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ARTICLE INCLUDING PACKAGE AND ABRASIVE TOOL INCLUDING BARRIER LAYER

FIELD OF THE DISCLOSURE

[0001] This disclosure, in general, relates to articles including an abrasive tool that includes a barrier layer and a package, and particularly to articles including a bonded abrasive including a barrier layer and a package.

BACKGROUND

[0002] Abrasive articles are used in various industries to machine workpieces by cutting, lapping, grinding, or polishing. Abrasive articles are often shipped from one location to another and stored for an amount of time prior to use. As some bonded abrasive articles have bond matrix materials that are susceptible to water vapor adsorption, humid environment can adversely affect performance and cause performance degradation of such bonded abrasive articles. Performance degradation can include, for example, an increase in wear rate of the abrasive article, a reduction in grind rate on a workpiece, or a reduction in the amount of cutting before the abrasive article wears out. A need for improved abrasive article packaging exists.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The present disclosure may be better understood, and its numerous features and advantages made apparent to those skilled in the art by referencing the accompanying drawings.

[0004] FIG. 1 includes an illustration of an exemplary article including an abrasive tool and a package according to an embodiment.

[0005] FIG. 2 includes an illustration of a cross-sectional view of a packaging material of FIG. 1.

[0006] FIG. 3 includes an illustration of an exemplary article including abrasive tools and a package according to another embodiment.

[0007] FIG. 4 includes an illustration of a cross-sectional view of a packaging material of FIG. 3.

[0008] FIG. 5A includes an illustration of a face view of an exemplary cutting wheel.

[0009] FIG. 5B includes an illustration of a cross-sectional view of the cutting wheel of FIG. 5A.

[0010] FIG. 6A includes an illustration of a cross-sectional view of an exemplary depressed-center wheel.

[0011] FIG. 6B includes an illustration of a cross-sectional view of the depressed-center wheel of FIG. 6A.

[0012] FIG. 7 includes an illustration of a cross-sectional view of an exemplary abrasive tool.

[0013] FIG. 8 includes an illustration of a cross-sectional view of another exemplary abrasive tool.

[0014] FIG. 9 includes an illustration of a cross-sectional view of another exemplary abrasive tool.

[0015] FIG. 10A to 10C include an illustration of a cross-sectional view of an abrasive tool according to embodiments described herein.

[0016] FIG. 11A to 11C includes an illustration of a cross-sectional view of a portion of a barrier layer according to embodiments described herein.

[0017] FIGs. 12A to 12J include a cross-sectional illustration of an abrasive tool including a portion of a bonded abrasive body and a barrier layer according to embodiments described herein.

[0018] FIG. 13 includes a cross-sectional illustration of a portion of an abrasive tool including a portion of a bonded abrasive body, a barrier layer, and a coating layer according to an embodiment.

[0019] FIG. 14 includes a plot of water vapor uptake over time of different bonded abrasive wheels.

[0020] Embodiments are illustrated by way of example and are not limited in the accompanying figures. The use of the same reference symbols in different drawings indicates similar or identical items. Skilled artisans appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the invention.

DETAILED DESCRIPTION

[0021] The following description in combination with the figures is provided to assist in understanding the teachings disclosed herein. The following discussion will focus on specific implementations and embodiments of the teachings. This focus is provided to assist in describing the teachings and should not be interpreted as a limitation on the scope or applicability of the teachings. However, other teachings can certainly be used in this application.

[0022] As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but may include other features not expressly listed or inherent to such method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to an inclusive-or and not to an exclusive-or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0023] Also, the use of "a" or "an" is employed to describe elements and components described herein. This is done merely for convenience and to give a general sense of the scope of the invention. This description should be read to include one or at least one and the singular also includes the plural, or vice versa, unless it is clear that it is meant otherwise. For example, when a single item is described herein, more than one item may be used in place of a single item. Similarly, where more than one item is described herein, a single item may be substituted for that more than one item.

[0024] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The materials, methods, and examples are illustrative only and not intended to be limiting. To the extent that certain details regarding specific materials and processing acts are not described, such details may include conventional approaches, which may be found in reference books and other sources within the manufacturing arts.

[0025] Embodiments are drawn to an article including a package and an abrasive tool including a barrier layer. The package in combination with the barrier layer can help to improve shipping and storage of the abrasive tool by significantly reducing water vapor adsorption of the abrasive tool over time. In some instances, the combination of the package and barrier layer can be particularly suited for shipping and storing a relatively large number of abrasive tools and for improved storage of a relatively large number of abrasive tools over an extended period of time.

[0026] In an embodiment, the article can include at least one abrasive tool. FIG. 1 includes an illustration of an exemplary embodiment of an article 100 including a plurality of abrasive tools 104. The article 100 can include a package 101 including a packaging material 102 that defines an interior volume 110, in which abrasive tools 104 are contained. As illustrated, the package 101 is in the form of a vacuum sealable pouch. Alternatively, an insert such as a cardboard insert or a stiff polymeric insert can be provided in the pouch or can be formed to one side of the pouch. The package 101 can further include a fastening structure 108 such that the package can be resealed after opening. The fastening structure 108 can be proximate to an opening and operable by a user to close and seal the package 101. In an example, the fastening structure 108 can include a pressure sensitive adhesive. In another example, the fastening structure 108 includes a mechanical fastener, such as a strip fastener. In one embodiment, the package may not be re-sealable.

[0027] In an embodiment, the packaging material 102 can include an organic material, an inorganic material, or a combination thereof. In an aspect, the packaging material 102 can an organic material, and in a particular aspect, the packaging material 102 can consist essentially of an organic material. An exemplary organic material can include a polymer, such as a thermoset or thermoplastic. For example, the packaging material 102 can include a natural or a synthetic plastics material, and in a particular instance, the packaging material can consist essentially of a plastics material. In another instance, an exemplary organic material can include polypropylene, polyethylene (e.g., high density polyethylene or low density polyethylene), polyvinyl chloride, or any combination thereof. In a further example, the organic material can include polyester, such as a polyethylene terephthalate, liquid crystal polymer (e.g., aromatic polyester polymers), or any combination thereof. In a particular instance, the packaging material 102 can include polypropylene. In another particular instance, the packaging material 102 can

include a polyethylene, such as co-extruded polyethylene. In a more particular instance, the packaging material 102 can consist essentially of at least one of the organic materials noted herein. For example, the packaging material 102 can consist essentially of polypropylene.

[0028] In another aspect, the packaging material 102 can include an inorganic material, such as an elemental metal, an alloy, or a combination thereof. For example, the packaging material 102 can include iron, nickel, chromium, aluminum, tin, copper, or any combination thereof. In another instance, the packaging material 102 can include steel, stainless steel, tin-coated steel, plastic-coated steel, or the like. In a particular example, the packaging material can consist essentially of an inorganic material, such as aluminum. In some applications, the metal may be in the form of a foil. For example, the packaging material 102 can include an aluminum foil, and in a particular instance, the packaging material may consist essentially of an aluminum foil.

[0029] In a further aspect, the packaging material 102 can include an organic material and an inorganic material. For instance, the packaging material 102 can include a metalized polymeric film, such as a metalized PET film. A typical metallized polymeric film differs from a metal foil, as a metalized film typically includes metal layer thickness that is significantly less than the thickness of a metal foil.

[0030] In an aspect, the packaging material 102 can include a single layer structure or include a plurality of layers. For example, as illustrated in FIG. 2, the packaging material 200 can include a packaging barrier layer 202 and optionally a support layer 204. The packaging barrier layer 202 can include metal, a polymeric material, or a combination thereof, such as any of those noted herein. In a particular example, the packaging barrier layer 202 can include aluminum, copper, nickel or alloys thereof. In another particular example, the packaging barrier layer 202 can include a polymer including polyethylene terephthalate, polypropylene, polyethylene, or any combination thereof.

[0031] In a particular aspect, the packaging barrier layer 202 can include a plurality of films (not illustrated). For instance, the packaging barrier layer 202 can include a plurality of metal-containing films, polymer-containing films, or any combination of a metal-containing film and polymer-containing film. In a particular instance, the packaging barrier layer 202 can include a plurality of polyethylene films. In another particular instance, the packaging barrier layer 202 can include a metal foil and a polyethylene film. In a more particular example, the packaging barrier layer 202 can include a metalized PET film and a co-extruded PE film.

[0032] In a further aspect, the packaging barrier layer 202 can have a certain thickness that can facilitate improved water vapor absorption of the abrasive article. For example, the thickness can be at least 0.2 micron, such as at least 0.5 micron, at least 1 micron, at least 10 microns, at least 100 microns, at least 125 microns, or even at least 500 microns. In another instance, the thickness can be at most 5 mm, such as at most 4 mm, at most 3 mm, at most 2 mm, or at most 1 mm. Moreover, the packaging barrier layer

202 can have a thickness in a range including any of the minimum and maximum values noted herein. For instance, an aluminum foil can have a thickness of at least 1 micron. A typical metallized polymeric film differs from a metal foil, as a metalized film typically includes metal layer thickness on the order of less than 200 nanometers.

[0033] Optionally, the packaging barrier layer 202 can be secured to the support layer 204 through lamination or with an adhesive (not shown). The support layer 204 can provide structural integrity to the packaging barrier layer 202, can enhance mechanical properties of the packaging material 200, or can act to bond to itself to form a seal. In an example, the support layer 204 can include cardboard, polylactic acid (PLA), a stiff polymer, or any combination thereof. In another example, the support layer 204 can include a thermoplastic material such as acrylic, vinyl acetate, ethylene vinyl acetate copolymer, polyester, polyolefin, polyamide, polycarbonate, polyvinylchloride, polyvinylidene chloride, polystyrene, or any copolymer, blend or combination thereof. An exemplary polyolefin includes polyethylene, polypropylene, ethylene propylene copolymer, ethylene butene copolymer, ethylene octene copolymer, olefinic block copolymers, polyvinyl butyral, or any combination thereof. An exemplary polyethylene includes linear low density polyethylene (LLDPE), low density polyethylene (LDPE), medium density polyethylene (MDPE), high density polyethylene (HDPE), or any combination thereof. In particular, the thermoplastic material can be a melt adhesive that can be melted in locations and bonded to an opposing sheet material to form a seal around an enclosed volume. Alternatively, a melt adhesive can be placed proximal to locations at which a seal is to be formed, such as along an edge of the packaging material 202.

[0034] In an embodiment, the packaging material 102 can have a certain water vapor transmission rate that can facilitate improved water vapor uptake of the abrasive articles contained therein. In an aspect, the packaging material 102 can have a WVTR of at most 3.0 g/m^2-day, such as at most 2.8 g/m^2-day, at most 2.5 g/m^2-day, at most 2.2 g/m^2-day, at most 2.0 g/m^2-day, at most 1.8 g/m^2-day, at most 1.6 g/m^2-day, at most 1.4 g/m^2-day, at most 1.2 g/m^2-day, at most 1 g/m^2-day, at most 0.8 g/m^2-day, at most 0.6 g/m^2-day, at most 0.4 g/m^2-day, at most 0.30 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/m^2-day, at most 0.18 g/m^2-day, at most 0.16 g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, or at most 0.05 g/m^2-day. Alternatively or additionally, the WVTR of the packaging material 102 can be greater than 0, such as at least 0.001 g/m^2-day, at least 0.005 g/m^2-day, at least 0.01 g/m^2-day, at least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.05 g/m^2-day, at least 0.08 g/m^2-day, at least 0.10 g/m^2-day, at least 0.15 g/m^2-day, at least 0.20 g/m^2-day, at least 0.30 g/m^2-day, at least 0.40 g/m^2-day, at least 0.50 g/m^2-day, at least 0.60 g/m^2-day, at least 0.70 g/m^2-day, at least 0.80 g/m^2-day, at least 0.90 g/m^2-day, at least 1.0 g/m^2-day, or at

least 1.2 g/m^2-day. Moreover, the WVTR of the packaging material 102 can be in a range of 0.001 g/m^2-day to 3 g/m^2-day or in a range of 0.005 g/m^2-day to at most 1.5 g/m^2-day.

[0035] FIG. 3 includes an illustration of an exemplary embodiment of an article 300 including a package 301 including at least one self-supporting wall 302 defining an interior volume 312 in which abrasive tools 304 are contained. The package 301 also includes a bottom 314 and a top 306. In an example, the bottom 314 can be formed of the same material as the wall 302. Alternatively, the bottom 314 can be formed of a different material than the wall 302. The bottom 314 can be friction fit with the wall 302. In another example, the wall 302 can have a screw configuration. In a further example, the bottom 314 can be integrally formed with the wall 302 or can be adhered to the wall 302, such as by using an adhesive. As illustrated, the package 300 is in the form of a bucket. A skilled artisan would understand that the package 300 can take any other forms to contain the abrasive articles, such as in the form of a box.

[0036] The top 306 can be secured to the wall 302 by for example, a friction fit or press fit. In another example, the top 306 can be secured to the wall 302 using a screw top configuration. Alternatively, the top 106 can include a peel tab to reveal an opening to allow an abrasive article to be taken out of the package, and in some particular instances, the peel tab may be pressed on to reclose the package. In an example, the top 306 can be formed of a material similar to the wall 302. In an alternative example, the top 306 can be formed of a material different from the wall 302.

[0037] As illustrated in the cross section, the wall 302 is formed of a packaging material 308. In an embodiment, the packaging material 308 can be rigid such that the packaging material 308 can be self-supporting. A self-supporting packaging material 308 is a material that can stand on its own absent additional support. For example, the self-supporting packaging material 308 can stand on its own (i.e., under its own weight without external forces) without deviating more than 10% in either direction from a longitudinal dimension extending from top to bottom of the self-supporting material 308 when viewed in cross-section.

[0038] In an embodiment, the packaging material 308 can include any of the materials noted herein in relation to the packaging material 108. For example, the packaging material 308 can include an organic material, such as a polymer including polypropylene, polyethylene (e.g., high density polyethylene or low density polyethylene), polyvinyl chloride, polyester (e.g., polyethylene terephthalate), liquid crystal polymer (e.g., aromatic polyester polymers), or any combination thereof. In a particular instance, the packaging material 308 can include polypropylene. In a more particular example, the packaging material 308 can consist essentially of an organic material, such as one or more of the polymers noted herein. In an even more particular example, the packaging material 308 can include polypropylene. In another example, the packaging material 308 can include an inorganic material, such as an elemental metal

including iron, nickel, chromium, aluminum, tin, copper, or alloy including steel, e.g., tin-coated steel, plastic-coated steel, or the like, or any combination thereof.

[0039] In a particular embodiment, the packaging material 308 can include a plurality of layers, as illustrated in FIG. 4. The self-supporting packaging material 400 can include a supporting layer 402 and a packaging barrier layer 404. The packaging barrier layer 404 can include any material noted herein in relation to the packaging barrier layer 202. For instance, the packaging barrier layer 404 can include a polymer, a metal element, or any combination thereof. In another instance, the packaging barrier layer 404 can include a plurality of films (not illustrated), such as a polymer-containing film, a metal-containing film, a metal foil, a metal-coated polymer film, or any combination thereof. A particular exemplary polymer-containing film can include a polyethylene film, PET film, polypropylene film, or the like. A particular example of a metal-containing film can include a metalized polymer film, such as a metalized PET film. An exemplary metal foil can include an aluminum foil. In a further example, the packaging barrier layer 404 can have the thickness as described in relation to the barrier layer 204.

