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(54) **LAPPING CARRIER AND METHOD OF USING THE SAME**

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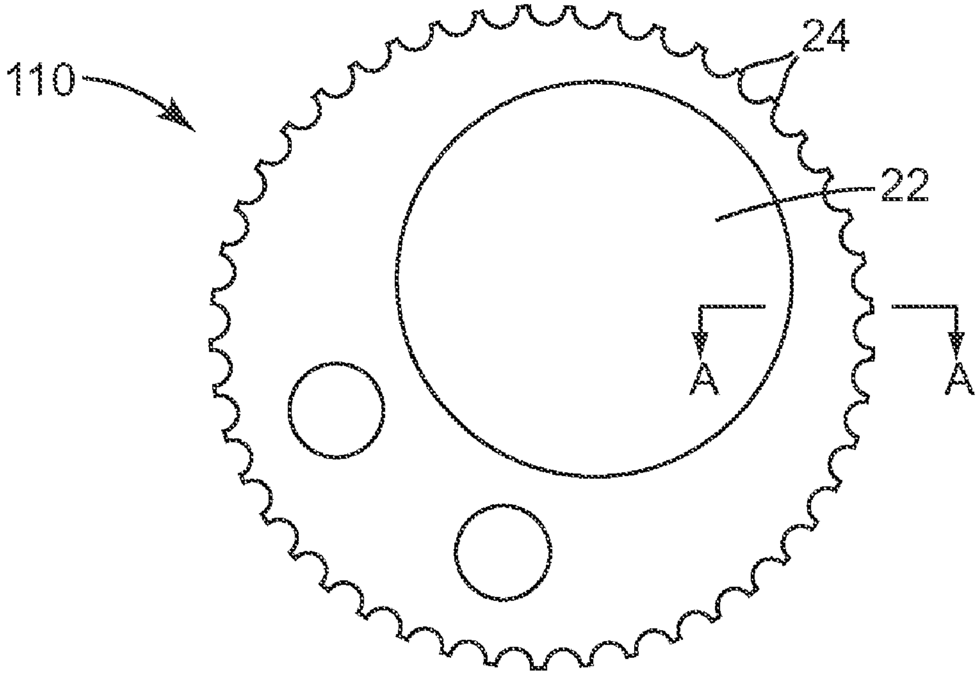
(57) **ABSTRACT**

A lapping carrier includes a base having first and second opposed major surfaces and at least one aperture extending from the first major surface to the second major surface. A wear layer is disposed on the first major surface of the base. The wear layer includes an outer polymer layer comprising at least one of polyether ether ketone or ultrahigh molecular weight polyethylene, and a first adhesive layer disposed between the outer polymer layer and the base



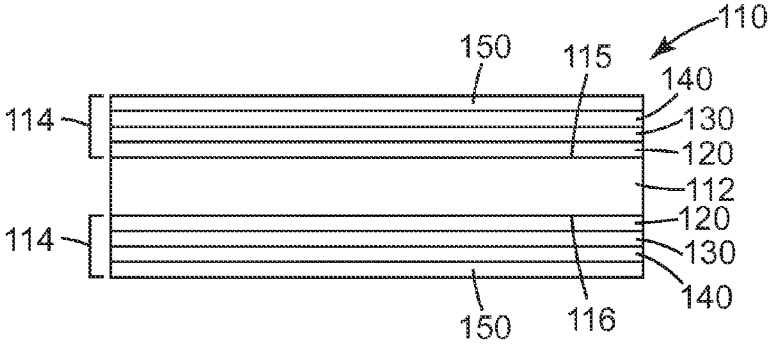


FIG. 1

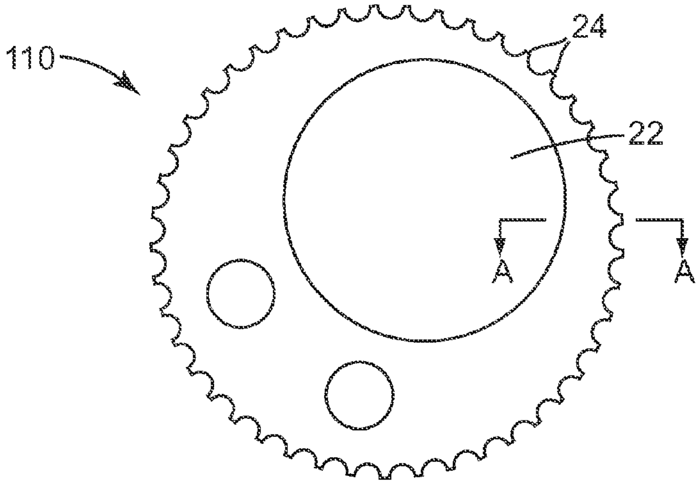


FIG. 2

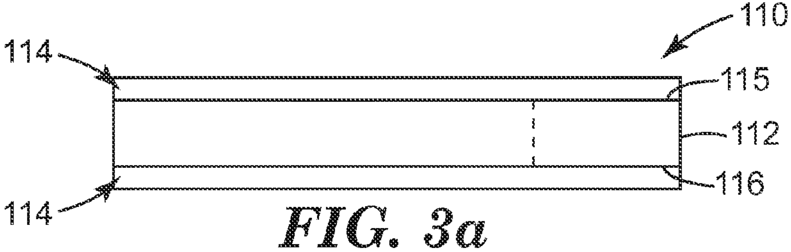


FIG. 3a

FIG. 3b

FIG. 3c

LAPPING CARRIER AND METHOD OF USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/506,253, filed Jul. 11, 2011, the disclosure of which is incorporated herein by reference.

FIELD

[0002] The present disclosure broadly relates to lapping carriers and processes for abrading a workpiece using them.

BACKGROUND

[0003] A need often arises to grind or polish flat workpieces such as disk-shaped articles (e.g., silicon wafers, sapphire disks, optical elements, or glass or aluminum substrates for magnetic recording devices like), such that the two major surfaces are both parallel and free from significant scratches. Such grinding or polishing operations, differing in the rate of material removal and final surface finish, may be referred to collectively as lapping.

[0004] A typical lapping machine used for finishing the disks may include two superposed platens respectively disposed over and under one or more of the disks, so that opposing surfaces of the disks can be ground or polished simultaneously. Moreover, the lapping machine may include lapping carriers that position and retain the disks during the grinding or polishing operation. Such lapping carriers may be adapted to rotate relative to the platens. For example, the lapping machine may also include an outer ring gear, disposed around an outer periphery of the platens, and an inner gear, that projects through a hole formed in a center of the platens. The lapping carriers can have a toothed outer periphery, which engages with the teeth or pins of the outer ring gear and the teeth or pins of the inner gear. Rotation of the inner gear and outer gear in opposite directions, for example, thus causes the lapping carrier to rotate globally around the inner gear, and about an axis of the lapping carrier. Typically, the surfaces of the platens are relatively flat and planar, and are suitable for most polishing operations using a lapping technique.

[0005] In certain lapping machines, fixed abrasive articles disposed over the working surfaces of the platens have been used to reduce maintenance costs and the accompanying unproductive time associated with periodic dressing of the platens to the necessary degree of flatness and coplanarity. In use, a workpiece is disposed within an aperture of the lapping carrier, the platens are brought together to exert a predetermined pressure upon the workpiece, and the lapping carrier and workpiece are rotated, thus planarizing, polishing, and/or thinning the surface(s) of the workpiece.

SUMMARY

[0006] During the lapping processes, flexing of the lapping carrier may cause it to contact the fixed abrasive article(s). If the lapping carrier is made of a durable material such as, for example, steel, such contact between the lapping carrier and the fixed abrasive article typically results in premature wear of the fixed abrasive article. Despite the above-mentioned publications, there remains a need for technical improvement in reducing premature wear of the fixed abrasive articles.

[0007] In one aspect, the present disclosure provides, a lapping carrier comprising:

- **[0008]** a base having first and second opposed major surfaces and at least one aperture extending from the first major surface to the second major surface; and
- **[0009]** a first wear layer disposed on the first major surface of the base, the wear layer comprising:
  - **[0010]** a first outer polymer layer secured to the base, wherein the first outer polymer layer has a first exposed major surface, and wherein the first outer polymer layer comprises at least one of polyether ether ketone or ultrahigh molecular weight polyethylene; and
  - **[0011]** a first adhesive layer disposed between the first outer polymer layer and the base.

[0012] In some embodiments, the lapping carrier further comprises:

- **[0013]** a second wear layer disposed on the second major surface of the base, the wear layer comprising:
  - **[0014]** a second outer polymer layer secured to the base, wherein the second outer polymer layer has a second exposed major surface, and wherein the second outer polymer layer comprises at least one of polyether ether ketone or ultrahigh molecular weight polyethylene; and
  - **[0015]** a second adhesive layer disposed between the first outer polymer layer and the base.

[0016] Advantageously, lapping carriers according to the present disclosure may exhibit wear characteristics during lapping-type abrading processes that are comparable or superior to those of commercial lapping carriers.

[0017] Lapping carriers according to the present disclosure are useful for lapping a workpiece. Accordingly, in another aspect, the present disclosure provides a method of lapping comprising:

- **[0018]** placing a workpiece in the at least one aperture of a lapping carrier according to the present disclosure;
- **[0019]** placing the lapping carrier into a lapping machine having at least one lapping surface; and
- **[0020]** providing relative motion between the workpiece and the at least one lapping surface thereby abrading the workpiece.

[0021] The features and advantages of the present disclosure will be further understood upon consideration of the detailed description as well as the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** is a schematic side view of an exemplary lapping carrier according to the present disclosure.

[0023] FIG. **2** is a plan view of an exemplary lapping carrier according to the present disclosure.

[0024] FIGS. **3**A-**3**C are exemplary partial sections of workpiece carriers according to the present disclosure.

[0025] It should be understood that numerous other modifications and embodiments can be devised by those skilled in the art, which fall within the scope and spirit of the principles of the disclosure. The figures may not be drawn to scale. Like reference numbers may have been used throughout the figures to denote like parts.

DETAILED DESCRIPTION

[0026] Referring to FIG. **1**, exemplary lapping carrier **110** comprises base **112** having first and second opposed major surfaces **115**, **116**. Wear layers **114** are disposed on respective first and second major surfaces **115**, **116**. Wear layers **114**

comprise outer polymer layers **150** secured to base **112** by adhesive layers **130**. Outer polymer layers **150** comprise at least one of polyether ether ketone or ultrahigh molecular weight polyethylene. Optional base adhesion promoting layers **120**, are disposed between adhesive layers **130** and the first and second major surfaces **115**, **116** of base **112**. Optional polymer adhesion promoting layers **140** are disposed between adhesive layers **130** and outer polymer layers **150**. The optional components in the wear layers may be present in one wear layer and not in the other.

