwoven members 174a, 174b.

In one embodiment, the vertical members 174a and the horizontal members 174b are cylindrical shafts or single strand wires constructed of stainless steel. Other materials from which the mesh core 154 can be constructed include stainless steel alloys, aluminum, steel, copper, and the like to provide a strong internal framework for the linear CMP processing belt 150 (e.g., see Figure 3A), that is resilient to the stresses caused by normal linear CMP processing, that is easily fabricated and encased in polymers and therefore not subject to delamination, and that provides a rigid structure that adequately supports the application of a wafer for CMP processing, provides a durable reinforced processing belt for sustained CMP tool operation, and is not subject to stretching or other deformation. The cylindrical shaft structure, similar to a single strand wire, shaft, or rod, is selected to provide the most resilient and strong or durable structure for use in constructing the mesh core 154. Other embodiments of the invention include the use of essentially rectangular-shaped shafts with flat faces and a thin profile providing a greater surface area for bonding at the joints between grid members 174a, 174b, or any other structure easily formed into the grid or matrix pattern of a mesh.

Figures 8A and 8B show embodiments of the mesh core 154 constructed of alternative grid or matrix patterns. In Figure 8A, the mesh core 154 is shown constructed in a simple cross- or diagonal-grid pattern. In Figure 8B, the mesh core 154 is shown constructed in a combination of a perpendicular grid as illustrated in Figure 7, and a cross- or diagonal-grid as illustrated in Figure 8A. Figures 8A and 8B show only two alternative embodiments of a plurality of grid arrangements or configurations. It should be appreciated that the grid members 174 of the mesh core 154 can be arranged and configured for specific applications. By way of example, the mesh core 154 can be configured to provide additional cross-belt reinforcement, to provide additional belt reinforcement around the girth of the linear CMP processing belt, to provide edge reinforcement, or to provide specific, localized reinforcement

or strengthening as desired. One example of specific, localized reinforcement is described further in reference to Figure 9B. The grid or matrix pattern alternatives provide a plurality of embodiments of the present invention to satisfy the requirements of a plurality of CMP processing applications.

5 Figure 9A illustrates a detailed view of a mesh core 154 in accordance with one embodiment of the present invention. In the embodiment illustrated in Figure 9A, an EPD opening 178 has been removed from the mesh core 154. As described above in reference to Figure 7, embodiments of the mesh core 154 are constructed by adhering, bonding, welding, soldering, or otherwise affixing the vertical members 174a and the horizontal members 174b.
10 Each joint 176 between grid members 174a, 174b, is fixed in order to allow for discontinuities in the grid. Figure 9A illustrates an example of discontinuities in the grid of the mesh core 154. The grid member joints are fixed so that removal of one shaft from the fixed joint leaves the remaining three shafts, and the fixed joint, intact. As illustrated in Figure 9A, an EPD opening 178 is constructed in the mesh core 154 by selectively severing a plurality of vertical
15 members 174a and a plurality of horizontal members 174b adjacent to grid joints to form the EPD opening 178. Because the grid joints 176 are fixed, the mesh core 154 retains the desired strength, rigidity, flexibility, and resilience originally provided by the mesh core 154. The EPD opening 178 allows for optical EPD signals to be transmitted through the linear CMP processing belt 150 (see Figure 3A). The EPD opening 178 is shown in Figure 9A in a shape
20 easily constructed from the illustrated grid of mesh core 154. In a typical CMP processing belt 150, the shape of the EPD opening 178 is circular, oval, or square, and can be modified as appropriate to conform to a particular processing requirement. The illustrated EPD opening 178 is representative of any of a plurality of possible shapes.