[0040] The packaging barrier layer 404 can be secured to the supporting layer 402 through lamination or with an adhesive (not shown). An exemplary supporting layer 402 can include cardboard, a stiff polymer, a thermoplastic material, a cured elastomer, a fibrous material, or any combination thereof. An exemplary fibrous material can include an impregnated glass fiber material. In another example, a fibrous material includes a pulp material, such as a paper product, a cardboard, or any combination thereof. In another example, the supporting layer 402 includes a thermoplastic material in a thickness to provide desirable self-supporting characteristics of the supporting layer 402. In an example, the thermoplastic material includes polyolefin, polyvinylchloride, polyester, ethylene vinyl acetate copolymer, polyvinylidene chloride, polystyrene, acrylic polymer, vinyl acetate, polyamide, polylactic acid (PLA)polycarbonate, a copolymer thereof, or any combination thereof. For example, the thermoplastic material can be a polyolefin material, such as polyethylene, polypropylene, ethylene propylene copolymer, ethylene butene copolymer, ethylene octene copolymer, olefinic block copolymers, polyvinyl butyral, or any combination thereof. An exemplary polyethylene includes linear low density polyethylene (LLDPE), low density polyethylene (LDPE), medium density polyethylene (MDPE), high density polyethylene (HDPE), or any combination thereof. In a further example, the supporting layer 402 includes a cured elastomer. An exemplary cured elastomer includes a diene elastomer such as an ethylene propylene diene monomer (EPDM) elastomer.

[0041] In an embodiment, the packaging material 308 can have a particular water vapor transmission rate that can facilitate improved packaging and storage of abrasive articles. In an aspect, the packaging material 308 can include any of the WVTR noted in relation to the packaging material 208. In a particular aspect, the packaging material 308 can have a water vapor transfer rate (WVTR) of at most 1

g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day. Alternatively or additionally, the WVTR can be 0.001 g/m^2-day, at least 0.005 g/m^2-day, at least 0.01 g/m^2-day, at least 0.02 g/m^2-day, at least 0.05 g/m^2-day, at least 0.07 g/m^2-day, at least 0.09 g/m^2-day, at least 0.1 g/m^2-day, at least 0.12 g/m^2-day, at least 0.15 g/m^2-day, at least 0.18 g/m^2-day, at least 0.2 g/m^2-day, or at least 0.3 g/m^2-day. Moreover, the WVTR of the packaging material 308 can be in a range including any of the minimum and maximum values noted herein. For instance, the WVTR of the packaging material 308 can be in a range from 0.001 g/m^2-day to 1 g/m^2-day or in a range from 0.1 g/m^2-day to 0.6 g/m^2-day. As used herein, the WVTR can be determined using ASTM F1249 (Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor) at 37.8°C and 100% relative humidity (RH). Alternatively, the water vapor transfer rate (WVTR) can be approximated using the material properties of the packaging material.

[0042] In embodiment, the article can include at least 2 abrasive articles, such as at least 3, at least 5, at least 8, at least 10, at least 15, at least 20, at least 30, at least 50, or at least 100 abrasive articles contained in the interior volume of the package. In other instances, the article can include at most 500 abrasive tools, such as at most 400, at most 300, or at most 200 abrasive tools. Moreover, the article can include the abrasive tools in an amount including any of the minimum and maximum values noted herein. It is further to be understood that the number of the abrasive tools in the package can vary to suit particular needs, and in some instances, the number may be different from the values or ranges noted herein.

[0043] In an embodiment, the abrasive tool can include a bonded abrasive in the form of, for example, a grinding wheel, a cutting wheel, an ultra thin wheel, a chop saw, a combination wheel, or the like. In a non-limiting embodiment, the bonded abrasive is not considered a convolute abrasive wheel or a nonwoven abrasive article. The abrasive tool can be mounted on a grinder or the like for conducting grinding or cutting operations. As illustrated in FIGs. 1 and 3, the abrasive tools can be thin cutting wheels.

[0044] FIG. 5A includes an illustration of a face view of an exemplary cutting wheel. The cutting wheel 500 includes a body 502 and a mounting hole 504 for mounting the cutting wheel 500 to a cutting tool. A diameter 506 of the mounting hole 504 can be an inner diameter of the body 502, and the body 502 can have an outer diameter 508. In an aspect, the outer diameter 508 can be at least 220 mm , at least 270 mm, at least 310 mm, at least 380 nm, or at least 415 mm. In another aspect, the outer diameter 508 can be at most 550 mm, such as at most 535 mm, at most 457 mm, or at most 430 mm. Moreover, the outer diameter 508 of the body 502 can be within a range between any of the values noted above. For example, the outer diameter 508 of the body 502 can be within a range of at least 380 mm to at most 535 mm, such as within a range of at least 415 mm to at most 430 mm. In another aspect, the inner diameter 506 can be at least 35 mm, such as at least 46 mm or at least 54 mm. In still another aspect, the inner diameter 506

can be at most 90 mm, such as at most 77 mm, or at most 62 mm. It is to be appreciated that the inner diameter 506 of the abrasive portion 502 can be within a range between any of the values noted above.

[0045] FIG. 5B includes a cross-sectional view of the exemplary cutting wheel 500 including the mounting hole 504 and the body 502. The body can include major surfaces 501 and 503 and an edge 507 extending between the major surfaces 501 and 503. The body further has a thickness 505, defined parallel to an axis of the abrasive article 104 and orthogonal to a radial dimension. In an aspect, the thickness 505 can be at least 0.5 mm, at least 0.7mm, at least 0.8 mm, such as, at least 0.9 mm, at least 1 mm, at least 1.2 mm, at least 1.3 mm, at least 1.5 mm, at least 1.8 mm, at least 2 mm, at least 2.2mm, at least 2.5 mm, at least 2.8 mm, at least 3 mm, at least 3.2 mm, at least 3.5 mm, at least 3.8 mm, at least 4 mm, at least 4.2 mm, at least 4.5 mm, at least 4.8 mm, or even at least 5 mm. In another aspect, the thickness 505 of the body 500 can be at most 20 mm, such as at most 18 mm, at most 16 mm, at most 15 mm, at most 12 mm, at most 10 mm, at most 9 mm, at most 8 mm, at most 7 mm, at most 6 mm, at most 5.8 mm, at most 5.5 mm, at most 5.2 mm, at most 5 mm, at most 4.5 mm, at most 4 mm, at most 3.5 mm, or even at most 3 mm. Moreover, the thickness 505 can be within a range including any of the minimum and maximum values noted herein, including for example, within a range including 0.8 mm to 20 mm, such as within a range of 0.8 mm to 15 mm, or even within a range of 0.8 mm to 10 mm.

[0046] In an embodiment, the body 502 may have a particular aspect ratio, which is a ratio of the outer diameter 508 of the body to the thickness 505 (diameter:thickness) that may facilitate certain abrasive operations. For example, the body 502 can have an aspect ratio of at least 10:1, at least 15:1, at least 20:1, at least 35:1, at least 50:1, at least 75:1, at least 100:1, or even at least 125:1. In other instances, the body 502 can have an aspect ratio (diameter:thickness) of at most 125:1, at most 100:1, at most 75:1, at most 50:1, at most 35:1, at most 25:1, at most 20:1, or at most 15:1. The ratio can be within a range including any of the above minimum and maximum values, such as within a range of 125:1 to 15:1, such as 100:1 to 30:1. However, the invention can be practiced with wheels having different dimensions and different ratios between dimensions. For example, the thin-wheel abrasive also can have a desirable aspect ratio within a range of 5 to 160, such as within a range of 15 to 160, within a range of 15 to 150, or even within a range of 20 to 125.

[0047] FIG. 6A includes an illustration of another example of the bonded abrasive article. The wheel 600 includes a body including a rear (top) face 612 and a front (bottom) face 614. The rear face 612 can include a raised hub region 616 and outer flat rear wheel region 618. The front face 614 can include a depressed center region 620 and outer flat front wheel region 622 (which provides the working surface of the wheel). In turn, raised hub region 16 can have raised hub surface 624 and back sloping (or slanted) surface 626; depressed center region 620 can include depressed center 628 and front sloping (or slanted) surface 630. The body of the bonded abrasive 600 can have central opening 632 for mounting the bonded

abrasive 600 on the rotating spindle of a tool, e.g., a hand-held angle grinder. During operation, the bonded abrasive 600 can be secured by mounting hardware (not shown in FIG. 6A) such as, for instance, a suitable flange system. The bonded abrasive 600 can also be part of an integrated arrangement that includes mounting hardware.

[0048] The body of the bonded abrasive 600 can have a thickness 660 that can be measured at various positions, including at the periphery of the bonded abrasive body. The thickness of the body of the bonded abrasive 600 can be the same or essentially the same along a radial direction from the central opening 636 to the outer edge (periphery) 638 of the bonded abrasive 600. In other designs, the thickness 660 of the body can vary (can increase or decrease) along a radial distance from the central opening 636 to the periphery 638. In an embodiment, the thickness 660 can include any of the values described with respect to the thickness 505.

[0049] Further, as illustrated in FIG. 6B, the body of the bonded abrasive 600 can also include an outer diameter 611 that defines the length extending between two points on the perimeter and through the center of the circular body. In an embodiment, the outer diameter 611 can include any of the values noted in relation to the outer diameter 508. In a further embodiment, the body of the bonded abrasive 600 can also include an aspect ratio of the outer diameter 611 to the thickness 660 that can include any of the values noted with respect to the aspect ratio of the body 520.

[0050] The bonded abrasive of the embodiments herein can have certain constructions. It is to be appreciated that the body of the embodiments herein may be monolithic articles formed of a single layer having a single construction, having a substantially uniform grade and structure throughout the volume of the body of the bonded abrasive. Alternatively, the body of the embodiments herein can be composite bodies having one or more layers, wherein at least two of the layers are different from each other based on a characteristic such as, abrasive particle type, content of abrasive particles, porosity type (e.g., closed or open), content of porosity, type of bond material, content of bond material, distribution of abrasive particles, hardness, flexibility, filler content, filler materials, shape of the layer, size (e.g., thickness, width, diameter, circumference, or length) of the layer, construction of the layer (e.g., solid, woven, non-woven, etc.) and a combination thereof. Aspects of the abrasive articles will be described in more details in subsequent paragraphs of this disclosure.

[0051] In an embodiment, each abrasive tool contained in the package can include a barrier layer coupled to the body of the abrasive tool. In another embodiment, one or more barrier layers can be applied to particular surfaces of the body of the abrasive tool to limit absorption of certain species (e.g., water) by the body, including for example, the bond material, which may facilitate improved performance of the abrasive article.

[0052] In an embodiment, the body of the bonded abrasive can be in close proximity with the barrier layer for construction of the abrasive article disclosed herein. In particular embodiments, the barrier layer can be in direct contact with (i.e., abutting) at least one major surface including the bond material and abrasive particles of the bonded abrasive body. In an even more particular embodiment, the barrier layer can be directly bonded to at least one major surface including the bond material and abrasive particles of the bonded abrasive body, such that the barrier layer would not be separated from the bonded abrasive during operation of the abrasive tool. In a particular, non-limiting embodiment, the barrier layer can bond directly to one or both of the major surfaces of the bonded body without using an adhesive between the bonded body and the barrier layer.

[0053] In another embodiment, a reinforcement layer can bond to a major surface of the bonded body and define an outmost surface of the bonded body, and the barrier layer can bond to the reinforcement layer. FIG. 7 includes a cross-sectional view of a portion of an exemplary abrasive article 700 including the barrier layer 702 overlying the reinforcement layer 730 that is attached to a major surface of the bonded body 706. In another instance, the reinforcement layer can be applied to both major surfaces of the body, and the barrier layer can bond to the reinforcement layer on both major surfaces. The reinforcement layer 730 can include any suitable material as noted in later paragraphs in this disclosure. In a particular embodiment, the reinforcement layer 730 can include fiberglass, and in a more particular example, the reinforcement layer 730 can consist essentially of fiberglass.

[0054] In another embodiment, an intermediate layer can be applied between the reinforcement layer and the barrier layer to facilitate formation of the abrasive article. The intermediate layer can be bonded to the reinforcement layer on one side and to the barrier layer on the opposite side. In a particular embodiment, the intermediate layer can include a nonwoven material, such as nonwoven fleece.

[0055] In other embodiments, the barrier layer can be in direct contact with a major surface, a peripheral surface, or both of the bonded body. FIG. 8 includes a cross-sectional view of a portion of an exemplary abrasive article 800 including the barrier layer 802 overlying the body 806 of the abrasive article. The body 806 includes major surfaces 808 and 810 and the barrier layer 802 can abut one of the major surfaces, such as surface 808 as illustrated, or alternatively, the barrier layer 802 can be adjacent and in contact with the major surface 810 (not illustrated). FIG. 9 includes an illustration of a cross-sectional view including another exemplary placement of the barrier layer in the abrasive article 900. Each of the major surfaces 908 and 910 of the body 906 can be in direct contact with a barrier layer, 902 and 904, respectively. In some instances, the barrier layer can overlie the entire surface area of one or both of the major surfaces of the body.

[0056] In a further example, the barrier layer may not extend over the peripheral surface that extends between the major surfaces of the body. For example, as illustrated in FIG. 10A, the barrier layer 1002

overlies a major surface 1008 of the body 1006 and does not extend over the peripheral surface 1010 of the body 1006. In another instance, as illustrated in FIG. 10B, the barrier layer 1002 can overlie the major surface 1008 of the body 1006 and extend over to at least a portion of the peripheral surface 1010. Alternatively, in FIG. 10C, the barrier layer 1002 can overlie the major surface 1008 and extend to overlie the entire surface area of the peripheral surface 1010 of the body 1006. In a particular instance, the barrier layer coupled to the major surface 1008 may include a different composition than the barrier layer coupled to the peripheral surface 1010. In an embodiment, the barrier layer can be a single layer, as illustrated in FIGs. 7 to 9 and 10A to 10C. In another embodiment, the barrier layer can include more than one layer (i.e., films).

[0057] In an embodiment, the barrier layer can include an organic material, an inorganic material, or a combination thereof. In a particular embodiment, the barrier layer can include metal, such as an elemental metal or a metal alloy. In an aspect, the barrier layer can include a metal-containing film including metal. Exemplary metal can include any element selected from the group consisting of aluminum, iron, tin, copper, scandium, titanium, vanadium, chromium, manganese, nickel, zinc, yttrium, zirconium, niobium, molybdenum, silver, palladium cadmium, tantalum, tungsten, platinum, gold, and a combination thereof. The metal alloy can include one or more of the metal element disclosed herein. In another aspect, the barrier layer can include a metal foil including any of the metal elements noted herein. In a particular instance, the barrier layer can consist essentially of a metal foil, such as an aluminum foil. In a further aspect, the barrier layer can include a metalized film, such as an aluminized polymer film. In a particular example, the barrier layer can consist essentially of a metal-containing film.