[0027] The base may comprise any dimensionally stable material such as, for example, metal, glass, polymer, or ceramic. Exemplary metals include titanium and steels (e.g., mild steel and stainless steel). Exemplary polymers include thermoset polymers, thermoplastic polymers and combinations thereof. The polymer may contain one or more fillers or additives, chosen for a specific purpose. Inorganic fillers may be employed to lower the cost of the carrier. Additionally, reinforcing fillers such as particles or fibers may be added to the polymer (e.g., a fiberglass/epoxy composite). Typical reinforcing fillers are inorganic in nature and may comprise surface modification to improve the reinforcing effect, although these are not requirements. Nanoparticles, e.g., nanosilica, may also be of utility. The polymer may also contain layers or regions of reinforcing matting, typically woven materials, e.g., polymeric fiber matting, fiber glass matting or a metal screen.

[0028] The base may have any thickness, typically depending on the intended workpiece, but advantageously is suitable for use at minimal thicknesses.

[0029] In some embodiments, the base has one or more apertures for introduction of a workpiece, and the base has one or more apertures for delivery of a slurry. In other embodiments such as, for example, those using a fixed abrasive pad, the base has one or more apertures for introduction of a workpiece, but may optionally have no aperture(s) for introduction of polishing slurry. It is believed that eliminating such apertures increases rigidity of the lapping carrier and decreases wear of the lapping carrier and fixed abrasive surfaces that it may contact. Increasing thickness of the base typically increases rigidity, and balancing between the thickness of the base relative to the thickness of the wear layer is generally desired for optimal wear properties. For example, if intended for use with for 300 mm diameter Si wafers, a stainless steel base may have a thickness in a range of from about 400 microns to about 800 microns. Likewise if intended for use with for 450 mm diameter Si wafers, a stainless steel base may have a thickness in a range of from about 500 to about 950 microns.

[0030] In order to facilitate bonding of the adhesive layer to the base, a base adhesion promoting layer may optionally be included in the wear layer between the adhesive layer and the base. The polymer adhesion promoting layer may comprise any material(s) or treatments that enhance bonding between the base and the adhesive layer. Examples include plasma treatments of the major surface(s) of the base, inorganic coatings, organic coatings, silane coupling agents, polymeric primers, surface texturing or abrasion and combinations thereof.

[0031] For example, the base adhesion promoting layer may be formed by chemical modification of one or more of the base's surfaces or by providing a coating on one or more of the base's surfaces. Chemical modification of the base's surface may be accomplished by conventional techniques, e.g., plasma, e-beam or ion beam processing. An exemplary process is plasma processing in the presence of one or more gases. Useful gases include, for example, tetramethylsilane, oxygen, nitrogen, hydrogen, butane, and argon. Plasma surface treatment results in the formation of various functional groups on the surface of the base. Desirable functional groups include atom pairs that comprise oxygen bonded to carbon, oxygen bonded to silicon, nitrogen bonded to carbon and hydrogen bonded to nitrogen. Plasma processing can also be used to clean the surface of the base prior to applying the base adhesion promoting layer. Argon gas is useful for this purpose.

[0032] Modification of the surface may also be accomplished by treatment with a cleaning or etching solution such as, for example, an alkali metal metasilicate treatment, and ALKONOX detergent wash (from Alconox, Inc., White Plains, N.Y.), or a phosphate wash.

[0033] The base adhesion promoting layer may comprise an inorganic coating and/or organic coating. Useful inorganic coatings include metals and metal oxides.

[0034] Physical vapor deposition techniques such as sputtering, ion plating, and cathodic arc type techniques are useful in precisely controlling the thickness and uniformity of the coatings for metals, alloys, nitrides, oxides, and carbides. These vacuum deposition techniques allow for a solvent-free, dry and clean process.

[0035] Useful organic coatings (e.g., polymeric primers) can vary widely in chemical composition and form. Generally, an organic base adhesion promoting layer has chemical characteristics, e.g., one or more functional groups that enhance the adhesion between the base and the wear layer. The organic coatings, in final form, are typically polymeric, although low molecular weight compounds may also be useful in enhancing adhesion.

[0036] Polymeric primers may initially comprise monomers and/or oligomers that are polymerized and/or crosslinked after coating onto the appropriate surface. When applied to the base, polymeric primers may be substantially one hundred percent in solids content or it may contain solvent that is substantially removed after coating. Polymeric primers may also be a polymer solution in which the solvent is substantially removed after coating. The polymeric primers may be polymerized and/or crosslinked after coating via standard techniques, including thermal curing and radiation curing.

[0037] Examples of polymeric primers include alkyd polymers, epoxy ester polymers, epoxy novolac polymers, vinyl polymers, chlorinated rubber polymers, polyamide-cured epoxy polymers, polyurethane polymers (aromatic or aliphatic), amine-cured epoxy polymers, phenolic polymer, organic zinc-rich coating, inorganic zinc-rich coating, phosphate conversion coatings, chromate conversion coatings, chromate-free conversion coatings, polyurea polymers, alkali silicate polymers, acrylic polymers, and combinations thereof. Acrylic polymeric primers such as that available as 3M TAPE PRIMER 94 from 3M Company, St. Paul, Minn., may be particularly useful. Adhesion Promoter **111** adhesion promoter available from 3M Company may also be useful.

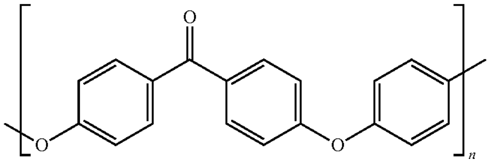
[0038] Silane coupling agents, e.g., aminosilanes, epoxysilanes, vinylsilanes, isocyanatosilanes, and ureidosilanes may also be useful as, or as a component in, the base adhesion promoting layer. An example of a useful epoxysilane coupling agent include 3-(glycidoxypropyl) trimethoxysilane (available from Gelest, Inc., Morrisville, Pa.).

[0039] The adhesive layer may comprise any material capable of adhering the wear layer to the base. Examples of suitable materials include hot melt adhesives, pressure-sensitive adhesives, glues, and structural adhesives. Desirably, the adhesive layer is comprises a pressure-sensitive adhesive in order to facilitate fabrication of the lapping carrier. Acrylic pressure-sensitive adhesives are typically useful in this regard. Examples include 3M 300 LSE 2 mil pressure-sensitive adhesive transfer tape, 3M 501F1 mil pressure-sensitive adhesive transfer tape, 3M 9457 1 mil pressure-sensitive adhesive transfer tape, 3M 9458 1 mil pressure-sensitive adhesive transfer tape, 3M 9009 2 mil pressure-sensitive adhesive transfer tape, 3M 9471 2 mil pressure-sensitive adhesive transfer tape, 3M 9461P 1 mil pressure-sensitive adhesive, all available from 3M Company. The adhesive layer may have any thickness, but is desirably thin. For example the adhesive layer may have a thickness in a range of from about 10 to about 75 microns, from about 15 to about 30 microns, or even from about 20 to about 30 microns.

[0040] The outer polymer layer comprises at least one of polyether ether ketone (PEEK) or ultrahigh molecular weight polyethylene (UHMW PE).

[0041] Ultrahigh molecular weight polyethylene (UHMW PE), which is also known as high-modulus polyethylene (HMPE) or high-performance polyethylene (HPPE), is a polyethylene characterized by extremely long polymer chains, with molecular weight numbering in the millions (e.g. above one million grams per mole), usually between 2 and 6 million grams per mole. It is resistant to corrosive chemicals, with the exception of oxidizing acids. UHMW PE may be readily obtained from commercial sources as film, pellets, or granules. Examples include 3M SQUEAK REDUCTION TAPE 9325—5 mil and 3M UHMW-PE 5425—4.5 mil (both from 3M Company), and UHMW-PE Ultra High Molecular Weight Polyethylene from McMaster Carr, Chicago, Ill.

[0042] PEEK is a generally colorless organic polymer thermoplastic used in engineering applications. PEEK has the structural formula



wherein n is a number greater than or equal to 5. PEEK polymers are obtained by step-growth polymerization by the dialkylation of bisphenolate salts. Typical is the reaction of 4,4'-difluorobenzophenone with the disodium salt of hydroquinone, which is generated in situ by deprotonation with sodium carbonate. The reaction is conducted around 300° C. in polar aprotic solvents such as, e.g., diphenylsulfone. PEEK is highly resistant to thermal degradation as well as attack by both organic and aqueous environments. It is attacked by halogens and strong Brønsted and Lewis acids as well as some halogenated compounds and aromatic hydrocarbons at high temperatures.

[0043] While the outer polymer layer typically consists or consists essentially of UHMW-PE and/or PEEK, it may further comprise additional components such as, e.g., lubricants, antioxidants, fillers, plasticizers, melt processing aids, and anti-static agents. Additionally, the outer polymer layer can be optionally textured through molding, scoring, embossing, etc.

[0044] Typically, the outer polymer layer is provided a film prior to incorporation into the wear layer. The film may be obtained, for example, from a commercial source or extruded into a film from pellets or granules. One commercial source of PEEK is available as VICTREX PEEK from Victrex Plc, Lancashire, England. One commercial source of UHMW PE is under the trade designation GUR UHMW PE from Ticona Polymers, Dallas, Tex. Examples of commercially available PEEK films include PEEK POLYETHER ETHER KETONE FILM—2 mil and PEEK Polyether Ether Ketone film—3 mil (both from McMaster Carr), and PEEK POLYETHER ETHER KETONE FILM—3 mil from C.S. Hyde, Lake Villa, Ill. The outer polymer layer may have any thickness, depending, e.g., on the workpiece chosen. In some embodiments, the outer polymer layer has a thickness in a range of from 25 microns to 155 microns.

[0045] Advantageously, outer polymer layers according to the present disclosure exhibit relatively lower coefficients of friction as compared to a commercially successful lapping carrier, and also have good durability.

[0046] The lapping carrier may have any thickness, typically depending on the intended workpiece and the thickness of the included components, but advantageously is suitable for use at minimal thicknesses. For example, in some embodiments, the lapping carrier may have a maximum thickness in a range of from about 600 to about 975 microns

[0047] In order to facilitate bonding of the adhesive layer to the outer polymer layer, a polymer adhesion promoting layer may optionally be included in the wear layer between the outer polymer layer and the adhesive layer. The polymer adhesion promoting layer may comprise any material(s) or treatments that enhance bonding between the outer polymer layer and the adhesive layer. Examples include plasma treatments (e.g., corona discharge or plasma etch) of the bonding surface of the outer polymer layer, a polymeric primer, and combinations thereof. Examples of such are given hereinabove with regard to the base adhesion promoting layer. Alternatively, or in addition, the outer polymer layer may be texturized.