Figure 9B illustrates a detailed view of a mesh core 154 in accordance with another
25 embodiment of the present invention. In Figure 9B, an EPD opening 178 is constructed in mesh core 154. The EPD opening 178 is reinforced with supporting members 180 in the illustrated embodiment. Supporting members 180 can be fabricated and attached as desired to define a perimeter of EPD opening 178. In an embodiment of mesh core 154 in which the grid is constructed by weaving, braiding, or otherwise intertwining the grid members 174, an EPD
30 opening 178 with supporting members 180 is particularly useful to prevent unraveling, stretching, or other deformity at the discontinuities in the grid. In one embodiment, supporting members are affixed at least at each grid joint around the perimeter of the EPD opening. The

illustrated embodiment is one of a plurality of configurations and patterns for grid members 174. In another embodiment (not pictured) one or more circular supporting members 180 define the perimeter of the EPD opening 178, attached to the grid of the mesh core 154 at least at each adjacent grid joint.

5 Figure 10A shows a method of fabricating a CMP processing belt in accordance with one embodiment of the present invention. Figure 10A shows a section of a CMP processing belt being formed within a casting mold 182a, 182b, and including an EPD opening 178 in the mesh core 154. In one embodiment, mesh core 154 is positioned between a first side 182a and a second side 182b of a casting mold. In one embodiment, the EPD opening 178 is positioned
10 adjacent to a feature 184 in the second side 182b of the casting mold to create a thinner region in the linear CMP processing belt at the EPD opening 178. Polymer precursor or liquid polymer is introduced into the casting mold to flow and form around the inner mesh core 154. The formation of a linear CMP processing belt using polymer and casting molds is described in greater detail below in reference to Figure 11.

15 In one embodiment of the present invention, the feature 184 at the EPD opening 178 forms a thinner region of polymeric 152 surface at the EPD opening 170. In linear belt CMP systems 100 (see Figures 1A and 1B) implementing an optical EPD system, an optical beam is transmitted through the linear CMP processing belt. The EPD opening 178 allows for an optical beam to be transmitted through the mesh core 154. A plurality of polymers allow for
20 limited optical transmission through the polymeric mass, and in one embodiment of the present invention, the thickness of the polymeric 152 mass is minimized to allow for optical transmission. Feature 184 provides for casting a thinner region of polymer 152 at the EPD opening 178. In an alternative embodiment, the first side 182a and the second side 182b of a casting mold have no feature 184, and the polymeric 152 surface at the EPD opening 178 is
25 thinned, if necessary, after formation of the linear CMP processing belt. In still a further embodiment, the polymeric 152 mass is locally treated at the EPD opening 178 to clear the polymer 152. The locally cleared polymeric 152 region acts as a window through the EPD opening 178.

30 Figure 10B shows another embodiment of the casting mold 182a, 182b of the present invention. The first side 182a and the second side 182b of the casting mold illustrated in Figure 10B each have a feature 184 positioned at the EPD opening 178. Feature 184 forms a

thinner region of polymeric 152 mass at both top and bottom surfaces of the linear CMP processing belt. As described above in reference to Figure 10A, the polymer 152 at the EPD opening 178 can additionally be treated to clear the polymeric 152 region, forming a window.

Figure 11 is a flow chart diagram 200 illustrating the method operations for manufacturing a polymeric linear CMP processing belt in accordance with one embodiment of the present invention. The illustrated method begins with operation 202 in which the mesh core for the polymeric linear CMP processing belt is positioned in the linear CMP processing belt mold. A linear CMP processing belt mold is described in greater detail below in reference to Figures 13A and 13B. In operation 202, the mesh core of the polymeric linear CMP processing belt, which may or may not include EPD openings as desired, is positioned within the mold to enable the casting of a polymer around and through the mesh core.

The method continues with operation 204 and the preparation of a polymer to be molded into a linear CMP processing belt. In one embodiment, a polymer material is prepared for molding into a polymeric linear CMP processing belt utilizing a completed polymeric molding container as described in more detail below in reference to Figures 13A and 13B. Any desired polymer may be used 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 linear CMP processing belt that is a microcellular polyurethane with a specific gravity of approximately $0.4-1.5\text{g/cm}^2$ 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 linear CMP processing belt.

After operation 204, the method proceeds to operation 206 in which the prepared polymer is injected into the mold. In one embodiment, urethane or other polymer or polymeric material is dispensed into a hot cylindrical mold. One embodiment of a cylindrical mold is described in greater detail below in reference to Figures 10A and 10B. It should be understood that other types and shapes of molds may be suitably used.