[0058] In a further embodiment, the barrier layer can include a polymer, such as a thermoplastic, a thermoset, or a combination thereof. In an aspect, the barrier layer can include a polymer-containing film including the polymer. An exemplary thermoplastic can include poly(methyl methacrylate) (PMMA), polybenzimidazole, polyethylene, polypropylene, polystyrene, polyvinyl chloride, polytetrafluoroethylene, a thermoplastic elastomer, or any combination thereof. An example of a thermoset can include polyester, polyurethanes, phenol-formaldehyde resin, an epoxy resin, polyimide, or any combination thereof. In a particular example, the polymer can be selected from the group consisting of polyamide, polyolefin, polyester, polypropylene, polyvinyl, an epoxy, a resin, polyurethanes, a rubber, polyimide, phenolic, polybenzimidazole, aromatic polyamide, ionomers (e.g., ion-containing polymers and ion-containing copolymers), and a combination thereof. In some instances, ionomer can include an acid group that is partially or completely neutralized with a metal ion, such as zinc, cesium, sodium, magnesium, calcium, or potassium. The acid group can be an acid group of acrylic acid, carboxylic acid, methacrylic acid, sulfonic acid, and copolymers thereof. Another particular example of the polymer can include a biaxially-oriented material including, for example, polyester, such as polyethylene terephthalate,

polyamide, such as Nylon 6,6 and Nylon 6, or polyolefin, such as polypropylene. An exemplary polymer-containing film can include a biaxially-oriented polyethylene terephthalate, biaxially-oriented nylon, or a combination thereof.

[0059] In a particular aspect, the barrier layer can include a polymer-containing film that consist essentially of any or a combination of the polymers noted in the embodiments herein. For instance, the barrier layer can include a polymer-containing film consisting essentially of polyester. In another instance, the barrier layer can include a polyethylene terephthalate film, a biaxially-oriented polyethylene terephthalate film, a biaxially-oriented nylon film, or a combination thereof. In another particular embodiment, the barrier layer can consist essentially of any or a combination of the polymers noted herein. For instance, the barrier layer can consist essentially of polyethylene terephthalate.

[0060] In an embodiment, the polymer-containing film can have a particular tensile strength that can facilitate formation of an abrasive article and a package with improved water resistance. For instance, the tensile strength in the machine direction of at least 25,000 psi, at least 28,000 psi, at least 29,000 psi, at least 32,000 psi, such as at least 34,000 psi. In another instance, the tensile strength in the machine direction can be at most at most 41,000 psi, such as at most 39,000 psi, 35,000 psi, or at most 32,000 psi. Moreover, the tensile strength in the machine direction can be within a range including any of the minimum and maximum values noted herein, such as within a range including at least 25,000 psi and at most 41,000 psi, or within a range including at least 25,000 psi and at most 35,000 psi, or within a range including at least 32,000 psi and at most 41,000 psi. As disclosed herein, tensile strength is measured in accordance with ASTM-D882.

[0061] In an embodiment, the barrier layer can include a plurality of films, such as the barrier layers illustrated in FIGs. 11A to 11C. The barrier layer 1110 illustrated in FIG. 11A, can include, for example, a polymer-containing film 1102 overlying a metal-containing film 1104. The polymer-containing film 1102 can be in direct contact with the metal-containing film 1104, and in some instances, the polymer-containing film 1102 can be bonded directly to the metal-containing film 1104 to facilitate enhanced structure stability of the barrier layer 1110. When applied to the body of the abrasive article, the polymer-containing film 1102 can be placed adjacent the body compared to the metal-containing film 1104. The metal-containing film 1104 can be the outmost layer of the barrier layer. Alternatively, the polymer-containing film 1102 can be the outmost layer and the metal-containing film 1104 can be adjacent the body or may be in direct contact with the major surface of the body. The metal-containing film 1104 or the polymer-containing film 1102 can be coupled or even directly bonded to the major surface of the body.

[0062] FIG. 11B depicts the metal-containing film 1104 disposed between two polymer-containing films 1102 and 1106. In FIG. 11C, the polymer-containing film 1102 is disposed between the polymer-

containing film 1106 and the metal-containing film 1104, as shown in FIG. 11C. In some particular instances, the polymer-containing film 1102, the metal-containing film 1104, or both can be treated with an agent that can promote adhesion, such as silane, to improve bonding between the bonded body and the barrier layer.

[0063] In a particular embodiment, the barrier layer can include a first polymer-containing film, a second polymer-containing film, a metal-containing film, a third polymer-containing film, and a fourth polymer-containing film. The first polymer-containing film can include a biaxially-oriented polymer, such as biaxially-oriented nylon, biaxially-oriented PET, or biaxially-oriented polypropylene. The second polymer-containing film can include polyethylene. The metal-containing film can include aluminum, or in some instances, an aluminum foil may be used in place of the metal-containing film. The third polymer-containing film can include polyethylene. The fourth polymer-containing film can include polyethylene, such as co-extruded polyethylene. In a particular instance, the fourth polymer-containing film can be the outmost layer of the barrier layer that is facing away from the bonded abrasive body. In another particular instance, the metal-containing film can be the outmost layer of the barrier layer. In still another particular instance, the first polymer-containing film can be the outmost layer of the barrier layer. It is to be appreciated that any of the foregoing films and the respective materials include films that consist essentially of the corresponding materials as noted herein. For example, the fourth polymer-containing film can consist essentially of co-extruded polyethylene.

[0064] In the embodiments employing barrier layer including the metal-containing film and the polymer-containing film, the average thickness of these films can be similar or different. In some instances, the average thickness of the polymer-containing film can be greater than the average thickness of the metal-containing film. In other examples, the average thickness of the metal-containing film may be greater than the average thickness of the polymer-containing film.

[0065] In a further embodiment, the barrier layer can include a film including wax. In certain instance, the barrier layer can include a film consisting essentially of wax. In another instance, the barrier layer can include a film including wax and a material different than wax, such as a blend of wax and a polymer. In still another instance, the barrier layer can include a wax-containing film including, for example, a blend of wax and polyethylene. In a particular example, the barrier layer can include a plurality of films including a wax-containing film that is immediately adjacent a major surface of the bonded body. In another particular example, the wax-containing film can be the outmost layer of the barrier layer (e.g., facing away from the bonded body). In another particular example, as the outmost layer of the barrier layer, the wax-containing film can consist essentially of wax. In yet another example, the barrier layer contacting the peripheral surface of the bonded body can include wax. Particularly, the barrier layer

contacting the peripheral surface can consist essentially of a wax-containing film, and more particularly, the barrier layer contacting the peripheral surface can consist essentially of wax.

[0066] In a further embodiment, the barrier layer can include one or more tie layers disposed between adjacent films. The tie layer can include a polymer, such as an adhesive, to facilitate bonding between dissimilar layers that otherwise may not adhere to each other. For instance, a tie layer can be placed between a PET film and a metal-containing film or a polymer-containing film.

[0067] In a further embodiment, the barrier layer can include a polymer based sealant layer to facilitate bonding between the barrier layer and the bonded body. An exemplary sealant layer can include a polyethylene based material having a certain melting point, such as, at most 200 °C, to facilitate improved formation of the package. For instance, the melting point can be at most 180 °C or at most 160 °C. In another instance, the melting point can be at least 100 °C, such as at least 120 °C. Moreover, the melting point can include any of the minimum and maximum values noted herein, such as within a range from at least 100 °C to at most 200 °C. In a particular example, the sealant layer can include a linear low density polyethylene based material. In another particular example, the sealant layer can include an ionomer. The ionomer can include poly(ethylene-co-methacrylic acid) neutralized with an ion including zinc, cesium, sodium, magnesium, calcium, potassium, or a combination thereof. A particular example of ionomer can include Surlyn™.

[0068] It is to be appreciated that various combinations of one or more metal-containing films, polymer-containing films, wax-containing films, tie layers, or sealant layers are within the scope of the present disclosure, and many other configurations of the barrier layer including more than one layer of the metal-containing film, the polymer-containing film, the tie layer, and sealant layer would be possible and within the scope of the embodiments herein.

[0069] It has been noted that given the particular forming process of the embodiments herein, the barrier layer may be susceptible to damage, such as the formation of perforations that can extend through the thickness of the barrier layer (e.g., partially through the thickness or entirely through the thickness). During the process of forming the abrasive tool, perforations may be formed in the barrier layer. In addition, perforations may be formed during routine handling and shipping. The perforations can have similar or different sizes. For example, the perforations can have various sizes of diameters. In an embodiment, the perforation diameter can be at least 2 μm, such as 8 μm, at least 13 μm, at least 25 μm, at least 50 μm, at least 75 μm, at least 105 μm, at least 145 μm, at least 220 μm, or even at least 280 μm. In another embodiment, the perforation diameter of the perforations may not be greater than 1000 μm, such as not greater than 950 μm, not greater than 890 μm, not greater than 810 μm, not greater than 750 μm, not greater than 680 μm, not greater than 610 μm, not greater than 520 μm, or even not greater than 420 μm. It will be appreciated that the diameter of the perforations can be within a range including any of

the minimum values and maximum values disclosed herein. For example, the diameters of the perforations can be within a range of 2 μm to 1000 μm, such as within a range of 50 μm to 890 μm.

[0070] The perforations can have an average size, such as an average diameter. In an embodiment, the average diameter of the perforations can be at least 200 μm, at least 240 μm, at least 260 μm, at least 285 μm, or even at least 310 μm. In another embodiment, the average diameter may be not greater than 580 μm, such as not greater than 520 μm, not greater than 480 μm, not greater than 430 μm, or even not greater than 380 μm. It will be appreciated that the average diameter of the perforations can be within a range including any of the minimum values and maximum values noted above. For example, the perforations can have an average diameter within a range of 200 μm to 580 μm, such as within a range of 285 μm to 430 μm.

[0071] Density of perforation may be determined by counting the number of the perforations within randomly selected areas of a surface of the barrier layer that is facing away from the bonded abrasive body. At least 4 areas can be selected. Magnifiers or microscopes with backside illumination can be used to aid identifying the perforations. Perforation density can be the total number of perforations normalized by the total areas examined.

[0072] According to another embodiment, the perforation density may be not greater than not greater than 200 perforations/cm^2, such as not greater than 180 perforations/cm^2, not greater than 160 perforations/cm^2, not greater than 140 perforations/cm^2, not greater than 120 perforations/cm^2, not greater than 100 perforations/cm^2, not greater than 90 perforations/cm^2, not greater than 80 perforations/cm^2, not greater than 70 perforations/cm^2, not greater than 60 perforations/cm^2, not greater than 50 perforations/cm^2, not greater than 40 perforations/cm^2, not greater than 30 perforations/cm^2, not greater than 20 perforations/cm^2, not greater than 15 perforations/cm^2, not greater than 10 perforations/cm^2, not greater than 9 perforations/cm^2, not greater than 8 perforations/cm^2, not greater than 7 perforations/cm^2, not greater than 6 perforations/cm^2, or not greater than 5 perforations/cm^2, not greater than 4 perforations/cm^2, not greater than 3 perforations/cm^2, not greater than 2 perforations/cm^2, not greater than 1 perforation/cm^2. For at least one embodiment, the barrier layer can be essentially free of perforations. Still, in at least one non-limiting embodiment, some minor content of perforations can exist, such that the perforation density can be at least 0.1 perforations/cm^2, such as at least 0:5 perforations/cm^2, at least 1 perforation/cm^2, at least 1.5 perforations/cm^2, at least 1.8 perforations/cm^2, at least 2 perforations/cm^2, at least 2.3 perforations/cm^2, at least 2.5 perforations/cm^2, at least 3 perforations/cm^2, at least 3.5 perforations/cm^2, at least 4 perforations/cm^2, at least 4.5 perforations/cm^2, at least 5 perforations/cm^2, at least 5.6 perforations/cm^2, at least 6 perforations/cm^2, at least 6.5 perforations/cm^2, at least 7.2 perforations/cm^2, at least 8 perforations/cm^2, at least 9 perforations/cm^2, or even at least 10 perforations/cm^2.It will be appreciated that the perforation density can be within a range including any of

the minimum values to maximum values noted above. For example, the perforation density can be within a range of 0.1 perforations/cm^2 to 200 perforations/cm^2, such as within a range of 0.5 perforations/cm^2 to 180 perforations/cm^2, within a range of 1 perforations/cm^2 to 160 perforations/cm^2, within a range of 2 perforations/cm^2 to 140 perforations/cm^2, within a range of 5 perforations/cm^2 to 120 perforations/cm^2, or within a range of 10 perforations/cm^2 to 100 perforations/cm^2.

[0073] In certain embodiments, orientation of the films of the barrier layer may affect the density of the perforation. It may be desired to have the polymer-containing film as the outermost layer for the barrier layer, as in some instances, depending upon the polymer-containing film material, during processing the material may exhibit a self-sealing capability configured to seal some perforations formed in the barrier layer. Notably, certain polymer-containing films may exhibit flow behaviors during processing that facilitate flowing and sealing of perforations formed during processing. For example, the polymer-containing film that includes co-extruded polyethylene may be disposed as the outmost layer to reduce perforation density of the barrier layer in some embodiments.

[0074] In at least one other application, the polymer-containing film can be placed between the metal-containing film and the bonded abrasive body, which may help to reduce formation of perforation in the metal-containing film during the process of forming the abrasive tool. For instance, during curing, the material of the polymer-containing film may flow and seal at least some of the perforations formed in the metal-containing film. Additionally or alternatively, during processing, the material may facilitate flowing and sealing of perforations in the metal-containing film. The metal-containing film may be used as the outmost layer for the barrier layer.

[0075] Notably, the barrier layer can be selected such that it can withstand the forming process of forming the bonded abrasive. The barrier layer can be puncture resistant such that during in-situ formation of the barrier layer, formation of perforations can be minimized or even diminished. For instance, the puncture resistant barrier layer may have the perforation density disclosed herein. Furthermore, the barrier layer may not interfere with function or performance of the abrasive article. Particularly, the barrier layer can be resistant to formation of perforations that extend through the entire barrier layer, and the presence of the barrier layer may not adversely affect performance, such as grinding performance. Moreover, the barrier layer may undergo some modification during the forming process, including for example, some physical or chemical changes that facilitate bonding of the barrier layer to one or more surfaces of the bonded abrasive body.