[0048] Prior to conducting chemical modification or applying an adhesion promoting layer to the base surface or wear layer surface, it is often desirable to clean the surface. Conventional cleaning techniques may be employed, such as, washing the surface with a soap solution followed by rinsing with water or washing the surface with an appropriate solvent (e.g., methyl ethyl ketone, isopropanol, or acetone) followed by drying. Depending on the composition of the carrier or wear layer, cleaning with an acid or base solution may also be useful. Sonication may also be used in conjunction with the above cleaning techniques. Additionally, plasma cleaning/surface contamination removal with argon as the gas is a preferred cleaning technique, particularly when the base being coated is a metal, e.g., stainless steel. Methods of implementing the adhesion promoting layers will vary according to the option selected, and will be known to those of ordinary skill in the art.

[0049] The outer polymer layer may be secured to the base by a lamination or adhesive bonding process. For example, a hot melt adhesive or glue may be used to secure the outer polymer layer to the base. Alternatively, lamination (e.g., of an adhesive coated outer polymer layer to the base) may be used.

[0050] After applying the wear layer to the base, further drying, annealing, and/or curing of the wear layer may be desirable in order for the polymeric layer to reach its optimal utility.

[0051] Different lapping applications may require different levels of adhesion between the base and the outer polymer layer. For example, a lapping process employing corrosive polishing solutions, high temperatures or having high degrees of shear transferred to the carrier may require higher adhesion between the base and wear layers compared to a process employing less severe conditions. The selection of the various adhesion promoting layers subsequently may depend on the lapping process conditions and or workpieces being abraded.

[0052] Referring now to FIG. **2**, exemplary lapping carrier **110** has an aperture **22** within lapping carrier **110** and teeth **24** around its perimeter. Typically, the aperture corresponds to the dimensions of the workpiece with which it is intended to be used, but in some instances, the circumference of the aperture in the lapping carrier is fabricated to be larger and may be of a different shape than the required circumference and shape to hold the workpiece. An insert (not shown), having a second aperture of the desired circumference and shape to facilitate holding of the workpiece, may then be mounted within the lapping carrier aperture. Any known insert can be used, e.g., those described in U.S. Pat. No. 6,419,555 (Goers). The insert typically comprises a different material from that of the lapping carrier. The lapping carrier may include one or more apertures for holding one or more workpieces. The lapping carrier teeth engage corresponding teeth or pins (not shown) disposed around an outer periphery of the platens of a lapping machine, and an inner gear, sometimes referred to as a sun gear, that projects through a hole formed in a center of the platens. The lapping carriers can then have a toothed outer periphery, which engages with the teeth or pins of the outer ring gear and the teeth or pins of the inner gear. Rotation of the inner gear and outer gear in opposite directions, for example, thus causes the lapping carrier to rotate globally around the inner gear, and about an axis of the lapping carrier. Lapping carriers also can be designed to rotate about a platen using a sun gear and a ring gear, which may move in the same direction but at different speeds.

[0053] FIG. **3***a* is illustrative of an exemplary embodiment of a cross-section corresponding to section A-A of FIG. **2** of lapping carrier **110**. In this embodiment lapping carrier **110** comprises wear layers **114** disposed on first and second opposed major faces **115**, **116** of base **112**. In this embodiment, wear layers **114** extend from the periphery of base **112** to aperture **22** (see FIG. **2**).

[0054] FIG. **3***b* is illustrative of an exemplary embodiment of a cross-section corresponding to section A-A of FIG. **2** of lapping carrier **110**. In this embodiment lapping carrier **110** comprises wear layers **114** disposed on first and second opposed major faces **115**, **116** of base **112**. In this embodiment, wear layers **114** extend peripherally from aperture **22** (see FIG. **2**), but terminate inwardly from teeth **24** (see FIG. **2**).

[0055] FIG. **3***c* is illustrative of an exemplary embodiment of a cross-section corresponding to section A-A of FIG. **2** of lapping carrier **110**. In this embodiment lapping carrier **110** comprises wear layers **114** disposed on first and second opposed major faces **115**, **116** of base **112**. In this embodiment, wear layers **114** are disposed between aperture **22** (see FIG. **2**) and teeth **24** (see FIG. **2**), but terminate prior to aperture **22** and teeth **24** (see FIG. **2**) leaving them and areas adjacent to them exposed.

[0056] Although the embodiments of FIGS. **3***a*-**3***c* indicate that substantially all of both major surfaces of the carrier, with the possible exception of the toothed region, are covered by the wear layers, it should be appreciated that the wear layers may be discontinuous in other embodiments and may be present in multiple regions on either or both major surfaces of the carrier. Continuous or discontinuous wear layers covering at least a portion of the major surfaces of the carrier may be desirable to optimize (e.g., reduce) the overall friction between the workpiece and carrier and the abrasive surfaces of the lapping platens and/or to provide enhanced flow of a working fluid for cooling, lubrication, chemical modification of the surfaces being abraded, swarf removal, and the like. In some embodiments, the wear layers or regions may be textured to reduce contact drag or to improve working fluid flow. In some embodiments, the polymeric region or regions on one major surface of the carrier may be connected to the polymeric region or regions on the opposite major surface. In some embodiments a third surface, corresponding to the surface area of the base defining the aperture circumference, may be at least partially coated by the polymer comprising the polymeric layers.

[0057] Selection of the wear layers to enhance the performance of workpiece carriers used in double-sided lapping typically requires balancing several properties. For example, the coated lapping carrier must remain sufficiently rigid to drive the workpiece or workpieces between the abrasive platens while remaining thin enough to be used to lap the very thin workpieces desired in the electronics and related industries. Generally, the thickness of the wear layer(s) should be selected such that the total thickness of the lapping carrier to be less than the desired final thickness of the workpiece. Desirably, the wear layer should not cause undue dulling of the abrasive or undue wear of fixed abrasive surfaces which it contacts, and it should be resistant to chemicals present in any working fluid that may be present. In some embodiments, it is also desirable to avoid interactions with the fixed abrasive which may lead to dulling. In some embodiments, wear layers with substantial wear resistance and/or low coefficient of friction are desirable.

[0058] The wear layer may have any thickness, but advantageously is thinner than the final lapped thickness of an intended workpiece (e.g., a silicon wafer). For example, in some embodiments, for 300 mm wafers, the wear layer may have a thickness in a range of from about 25 to about 300 microns, from about 75 to about 250 microns, or even from about 100 to about 200 microns. For example, in some embodiments, for 450 mm wafers, the wear layer may have a thickness in a range of from about 25 to about 300 microns, from about 75 to about 275 microns, or even from about 125 to about 250 microns

[0059] Lapping carrier according to the present disclosure can be used to abrading (e.g., lapping) a surface of a workpiece. In some embodiments, a working fluid is provided at the interface between the workpiece and the lapping surfaces. In some embodiments, the working fluid comprises water. In some embodiments, working fluid comprises abrasive particles. In some embodiments, the working fluid comprises surfactant. In some embodiments, the method of the invention includes the use of a double-sided lapping machine wherein at least one of the two opposed lapping surfaces comprises a three-dimensional, textured, fixed-abrasive article. In some embodiments, the method of the invention employs three-dimensional, textured, fixed-abrasive articles comprising diamond particles disposed in a binder as at least one of the two opposed surfaces of the lapping machine. In some embodiments, the method of the invention employs three-dimensional, textured, fixed-abrasive articles comprising diamond agglomerates disposed in a binder as at least one of the two opposed surfaces of the lapping machine. In some embodiments, the method uses three-dimensional, textured, fixed-abrasive articles comprising diamond agglomerates disposed in a binder wherein the diamond agglomerates comprise a binder different from the binder of the three-dimensional, textured, fixed-abrasive article.

[0060] In yet other embodiments, the disclosed method employs pellet laps on at least one of the two opposed lapping surfaces of the lapping machine. In some embodiments, the double-sided lapping machine is replaced by a single-sided lapping machine and the base includes at least one polymeric region on the surface of the carrier which contacts the abrasive surface of the lapping machine.

SELECT EMBODIMENTS OF THE PRESENT DISCLOSURE

[0061] In a first embodiment, the present disclosure provides a lapping carrier comprising:

- **[0062]** a base having first and second opposed major surfaces and at least one aperture extending from the first major surface to the second major surface; and
- **[0063]** a first wear layer disposed on the first major surface of the base, the wear layer comprising:
  - **[0064]** a first outer polymer layer secured to the base, wherein the first outer polymer layer has a first exposed major surface, and wherein the first outer polymer layer comprises at least one of polyether ether ketone or ultrahigh molecular weight polyethylene; and
  - **[0065]** a first adhesive layer disposed between the first outer polymer layer and the base.

[0066] In a second embodiment, the present disclosure provides a lapping carrier according to the first embodiment, wherein the first outer polymer layer comprises polyether ether ketone.

[0067] In a third embodiment, the present disclosure provides a lapping carrier according to the first embodiment, wherein the first outer polymer layer comprises ultrahigh molecular weight polyethylene.

[0068] In a fourth embodiment, the present disclosure provides a lapping carrier according to any one of the first to third embodiments, further comprising a first base adhesion promoting layer, disposed between the first adhesive layer and the first major surface of the base, wherein the first base adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, silane coupling agents, and combinations thereof.

[0069] In a fifth embodiment, the present disclosure provides a lapping carrier according to any one of the first to fourth embodiments, further comprising a first polymer adhesion promoting layer disposed between the first adhesive layer and the first outer polymer layer, wherein the first polymer adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, and combinations thereof.

[0070] In a sixth embodiment, the present disclosure provides a lapping carrier according to any one of the first to fifth embodiments, wherein the first adhesive layer comprises a pressure-sensitive adhesive.

[0071] In a seventh embodiment, the present disclosure provides a lapping carrier according to any one of the first to sixth embodiments, further comprising:

- **[0072]** a second wear layer disposed on the second major surface of the base, the wear layer comprising:
  - **[0073]** a second outer polymer layer secured to the base, wherein the second outer polymer layer has a second exposed major surface, and wherein the second outer polymer layer comprises at least one of polyether ether ketone or ultrahigh molecular weight polyethylene; and
  - **[0074]** a second adhesive layer disposed between the first outer polymer layer and the base.