Then, in operation 208, 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 linear CMP processing belt. In one embodiment, a urethane mixture is heated and cured for a predetermined time at a
5 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.

After operation 208, the method advances to operation 210 and the polymeric linear
10 CMP processing belt is de-molded by removing the belt from the mold. In one embodiment, the mold is a polymeric linear CMP processing belt molding container as described in further detail in reference to Figures 13A and 13B.

Then, in operation 212, the polymeric linear CMP processing belt is lathed to predetermined dimensions. In operation 212, the polymeric linear CMP processing belt is cut
15 to the desired thickness and dimensions for optimal linear CMP processing. If the polymeric linear CMP processing belt is an embodiment with EPD openings, operation 212 includes the thinning and clearing of the polymeric regions at the EPD openings as described above. In one embodiment, the polymeric linear 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 0.09 inch,
20 according to the CMP process for which the polymeric linear CMP processing belt is intended to be used.

After operation 212, the method proceeds to operation 214 and grooves are formed on a processing surface of the polymeric linear CMP processing belt in accordance with one
25 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.

After operation 214, the method advances to operation 216 in which the edges of the polymeric linear CMP processing belt are trimmed. Then, in operation 218 the polymeric
30 linear 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 TeresTM linear polishing apparatus manufactured by Lam Research Corporation. Once the polymeric linear CMP processing belt is prepared for use, the method is done.

Figure 12A illustrates a section of a mesh core 154 as positioned within a linear CMP processing belt mold (not shown). In one embodiment, the mesh core 154 is positioned within the mold in a track and on supports extending from a bottom track 220c of the mold. In another embodiment, vertical members 174a of the mesh core 154 are periodically extended to provide a support for the mesh core 154. The support for the mesh core 154 is provided to position the mesh core 154 within the mold (not shown) so that the polymeric linear CMP processing belt is cast around and through the mesh core 154 with a sufficient desired separation of the edge of the mesh core 154 and the edge of the finished polymeric linear CMP processing belt. It should be appreciated that the rigid structure of mesh core 154 allows for the placement and support of the mesh core 154 within the mold (not shown). The mesh core 154 is positioned on supports in one embodiment (see Figure 12B), and in one embodiment is positioned on those vertical members 174a extended for the purpose of supporting the mesh core 154 within the mold. When positioned, the material properties of the mesh core 154 prevent sagging, bending, folding, and the like. In one embodiment, interior positioning pins (not shown) are provided for precise mesh core 154 positioning within the mold and, by way of example, adjacent to EPD openings.

Figure 12B illustrates a mesh core support 230 positioning a mesh core 154 in accordance with one embodiment of the invention. In one embodiment, the mesh core support 230 extends from the bottom track of the mold (not shown) to position the mesh core 154 a desired distance from the edge of the finished polymeric linear CMP processing belt. In one embodiment, the stem 230a of the mesh core support 230 is constructed of a material having sufficient strength to support the mesh core 154 in position, to withstand the heat or any forces of polymer casting, and to easily break away from the bottom track 220c after the polymeric linear CMP processing belt is cast. Exemplary materials include soft or brittle metals and the like.

Figures 13A and 13B illustrate a polymeric linear CMP processing belt mold 220 in accordance with one embodiment of the present invention. In Figure 13A, the mold 220 is shown separated to show a first side 220a and a second side 220b of the mold 220, as well as

the bottom track 220c. A mesh core positioning track 220d is shown within bottom track 220c. The first side 220a and the second side 220b are assembled to be concentric, as shown by directional arrow 222, so that first side 220a defines a first surface of the resulting polymeric linear CMP processing belt, second side 220b defines a second surface of the resulting polymeric linear CMP processing belt, and bottom track 220c defines a third surface of the resulting polymeric linear CMP processing belt. In one embodiment, first side 220a defines a top surface of the resulting belt, second side 220b defines a bottom surface of the resulting belt, and bottom track 220c defines an edge of the resulting belt. Inner mesh core 154 (see Figure 12A) is positioned between first side 220a and second side 220b, and is supported over bottom track 220c.