[0076] Accordingly, in some applications, the barrier layer can include at least one film that is puncture resistant. The puncture resistant film can be a polymer-containing film including a biaxially-oriented material. For example, the barrier layer can include a puncture resistant film, a tie layer, a metal-containing film, another tie layer, and a sealant layer. The sealant layer can be facing a major surface of

the body and the puncture resistant film can form an exterior surface of the abrasive article. In a particular example, the barrier layer can include a biaxially-oriented PET film, a tie layer, an aluminum-containing film, a tie layer, and a polyethylene sealant layer, with the polyethylene sealant layer facing a major surface of the body and the biaxially-oriented PET film defining an exterior surface of the abrasive article. In another particular example, the barrier layer can include a biaxially-oriented nylon film, a tie layer, an aluminum-containing film, a tie layer, and a polyethylene sealant layer with the polyethylene sealant layer facing a major surface of the body and the biaxially-oriented nylon film forming an exterior surface of the abrasive article.

[0077] In some instances, formation of the barrier layer can be carried out in-situ with the formation of the abrasive article (e.g. the bonded abrasive wheel). It may not be necessary to remove the barrier layer from the body prior to use of the abrasive article. For example, the barrier layer may be removed during operation of the abrasive article without interfering with the process of operation, such as grinding or cutting. In another instance, the barrier layer can be formed such that force encountered during an operation of the abrasive article can be sufficient to selectively remove at least a portion of the barrier layer to expose at least a portion of the work surface of the abrasive article. Removal of the barrier layer may occur without affecting the abrasive capabilities of the abrasive article.

[0078] In certain instances, the barrier layer can be a temporary component of the abrasive article and removed prior to use of the abrasive article. For example, the barrier layer is a temporary component configured to be applied to at least a portion of the body of the bonded abrasive for handling and shipment of the body. A temporary barrier layer is configured to be applied during or after formation of the bonded abrasive and removed by the user prior to use of the bonded abrasive article.

[0079] The temporary barrier layer can include any of the barrier layer materials and features noted in the embodiments disclosed above. For instance, the temporary barrier layer can overlie and be adhered directly to any of the surfaces of the body. See, for example, the description of embodiments relevant to FIGs. 8, 9, and 10A-10C. In a particular example, the temporary barrier layer overlying a portion of the body can include a wax, and in some instances, may be made entirely of wax. Alternatively, the temporary barrier layer can include a wax-containing film. In a more particular example, the barrier layer including wax can cover the entire surface of the bonded abrasive body, such that the barrier layer consists essentially of wax and surrounds and seals the entire body of the bonded abrasive article.

[0080] FIG. 12A includes a cross-sectional illustration of an abrasive article 1200 including a portion of a bonded abrasive body 1201 and a barrier layer 1202 according to an embodiment. In at least one embodiment, the barrier layer 1202 can be adhered to at least a portion of the bonded abrasive body, such as at least a portion of the major surface of the body 1201 in a peelable configuration. A peelable

configuration is reference to the temporary manner in which the barrier layer 1202 can be attached to the body 1201.

[0081] For purposes herein, a peelable configuration is reference to a barrier layer that is configured to be removed from the body according to a particular peel strength. Notably, a peelable configuration can be adapted to be removed by hand, such that the barrier layer can be separated from the body of the abrasive article by hand. This can include removal of the barrier layer and an adhesive only by hand without any further external stimulus, such as the application of a temperature change, radiation, solvents or other chemicals and the like.

[0082] However, in alternative embodiments, the barrier layer may be attached in a temporary manner, which may also be considered a peelable configuration, wherein the peelable configuration is achieved by application of one or more external stimuli, including but not limited to a temperature change, radiation, solvent or other chemicals and the like. For such alternative embodiments wherein the external stimuli is applied, such external stimuli may be before or during the peeling operation, wherein an operator applies a suitable force by hand to separate the barrier layer from the body of the abrasive article. For example, in one particular alternative embodiment, the body of the abrasive article including the barrier layer may be subject to a temperature change, such as application of heat for a given duration. Such stimuli may affect a physical or chemical change in the barrier layer or an adhesive layer disposed between the barrier layer and the body that can facilitate a peelable configuration. Notably, in such alternative embodiments, prior to the application of the external stimulus the barrier layer may not be in a peelable state, such that the peel strength is too great to remove the barrier layer from the body by hand alone. However, the application of the external stimulus can facilitate a change to at least a portion of the barrier layer and/or adhesive layer, which may change (e.g., reduce) the peel strength and facilitate a peelable configuration wherein the barrier layer can be removed from the body of the abrasive article by hand. Other non-limiting examples of external stimuli can include the application of a particular type of radiation (e.g., ultraviolet light, microwaves) to at least a portion of the barrier layer, application of a chemical compound (e.g., acid, base, solvent, etc.) to at least a portion of the barrier layer that will dissolve at least a portion of the barrier layer, application of heat to at least a portion of the barrier layer, application of an electrical signal, electrical current or electrical field, application of a magnetic field, application of one or more vibratory stimuli (e.g., ultrasonic energy), and the like.

[0083] In one embodiment, the peelable configuration can be defined by particular peel strength of the barrier layer 1202 relative to the body 1201. For example, the barrier layer 1202 can be adhered to the body 1201 such that the peel strength defining the adhesion of the barrier layer 1202 to the body 1201 can be not greater than 3000 g/in as measured according to ASTM F88 using a 180 degree testing setup. In still other instances, the peel strength can be not greater than 2900 g/in, such as not greater than 2800 g/in

or not greater than 2700 g/in or not greater than 2600 g/in or not greater than 2500 g/in or not greater than 2400 g/in or not greater than 2300 g/in or not greater than 2200 g/in or not greater than 2100 g/in or not greater than 2000 g/in or not greater than 1900 g/in or not greater than 1800 g/in or not greater than 1700 g/in or not greater than 1600 g/in or not greater than 1500 g/in or not greater than 1400 g/in or not greater than 1300 g/in or not greater than 1200 g/in or not greater than 1100 g/in or not greater than 1000 g/in or not greater than 900 g/in or not greater than 800 g/in or not greater than 700 g/in or not greater than 600 g/in or not greater than 500 g/in or not greater than 400 g/in. In still another example, the peel strength can be at least 10 g/in, such as at least 20 g/in or at least 30 g/in or at least 40 g/in or at least 50 g/in or at least 60 g/in or at least 70 g/in or at least 80 g/in or at least 90 g/in or at least 100 g/in or at least 200 g/in or at least 300 g/in or at least 400 g/in or at least 500 g/in or at least 600 g/in or at least 700 g/in or at least 800 g/in or at least 900 g/in or at least 1000 g/in or at least 1100 g/in or at least 1200 g/in or at least 1300 g/in or at least 1400 g/in or at least 1500 g/in or at least 1600 g/in or at least 1700 g/in or at least 1800 g/in or at least 1900 g/in or at least 2000 g/in. It will be appreciated that the peel strength can be within a range including any of the minimum and maximum values noted above. For example, the peel strength can be within a range including at least 10 g/in and not greater than 3000 g/in, or within a range including at least 10 g/in and not greater than 2000 g/in or within a range including at least 10 g/in and not greater than 1500 g/in or within a range including at least 10 g/in and not greater than 500 g/in or even within a range including at least 10 g/in and not greater than 300 g/in. Such peel strengths have been shown to be suitable for adherence of the barrier layer for shipment and general handling, while also being suitable for peeling and removal of the barrier layer by hand and without the need for aggressive abrasive removal techniques (e.g., grinding of the bonded abrasive during use).

[0084] As further illustrated in FIG. 12A and as disclosed in other embodiments herein, the barrier layer 1202 can include one or more films of materials. As illustrated in FIG. 12A, the barrier layer 1202 can include a first film 1203 defining the outermost surface of the barrier film, a second film 1204 adjacent and underlying the first film 1203, and a third film 1205 adjacent and underlying the second film 1204. The third film 1205 can define the innermost layer and be in direct contact with the body 1201 of the bonded abrasive. An example of the barrier layer 1202 can include a metal-containing film, which may be any one of the first film 1203, second film 1204, and third film 1205. In a particular instance, the second film 1204 may be the metal-containing film.

[0085] In another embodiment, one of the films of the barrier layer 1202 may be an adhesive layer comprising an adhesive material and configured to facilitate adhesion between the barrier layer 1202 and the body 1201. In such embodiments, the inner most layer, such as the third film 1205 can be the adhesive layer. The adhesive layer may facilitate attachment of the barrier layer to and removal of the

barrier layer from the body. In some instances, when peeled away from the body, the adhesive layer can remain attached to the rest of the barrier layer.

[0086] In a particular embodiment, the barrier layer 1202 can include a pressure sensitive adhesive film. In certain aspect, the pressure sensitive adhesive film can form the innermost layer of the barrier layer 1202. As illustrated in FIG. 12A, the film 1205 can be a pressure sensitive adhesive film. In another aspect, the pressure sensitive adhesive film can include acrylic based adhesives. In a further aspect, the pressure sensitive adhesive film can have a thickness of at least 40 microns, such as at least 45 microns, at least 48 microns, at least 52 microns, at least 56 microns, at least 58 microns, at least 60 microns, or at least 62 microns. In yet another aspect, the pressure sensitive adhesive film may have a thickness not greater than 90 microns, such as not greater than 86 microns, not greater than 82 microns, not greater than 80 microns, not greater than 77 microns, not greater than 75 microns, not greater than 72 microns, not greater than 68 microns, not greater than 65 microns, not greater than 66 microns, not greater than 64 microns, or not greater than 61 microns. Moreover, the thickness of the pressure sensitive adhesive can have a thickness in a range including any of the minimum and maximum values disclosed herein, such as within a range including at least 40 microns to not greater than 90 microns, or within a range including at least 55 microns to not greater than 68 microns.

[0087] In a further embodiment, one or more layers of materials may be disposed over the barrier layer 1202 (not illustrated). For instance, an additional layer that is suitable for carrying markings or indicia to identify the product may be placed over the barrier layer. In some other instances, the outmost film, such as the film 1203 of the barrier layer 1202, may be suitable to carry markings or indicia. In such instances, the first film 1203 may be selected from a group of materials most suitable to contain markings or indicia.

[0088] The barrier layer 1202 is illustrated to including a plurality of films in FIG. 12A. In another instance, the temporary barrier layer can be a single layer, and in some particular instances, the barrier layer can be made of a single layer of metal foil.

[0089] In another embodiment, a separate adhesive layer may be disposed between the barrier layer 1202 and the body 1201. The adhesive layer can abut the barrier layer and the body. FIG. 12B include a cross-sectional illustration of a portion of another exemplary abrasive article 1220 including a bonded abrasive body 1221, a barrier layer 1222, and an adhesive layer 1223 disposed between the barrier layer 1222 and the body 1221. As illustrated, the adhesive layer 1223 is in direct contact with the barrier layer 1222 and the body 1221. The adhesive layer 1223 can be used to temporarily attach the barrier layer 1222 to the body 1221 with sufficient strength such that the abrasive article 1220 can be handled, shipped and stored. Still the adhesive strength of the adhesive layer 1223 can be suitable for allowing the barrier layer 1222 to be removed from the body 1221 by hand, and thus configured to facilitate the peelable configuration of the barrier layer 1222.

[0090] In a further embodiment, the barrier layer 1222 can include a plurality of films (not illustrated) and be attached to the body by the separate adhesive layer 1223. For example, the barrier layer 1222 can include a polymer-containing film and a metal-containing film, and in some instances, a tie layer can be disposed between the films to improve bonding. In a particular example, the barrier layer 1222 can include from the innermost to outmost layer, a sealant layer, a tie layer, a foil, another tie layer, and a polymer-containing film. The polymer-containing film can include polyester or a biaxially-oriented material, such as biaxially-orientated PET or biaxially-oriented nylon.

[0091] As illustrated in FIG. 12B, the adhesive layer 1223 is disposed between a major surface of the body 1221 and the barrier layer 1223. In other instances, the adhesive layer 1223 can be applied to any surface of the body 1221 to facilitate suitable temporary adhesion of the barrier layer 1222 to any portion of the body 1221. In another instance, the adhesive layer 1223 may be adhered directly to a component of the abrasive article, such as an abrasive portion, a reinforcing layer, or any combination thereof.

[0092] In an embodiment, the adhesive layer 1223 can be a double-sided adhesive, including adhesive material on both surfaces to facilitate suitable adhesion of the barrier layer 1222 to the body 1221.

[0093] In another embodiment, the adhesive layer 1223 can include a pressure-sensitive adhesive. The pressure-sensitive adhesive can include an adhesive that adheres to a surface under mechanical force applied to the adhesive layer 1223. An exemplary pressure-sensitive adhesive can include at least one composition selected from the group consisting of an acrylic, an acrylate, butyl rubber, ethylene-vinyl acetate, natural rubber, nitriles, silicone rubber, styrene block copolymer, vinyl ether, or any combination thereof, blend, and/or copolymer thereof. In a particular example, the pressure sensitive adhesive can consist essentially of an acrylic. In some instances, the pressure sensitive adhesive may include one or more tackifiers, including but not limited to, resins (e.g., rosins and their derivatives, terpenes, modified terpenes, aliphatic resins, cycloaliphatic resins, aromatic resins, hydrogenated hydrocarbon resins, terpene-phenol resins, silicate resins (e.g., monofunctional trimethyl silane and/or quadrafunctional silicon tetrachloride), or any combination thereof, blend, or copolymer thereof.

[0094] In still another embodiment, the adhesive layer 1223 can include a sealant including an adhesive material. For instance, the adhesive layer 1223 can include silicone, and more particularly, a silicone based sealant. In another instance, the sealant can allow formation of a waterproof bonding between the barrier layer 1222 and the bonded body 1221. In yet another embodiment, the adhesive layer 1223 can include a water-based adhesive material that facilitates adherence to the barrier layer 1222 or the body 1221.

[0095] In still another embodiment, the adhesive layer 1223 can include a temperature-sensitive adhesive, which can facilitate suitable bonding and de-bonding of the adhesive to the barrier layer 1222 or

body 1221 by applying a particular temperature to the adhesive layer 1223. Such example of the adhesive layer 1223 can include a hot melt adhesive.

[0096] In yet another embodiment, the adhesive layer 1223 can include an adhesive comprising a solvent-based adhesive. In still another embodiment, the adhesive layer 1223 can include a polymer dispersion adhesive. For certain embodiments, it may be desirable for the adhesive layer 1223 to include a non-reactive adhesive material, which does not chemically interact with the substrate to which it is adhered (e.g., the barrier layer 1222 or body 1221). For example, the non-reactive adhesive material can include melt-flowable material that forms a mechanical bond to the substrate to which it is adhere.

[0097] Further example of the adhesive layer 1223 may include a reactive adhesive, which chemically interacts with the substrate to which it is adhered (e.g., the barrier layer 1222 or body 1221). In at least one embodiment, the adhesive layer 1223 may include a reactive adhesive that can include a compatible surface coating relative to the surface of the bonded abrasive body 1221. For example, the adhesive layer may include a silane coating that is configured to chemically react with the one or more material components on the surface of the bonded abrasive body.

[0098] In certain aspects, the adhesive layer 1223 can include one or more materials selected from the group of starch, casein, a natural gum, a viscoelastic polymer, acrylate polymer, rubber, thermoplastic elastomer, silicone rubber, polybutene, polybutadine, lacquer, polyethylene, polypropylene, ethylene vinylacetate, ethylene methacrylic acid, polystyrene, polyvinylchloride, polyethylene terephthalate, epoxy, ethylene acrylic acid, sulfonated polystyrene, polyamide, or any combination, blend, and/or copolymer thereof.