[0075] In an eighth embodiment, the present disclosure provides a lapping carrier according to the seventh embodiment, wherein the second outer polymer layer comprises polyether ether ketone.

[0076] In a ninth embodiment, the present disclosure provides a lapping carrier according to the seventh embodiment, wherein the second outer polymer layer comprises ultrahigh molecular weight polyethylene.

[0077] In a tenth embodiment, the present disclosure provides a lapping carrier according to any one of the seventh to ninth embodiments, further comprising a second base adhesion promoting layer, disposed between the second adhesive layer and the second major surface of the base, wherein the second base adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, silane coupling agents, and combinations thereof.

[0078] In an eleventh embodiment, the present disclosure provides a lapping carrier according to any one of the seventh to tenth embodiments, further comprising a second polymer adhesion promoting layer disposed between the second adhesive layer and the second outer polymer layer, wherein the second polymer adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, and combinations thereof.

[0079] In a twelfth embodiment, the present disclosure provides a lapping carrier according to any one of the seventh to eleventh embodiments, wherein the second adhesive layer comprises a pressure-sensitive adhesive.

[0080] In a thirteenth embodiment, the present disclosure provides a lapping carrier according to any one of the seventh to twelfth embodiments, wherein the base comprises a steel.

[0081] In a fourteenth embodiment, the present disclosure provides a lapping carrier according to any one of the first to thirteenth embodiments, wherein the lapping carrier has a maximum thickness of less than 975 microns.

[0082] In a fifteenth embodiment, the present disclosure provides a method of lapping comprising:

- **[0083]** placing a workpiece in the at least one aperture of a lapping carrier according to any one of the first to fourteenth embodiments;
- **[0084]** placing the lapping carrier into a lapping machine having at least one lapping surface; and
- **[0085]** providing relative motion between the workpiece and the at least one lapping surface thereby abrading the workpiece.

[0086] In a sixteenth embodiment, the present disclosure provides a method according to the fifteenth embodiment, further comprising providing a working fluid at the interface between the workpiece and the at least one lapping surface.

[0087] In a seventeenth embodiment, the present disclosure provides a method according to the fifteenth or sixteenth embodiment, wherein the working fluid comprises water.

[0088] In an eighteenth embodiment, the present disclosure provides a method according to any one of the fifteenth to seventeenth embodiments, wherein the at least one lapping surface comprises a three-dimensional, textured, fixed-abrasive article.

[0089] Objects and advantages of this disclosure are further illustrated by the following non-limiting examples, but the particular materials and amounts thereof recited in these examples, as well as other conditions and details, should not be construed to unduly limit this disclosure.

EXAMPLES

[0090] Unless otherwise noted, all parts, percentages, ratios, etc. in the Examples and the rest of the specification are by weight. In tables, "NA" means not applicable.

MATERIALS	
A431SS	Abraded 431 Stainless steel 4-inch (10-cm) disks and 45T carriers from PR Hoffman, Carlisle, Pennsylvania
MS	Mild steel 4-inch (10-cm) disks and 45T carriers from PR Hoffman
U431SS	Unabraded 431 Stainless Steel 4-inch (10-cm) disks and 45T carriers from PR Hoffman
X1	3M SQUEAK REDUCTION TAPE 9325 - 5 mil, ultra high molecular weight polyethylene film from 3M Company
X2	UHMW-PE ultra high molecular weight polyethylene from McMaster Carr, Chicago, IL
X3	3M UHMW-PE 5425 - 4.5 mil ultra high molecular weight polyethylene film from 3M Company
L1	PEEK POLYETHER ETHER KETONE FILM - 2 mil PEEK film from McMaster Carr
L2	PEEK POLYETHER ETHER KETONE FILM - 3 mil from McMaster Carr
PSA1	3M 300 LSE 2 mil pressure-sensitive adhesive transfer tape from 3M Company
PSA2	3M 501F 1 mil pressure-sensitive adhesive transfer tape from 3M Company
PSA3	3M 9457 1 mil pressure-sensitive adhesive transfer tape from 3M Company
PSA4	3M 9458 1 mil pressure-sensitive adhesive transfer tape from 3M Company
PSA5	3M 9009 2 mil pressure-sensitive adhesive transfer tape from 3M Company
PSA6	3M 9471 2 mil pressure-sensitive adhesive transfer tape from 3M Company
PSA7	3M 9461P 1 mil pressure-sensitive adhesive transfer tape from 3M Company
442DL	3M Double Coated Tape 442DL 5 mil from 3M Company
ALKONOX	ALKONOX powder soap from ALKONOX Inc., White Plains, NY
Epoxy Silane	(3-Glycidoxypropyl)trimethoxysilane from Gelest, Inc., Morrisville, PA
S35	Taber Abrader Tungsten Carbide Wheels S-35 from Taber Industries, Buffalo, NY
268XA	268XA, 3M TRIZACT FILM ABRASIVE (grade A5Mix, Aluminum Oxide) 5-inch (13-cm) disc with a PSA backing from 3M Company
TDT6EL	3M TRIZACT DIAMOND TILE, 677XA, 6 micron from 3M Company

Comparative Example 1

CE1

[0091] A 4-inch (10-cm) disk having a stainless steel base and a polyurethane outer coating on one side, and a 45-tooth 7-inch (18-cm) diameter lapping carrier having a stainless steel base and polyurethane outer coating on both sides, generally prepared according to the disclosure in PCT Internat. Appl. Publ. No. WO 2010/078312 A1 (Fletcher et al.), and commercially available from PR Hoffman.

Carrier Surface Preparations for Lamination

[0092] The following surface treatment methods were used where indicated to prepare the carrier blanks and 4-inch (10-cm) disk surfaces for lamination.

Surface Treatment 1 (ST1)

[0093] Stainless steel carrier blanks were subjected to a 10 minute sonication bath while soaking in a soap solution of 45 grams of ALKONOX powder in about 4 liters of distilled water. The parts were briefly scrubbed prior to removal from the ALKONOX Solution. After sonication the steel blanks were placed in a distilled water bath prior to further rinsing of the blanks The blanks were scrubbed briefly, rinsed with distilled water, water was blown off of the blanks, and the samples were dried. The carrier teeth, work holes, and slurry holes were masked with 442DL adhesive, and the carrier blanks were laminated as indicated or treated further as indicated.

Surface Treatment 2 (ST2)

[0094] Carrier blanks were cleaned as in ST1 (above). The carrier blanks were placed on a clean surface. A thin layer of 3M Tape Primer 94 was painted on one side and allowed to dry. The sample was flipped and a thin layer of 3M Tape Primer 94 was painted on the other side and allowed to dry. The carrier teeth, work holes, and slurry holes were masked with 442DL adhesive, and the carrier blank was laminated as indicated.

Surface Treatment 3 (ST3)

[0095] Carrier blanks were cleaned as in ST1 (above). The blanks were then treated with an Epoxy Silane solution. The Epoxy Silane surface treatment solution was prepared by stirring 50 grams of absolute ethanol with 50 grams of Epoxy Silane and 11.5 grams of de-ionized water. The solution was equilibrated 15-20 minutes, and the solution was diluted to a 10 weight percent solution of Epoxy Silane by adding 388 grams of absolute ethanol. After dilution, the carrier blanks were treated by dip coating into the Epoxy Silane solution, drying in an electric oven for 30-45 minutes at 110-120° C. The parts were allowed to cool. The carrier teeth, work holes, and slurry holes were masked with 442DL adhesive, and the carrier blanks were laminated as indicated.

Surface Treatment 4 (ST4)

[0096] Carrier blanks were cleaned as in ST1 (above). The blanks were then treated with a sodium metasilicate (SMS) solution prepared by stirring 950 parts by weight (pbw) of deionized water, 25 pbw sodium metasilicate, 11 pbw of tetrasodium pyrophosphate, 11 pbw of sodium hydroxide, and 3 pbw of sodium dodecylbenzenesulfonate. The solution was brought to a temperature of 71-82° C. to completely dissolve the solid materials. The carrier blanks were treated for 10 minutes with the SMS solution, rinsed with de-ionized water, dried. The carrier teeth, work holes, and slurry holes were masked with 442DL adhesive. The carrier blanks were laminated as indicated.

Surface Treatment 5 (ST5)

[0097] Carrier blanks were cleaned as in ST1 (above). The blanks were placed on a clean surface. A thin layer of Adhesion Promoter **111** was painted on one side and allowed to dry. The sample was flipped and a thin layer of 3Adhesion Promoter **111** was painted on the other side and allowed to dry. The carrier teeth, work holes, and slurry holes were masked with 442DL adhesive. The carrier blanks were laminated as indicated.

Pressure-Sensitive Adhesive Application to Films without Adhesive

[0098] One of the following surface treatment methods was used where indicated to prepare the carrier blanks and 4-inch (10-cm) disk surfaces for lamination:

Pressure-Sensitive Adhesive Application to Film Method 1 (AA1)

[0099] Pressure-sensitive adhesive was applied to polymer film as received using the following method. A suitable size piece of film and adhesive was selected for lamination. The adhesive liner was removed and the adhesive was carefully applied to the film, while avoiding the lamination of bubbles in between the adhesive and the film. The film was then rolled against the liner backed adhesive with a small hand roller. The lamination was at room temperature.

Pressure-sensitive Adhesive Application to Film Method 2 (AA2)

[0100] The polymer film was treated with ST2 by applying a thin layer of ST2 with a varnish brush over the entire surface of the polymer film to be treated. The primer was allowed to dry at least 5 minutes before adhesive lamination. The adhesive liner was removed and the adhesive with the ST2-treated polymer film was carefully applied to the film, while avoiding the lamination of bubbles in between the adhesive and the film. The film was then rolled against the liner-backed adhesive with a small had roller. The lamination was at room temperature.

Pressure-Sensitive Adhesive Application Method Film 3 (AA3)

[0101] The polymer film was corona treated with a handheld corona treater operated at an input power of 30 watts. The handheld corona treater, Model BD-20AC, was from Electro Technic Products Inc., Chicago, Ill. The corona-treated polymer film and the adhesive with the liner removed were carefully laminated, while avoiding the lamination of bubbles in between the adhesive and the film. The film was then rolled against the liner-backed adhesive with a small had roller. The lamination was at room temperature.