Figure 13B shows an assembled polymeric linear CMP processing belt mold 220 into which an inner mesh core 154 (see Figure 12A) can be positioned, and then liquid polymer or polymeric precursor can be flowed into the mold to form the polymeric linear CMP processing belt. As described in reference to Figure 13A, in one embodiment the bottom track 220c defines an edge of the resulting polymeric linear CMP processing belt. In the formation of a polymeric belt, the polymeric material is flowed into the mold 220, in one embodiment, as a liquid polymer or polymeric precursor. The liquid polymer or polymeric precursor then fills the mold 220, flowing around and through the inner mesh core in accordance with one embodiment of the present invention. At the top of the mold, the surface of the liquid polymer or polymeric precursor then defines the second edge of the resulting polymeric linear CMP processing belt.

Figure 14 is a flow chart diagram 250 illustrating the method operations for manufacturing a reinforced polymeric CMP processing belt in accordance with another embodiment of the present invention. The illustrated method begins with operation 252 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.

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 252 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.

The method continues with operation 254 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 254 includes the preparation of the polymer or polymeric material to be used to cast the polymeric material described above in reference to Figures 4A, 4B, 5, and 6, and identified by reference numeral 162. In one embodiment, the preparation of the polymer or polymeric material in method operation 254 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 166.

Any desired polymer or polymeric material may be used in operation 254 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/cm² 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.

After operation 254, the method proceeds to operation 256 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 162 in the Figures described above.

In operation 258, 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.

After operation 258, the method advances to operation 260 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.

Then, in operation 262, 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 262, 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.

The method proceeds with operation 264 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.

5 In method operation 266, 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.

15 The method continues with operation 268 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 268 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 256 includes structural definition of EPD openings within the mold or form. The woven fabric or synthetic material reinforcing layer is positioned in method operation 264 with fabricated EPD openings aligned with the structures defined in the polymeric material, and in operation 268, the final thinning or piercing of the EPD openings is accomplished as desired.

30 In one embodiment of method operation 268, 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.

In one embodiment of method operation 268, 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 TeresTM linear polishing apparatus manufactured by Lam Research Corporation.

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 270 in which a desired preparation surface is fabricated. In the fabrication of the preparation surface of method operation 270 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 270 is accomplished, the reinforced polymer CMP processing belt is completed upon fabrication and preparation of the processing surface, and the method is done.

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:

CLAIMS

1. 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 continuous mesh core embedded in the polymeric material, the continuous mesh core being defined as a rigid inner core of the polymeric material.

2. The belt of claim 1, wherein the polymeric material includes polyurethane, polyester, PVC, polyacrylate, and epoxy.

3. The belt of claim 1, wherein the continuous mesh core is defined as a grid of intersecting members, and the intersecting members are joined at fixed joints to form a rigid support structure for the belt.

4. The belt of claim 1, wherein the continuous mesh core is defined as a grid of intersecting members, and the intersecting members define a woven structure.

5. The belt of claim 4, further comprising discontinuities in the grid of the continuous mesh core, the discontinuities being configured to provide an opening in the grid suitable for optical transmissions through the grid.

6. The belt of claim 5, wherein the opening in the grid of the continuous mesh core is defined with reinforcing perimeter members, the perimeter members being affixed to the joints around the perimeter of the opening in the grid.

7. The belt of claim 6, wherein the polymeric material is made thinner at the opening in the grid of the continuous mesh core, and the polymeric material is treated to allow optical transmission through the thinner polymeric material at the opening in the grid of the continuous mesh core.

8. The belt of claim 1, further comprising:

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

9. 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.

10. The belt of claim 9, wherein the polymeric material includes polyurethane, polyester, PVC, polyacrylate, and epoxy.

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

12. The belt of claim 9, further comprising openings fabricated in the reinforcing fabric, the openings being suitable for optical transmissions through the reinforcing fabric.

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

14. The belt of claim 9, wherein the reinforcing fabric is defined from one of kevlar and a synthetic fiber including nylon, polyester, polyimide, rayon, and PVC.

15. The belt of claim 9, 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.