[0099] A particular exemplary material of the adhesive layer 1223 can include an adhesive material including an ionomer, which can be a copolymer containing an ion including a group of an acrylic acid, a methacrylic acid, a sulfonic acid, a carboxylic acid, an unneutralized metal ion, a partially neutralized metal ion, a fully neutralized metal ion or a combination thereof. Some suitable examples of metal ions may include at least one of zinc, cesium, magnesium, sodium, calcium, or any combination thereof.

[00100] In one embodiment, the adhesive layer 1223 may include an adhesive material formed from a plasma treated polymer, a plasma deposited polymer, a flame-treated polymer, a corona-treated polymer, a mechanically roughened polymer, a silane treated polymer, a metallized polymer, a fluorinated polymer, a hydrolyzed polymer, a chemically-treated polymer, an etched polymer, an arc and flame-sprayed polymer, a vapor-polished polymer, a printed polymer, a coated polymer, or any combination thereof. Some suitable polymers can include fluorinated polymers (e.g., PVDF), polyethylene terephthalate, polypropylene, polyolefins, polyamides, polystyrene, vinyl, biaxially oriented polymers, or a combination thereof.

[00101] In another embodiment, the barrier layer 1202 can include at least one film including a sacrificial material (referred to as "sacrificial film" hereinafter). In certain instances, the sacrificial material can be configured to be an impermanent material, which can have one or more characteristics that change due to one or more stimuli that facilitate debonding of the barrier layer 1202 from the body 1201. In certain instances, sacrificial film can undergo a mechanical or chemical change when receiving the stimuli such that the remaining layers of the barrier layer 1202 can be separated from the body 1201. In a particular instance, the sacrificial film may be the innermost layer of the barrier layer 1202 to facilitate removal of the barrier layer. In some other instances, the sacrificial material may be located within the barrier layer 1202 such that the barrier layer 1202 may be separated into two or more portions. For example, the sacrificial film may be an interior layer disposed between two or more films on either surface, such as the second film 1204 of the barrier layer 1202 disposed between the first film 1203 and the third film 1205. Upon application of a stimulus, the sacrificial film can undergo a change and be configured to separate the barrier layer into two separate portions including the first film 1203 and the third film 1205. Such configuration may be particular useful if the third film comprises a material that may be suitable for use on the bonded abrasive during grinding (e.g., a thermal barrier, lubricant layer, etc.).

[00102] In certain instances, the sacrificial material can be configured to mechanically or chemically alter when exposed to electromagnetic radiation. Some non-limiting examples of such alterations can include dissociation of the adhesive material or a weakening sufficient to debond at least a portion of the barrier layer 1202 from other portions of the barrier layer 1202 or the body 1201. The electromagnetic radiation can be selected depending upon the properties of the sacrificial material. For example, in at least one embodiment, the electromagnetic radiation can be ultraviolet radiation (400 nm to 10 nm).

[00103] In another instance, the sacrificial material can be configured to mechanically or chemically alter when exposed to a reactive chemical agent. The chemical reactive agent may be a particular chemical compound or material that facilitates selective dissociation of the sacrificial material while leaving the other components of the abrasive tool intact. Notably, it may be particularly suitable to select a reactive chemical agent that is not reactive with the bonded abrasive body. Some non-limiting examples of suitable reactive chemical agents may include bases, acids, water, alcohol, polar materials (e.g., liquids), non-polar materials, surfactants, and the like. In certain instances, the sacrificial material may be configured to chemically react with the reactive chemical agent in a chemical reaction to form one or more reaction products.

[00104] In yet another instance, the configured to mechanically or chemically alter when exposed to a particular temperature. For example, the sacrificial material may be a temperature-sensitive material that is configured to undergo a physical or chemical change at a particular temperature, and such a change can be configured to facilitate separation between a portion of the barrier layer 1202 and the body 1201. For

example, the sacrificial material may be configured to mechanically or chemically alter at a transition temperature. Notably, the sacrificial material can be configured to have a transition temperature that is not sufficient to cause significant changes to the bonded abrasive body 1201. For example, the sacrificial material can have a transition temperature that is less than a melting temperature, softening temperature, or transition temperature of the bond material (or any other components) of the bonded abrasive body 1201. Such a relationship between the transition temperature of the sacrificial material and the materials of the bonded abrasive body 1201 can facilitate suitable removal of at least a portion of the barrier layer 902 without causing damage to the bonded abrasive body 1201 prior to use. For example, the sacrificial material comprises a transition temperature of at most 300°C, such as at most 250°C or at most 200°C or at most 180°C or at most 150°C or at most 120°C or at most 100°C. Still, in another instance, the sacrificial material can have a transition temperature of at least 30°C or at least 50°C or at least 80°C or at least 100°C or at least 150°C or at least 200°C or at least 250°C. It will be appreciated that the transition temperature can be within a range including any of the minimum and maximum temperatures noted above.

[00105] In another aspect, the abrasive article can include certain features associated with the barrier layer to facilitate hand removal of the barrier layer from at least a portion of the body prior to use of the bonded abrasive. For example, in one embodiment, the abrasive tool can include a tab extending from the barrier layer in a sealed position and configured to be moved from the sealed position to an unsealed position and release at least a portion of the barrier layer from the portion of the body. FIG. 12C includes a cross-sectional illustration of an abrasive article including a tab in a sealed position according to an embodiment. FIG. 12D includes a cross-sectional illustration of an abrasive article including a tab in an unsealed position according to an embodiment.

[00106] Referring to FIG. 12C, the abrasive tool 1230 can include a body 1231 and a barrier layer 1232 adhered to at least a portion of the body 1231, wherein the barrier layer 1232 can include a plurality of films 1233, 1234, and 1235. As noted in other embodiments herein, the barrier layer 1232 does not necessarily include a plurality of films and can be a monolithic material made of a single material. In one aspect, the barrier layer 1232 can include a tab 1236 that is extending from the barrier layer 1232 and extending over a side surface 1237 of the body. The tab 1236 can be extending from body 1231 and spaced apart from the surface of the body 1231 to provide a user a suitable structure to grasp and initiate the removal of the barrier layer 1232 from the body 1231. As illustrated in FIG. 12D, the tab 1236 can be moved in the direction 1238, which can facilitate removal of the barrier layer 1232 from the major surface 1239 of the body 1231. Accordingly, in the unsealed position as illustrated in FIG. 12D, the tab 1236 is spaced apart from the surface 1239 of the body 1231and the portion of the body 1231 that was previously covered by the barrier layer 1232 is exposed and ready for use in a grinding operation.

[00107] In another embodiment, a tab can be formed having a suitable shape and dimension and applied to the body separately from the barrier layer. For instance, the tab can be attached directly to the major surface of the body prior to applying the barrier layer. In a further embodiment, the tab can underlie a portion of the barrier layer in a sealed position and configured to facilitate release of at least a portion of the barrier layer. In another embodiment, the tab can be attached to the body and extend over the edge of the body, such as overhanging the outside of the body, to facilitate grasp of the tab by hand. In yet another embodiment, the tab can have any shape and dimension suitable for hand grasping. For instance, the tab can have a rectangular, square, semicircular, or an irregular shape.

[00108] Other variations of a tab are contemplated and part of the embodiments herein. For example, the tab 1236 may only be formed from a portion of the films making up the barrier layer 1232. In one embodiment, wherein the barrier layer 1232 includes a plurality of films (e.g., films 1233, 1234 and 1235), the tab 1236 may be formed from a portion of the films, including for example, only the film 1235, or only the film 1233. In certain instances, it may be suitable to make the tab 1236 from the innermost film that is closest to the body 1231 to ensure that the barrier layer can be properly removed.

[00109] In at least one embodiment, the tab 1236 can be made of the same material as the barrier layer 1232. More particularly, the tab 1236 can include the same material as at least one component material of the barrier layer 1232, such as one of the films of the barrier layer 1232. Still, in another embodiment, the tab 1236 may be made of a different material from the material of the barrier layer 1232. More particularly, the tab 1236 may be made of a different material compared to at least one component material (e.g., a material of one of the films) of the barrier layer 1232.

[00110] FIG. 12E includes a cross-sectional illustration of an abrasive article including a tab in a sealed position. As illustrated in FIG. 12E, the abrasive article 1240 can include a body 1241 and a barrier layer 1242 adhered to at least a portion of the body 1241. The abrasive article 1240 can further include a tab 1243 extending from a portion of the barrier layer 1242 over the body 1241 that may facilitate grasping by a user and removal of the barrier layer 1242. In particular instances as illustrated in FIG. 12E, the barrier layer 1242 can have a thickness 1244 and the tab 1243 can have a thickness 1245. Notably, in certain instances, the thickness 1245 of the tab 1243 can be less than the thickness of the barrier layer 1244. Reference herein to the thicknesses can be reference to an average thickness of such components.

[00111] FIG. 12F includes a cross-sectional illustration of an abrasive article including a tab in a sealed position according to an embodiment. As illustrated in FIG. 12F, the abrasive article 1250 can include a body 1251 and a barrier layer 1252 adhered to at least a portion of the body 1251. The abrasive article 1250 can further include a tab 1253 extending from a portion of the barrier layer 1252 over the body 1251 that may facilitate grasping by a user and removal of the barrier layer 1252 from the body 1251. In particular instances as illustrated in FIG. 12F, the barrier layer 1252 can have a portion 1254 including

perforations 1255. The portion 1254 may be a film or discrete layer within the barrier layer 1252, but does not necessarily need to be in the form of a film or layer. The perforations 1255 can extend partially through the thickness of the barrier layer 1252 and facilitate controlled tearing of the barrier layer 1252, which may facilitate removal of the barrier layer 1252 from the body 1251.

[00112] FIG. 12G includes a cross-sectional illustration of an abrasive article including a tab in a sealed position according to an embodiment. As illustrated in FIG. 12G, the abrasive tool 1260 can include a body 1261 and a barrier layer 1262 adhered to at least a portion of the body 1261. The abrasive tool 1260 can further include a tab 1263. At least a portion of the tab 1263 can be disposed between the barrier layer 1262 and the body 1261, such that upon movement of the tab 1263 from the sealed position (as illustrate) to an unsealed position (not shown) at least a portion of the barrier layer 1262 is removed or torn. For example, the tab 1263 may be a wire or string or other elongated body that can be configured to be pulled from a sealed position to an unsealed position, which will tear a portion of the barrier layer 1262 and facilitate removal of the barrier layer 1262 from the body 1261.

[00113] FIG. 12H includes an illustration of an exemplary abrasive article 1270 including a barrier layer 1272 attached to the body 1271 in a peelable configuration. The barrier layer 1272 can include an adhesive material 1274 on the inner surface of the barrier layer 1272, which can facilitate bonding and de-bonding the barrier layer to the body 1271. In a particular embodiment, the adhesive material 1274 can include a hot melt adhesive. In another embodiment, the barrier layer can include a polymer-containing layer that forms the outer surface of the barrier layer. A particularly suitable polymer in this configuration can include polypropylene. In a more particular embodiment, the barrier layer 1272 can be in the form of a tape.

[00114] In an embodiment, the entire body of the bonded abrasive article can be sealed by the barrier layers. For instance, a barrier layer applied to a major surface of the body can extend over the edge of the body (e.g., by at least ¼ inches) and adhere to the other barrier layer applied to the other major surface by using an adhesive material. FIG. 12I includes an illustration of an exemplary abrasive article 1280 including barrier layers 1282 and 1285 attached to the major surfaces of the body 1288 in a peelable configuration. Each of the barrier layers 1282 and 1285 includes a first film (1284 or 1287) and a second film (1283 or 1286). The second film 1283 and 1286 can be an adhesive film, and in some particular examples, the adhesive films 1283 and 1286 can include a pressure sensitive adhesive. The films 1284 and 1287 can include the same or different material. For instance, both or one of films 1284 and 1287 can be a metal-containing film or metal foil. In another instance, the film 1284, 1287, or both can be a polymer-containing film. In a particular instance, either or both of films 1284 and 1287 can be an aluminized polymer film, such as a PET film coated with aluminum, or another polymer film coated with an oxide.

[00115] As illustrated in FIG. 12I, the barrier layers 1282 and 1285 extend over the peripheral edge 1289 of the body 1288 and adhere to one another forming a sealed rim 1291. The edge 1289 is enclosed within the sealed volume 1290 and spaced apart from the sealed rim 1291 of the barrier layers. As illustrated, the barrier layers 1282 or 1285 may not be attached to the edge 1289. In at least one other instance, the barrier layers 1282 or 1285 may be attached to at least a portion of the edge 1289. The barrier layers 1282 and 1285 can be attach to at least a portion of a major surface of the body 1288, or as illustrated, attached to the entirety of the major surfaces. In a particular instance, at least one tab can be placed between the barrier layers 1282 and 1285 and extend away from the sealed rim to facilitate removal of the barrier layers by hand.

[00116] FIG. 12J includes an illustration of another exemplary abrasive article 1290 including barrier layers 1292 and 1295 that are attached to the body 1298 in a peelable manner. Each of the barrier layers 1292 and 1295 can include a first film (1294 or 1297) and a second film, such as an adhesive film (1293 or 1296). The barrier layer 1292 can be adhered to at least a portion of the major surface of the body 1298 and folded over to attach to at least a portion of the peripheral edge 1299 of the body 1298. In some instances, the barrier layer 1292 can be attached to the entire major surface 1210, the entire peripheral edge 1299, or both. The barrier layer 1295 can be adhered to the major surface 1211, and folded over to adhere to the barrier layer 1292 to form a sealed rim on the edge 1299. In a particular instance, at least one tab can be placed between the barrier layers and extend from the sealed rim to facilitate removal of the barrier layers by hand.

[00117] Although not illustrated in FIG. 12I or FIG. 12J, the barrier layers 1282, 1285, 1292, and 1295 can include additional films, such as a metal-containing film, a polymer-containing film, an oxide-coated film, a foil, or any combination thereof. In certain instances, a tie layer may be placed between adjacent films to improve bonding of the films.

[00118] In some instances, an oversized barrier layer may not include an adhesive film, and a separate adhesive layer can be applied to the body or barrier layers to facilitate bonding of the barrier layer to the major surface or peripheral edge of the body of the abrasive article and formation of the sealed rim.

[00119] Any aspects and features of the foregoing embodiments may be combined with any other features of other embodiments herein, such that various combinations of features from different illustrations and/or embodiments may be utilized.