Carrier Lamination

[0102] Lamination Method 1 (M1)

[0103] Both sides of the carrier blank were wiped with isopropanol. A suitable size piece of the indicated adhesive-backed film was selected for each masked blank to be laminated. The adhesive liner was removed and the adhesive side of the indicated adhesive-backed film was carefully applied to the steel blank while avoiding the lamination of bubbles in between the steel and the film. The film was then rolled against the steel blank with a hand roller. After lamination, the film was removed from areas of the steel part where no metal was present by using a razor blade or X-Acto knife. The carrier was then placed on metal sheet and both sides were slowly run through the laminator with the roll pressure set to 100 psi (690 kPa), and with the heated roll set at 200° F. (93° C.).

Lamination Method 2 (M2)

[0104] Both sides of the carrier blank were wiped with isopropanol. A thin layer of the indicated primer was applied using a brush over the entire surface of the carrier to be laminated. The primer was allowed to dry at least 5 minutes before applying 442DL adhesive mask to the carrier teeth, work holes, and slurry holes. The adhesive-backed film was cut to size and spliced together the 3M Blue Painters Tape from 3M Company. The masked carrier was laid on a flat plastic sheet or metal plate. About 2 inches (5.1 cm) of release liner was removed from one edge of the adhesive-backed film. The edge of the adhesive-backed film was laid down about one inch (2.5 cm) in front of the carrier edge. A plate or plastic sheet was placed on a roll laminator (Shore 55 A durometer). The roll pressure was about 100 psi (690 kPa). The roll drive was slowly turned to laminate the film to the primed carrier. The mask was removed using a razor blade to cut along the edges of the tape mask. The carrier was flipped over and the procedure was repeated. The top roll was heated to 200° F. (93° C.). The carrier was placed on metal sheet and slowly run the carrier through the laminator on both sides

Preparation of Examples 2 to 30

[0105] Carrier Surface Preparation for Lamination Surface Treatments (ST1 to ST5), Pressure-sensitive Adhesive Application to Film Methods (AA1 to AA3), and Lamination Methods (M1 to M2) were used to prepare Examples 2 to 30 as reported in Table 1 (below).

TABLE 1

EXAMPLE	METAL TYPE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL
2	A431SS	ST5	M2	PSA1	AA1	L1
3	A431SS	ST2	M2	PSA1	AA1	L1
4	A431SS	ST2	M2	PSA1	AA2	L2
5	A431SS	ST2	M2	PSA1	AA1	L2
6	A431SS	ST1	M1	PSA1	AA2	L2
7	A431SS	ST2	M2	PSA2	AA2	L2

TABLE 1-continued

EXAMPLE	METAL TYPE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL
8	A431SS	ST2	M2	PSA2	AA1	L2
9	A431SS	ST2	M2	PSA2	AA1	L2
10	A431SS	ST2	M2	PSA3	AA2	L2
11	A431SS	ST2	M2	PSA3	AA1	L2
12	A431SS	ST2	M2	PSA3	AA1	L2
13	A431SS	ST2	M2	PSA4	AA2	L2
14	A431SS	ST2	M2	PSA4	AA1	L2
15	A431SS	ST2	M2	PSA4	AA1	L2
16	A431SS	ST2	M2	PSA5	AA2	L2
17	A431SS	ST2	M2	PSA5	AA1	L2
18	A431SS	ST1	M1	PSA5	AA2	L2
19	A431SS	ST2	M2	PSA6	AA2	L2
20	A431SS	ST2	M2	PSA6	AA1	L2
21	A431SS	ST1	M1	PSA6	AA2	L2
22	A431SS	ST2	M2	PSA7	AA2	L2
23	A431SS	ST2	M2	PSA7	AA3	L2
24	A431SS	ST2	M2	PSA7	AA1	L2
25	A431SS	ST2	M2	PSA7	AA1	L2
26	A431SS	ST2	M2	PSA7	AA2	L2
27	A431SS	ST5	M2	PSA1	AA1	L2
28	A431SS	ST2	M2	PSA1	AA1	L1
29	A431SS	ST2	M2	PSA1	AA1	L1
30	A431SS	ST2	M2	PSA1	AA1	L1

[0106] Surface Treatments, Coatings, and Laminate Material Abbreviations used in Table 1 are reported in Table 2 (below).

TABLE 2

ABBREVIATION	SURFACE TREATMENT, OR LAMINATE MATERIAL
L1	2 mil PEEK film from McMaster Carr
L2	3 mil PEEK film from McMaster Carr
PSA1	3M 300 LSE 2 mil
PSA2	3M 501F 1 mil
PSA3	3M 9457 1 mil
PSA4	3M 9458 1 mil
PSA5	3M 9009 2 mil
PSA6	3M 9471 2 mil
PSA7	3M 9461P 1 mil
ST1	ALKONOX wash Surface Treatment
ST2	3M Tape Primer 94 Surface Treatment
ST3	Epoxy Silane Surface Treatment
ST4	Sodium meta-Silicate Surface Treatment
ST5	3M Primer 111 Surface Treatment

Test Methods

90° Peel Adhesion Test

[0107] The procedure was generally according to ASTM D6862-04 "Standard Test Method for 90 Degree Peel Resistance of Adhesives" with differences as noted below.

[0108] Sample preparation consisted of the following steps. A 4-inch×6.5-inch (10-cm×17-cm) 431 SS metal plate was cleaned with isopropanol. 3M TAPE PRIMER 94 was applied to the SS surface with a varnish brush and let dry 5 minutes. The pressure-sensitive adhesive side of a 4-inch×4-inch (10-cm×10-cm) film specimen to be tested was laminated to the primed metal surface. The film was positioned so it covered about half of the metal surface (4-inch×4-inch (10-cm×10-cm) area) over the length of the metal plate. The sample had a 2-inch (5.1-cm) overhang off the edge of the length of the metal plate. Samples were prepared as 0.280-inch (7.11-mm) strips.

[0109] An MTS Q 100 tensile testing apparatus from MTS Systems Corp., Eden Prairie, Minn., was used. A Model SMT1-250N-192 load cell was used (extension one inch (2.5), speed 2 inches (5.1 cm)/minute).

[0110] Samples were pulled at a 90-degree angle for one inch (2.5 cm) and the results were recorded.

Shear Strength Test

[0111] The Shear Strength Test procedure is used to obtain tensile strength data for laminated film samples. The procedure was generally according to ASTM D638-10 "Standard Test Method for Tensile Properties of Plastics" with differences as noted below.

[0112] Sample preparation consisted of the following steps. A 4-inch×4-inch (10-cm×10-cm) 431 SS metal plate was cleaned with isopropanol. 3M TAPE PRIMER 94 was applied to the SS surface with a varnish brush and let dry 5 minutes. The pressure-sensitive adhesive side of a 4-inch×4-inch (10-cm×10-cm) film specimen to be tested was laminated to the primed metal surface. The film was positioned so it covered 0.5 inch (1.3 cm) of the metal surface (4-inch×4-inch (10-cm×10-cm) area) over the length of the metal plate. The sample had a 3.5-inch (8.9-cm) overhang off the edge of the length of the metal plate. Samples were prepared as 0.5-inch (1.3-cm) strips.

[0113] An MTS Q 100 tensile testing apparatus from MTS Systems Corp., Eden Prairie, Minn., was used. A Model SMT1-250N-192 load cell was used (extension 1 inch (2.5 cm), speed 2 inches/minute (5.1 cm/min)). Samples were pulled at a 180-degree opposing angle until failure, and the results were recorded.

Taber Abraser Test

[0114] A Taber Abraser (Taber Industries, Buffalo, N.Y.) was run using 4-inch (10-cm) round blanks for each laminated or sprayed sample which were soaked at 60° C. The list of Surface Treatments, Coatings, and Laminate Material Abbreviations can be found in Table 2 (above) in a phosphate buffer for 24 hours before testing. The phosphate buffer was 0.348 pbw K_2HPO_4, 0.087 pbw KH_2PO_4, and 99.565 pbw de-ionized Water by weight. The pH of the phosphate buffer was between 7.3 and 7.5. The Taber Abraser Test was run wet with de-ionized water unless otherwise indicated, using Tungsten Carbide Wheels S-35 with a load of 1 kg weight for 10 minutes or the indicated amount of time. Comparative Example 1 was used as a control reference point for the Taber Abraser Testing. The Taber Abraser Test results were reported in microns of thickness loss or in grams of weight loss. In cases when the laminate film was raised from being roughed up by the Tungsten Carbide Wheel the thickness loss in microns was not reported since the measurement was not as accurate as the weight loss in grams.

Aggressive Carrier Adhesion Test

[0115] The test was run using 45-tooth carriers from PR Hoffman, Carlisle, Pa. The spray coated or laminated carriers were soaked at 60° C. in a phosphate buffer for 24 hours before testing. The phosphate buffer was 0.348 pbw K_2HPO_4, 0.087 pbw KH_2PO_4, and 99.565 pbw of de-ionized water. The pH of the phosphate buffer was between 7.3 and 7.5.

[0116] The test was run using a Peter-Wolters AC500 (Peter-Wolters of America, Des Plaines, Ill.) double-sided lapping machine. TDT6EL was installed on the bottom plate of the double-sided polisher, using a rubber roller to insure the abrasive was adhered well.

[0117] The TDT6EL was dressed in the following manner. A piece of 268XA was cut into fourths. The 268XA wedges were applied onto an epoxy carrier blank that has a weight of 400 grams. The segments were evenly spaced around the carrier with the large curvature edge toward the teeth. The pump was set up to deliver 100 mL per minute of de-ionized water to the TDT6EL pad near the inner opening. The bottom platen was set to run at 69 rpm, clockwise. The ring speed was set to 13 rpm, clockwise. The carrier blank was placed on the TDT6EL with the 268XA wedge laminated side down, contacting the diamond abrasive. Weight (7.397 kg) was placed on top of the carrier blank. The de-ionized water was turned on, and a 60 second dressing cycle was run. The weight and the carrier blank were then removed. The TDT6EL pad was rinsed off with tap water, and spin dried.

Testing of Side A for 3 Minutes and Side B for 10 Minutes

[0118] The carrier was checked for urethane flash near the areas that were masked, and the flash was removed. Side A of the carrier was placed on the TDT6EL abrasive. Weight 20.36 kg (44.78 lbs) was evenly distributed on the top of the carrier. The weight that was directly in contact with the carrier had the same dimensions as the carrier. The first weight was checked for high spots and dirt on the surface to avoid high pressure areas on the carrier during the test. The weight and thickness measurements were taken from the carrier before starting the test. The pump was set to deliver 100 ml per minute of pH 7.4 buffer solution (same as soak solution above) to the TDT6EL pad near the inner opening. The bottom platen was set to run at 69 rpm, clockwise. The ring speed was set to 13 rpm, clockwise. The pH 7.4 buffer was turned on and the bottom platen and ring were turned on. The buffer solution was used only once and was not recycled. The test was run for 3 minutes. The weights and carrier were removed and the carrier was rinsed with de-ionized water. The carrier was dried and the weight and thickness measurements were taken from the carrier after the test

[0119] The weight and thickness measurements were taken from the carrier before testing side B. Side B of the carrier was placed on the TDT6EL abrasive. 20,355 g (44.78 lbs) of weight were evenly distributed on the top of the carrier. The weight that was directly in contact with the carrier had the same dimensions as the carrier. The first weight was checked for high spots and dirt on the surface to avoid high pressure areas on the carrier during the test. The pump was set to deliver 100 ml per minutes of pH 7.4 buffer solution (same as soak solution above) to the TDT6EL pad near the inner opening. The bottom platen was set to run at 69 rpm, clockwise. The ring speed was set to 13 rpm, clockwise. The pH 7.4 buffer was turned on and the bottom platen and ring were turned on. The buffer solution was used only once and was not recycled. The test was run for 10 minutes. The weights and carrier were removed, and the carrier was rinsed with de-ionized water. The carrier was dried and the weight and thickness measurements were taken from the carrier after the test

[0120] After testing, the test blank was observed for delamination and rated on a scale from 0 to 5 per carrier side as reported in Table 3 (below).

TABLE 3

CARRIER RATING	VISUAL
5	No delamination visible anywhere on the carrier
4	One small delamination spot by the work hole
3	Increasing delamination by work hole
2	Inter layer delamination
1	Almost complete delamination
0	Complete delamination

Results

[0121] Taber Abraser Test thickness loss results are reported in Table 4 (below). Results of the 90° Peel Adhesion Test for the laminated carrier blanks are reported in Table 5. The results of the Adhesive Shear Strength Test of laminated carrier blanks are reported in Table 6.

TABLE 4

EXAMPLE	METAL SURFACE TREATMENT	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	COATING, OR FILM, OR LAMINATE MATERIAL	TIME, MINUTES	AVERAGE SURFACE WEAR, micron	WEIGHT LOSS, grams
CE1					12	21	NA
CE1					60	67.3	NA
2	ST5	PSA1	AA1	L1	60	2.5	0.0138
26	ST2	PSA7	AA2	L2	60	4.5	NA

TABLE 4-continued

EXAMPLE	METAL SURFACE TREATMENT	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	COATING, OR FILM, OR LAMINATE MATERIAL	TIME, MINUTES	AVERAGE SURFACE WEAR, micron	WEIGHT LOSS, grams
27	ST5	PSA1	AA1	L2	60	5.3	0.0155
28	ST2	PSA1	AA1	L1	60	1.75	0.0144

TABLE 5

EXAMPLE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA, IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	COATING, OR FILM, OR LAMINATE MATERIAL	90° PEEL ADHESION TEST, lbs/in (N/cm)
2	ST5	M2	PSA1	AA1	L1	5.40 (0.478)
3	ST2	M2	PSA1	AA1	L1	5.83 (0.516)
4	ST2	M2	PSA1	AA2	L2	5.50 (0.487)
5	ST2	M2	PSA1	AA1	L2	3.09 (0.273)
6	ST1	M1	PSA1	AA2	L2	5.17 (0.457)
7	ST2	M2	PSA2	AA2	L2	4.02 (0.356)
8	ST2	M2	PSA2	AA1	L2	0.23 (0.200)
9	ST2	M2	PSA2	AA1	L2	1.88 (0.166)
10	ST2	M2	PSA3	AA2	L2	3.48 (0.308)
11	ST2	M2	PSA3	AA1	L2	2.11 (0.187)
12	ST2	M2	PSA3	AA1	L2	1.82 (0.161)
13	ST2	M2	PSA4	AA2	L2	2.27 (0.201)
14	ST2	M2	PSA4	AA1	L2	2.09 (0.185)
15	ST2	M2	PSA4	AA1	L2	2.27 (0.201)
16	ST2	M2	PSA5	AA2	L2	2.29 (0.203)
17	ST2	M2	PSA5	AA1	L2	2.54 (0.225)
18	ST1	M1	PSA5	AA2	L2	2.64 (0.234)
19	ST2	M2	PSA6	AA2	L2	2.92 (0.258)
20	ST2	M2	PSA6	AA1	L2	3.70 (0.327)
21	ST1	M1	PSA6	AA2	L2	2.71 (0.240)
22	ST2	M2	PSA7	AA2	L2	4.70 (0.416)
23	ST2	M2	PSA7	AA3	L2	5.07 (0.449)
24	ST2	M2	PSA7	AA1	L2	2.38 (0.211)
25	ST2	M2	PSA7	AA1	L2	2.59 (0.229)
26	ST2	M2	PSA7	AA2	L2	4.45 (0.394)

TABLE 6

EXAMPLE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL	SHEAR STRENGTH TEST, lbs/in (kg/cm)
2	ST5	M2	PSA1	AA1	L1	18.25 (3.26)
3	ST2	M2	PSA1	AA1	L1	18.90 (3.38)

[0122] The AGGRESSIVE CARRIER ADHESION Test procedure was also performed after a 24 hour soak in a pH 7.4 phosphate buffer solution. A431 SS carrier blanks were used for all samples. Results are reported in Tables 7 and 8 (below).

TABLE 7

EXAMPLE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL
2	ST5	M2	PSA1	AA1	L1
4	ST2	M2	PSA1	AA2	L2
4	ST2	M2	PSA1	AA2	L2
27	ST5	M2	PSA1	AA1	L2
28	ST2	M2	PSA1	AA1	L1
29	ST2	M2	PSA1	AA1	L1
30	ST2	M2	PSA1	AA1	L1

TABLE 8

EXAMPLE	TEST TIME, min	CARRIER RATING	AVERAGE CARRIER WEAR, microns	CARRIER WEIGHT LOSS, grams
CE1	3	4	4.6	0.0558
CE1	10	5	2.4	0.0212
CE1	3	0	3.8	0.0781
CE1	10	5	4.6	0.0277
CE1	3	5	5.8	0.0186
CE1	3	5	2.8	0.0362
2	10	5	1.4	0.0206
4	10	4	2.0	0.0254
4	10	5	2.8	0.0184
27	10	5	2.0	0.0156
28	10	5	2.0	0.0211
29	10	5	2.4	0.0226
30	10	5	1.4	0.0206

100 mm Silicon Wafer Removal Rate/TDT6EL Pad Wear Rate/Laminated 45T Carrier Wear Rate Evaluation

[0123] Five carriers were prepared as described in Example 3 using ST2 and L1. The five carriers were used to determine if the laminated L1 film had a negative effect upon the removal rate while polishing silicon wafers on a model PW AC 500 double-sided lapping machine from Peter Wolters, Rendsburg, Germany, using TDT6EL abrasive. The material removal rate from the silicon wafers was monitored during the testing to evaluate the stability of the wear rate and average wear rate. The total TDT6EL abrasive wear rate, and the total carrier wear rate from last measurement of each set were reported at the end of each set. Results are reported in Table 9 (below), wherein "cw" means clockwise and "ccw" means counter-clockwise.

TABLE 9

SET 1

100 mm Silicon Wafers	Time Interval, minutes	Total Accumulated Time, minutes	Silicon Wafer Removal Rate (μm/min)	Carrier Rotation Direction
New rough-	10	10	6.7	cw
lapped	10	20	6.1	ccw
wafers, 1.4 psi	10	30	5.4	cw
(96 kPa),	10	40	5.9	ccw
50 rpm, 200 mL/min,	10	50	5.3	cw
deionized	10	60	5.9	ccw
water				
Ave. Removal Rate 5.9 +/− 0.5 μm/min				
Average Surface Finish R_{max} for time period 5.18 μm				
Used wafers,	10	70	4.2	cw
1.4 psi (96 kPa),	10	80	4.8	ccw
50 rpm,	10	90	4.8	cw
200 mL/min,	10	100	5.4	ccw
deionized	10	110	4.8	cw
water	10	120	5.3	ccw
Ave. Removal Rate 4.9 +/− 0.4 μm/min				
Average Surface Finish R_{max} for time period 0.39 μm				
Ave. Carrier Wear Rate 0.059 μm/min				
Ave. TDT6EL Abrasive Wear Rate 0.067 μm/min				

Set 2

100 mm Silicon Wafers	Time Interval (min.)	Total Accumulated Time (min.)	Silicon Wafer Removal Rate (μm/min)	Carrier Rotation Direction
New rough-	5	125	14.5	cw
lapped	5	130	14.4	ccw
wafers, 1.4 psi	5	135	12.5	cw
(96 kPa),	5	140	12.8	ccw
96 rpm, 500 mL/min,	5	145	12.4	cw
deionized	5	150	12.6	ccw
water	5	155	12.1	cw
Ave. Removal Rate 13.0 +/− 1.0 μm/min				
Average Surface Finish R_{max} for time period 4.22 μm				
Used wafers,	5	160	10.6	ccw
1.4 psi (96 kPa),	5	165	9.8	cw
96 rpm,	5	170	9.4	ccw
500 mL/min,	5	175	10.5	cw
deionized	5	180	9.8	ccw
water	5	185	9.5	cw
	5	190	10.3	ccw
	5	195	9.9	cw
	5	200	10.2	ccw
	5	205	8.9	cw
	5	210	11.2	ccw
	5	215	10.0	cw
	5	220	10.7	ccw
	5	225	9.6	cw
	5	230	10.3	ccw
	5	235	9.0	cw
Ave. Removal Rate 10.0 +/− 0.6 μm/min				
Average Surface Finish R_{max} for time period 1.10 μm				
Ave. Carrier Wear Rate 0.060 μm/min				
Ave. TDT6EL Abrasive Wear Rate 0.174 μm/min				

[0124] Results show an average silicon wafer removal rate for Set 1 of 5.9+/−0.5 μm/min with new rough-lapped wafers and 4.9+/−0.4 um/min with used wafers at 14 psi (96 kPa), 50 rpm, 200 mL/min deionized water, and an average silicon wafer removal rate for Set 2 of 13.0+/−1.0 μm/min with new rough-lapped wafers and 10.0+/−0.6 μm/min with used wafers at 14 psi (96 kPa), 96 rpm, 500 mL/min deionized water. These values show a stable wear rate for each set of wafers under the polishing conditions used.