[00120] In another embodiment, the abrasive article can include a coating layer overlying the barrier layer. FIG. 13 includes a cross-sectional illustration of an abrasive article including a barrier layer 1302 overlying a body 1301 and a coating layer 1303 over the barrier layer 1302. In at least one embodiment, the coating layer 1303 can be bonded directly to the barrier layer 1302. The barrier layer 1302 can be attached to the body 1301 in a peelable manner. In a further embodiment, the coating layer 1303 can

include a material selected from the group consisting of inorganic materials, organic materials, naturally occurring materials, synthetic materials, metals, metal alloys, oxides, carbides, nitrides, borides, elastomers, thermoplastics, thermosets, resins, or any combination thereof. In particular example, the coating layer 1303 can include wax, and more particularly, the coating layer 1303 can consist essentially of wax. The coating layer 1303 may provide additional support to the abrasive article and protection while handling and shipping. The coating layer 1303 may be removed with the barrier layer 1303 using any of the techniques described in the embodiments herein.

[00121] The abrasive articles, such as wheels, can be formed by, for example, preparing a mixture including one or more types of abrasive particles, a bond material (e.g., an organic material (resin) or an inorganic material), and optionally, other ingredients, such as, active or inactive fillers, processing aids, lubricants, crosslinking agents, antistatic agents and so forth, and further processing the mixture as described later in this disclosure in more details.

[00122] An exemplary abrasive particle can include inorganic materials, organic materials, naturally occurring materials (e.g., minerals), superabrasive materials, synthesized materials (e.g., polycrystalline diamond compacts) or a combination thereof. A particular example of abrasive particle can include silica, alumina (fused or sintered), zirconia, zirconia/alumina oxides, silicon carbide, garnet, diamond, cubic boron nitride, silicon nitride, ceria, titanium dioxide, titanium diboride, boron carbide, tin oxide, tungsten carbide, titanium carbide, iron oxide, chromia, flint, emery, or any combination thereof. A more particular example of the abrasive particle can include alumina, such as seeded or unseeded sintered sol gel alumina, with or without chemical modification, such as rare earth oxides, MgO, and the like can be utilized.

[00123] The abrasive particles also can include various shapes, structures, and/or configurations. For example, the abrasive particle can be a shaped abrasive particle. Shaped abrasive particles can have a well-defined and regular arrangement (i.e., non-random) of edges and sides, thus defining an identifiable and controlled shape. Moreover, shaped abrasive particles are distinct from traditional crushed or non-shaped abrasive particles as the shaped abrasive particles have substantially the same shape with respect to each other, wherein traditional crushed abrasive particles vary significantly in their shape with respect to each other. For example, a shaped abrasive particle may have a polygonal shape as viewed in a plane defined by any two dimensions of length, width, and height (e.g., viewed in a plane defined by a length and a width). Some exemplary polygonal shapes can be triangular, quadrilateral (e.g., rectangular, square, trapezoidal, parallelogram), a pentagon, a hexagon, a heptagon, an octagon, a nonagon, a decagon, and the like. Additionally, the shaped abrasive particle can have a three-dimensional shape defined by a polyhedral shape, such as a prismatic shape or the like. Further, the shaped abrasive particles may have curved edges and/or surfaces, such that the shaped abrasive particles can have convex, concave,

ellipsoidal shapes. Exemplary shaped abrasive particles are disclosed in U.S. Pat. No. 8,758,461, which is incorporated herein in its entirety. In a particular example, the shaped abrasive particles can be in the form of any alphanumeric character, e.g., 1, 2, 3, etc., A, B, C, etc. Further, the shaped abrasive particles can be in the form of a symbol, trademark, a character selected from the Greek alphabet, the modern Latin alphabet, the ancient Latin alphabet, the Russian alphabet, any other alphabet (e.g., Kanji characters), and any combination thereof.

[00124] The size of abrasive particles can be expressed as a grit size, and charts showing a relation between a grit size and its corresponding average particle size, expressed in microns or inches, are known in the art as correlations to the corresponding United States Standard Sieve (USSS) mesh size. In an aspect, particle size selection can depend upon the application or process for which the abrasive article is intended and may range from 10 to 325 as per ANSI grit size designation. In a particular aspect, grit sizes may range from 16 to 120 or 16 to 80.

[00125] In another aspect, the abrasive particles can have an average particle size (i.e., D_{50}) of at least 1 micron, such as at least 10 microns, at least 20 microns, at least 30 microns, or at least 40 microns. Still, in another aspect, the abrasive particles can have an average particle size of at most 2 mm, such as at most 1 mm, at most 800 microns, at most 600 microns, at most 500 microns, at most 400 microns, at most 300 microns, at most 280 microns, at most 250 microns, or at most 200 microns. It is to be appreciated that the abrasive particles can have an average particle size within a range including any of the minimum and maximum values noted above, including for example, within a range between 1 micron and 2 mm, within a range between 10 microns and 1 mm, or even within a range between 20 microns and 200 microns.

[00126] An exemplary bond material can include an organic material, an inorganic material, or any combination thereof. In a particular embodiment, the bonded abrasive article can include a hygroscopic bond material, such as a resin-based bond material or a hygroscopic inorganic material. Prior to forming the finally formed bonded abrasive article, the bond material may be in the form of a precursor bond material that upon further treatment (e.g., thermal treatment) can form a finally formed bond material.

[00127] An exemplary bond precursor material can include one or more organic materials. An organic material can include resins, such as phenolic resin, boron-modified resin, nano-particle-modified resin, urea-formaldehyde resin, acrylic resin, epoxy resin, polybenzoxazine, polyester resin, isocyanurate resin, melamine-formaldehyde resin, polyimide resin, other suitable thermosetting or thermoplastic resins, or any combination thereof. An exemplary phenolic resin can include resole and novolac.

[00128] An epoxy resin can include an aromatic epoxy or an aliphatic epoxy. Aromatic epoxies components include one or more epoxy groups and one or more aromatic rings. An example aromatic epoxy includes epoxy derived from a polyphenol, e.g., from bisphenols, such as bisphenol A (4,4'-isopropylidenediphenol), bisphenol F (bis[4-hydroxyphenyl]methane), bisphenol S (4,4'-

sulfonyldiphenol), 4,4'-cyclohexylidenebisphenol, 4,4'-biphenol, 4,4'-(9-fluorenylidene)diphenol, or any combination thereof. The bisphenol can be alkoxylated (e.g., ethoxylated or propoxylated) or halogenated (e.g., brominated). Examples of bisphenol epoxies include bisphenol diglycidyl ethers, such as diglycidyl ether of Bisphenol A or Bisphenol F. A further example of an aromatic epoxy includes triphenylolmethane triglycidyl ether, 1,1,1-tris(p-hydroxyphenyl)ethane triglycidyl ether, or an aromatic epoxy derived from a monophenol, e.g., from resorcinol (for example, resorcin diglycidyl ether) or hydroquinone (for example, hydroquinone diglycidyl ether). Another example is nonylphenyl glycidyl ether. In addition, an example of an aromatic epoxy includes epoxy novolac, for example, phenol epoxy novolac and cresol epoxy novolac. Aliphatic epoxy components have one or more epoxy groups and are free of aromatic rings. The external phase can include one or more aliphatic epoxies. An example of an aliphatic epoxy includes glycidyl ether of C2-C30 alkyl; 1,2 epoxy of C3-C30 alkyl; mono or multi glycidyl ether of an aliphatic alcohol or polyol such as 1,4-butanediol, neopentyl glycol, cyclohexane dimethanol, dibromo neopentyl glycol, trimethylol propane, polytetramethylene oxide, polyethylene oxide, polypropylene oxide, glycerol, and alkoxylated aliphatic alcohols; or polyols. In one embodiment, the aliphatic epoxy includes one or more cycloaliphatic ring structures. For example, the aliphatic epoxy can have one or more cyclohexene oxide structures, for example, two cyclohexene oxide structures. An example of an aliphatic epoxy comprising a ring structure includes hydrogenated bisphenol A diglycidyl ether, hydrogenated bisphenol F diglycidyl ether, hydrogenated bisphenol S diglycidyl ether, bis(4-hydroxycyclohexyl)methane diglycidyl ether, 2,2-bis(4-hydroxycyclohexyl)propane diglycidyl ether, 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexanecarboxylate, 3,4-epoxy-6-methylcyclohexylmethyl-3,4-epoxy-6-methylcyclohexanecarboxylate, di(3,4-epoxycyclohexylmethyl)hexanedioate, di(3,4-epoxy-6-methylcyclohexylmethyl)hexanedioate, ethylenebis(3,4-epoxycyclohexanecarboxylate), ethanedioldi(3,4-epoxycyclohexylmethyl) ether, or 2-(3,4-epoxycyclohexyl-5,5-spiro-3,4-epoxy)cyclohexane-1,3-dioxane.

[00129] An exemplary multifunctional acrylic can include trimethylolpropane triacrylate, glycerol triacrylate, pentaerythritol triacrylate, methacrylate, dipentaerythritol pentaacrylate, sorbitol triacrylate, sorbital hexacrylate, or any combination thereof. In another example, an acrylic polymer can be formed from a monomer having an alkyl group having from 1-4 carbon atoms, a glycidyl group or a hydroxyalkyl group having from 1-4 carbon atoms. Representative acrylic polymers include polymethyl methacrylate, polyethyl methacrylate, polybutyl methacrylate, polyglycidyl methacrylate, polyhydroxyethyl methacrylate, polymethyl acrylate, polyethyl acrylate, polybutyl acrylate, polyglycidyl acrylate, polyhydroxyethyl acrylate and mixtures thereof.

[00130] Optionally, additional components can be added to the abrasive particles and bond material, such as solvents, plasticizers, crosslinkers, chain transfer agents, stabilizers, dispersants, reaction mediators and agents for influencing the fluidity of the dispersion. For example, one or more chain transfer agents can

be added, such as polyol, polyamine, linear or branched polyglycol ether, polyester and polylactone. In certains implementation, catalyst and initiators can be added. For example, a cationic initiator can catalyze reactions between cationic polymerizable constituents. A radical initiator can activate free-radical polymerization of radically polymerizable constituents. The initiator can be activated by thermal energy or actinic radiation. For example, an initiator can include a cationic photoinitiator that catalyzes cationic polymerization reactions when exposed to actinic radiation. In another example, the initiator can include a radical photoinitiator that initiates free-radical polymerization reactions when exposed to actinic radiation. Actinic radiation includes particulate or non-particulate radiation and is intended to include electron beam radiation and electromagnetic radiation. In a particular embodiment, electromagnetic radiation includes radiation having at least one wavelength in the range of about 100 nm to about 700 nm and, in particular, wavelengths in the ultraviolet range of the electromagnetic spectrum. In an exemplary application, the bond precursor material can be thermally curable or can be curable through actinic radiation, such as UV radiation, to form the finally formed bond material.

[00131] Curing or cross-linking agents that can be utilized depend on the bond material selected. For curing phenol novolac resins, for instance, a typical curing agent is hexamethylenetetramine. Other amines, e.g., ethylene diamine; ethylene triamine; methyl amines and precursors of curing agents, e.g., ammonium hydroxide which reacts with formaldehyde to form hexamethylenetetramine, also can be employed. Suitable amounts of curing agent can be within the range, for example, of from 5 to 20 parts, or 8 parts to 15 parts, by weight of curing agent per hundred parts of total novolac resin. It is to be appreciated that the ratio can be adjusted based on various factors, including for example the particular types of resins used, the degree of cure needed, and the desired final properties for the articles, such as strength, hardness, and grinding performance.

[00132] In some situations, bonded abrasive article can further include filler (active or inactive filler). In an aspect, the filler can include powders, granules, spheres, fibers, or a combination thereof. In another aspect, the filler can include an inorganic material, an organic material, or a combination thereof. A particular example of filler can include Cryolite, PAF (K_3AlF_6 and $KAlF_4$), KBF_4, K_2SO_4, barium sulfate, sulfides (FeS_2, ZnS), NaCl/KCl, low melting metal oxides, or any combination thereof. A non-exhaustive list of inactive filler can include CaO, $CaCO_3$, $Ca(OH)_2$, $CaSiO_3$, Kyanite (a mixture of Al_2O_3-SiO_2), Saran (Polyvinylidene chloride), Nephenline (Na, K) $AlSiO_4$, wood powder, coconut shell flour, stone dust, feldspar, kaolin, quartz, other forms of silica, short glass fibers, asbestos fibers, balotini, surface-treated fine grain (silicon carbide, corundum etc.), pumice stone, cork powder, or any combinations thereof. In a further aspect, the filler can include an antistatic agent, a metal oxide, a lubricant, a porosity inducer, a coloring agent, or a combination thereof. Examples of the lubricants can include stearic acid, glycerol monostearate, graphite, carbon, molybdenum disulfide, wax beads, calcium carbonate, calcium

fluoride, or any combination thereof. Examples of the metal oxides can include lime, zinc oxide, magnesium oxide, or any combination thereof.

[00133] Note that fillers may be functional, such as, grinding aids, lubricants, and porosity inducers. In alternative instances, the fillers can be used for functional and/or aesthetics, such as a coloring agent. According to an embodiment, the filler can be distinct from the abrasive particles. In yet another embodiment, the filler can include secondary abrasive grains.

[00134] The various ingredients can be added in any suitable order and blended using known techniques and equipment such as, for instance, Eirich mixers, e.g., Model RV02, Littleford, bowl-type mixers and others. The resulting mixture can be used to form a green body by using a shaping device, e.g., a mold. Wheels may be molded individually or large "bats" can be molded, from which individual wheels are later cored out. As used herein, the term "green" refers to a body which maintains its shape during the next process step, but generally does not have enough strength to maintain its shape permanently. Green may also refer to a body that is unfinished, or that there are further processes yet to be completed before transforming the green body to a finally-formed bonded abrasive article. For example, a precursor bond material (e.g., a resin) present in the green body is in an uncured or unpolymerized state. The green body preferably is molded in the shape of the desired article, including for example, a bonded abrasive wheel.

[00135] In some embodiments, one or more, (e.g., two or three) reinforcing components can be incorporated in the green body such that the bonded abrasive article can be reinforced. The reinforcing component may be in the form of layers, partial layers, discrete bundles of material distributed throughout the bond material, or a combination thereof. As used herein, the term "reinforcing layer" can refer to a discrete component that can be made of a material that is different from the bond material and abrasive particles utilized to make the abrasive layers within the bonded abrasive body. In an embodiment, the reinforcing layer does not include abrasive particles. With respect to the thickness of the bonded abrasive, a reinforcing layer can be embedded within the body of the bonded abrasive article and such bonded abrasive article may be referred to as "internally" reinforced. In another instance, a reinforcing layer also can be close to, or attached to the front or back face of the body of the bonded abrasive. In still another instance, several reinforcing layers can be disposed at various depths through the thickness of the bonded abrasive.