[0125] The average TDT6EL 6 micron EL Pad wear rate for Set 1 was 0.067 μm/min. The average carrier wear rate for Set 1 over the 120 minute interval was 0.059 μm/min. The average TDT6EL 6 micron EL Pad wear rate for Set 2 was 0.174 μm/min. The average carrier wear rate for Set 2 over the 115 minute interval was 0.060 μm/min. The carrier wear rate was stabile under the Set 1 and Set 2 polishing conditions.

[0126] The increase in the average Silicon Wafer Removal rate and the average TDT6EL 6 micron EL Pad wear rate from Set 1 to Set 2 is due to the increase from the 50 rpm in Set 1 to the 96 rpm in Set 2.

Coefficients of Friction for Various Carrier Treatments

[0127] Coefficients of friction (CoFs) were measured using the horizontal plane method in which a sled of a single material is drawn across the sample at constant velocity. Seven samples were tested and CoFs calculated to assist in determining wear resistance. Testing was done using a circular steel sled of 15.85 mm diameter **220** grit polished and weight of 80 g. Static CoFs may assess a material's ability to minimize stiction (stick-slip), while kinetic CoFs may aid in predicting wear in dynamic contact with shear motion between two bodies.

[0128] The spray coated sample CE1 gave higher CoFs (Static 0.49, Kinetic 0.33) than sample 3 (Polyether Ether Ketone, Static 0.36, Kinetic 0.24) in Table 10 (below). Results of Coefficient of Friction measurements are reported in Table 10 (below).

TABLE 10

EXAMPLE	METAL TYPE	SURFACE TREATMENT	COATING OR LAMINATE MATERIAL	AVERAGE COEFFICIENT OF FRICTION	
				STATIC (St. Dev.)	KINETIC (St. Dev.)
CE1				0.49 (0.04)	0.33 (0.02)
3	A431SS	ST2	L1	0.36 (0.02)	0.24 (0.02)

Preparation of Examples 31 to 58

[0129] Carrier Surface Preparation for Lamination Surface Treatments (ST1 to ST5), Pressure-sensitive Adhesive Application to Film Methods (AA1 to AA3), and Lamination Methods (M1 to M2) were used to prepare Examples 31 to 58 as reported in Table 11 (below).

TABLE 11

EXAMPLE	METAL TYPE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	COATING, OR FILM, OR LAMINATE MATERIAL
31	MS	ST2	M2	NA	NA	X2
32	U431SS	ST2	M2	NA	NA	X2
33	A431SS	ST2	M2	NA	NA	X2
34	A431SS	ST3	M1	NA	NA	X2
35	U431SS	ST3	M1	NA	NA	X2
36	A431SS	ST4	M1	NA	NA	X2
37	U431SS	ST4	M1	NA	NA	X2
38	A431SS	ST1	M1	NA	NA	X2
39	U431SS	ST1	M1	NA	NA	X2
40	A431SS	ST2	M2	NA	NA	X2
41	U431SS	ST2	M2	NA	NA	X2
42	A431SS	ST2	M2	NA	NA	X1
43	A431SS	ST2	M2	PSA7	AA2	X2
44	A431SS	ST2	M2	PSA7	AA3	X2
45	A431SS	ST2	M2	PSA7	AA1	X2
46	A431SS	ST1	M2	NA	NA	X2
47	A431SS	ST2	M2	NA	NA	X2
48	A431SS	ST1	M2	NA	NA	X1
49	A431SS	ST2	M2	NA	NA	X1
50	A431SS	ST2	M1	NA	NA	X1
51	A431SS	ST2	M1	NA	NA	X1
52	A431SS	ST2	M1	NA	NA	X1
53	A431SS	ST2	M1	NA	NA	X1
54	A431SS	ST5	M1	NA	NA	X1
55	A431SS	ST5	M1	NA	NA	X3
56	A431SS	ST2	M1	NA	NA	X2
57	A431SS	ST2	M1	NA	NA	X2
58	A431SS	ST5	M1	NA	NA	X2

Results

[0130] Taber Abraser Test thickness loss results are reported in Table 12 (below). Examples 46, 48, and 55 all show lower surface wear than CE1.

TABLE 12

EXAMPLE	METAL SURFACE TREATMENT	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL	TIME, MINUTES	AVERAGE SURFACE WEAR, micron	WEIGHT LOSS, grams
CE1					12	21	NA
CE1					60	67.3	NA
46	ST1	NA	NA	X2	60	1.75	0.0017

TABLE 12-continued

EXAMPLE	METAL SURFACE TREATMENT	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL	TIME, MINUTES	AVERAGE SURFACE WEAR, micron	WEIGHT LOSS, grams
48	ST1	NA	NA	X1	60	2.5	0.0050
55	ST5	NA	NA	X3	60	0.75	0.0043

[0131] The results of the 90° Peel Adhesion Test of the laminated A431 SS carrier blanks are reported in Table 13. The results of the Shear Strength Test of the laminated A431 SS carrier blanks are reported in Table 14.

TABLE 13

EXAMPLE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL	90° PEEL ADHESION TEST, LBS/IN
46	ST2	M2	PSA7	AA3	X2	1.41
47	ST1	M2	NA	NA	X2	2.64
48	ST2	M2	NA	NA	X2	2.94
49	ST1	M2	NA	NA	X1	3.38
50	ST2	M2	NA	NA	X1	3.55

TABLE 14

EXAMPLE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL	SHEAR STRENGTH, LBS/IN
47	ST1	M2	NA	NA	X2	10.05
48	ST2	M2	NA	NA	X2	10.28
49	ST1	M2	NA	NA	X1	10.81
50	ST2	M2	NA	NA	X1	10.85

[0132] The AGGRESSIVE CARRIER ADHESION Testing was performed after a 24 hr soak in a pH 7.4 phosphate buffer solution. A431 SS carrier blanks were used for all samples. Results are reported in Tables 15 and 16.

TABLE 15

EXAMPLE	METAL TYPE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL
31	MS	ST2	M2	NA	NA	X2
31	MS	ST2	M2	NA	NA	X2
32	U431SS	ST2	M2	NA	NA	X2
32	U431SS	ST2	M2	NA	NA	X2
33	A431SS	ST2	M2	NA	NA	X2
33	A431SS	ST2	M2	NA	NA	X2
34	A431SS	ST1	M1	NA	NA	X2
34	A431SS	ST1	M1	NA	NA	X2
35	U431SS	ST1	M1	NA	NA	X2
35	U431SS	ST1	M1	NA	NA	X2
36	A431SS	ST3	M1	NA	NA	X2
36	A431SS	ST3	M1	NA	NA	X2
37	U431SS	ST3	M1	NA	NA	X2
37	U431SS	ST3	M1	NA	NA	X2
38	A431SS	ST4	M1	NA	NA	X2
38	A431SS	ST4	M1	NA	NA	X2
39	U431SS	ST4	M1	NA	NA	X2
39	U431SS	ST4	M1	NA	NA	X2
40	A431SS	ST2	M2	NA	NA	X2

TABLE 15-continued

EXAMPLE	METAL TYPE	METAL SURFACE TREATMENT	METAL TO PSA BACKED FILM LAMINATION METHOD	PSA IF APPLIED TO FILM	PSA TO FILM LAMINATION METHOD	FILM, OR LAMINATE MATERIAL
40	A431SS	ST2	M2	NA	NA	X2
41	U431SS	ST2	M2	NA	NA	X2
41	U431SS	ST2	M2	NA	NA	X2
46	A431SS	ST1	M2	NA	NA	X2
46	A431SS	ST1	M2	NA	NA	X2
48	A431SS	ST1	M2	NA	NA	X1
50	A431SS	ST2	M1	NA	NA	X1
50	A431SS	ST2	M1	NA	NA	X1
51	A431SS	ST2	M1	NA	NA	X1
51	A431SS	ST2	M1	NA	NA	X1
52	A431SS	ST2	M1	NA	NA	X1
53	A431SS	ST2	M1	NA	NA	X1
54	A431SS	ST5	M1	NA	NA	X1
54	A431SS	ST5	M1	NA	NA	X1
55	A431SS	ST5	M1	NA	NA	X3
56	A431SS	ST2	M1	NA	NA	X2
56	A431SS	ST2	M1	NA	NA	X2
57	A431SS	ST2	M1	NA	NA	X2
58	A431SS	ST5	M1	NA	NA	X2
58	A431SS	ST5	M1	NA	NA	X2

TABLE 16

EXAMPLE	TEST TIME, minutes	CARRIER RATING	AVERAGE CARRIER WEAR, microns	CARRIER WEIGHT LOSS, grams
CE1	3	4	4.6	0.0558
CE1	10	5	2.4	0.0212
CE1	3	0	3.8	0.0781
CE1	10	5	4.6	0.0277
CE1	3	5	5.8	0.0186
CE1	3	5	2.8	0.0362
31	10	0	72.3	0.95
31	3	3	21.7	0.28
32	10	5	3.6	0.05
32	3	4	1.0	0.01
33	10	5	14.0	0.15
33	3	5	4.3	0.06
34	10	5	6.4	0.04
35	10	4	6.2	0.03
36	10	5	12.7	0.05
37	10	4	6.4	0.08
38	10	4	12.7	0.02
39	10	4	10.2	0.03
40	10	5	19.1	0.07
40	10	5	14.0	0.03
41	10	4	20.6	0.10
41	10	5	1.8	0.06
46	10	5	1.4	0.0113
46	10	5	2.0	0.0101
48	10	5	2.3	0.0055
50	10	5	2.8	0.0058
50	10	5	2.0	0.0109
51	10	5	3.4	0.0127
51	10	5	3.4	0.0154
52	10	5	2.4	0.0072
53	10	5	2.4	0.0057
54	10	5	3.2	0.0061
54	10	5	2.0	0.0061
55	10	5	1.2	0.0026
56	10	5	2.0	0.0119
56	10	5	2.8	0.0100
57	10	5	1.6	0.0081
58	10	5	2.8	0.0119
58	10	5	1.6	0.0114

100 mm Silicon Wafer Removal Rate/TDT6EL 6 Micron EL Pad Wear Rate/Laminated 45T Carrier Wear Rate Evaluation

[0133] Five carriers were prepared as described in Example 42 using ST2 and X1. The five carriers were used to determine if the laminated X1 film had a negative effect upon the removal rate while polishing silicon wafers on a PW AC 500 double-sided lapping machine from Peter Wolters, Rendsburg, Germany, using TDT6EL abrasive. The material removal rate from the silicon wafers was monitored during the testing to evaluate the stability of the wear rate and average wear rate. The total TDT6EL wear rate, and the total carrier wear rate from last measurement of each set were reported at the end of each set. Results are reported in Table 17 (below), wherein "cw" means clockwise and "ccw" means counter-clockwise.