[00136] A reinforcing layer can have certain geometry. For example, a reinforcing layer can have a circular geometry. Alternatively, the outer periphery of the reinforcing layer also can have a square, hexagon or another polygonal geometry. An irregular outer edge also can be used in certain instances. Suitable non-circular shapes that can be utilized are described in U.S. Patent Nos. 6,749,496 and 6,942,561, incorporated herein by reference in their entirety. In certain instances wherein the bonded abrasive article is in the form of a wheel or disc, the reinforcing layer can extend from the inner diameter

(edge of the central opening) to the outermost edge (i.e., peripheral surface) of the bonded abrasive body. Partial reinforcing layers can be employed and in such cases, the reinforcing layer may extend, for example, from the mounting hole to at least 30% along the radius or, for non-circular shapes, along the equivalent of the largest "radius" of the bonded abrasive body. For example, a partial reinforcing layer can extend for at least 60 %, at least 70 %, at least 75 %, at least 80 %, at least 85 %, at least 90 %, at least 95%, or even at least 99% along the radius or, for non-circular shapes, along the equivalent of the largest "radius" of the body of the bonded abrasive. In another non-limiting embodiment, the partial reinforcing layer may extend for not greater than 100%, such as not greater than 99%, not greater than 97%, not greater than 95%, not greater than 90%, not greater than 85%, not greater than 80%, not greater than 70%, or even not greater than 60% along the radius or the equivalent of the largest "radius" of the bonded abrasive body. It will be appreciated that the partial reinforcing layer can extend within a range including any of the minimum and maximum values noted above. For instance, the partial reinforcing layer can extend within a range of 60% to 100%, such as, within a range of 70% to 99%, or within a range of 80% to 90% along the radius or the equivalent of the largest "radius" of the bonded abrasive body.

[00137] A reinforcing layer can be made of any number of various materials, including a single material or more than one type of materials, such as a composite material. Moreover, a bonded abrasive of the embodiments herein can use a single type of reinforcing layer or may use different types of reinforcing layers, which can employ different materials with respect to each other. Some suitable reinforcing layer materials can include woven materials or non-woven materials. In a non-limiting embodiment, the body of the bonded abrasive can be essentially free of a non-woven material. In at least one embodiment, the reinforcing layer can include a glass material, including but not limited to a fiberglass material. In yet other embodiments, the reinforcing layer can include a fiber (e.g., Kevlar®), basalt, carbon, fabric organic materials (e.g., elastomers, rubbers), combinations of materials and so forth. An further exemplary reinforcing layer can include a polymeric film (including primed films) including for example, a polyolefin film (e.g., polypropylene including biaxially oriented polypropylene), a polyester film (e.g., polyethylene terephthalate), a polyamide film, a cellulose ester film, a metal foil, a mesh, a foam (e.g., natural sponge material or polyurethane foam), a cloth (e.g., cloth made from fibers or yams comprising fiberglass, polyester, nylon, silk, cotton, poly-cotton, or rayon), a paper, a vulcanized paper, a vulcanized rubber, a vulcanized fiber, a nonwoven material, or any combination thereof, or treated versions thereof. A cloth backing can be woven or stitch bonded. In particular examples, the reinforcing layer is selected from a group consisting of paper, polymer film, cloth, cotton, poly-cotton, rayon, polyester, poly-nylon, vulcanized rubber, vulcanized fiber, fiberglass fabric, metal foil or any combination thereof. In other examples, the reinforcing layer includes a woven fiberglass fabric. In a particular example, the bonded abrasive article can include one more layers of fiberglass between which a blend abrasive grains or

particles are bound in a bond material such as a polymer matrix. Using reinforcing layers also can allow for shear at the interface between the reinforcing layer and adjacent region(s) of the bonded abrasive (which contain abrasive grains or particles distributed in a three dimensional bond material matrix). It will be appreciated that a reinforcing layer can consist essentially of any of the foregoing materials or consists essentially of two or more of the foregoing materials noted above.

[00138] In specific examples, the body of the bonded abrasive article can include at least one or more fiberglass reinforcing layers, provided, for instance, in the form of fiberglass web(s). Fiberglass webs can include fiberglass woven from very fine fibers of glass. Fiberglass web can include leno or plain woven. The fiberglass utilized can include E-glass (alumino-borosilicate glass with less than 1 wt % alkali oxides). Other types of fiberglass can include, for example, A-glass (alkali-lime glass with little or no boron oxide), E-CR-glass (alumino-lime silicate with less than 1 wt % alkali oxides, with high acid resistance), C-glass (alkali-lime glass with high boron oxide content, used for example for glass staple fibers), D-glass (borosilicate glass with high dielectric constant), R-glass (alumino silicate glass without MgO and CaO with high mechanical requirements), or S-glass (alumino silicate glass without CaO but with high MgO content with high tensile strength).

[00139] Fiberglass webs can be arranged in the bonded abrasive such as a bonded abrasive wheel in any suitable manner. In certain implementations, placement of a glass fiber web at the working face of the wheel may be avoided. Any of the embodiments herein can be reinforced with at least one fiberglass web having a hole corresponding to the mounting hole of the wheel and the same diameter as the wheel. Partial web reinforcing layers that extend from the mounting hole through some but not the total radius of the wheel also can be used, as can be other web reinforcement placements.

[00140] The reinforcing layer can be characterized by one or more of the following physical parameters: weight (g/ m^2), thickness (mm), openings per cm and tensile strength (MPa), which can be further delineated with respect to the tensile strength of the warp (the long web components that run continuously for the length of the roll) and the tensile strength of the fill (the short components that run crosswise to the roll direction). In certain instances, one or more of the fiberglass webs employed has a minimum tensile strength of at least 200 MPa. Other factors include filament diameter, amount of coating, for instance, the coverage of the web with coating and others, as known in the art.

[00141] Chemical parameters can relate to the chemistry of the coating provided on the fiberglass web. Generally, there are two types of chemical "coatings." A first coating, referred to as "sizing," can be applied to the glass fiber strands immediately after they exit the bushing and include ingredients such as film formers, lubricants, silanes, which for example, can be dispersed in water. The sizing can provide protection of the filaments from processing-related degradation (such as abrasion). It can also provide abrasion protection during secondary processing such as weaving into a web. Strategic manipulation of

properties associated with the first coating (sizing) can affect the compatibility of the glass fibers with the second coating, which, in turn, can affect compatibility of the coating with the resin bond. The second coating can be applied to the glass web and can include phenolic resin, and wax paper may be used between coated glass web to primarily prevent "blocking" of the webs during shipping and storage. In many cases, the second coating can be compatible with both the sizing (first coating) and the matrix resin for which the reinforcement is intended.

[00142] In an embodiment, the mixture, reinforcing component(s), and barrier layer material can be placed into a mold cavity in the appropriate configuration. The barrier layer can serve as the outmost layers of the stack. As desired, the barrier layer can be placed in the bottom of the mold, overlying the upper surface of the mixture, or both such that when the green body is formed, the barrier layer is joined to at least one major surface of the green body. In some instances, a barrier layer may be placed in the mold such that it is adjacent the peripheral surface of the abrasive layer, such that the barrier layer can be formed on the peripheral surface of the bonded abrasive body. The barrier layer may adhere directly to the abrasive mixture, and thus ultimately be bonded in-situ to the abrasive wheel as a result of the curing process. In some other instances, the barrier layer material can be joined to a reinforcement portion, such as fiberglass reinforcement, to form a barrier layer construction, and then the barrier layer construction can be placed into the mold prior to or after the mixture is disposed into the mold. The reinforcement portion of the barrier layer construction can be in direct contact with the mixture, and particularly, the reinforcement portion of the barrier construction can be directly joined to the green body.

[00143] In an exemplary process for forming the bonded abrasive article, a first barrier layer can be placed at the bottom of an appropriate mold cavity, a first portion of the mixture (referred to as "the first abrasive layer a_1" herein after) can be placed and distributed over the first barrier layer; and then a first reinforcing layer V_1 can be placed over the first abrasive layer a_1. A second portion of the mixture can then be disposed and distributed over the first reinforcing layer V_1 forming the second abrasive layer a_2. A second reinforcing layer, V_2, can be disposed over the second abrasive layer, a_2. If desired, a third abrasive layer, a_3, can be used to cover the second reinforcing layer, V_2. Additional reinforcing layers and abrasive layers can be added, essentially as described, to obtain the desired number of abrasive layers and reinforcing layers, and a second barrier layer can be placed over the top layer that can be either a mixture layer or reinforcing layer. In another approach, a first reinforcing layer V_1 is placed over the first barrier layer that is disposed at the bottom of the mold and then covered by a first abrasive layer a_1, with additional reinforcing layers and abrasive layers being disposed as described above, and the top layer of the stack can be covered by a second barrier layer. Alternatively, a barrier construction can be formed and disposed at the bottom of the mold cavity for the rest of the layers to be then placed sequentially, and another barrier construction can be placed over the top layer that can be a layer of the mixture.

[00144] The individual thickness of the abrasive layers can be substantially the same. The amounts of the mixture added to form a particular layer thickness can be modified as suitable for the intended purposes of the abrasive article. Other suitable sequences or techniques can be employed to shape the reinforced green body. Arrangements in which adjacent abrasive layers a_n and a_{n+1} are not separated by a reinforcing layer also are possible, as are those in which two or more reinforcing layers, e.g., V_n and V_{n+1}, are not separated by an abrasive layer. Labels made of paper or polymer may also be affixed to major faces of the body of the abrasive article. These labels may be used to identify the abrasive articles. They may be affixed to the wheel during the abrasive wheel formation process or applied after curing.

[00145] In some arrangements, the abrasive layers can differ from one another with respect to one or more characteristics such as, for instance, layer thickness, layer formulation (e.g., amounts and or types of ingredients being employed, grit size, grit shape, porosity), filler materials, bond composition, bond content, abrasive content, abrasive particle composition, porosity, pore size, porosity distribution, porosity type (i.e., closed or open porosity) and the like. In certain instances, the thickness of the abrasive layers can be different. The difference in thickness between any two of the mix layers may be calculated by using formula [(tab1-tab2)/tab1]x100%, wherein tab1 is the greater thickness of the thicknesses of the two mix layers and tab2 is the smaller thickness with respect to tab1. For example, the difference in thickness between two abrasive layers can be at least 5% different, at least 10% different, at least 20% different, at least 25% different, at least 30% different, or even at least 50% different. Engineered differences in the thicknesses between two abrasive layers can promote certain mechanical properties and advantages in grinding performance. Further, the body of the bonded abrasive article can include reinforcing layers that are similar or reinforcing layers that differ with respect to formulation, materials employed, or other properties. In a further embodiment, the major surfaces of the body may be attached to barrier layers that are the same or different.

[00146] In an embodiment, the green body can be formed in the mold and at the same time, joined to a barrier layer. The stack of layers (e.g., layers of the mixture and barrier layer with or without a reinforcing layer) can be pressed by suitable means, such as a hydraulic press, by for example, performing cold pressing, warm pressing, or hot pressing. A particular example of a pressing operation can include cold pressing. In cold pressing, the materials in the mold are maintained at approximately ambient temperature, such as from 15 °C to 40 °C. Pressing the stack can be performed at force of at least 40 tons and at most 2000 tons. Particularly, the force can be within a range of 100 tons to 2000 tons. In some instances, pressing can include a pressure in the range of 4.2 kg/cm^2 (60 psi or 0.03 tsi) to 8.4 kg/cm^2 (120 psi or 0.06 tsi) may be applied to the green body. Particularly, the pressure can be in the range of 70.3 kg/cm^2 (0.5 tsi) to 2109.3 kg/cm^2 (15 tsi), or in the range of 140.6 kg/cm^2 (1 tsi) to 843.6 kg/cm^2 (6 tsi).

The holding time within the press can be, for example, within the range of from less than 2.5 seconds to 1 minute.

[00147] In another example, warm pressing or hot pressing may be utilized to form the abrasive articles. Warm pressing and hot pressing are similar to cold pressing operations, except that higher temperatures may be utilized during the application of pressure. In some instances, green body may be allowed to cure to form the bonded body during pressing by heating the green body at the curing temperature of the bond precursor material.

[00148] In embodiments, a separate operation can be performed to cure the green body to form the bonded body including abrasive particles contained in the bond material. In at least one embodiment, the barrier layer can be applied after the green body is formed, and the green body can be allowed to cure after the barrier layer is applied. During curing of the green body, the barrier layer can adhere to one or more major surfaces of the body and/or a peripheral surface of the body. When a barrier layer construction is utilized, the reinforcement portion can be bonded to the major surface during curing of the green body, and the barrier layer can be bonded to the reinforcement portion, such that the barrier layer forms an exterior surface of the bonded body. In certain instances, the barrier layer may be melt bonded to a major surface and/or peripheral surface of the body.

[00149] In some embodiments, after formation, the green bodies including barrier layers can be stacked with a metal separator placed between adjacent ones for curing. In some instances, a spacer can be used between a body and a metal separator to prevent the body from adhering to the metal separator during curing. To facilitate separation of bodies from metal separators, the spacer can be non-sticky. A particular example of the spacer can be a non-stick film including silicone, Teflon, or Kapton. Alternatively, the spacer can include fluoropolymer coated, such as PTFE, coated fiberglass. Use of the spacer can also improve contact between the barrier layer and the major surface of the bonded body, which can be expected to improve moisture resistance of the abrasive tool.

[00150] Selection of a curing temperature depends, for instance, on factors such as the type of the bond and bond precursor materials, strength, hardness, and grinding performance desired. According to certain embodiments, the curing temperature can be in the range including at least 100°C to not greater than 250° C. In more specific embodiments employing organic bonds, the curing temperature can be in the range including at least 150°C to not greater than 230° C. Polymerization of novolac-based resins may occur at a temperature in the range of including at least 110° C and not greater than 225°C. Resole resins can polymerize at a temperature in a range of including at least 100° C and not greater than 225° C. Certain novolac resins suitable for the embodiments herein can polymerize at a temperature in a range including at least 110° C and not greater than 250° C. Generally, the molded article can be held at a final cure temperature for a period of time, such as between 6 hours and 48 hours, between 10 and 36 hours, or until

the center of mass of the molded article reaches the cross-linking temperature and desired grinding performance (e.g., density of the cross-link). As used herein, the term "final cure temperature" is the temperature at which the molded article is held to effect polymerization, e.g., cross-linking, of the organic bond material, thereby forming the final composition of the bond material, although cross-linking can begin at lower temperatures.

[00151] In certain instances, the barrier layer or a portion of the barrier layer can be applied to a surface of the body after the body is finally formed. For instance, the barrier layer can include a coating overlying at least one major surface of the body. In some particular instance, the coating can be in direct contact with the major surfaces of the body. In some instances, all the exterior surfaces of the body can be coated, and in other instances, the major surfaces of the body can be coated and the peripheral surface can be exposed to facilitate a grinding operation. In an exemplary process, the bonded body of an abrasive article may be dipped into a coating material to coat an exterior surface of the body. A further treatment may be applied, such as heating, drying, or the like, for the coating material to form into the barrier layer. Alternatively, a coating material may be sprayed or painted on a surface of the body or may be deposited using other known technologies. In certain instances, the coating material can be applied to the green body, both of which can be subjected to a further process, such as heating, curing, or the like, to the form the finally formed body having the barrier layer. The coating can include a film-forming material, a polymer, oil, wax, or any combination thereof. An exemplary polymer can include any of the polymers or a combination thereof noted in embodiments herein in relation to the barrier layer.