TABLE 17

Time Interval, minutes	Total Accumulated Time, minutes	Silicon Wafer Removal Rate, μm/min	Carrier Rotation Direction
Test Set 1			
5	5	8.9	cw
5	10	8.8	ccw
3.75	13.75	8.7	cw
5	18.75	7.1	ccw
5	23.75	7.9	cw
5	28.75	7.8	ccw
5	33.75	8.3	cw
5	38.75	8.2	ccw
5	43.75	8.1	cw
20	63.75	8.1	cw
20	83.75	7.5	ccw
20	103.75	7.5	cw
20	123.75	7.4	ccw
20	143.75	7.1	cw
20	163.75	6.8	ccw

TABLE 17-continued

Time Interval, minutes	Total Accumulated Time, minutes	Silicon Wafer Removal Rate, μm/min	Carrier Rotation Direction
Ave. Removal Rate 7.9 +/− 0.6			
Ave. Carrier Wear Rate 0.083 μm/min			
Ave. TDT6EL 6 micron Wear Rate 0.075 μm/min			
Test Set 2			
5	5	6.8	cw
5	10	5.6	ccw
5	15	5.4	cw
5	20	5.0	ccw
5	25	5.2	cw
5	30	5.2	ccw
5	35	4.8	cw
Ave. Removal Rate 5.4 +/− 0.7			
Ave. Carrier Wear Rate 0.180 μm/min			
Ave. TDT6EL 6 micron Pad Wear Rate 0.180 μm/min			

[0134] Results show an average silicon wafer removal rate of 7.9+/−0.6 μm/min for Set 1 when run at 14 psi (96 kPa), 96 rpm, 500 mL/minute deionized water, and an average silicon wafer removal rate of 5.4+/−0.7 μm/min for Set 2 when run at 14 psi (96 kPa), 60 rpm, 500 mL/minute deionized water. These values show a stable wear rate for each set of wafers under the polishing conditions used.

[0135] For Set 1, the average TDT6EL wear rate was 0.075 microns per minute and the average carrier wear rate was 0.083 micron per minute. The average TDT6EL 6 micron EL Pad wear rate for Set 2 was 0.180 microns per minute. The average carrier wear rate for Set 2 over the 115 minute interval was 0.0180 microns per minute. The decrease in the average Silicon Wafer Removal rate from Set 1 to Set 2 is due to the decrease from the 96 rpm in Set 1 to the 60 rpm in Set 2.

[0136] The Aggressive Carrier Adhesion Test results are reported in Table 18 for Example 42, which demonstrate the stability of the X1 laminate to the presence of seams and removed film when absent on the test carrier surface. Both examples had passing ratings of 5.

TABLE 18

EXAMPLE	SURFACE DESCRIPTION	DAYS SOAKED at 60° C.	TEST TIME SIDE 1, MINUTES	CARRIER RATING SIDE 1
42	with one Seam	1	10	Pass, 5
42	with one Seam and holes cut in film/reduced surface area by 25%	1 day/some delamination by punched holes. There was a wrinkle in film when laminated. Removed delamination area by razor.	10	Pass, 5

[0137] Aggressive Carrier Adhesion Test results reported in Table 19 (below) demonstrate the stability of Example 42 under the treatment conditions of a buffer soak solution at 60° C., of a dry oven at 60° C., and of no post-treatment.

TABLE 19

EXAMPLE, LOT	TREATMENT CONDITIONS WITH ONE SEAM PRESENT	DAYS SOAKED at 60° C.	WEIGHTED WEAR TEST 3 MINUTES/ SIDE 1 AND CARRIER RATING SIDE 1	WEIGHTED WEAR TEST 10 MINUTES/ SIDE 2, AND CARRIER RATING SIDE 2
42	pH 7.4 buffer solution overnight at 60° C.	1	pass, 4	pass, 5
42	oven at 60° C. overnight	0	pass, 5	pass, 5
42	no post treatment	0	pass, 5	pass, 5
42	pH 7.4 buffer solution overnight at 60° C.	1	pass, 5	pass, 5
42	oven at 60° C. overnight	0	pass, 5	pass, 5
42	no post treatment	0	pass, 5	pass, 5
42	pH 7.4 buffer solution overnight at 60° C.	1	pass, 5	pass, 5
42	oven at 60° C. overnight	0	pass, 5	pass, 5
42	no post treatment	0	pass, 5	pass, 5

[0138] Evaluation of Example 42 (6 sides from three carriers) in Table 19, all gave ratings of 5.

Coefficients of Friction for Various Carrier Treatments

[0139] Coefficients of friction (CoFs) were measured using the horizontal plane method in which a sled of a single material is drawn across the sample at constant velocity. Seven samples were tested and CoFs calculated to assist in determining wear resistance. Testing was done using a circular steel sled of 15.85 mm diameter **220** grit polished and weight of 80 g. Static CoFs may assess a material's ability to minimize stiction (stick-slip), while kinetic CoFs may aid in predicting wear in dynamic contact with shear motion between two bodies.

[0140] The spray coated sample CE1 gave a higher CoFs (Static 0.49, Kinetic 0.33) than the other Examples in Table 22. Examples 31, 32, and 33 gave the lowest CoFs of Static 0.28, 0.27, and 0.28; Kinetic 0.21, 0.21, and 0.21.

[0141] Static and Kinetic CoFs are reported in TABLE 20 (below) for Examples 31-33 and CE1.

TABLE 20

		SURFACE	COATING OR	AVERAGE COEFFICIENT OF FRICTION	
EXAMPLE	METAL TYPE	TREATMENT	LAMINATE MATERIAL	STATIC (st. dev.)	KINETIC (st. dev.)
CE1				0.49 (0.04)	0.33 (0.02)
31	MS	ST2	X2	0.28 (0.01)	0.21 (0.02)

TABLE 20-continued

EXAMPLE	METAL TYPE	SURFACE TREATMENT	COATING OR LAMINATE MATERIAL	AVERAGE COEFFICIENT OF FRICTION STATIC (st. dev.)	AVERAGE COEFFICIENT OF FRICTION KINETIC (st. dev.)
32	U431SS	ST2	X2	0.27 (0.01)	0.21 (0.01)
33	A431SS	ST2	X2	0.28 (0.02)	0.21 (0.02)

Work to Failure Energies for Polymer Films

[0142] Work to failure energies were measured for carriers with various polymer films generally according to using ASTM D638-10 "Standard Test Method for Tensile Properties of Plastics" with changes as noted. The sample gauge length of one inch (25 mm), a sample width of one inch (25 mm) was used, and the crosshead speed was 40 inches/minute (100 cm/min, and a 200 N MTS load cell. Results are reported in Table 21 (below).

TABLE 21

POLYMER FILM	THICKNESS, mm	BREAK LOAD, N	PEAK STRESS, MPa	STRAIN AT BREAK, mm	ENERGY TO BREAK, J
X1, UHMW PE with adhesive layer removed	0.07	102.8	57.8	4.4	7.8
L2, PEEK	0.07	180.0	101.3	2.7	8.9

[0143] All patents and publications referred to herein are hereby incorporated by reference in their entirety. All examples given herein are to be considered non-limiting unless otherwise indicated. Various modifications and alterations of this disclosure may be made by those skilled in the art without departing from the scope and spirit of this disclosure, and it should be understood that this disclosure is not to be unduly limited to the illustrative embodiments set forth herein.

What is claimed is:

1. A lapping carrier comprising:

a base having first and second opposed major surfaces and at least one aperture extending from the first major surface to the second major surface; and

a first wear layer disposed on the first major surface of the base, the wear layer comprising:

a first outer polymer layer secured to the base, wherein the first outer polymer layer has a first exposed major surface, and wherein the first outer polymer layer comprises at least one of polyether ether ketone or ultrahigh molecular weight polyethylene; and

a first adhesive layer disposed between the first outer polymer layer and the base.

2. The lapping carrier of claim **1**, wherein the first outer polymer layer comprises polyether ether ketone.

3. The lapping carrier of claim **1**, wherein the first outer polymer layer comprises ultrahigh molecular weight polyethylene.

4. The lapping carrier of claim **1**, further comprising a first base adhesion promoting layer, disposed between the first adhesive layer and the first major surface of the base, wherein the first base adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, silane coupling agents, and combinations thereof.

5. The lapping carrier of claim **1**, further comprising a first polymer adhesion promoting layer disposed between the first adhesive layer and the first outer polymer layer, wherein the first polymer adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, and combinations thereof.

6. The lapping carrier of claim **1**, wherein the first adhesive layer comprises a pressure-sensitive adhesive.

7. The lapping carrier of claim **1**, further comprising:

a second wear layer disposed on the second major surface of the base, the wear layer comprising:

a second outer polymer layer secured to the base, wherein the second outer polymer layer has a second exposed major surface, and wherein the second outer polymer layer comprises at least one of polyether ether ketone or ultrahigh molecular weight polyethylene; and

a second adhesive layer disposed between the first outer polymer layer and the base.

8. The lapping carrier of claim **7**, wherein the second outer polymer layer comprises polyether ether ketone.

9. The lapping carrier of claim **7**, wherein the second outer polymer layer comprises ultrahigh molecular weight polyethylene.

10. The lapping carrier of claim **7**, further comprising a second base adhesion promoting layer, disposed between the second adhesive layer and the second major surface of the base, wherein the second base adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, silane coupling agents, and combinations thereof.

11. The lapping carrier of claim **7**, further comprising a second polymer adhesion promoting layer disposed between the second adhesive layer and the second outer polymer layer, wherein the second polymer adhesion promoting layer is selected from the group consisting of plasma treatments, polymeric primers, and combinations thereof.

12. The lapping carrier of claim **7**, wherein the second adhesive layer comprises a pressure-sensitive adhesive.

13. The lapping carrier of claim **1**, wherein the base comprises a steel.

14. The lapping carrier of claim **1**, wherein the lapping carrier has a maximum thickness of less than 975 microns.

15. A method of lapping comprising:

placing a workpiece in the at least one aperture of a lapping carrier according to claim **1**;

placing the lapping carrier into a lapping machine having at least one lapping surface; and

providing relative motion between the workpiece and the at least one lapping surface thereby abrading the workpiece.

16. The method of claim **15**, further comprising providing a working fluid at the interface between the workpiece and the at least one lapping surface.

17. The method of claim **16**, wherein the working fluid comprises water.

18. The method of claim **15**, wherein the at least one lapping surface comprises a three-dimensional, textured, fixed-abrasive article.

* * * * *