[00152] The barrier layer described in embodiments herein can have a certain water vapor transmission rate (WVTR) that can facilitate improved water vapor resistance of the package over an extended period of time. In an aspect, the barrier layer may have a WVTR of at most 2.0 g/m^2-day (i.e., grams per square meter, per 24 hours), such as at most 1.8 g/m^2-day, at most 1.6 g/m^2-day, at most 1.5 g/m^2-day, at most 1.4 g/m^2-day, at most 1.2 g/m^2-day, at most 1 g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day, at most 0.5 g/m^2-day, or at most 0.4 g/m^2-day, at most 0.3 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/ g/m^2-day, at most 0.18 g/ g/m^2-day, at most 0.16 g/ g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.10 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, at most 0.05 g/m^2-day 0.015 g/m^2-day, at most 0.010 g/m^2-day, at most 0.005 g/m^2-day, at most 0.001 g/m^2-day, or at most 0.0005 g/m^2-day. In another aspect, the WVTR of the barrier layer can be greater than 0 g/m^2-day, such as at least 0.00001 g/m^2-day, at least 0.00005 g/m^2-day, at least 0.0001 g/m^2-day, at least 0.0005 g/m^2-day, at least 0.001 g/m^2-day, or at least 0.005 g/m^2-day, at least 0.01 g/m^2-day, at least 0.02 g/m^2-day, such as, at least 0.03 g/m^2-day, at least 0.04 g/m^2-day, at least 0.05 g/m^2-day, or at least 0.06 g/m^2-day, at least 0.07 g/m^2-day, at least 0.08 g/m^2-day, at least 0.09 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-

day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, at least 0.6 g/m^2-dayat least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-day. Moreover, the barrier layer can have a WVTR in a range including any of the minimum and maximum values noted herein. For instance, the WVTR may be within a range including greater than 0 g/m^2-day and at most 2.0 g/m^2-day, such as within a range including at least 0.00001 g/ m^2-day and at most 2.0 g/m^2-day.

[00153] In an embodiment, the package can be sealed after a desired number of abrasive tools are placed into the interior volume. In a particular embodiment, the package may not contain a desiccant. In another embodiment, the package can have a certain WVTR that can facilitate improved water resistance of the package. For example, the WVTR of the package can be at most 2.0 g/m^2-day, such as at most 1.8 g/m^2-day, at most 1.6 g/m^2-day, at most 1.5 g/m^2-day, at most 1.4 g/m^2-day, at most 1.2 g/m^2-day, at most 1 g/m^2-day, at most 1 g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day, at most 0.5 g/m^2-day, or at most 0.4 g/m^2-day, at most 0.3 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/ g/m^2-day, at most 0.18 g/ g/m^2-day, at most 0.16 g/ g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, or at most 0.05 g/m^2-day. In another instance, the WVTR of the package can be greater than 0 g/m^2-day, such as at least 0.0001 g/m^2-day, at least 0.001 g/m^2-day, at least 0.01 g/m^2-day, at least at least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.04 g/m^2-day, at least 0.05 g/m^2-day, or at least 0.06 g/m^2-day, at least 0.07 g/m^2-day, at least 0.08 g/m^2-day, at least 0.09 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-day. Moreover, the package can have a WVTR in a range including any of the minimum and maximum values noted herein. For instance, the package can have a WVTR in a range including greater than 0 and at most 1 g/m^2-day. In a particular embodiment, the package and the barrier layer can include the same material, more particularly, the package and the barrier layer can be substantially the same. In another embodiment, the package and the barrier layer can include different materials.

[00154] Notably, the abrasive tool contained within the package as described in embodiments herein can have low water vapor uptake over an extended period of time. Water vapor uptake of the abrasive tool can be determined as follows. The article can be exposed to the condition of 20 °C and 90% relative humidity (RH) for over 1 month, such as 2 months, 3 months, 4 months, 5 months, 6 months, or even longer. In this disclosure, the percentage of the weight change of the abrasive tool is used as water vapor uptake, Wu, and determined by the formula Wu=[(Wa-Wo)/Wo]×100%, where Wo is the weight of the abrasive tool prior to exposure and Wa is the weight after the exposure. In an embodiment, the abrasive tool can have a water vapor uptake of at most 0.3% or at most 0.2% or at most 0.1% or at most 0.05% or at most 0.03% or at most 0.02% or at most 0.01% when exposed to 90% relative humidity at 20 °C for 1

month. In another embodiment, the abrasive tool can have a water vapor uptake of at most 0.3% or at most 0.2% or at most 0.1% or at most 0.08% or at most 0.05% when exposed to 90% relative humidity at 20 °C for 2 months. In still another embodiment, the abrasive tool can have a water vapor uptake of at most 0.3% or at most 0.2% or at most 0.15% or at most 0.1 or at most 0.08% when exposed to 90% relative humidity at 20 °C for 3 months. In still another embodiment, the abrasive tool can have a water vapor uptake of at most 0.3% or at most 0.2% or at most 0.15% or at most 0.1 or at most 0.08% or at most 0.05% when exposed to 90% relative humidity at 20 °C for more than 3 months. In some instances, in situations a plurality of abrasive tools are contained in the package, the water vapor uptake of the abrasive tools can be the average of the water vapor uptake of all the abrasive tools.

[00155] Many different aspects and embodiments are possible. Some of those aspects and embodiments are described herein. After reading this specification, skilled artisans will appreciate that those aspects and embodiments are only illustrative and do not limit the scope of the present invention. Embodiments may be in accordance with any one or more of the items as listed below.

[00156] Embodiment 1. An article comprising:

a bonded abrasive including a body and a barrier layer coupled to the body, wherein the body comprises abrasive particles contained within a bond material; and

a package having an interior volume and the bonded abrasive contained in the interior volume,

wherein the bonded abrasive article has a water vapor uptake of at most 0.3% when exposed to 90% relative humidity at 20°C for more than 3 months.

[00157] Embodiment 2. An article comprising:

a bonded abrasive including a body and a barrier layer coupled to the body, wherein the body comprises abrasive particles contained within a bond material; and

a package having an interior volume and the bonded abrasive contained in the interior volume, wherein the package has a water vapor transmission rate of at most 2 g/m^2-day.

[00158] Embodiment 3. An article comprising:

a plurality of bonded abrasives, each including a body and a barrier layer coupled to the body, wherein the body comprises abrasive particles contained within a bond material; and

a package having an interior volume and the plurality of bonded abrasives contained in the interior volume, wherein the package has a water vapor transmission rate of at most 2 g/m^2-day.

[00159] Embodiment 4. The article of any one of the preceding embodiments, wherein the barrier layer comprises a water vapor transmission rate of at least 0.00001 g/ m^2-day, at least 0.00005 g/m^2-day, at least 0.0001 g/m^2-day, at least 0.0005 g/m^2-day, at least 0.001 g/m^2-day, or at least 0.005 g/m^2-day, at least 0.01 g/m^2-day, at least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.04 g/m^2-day, at least 0.05 g/m^2-day, or at least 0.06 g/m^2-day, at least 0.07 g/m^2-day, at least 0.08 g/m^2-day, at least 0.09 g/m^2-day,

at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-dayat least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-day.

[00160] Embodiment 5. The article of any one of the preceding embodiments, wherein the barrier layer comprises a water vapor transmission rate of at most 2.0 g/m^2-day, at most 1.8 g/m^2-day, at most 1.6 g/m^2-day, at most 1.4 g/m^2-day, at most 1.2 g/m^2-day, at most 1.0 g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day, at most 0.5 g/m^2-day, or at most 0.4 g/m^2-day, at most 0.3 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/ g/m^2-day, at most 0.18 g/ g/m^2-day, at most 0.16 g/ g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, or at most 0.05 g/m^2-day.

[00161] Embodiment 6. The article of any one of the preceding embodiments, wherein the body comprises a first major surface, a second major surface opposite the first major surface, and a peripheral surface extending between the first and second major surfaces, wherein the barrier layer is adhered to at least one of the first and second major surfaces.

[00162] Embodiment 7. The article of any one of the preceding embodiments, wherein the barrier layer comprises a wax, oil, a polymer, a metal, or any combination thereof.

[00163] Embodiment 8. The article of any one of the preceding embodiments, wherein the barrier layer is directly bonded to at least one of the first and second major surfaces.

[00164] Embodiment 9. The article of any one of embodiments 1 to 7, wherein the barrier layer is in a peelable configuration having a peel strength of not greater than 3000 g/in.

[00165] Embodiment 10. The article of any one of the preceding embodiments, wherein the barrier layer comprises a metal-containing film, a polymer-containing film, a metal foil, or any combination thereof.

[00166] Embodiment 11. The article of any one of the preceding embodiments, wherein the barrier layer comprises a polymer selected from the group consisting of a thermoplastic and a thermoset.

[00167] Embodiment 12. The article of any one of the preceding embodiments, wherein the barrier layer comprises a polymer selected from the group consisting of polyamides, polyesters, polyethlyenes, polypropylene, polyvinyls, epoxies, resins, polyurethanes, rubbers, polyimides, phenolics, polybenzimidazole, aromatic polyamide, and a combination thereof.

[00168] Embodiment 13. The article of any one of the preceding embodiments, wherein the polymer-containing film comprises a polymer including a biaxially-oriented material.

[00169] Embodiment 14. The article of embodiment 13, wherein the polymer comprises polyethylene terephthalate, nylon, or a combination thereof.

[00170] Embodiment 15. The article of any one of the preceding embodiments, wherein the barrier layer comprises aluminum, iron, tin, copper, scandium, titanium, vanadium, chromium, manganese, nickel,

zinc, yttrium, zirconium, niobium, molybdenum, silver, palladium cadmium, tantalum, tungsten, platinum, gold, or any combination thereof.

[00171] Embodiment 16. The article of any one of the preceding embodiments, wherein the barrier layer comprises a metal-containing film including aluminum, a metal foil including aluminum, or a combination thereof.

[00172] Embodiment 17. The article of any one of the preceding embodiments, wherein the barrier layer comprises a polymer-containing film overlying the metal-containing film.

[00173] Embodiment 18. The article of any one of the preceding embodiments, wherein the barrier layer comprises a polymer-containing film bonded directly to the metal-containing film.

[00174] Embodiment 19. The article of any one of the preceding embodiments, wherein the barrier layer comprises a polymer-containing film and wherein the polymer-containing film is bonded directly to at least one of the first and second major surface of the body.

[00175] Embodiment 20. The article of any one of the preceding embodiments, wherein the barrier layer comprises a first polymer-containing biaxially-oriented nylon, a second polymer-containing film including polyethylene, a third polymer-containing film including polyethylene, and a fourth polymer-containing film including co-extruded polyethylene, and a foil.

[00176] Embodiment 21. The article of any one of the preceding embodiments, wherein the barrier layer comprises a wax-containing film as an outermost film of the barrier layer.

[00177] Embodiment 22. The article of any one of the preceding embodiments, wherein the barrier layer comprises a coating including a polymer, oil, wax, or any combination thereof.

[00178] Embodiment 23. The article of embodiment 22, wherein the coating is in direct contact with the body.

[00179] Embodiment 24. The article of any one of embodiments 1 to 6, wherein the barrier layer comprises a coating including wax, wherein the coating is in direct contact with the body.

[00180] Embodiment 25. The article of any one of embodiments 1 to 6, wherein the barrier layer comprises a coating including a polymer including polyurethane, polyvinylidene chloride (PVDC), latex, or any combination thereof, , wherein the coating is in direct contact with the body.

[00181] Embodiment 26. The article of any one of the preceding embodiments, wherein the package has a water vapor transmission rate of at most 1.9 g/m^2-day, at most 1.8 g/m^2-day, at most 1.7 g/m^2-day, or at most 1.6 g/m^2-day, at most 1.5 g/m^2-day, or at most 1.4 g/m^2-day, at most 1.3 g/m^2-day, at most 1.2 g/m^2-day, at most 1.1 g/m^2-day, at most 1.0 g/ g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day, at most 0.5 g/m^2-day, or at most 0.4 g/m^2-day, at most 0.3 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/ g/m^2-day, at most 0.18 g/ g/m^2-day, at

most 0.16 g/ g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, or at most 0.05 g/m^2-day.

[00182] Embodiment 27. The article of any of the preceding embodiments, wherein the package comprises a water vapor transmission rate of greater than 0 g/m^2-day, at least 0.0001 g/m^2-day, at least 0.001 g/m^2-day, at least 0.01 g/m^2-day, at least at least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.04 g/m^2-day, at least 0.05 g/m^2-day, or at least 0.06 g/m^2-day, at least 0.07 g/m^2-day, at least 0.08 g/m^2-day, at least 0.09 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-day.

[00183] Embodiment 28. The article of any one of the preceding embodiments, wherein the package comprises a packaging material forming a side wall surrounding the interior volume.

[00184] Embodiment 29. The article of embodiment 28, wherein the packaging material comprises a self-supporting material.

[00185] Embodiment 30. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including an elemental metal, an alloy, a polymer, or any combination thereof.

[00186] Embodiment 31. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including a metal coated in a polymer film.

[00187] Embodiment 32. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including iron, nickel, chromium, aluminum, tin, or a combination thereof.

[00188] Embodiment 33. The article of embodiment 32, wherein the packaging material comprises steel.

[00189] Embodiment 34. The article of embodiment 32 or 33, wherein the packaging material comprises tin-coated steel.

[00190] Embodiment 35. The article of any one of embodiments 32 to 34, wherein the packaging material comprises plastic-coated steel.

[00191] Embodiment 36. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including a high density polyethylene, low density polyethylene, polypropylene, or any combination thereof.

[00192] Embodiment 37. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including a metalized film.

[00193] Embodiment 38. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including a metal foil.

[00194] Embodiment 39. The article of any one of the preceding embodiments, wherein the package comprises a packaging material including a plastic.

[00195] Embodiment 40. The article of any one of embodiments 1 to 29, wherein the package comprises a packaging material consisting essentially of an organic material.

[00196] Embodiment 41. The article of any one of the preceding embodiments, wherein the bonded abrasive article has a water vapor uptake of at most 0.3% or at most 0.2% or at most 0.1% when exposed to 90% relative humidity at 20°C for 4 months.

[00197] Embodiment 42. The article of any one of the preceding embodiments, wherein the bonded abrasive article has a water vapor uptake of at most 0.3% when exposed to 90% relative humidity at 20°C for at least 3 moths, at least 4 moths, at least 5 months, or at least 6 months.

[00198] Embodiment 43. The article of any one of the preceeding embodiments, wherein at least 3, at least 5, at least.8, at least 10, at least 15, at least 20, at least 30, at least 50 , or at least 100 bonded abrasives are contained in the interior volume.

[00199] Embodiment 44. The article of any one of the preceding embodiments, wherein the bond material comprises an organic bond material.

[00200] Embodiment 45. The article of any one of the preceding embodiments, wherein the bonded abrasive article comprises an ultra thin wheel, a grinding wheel, combination wheel, or a cutoff wheel.

[00201] Embodiment 46. The article of any one of the preceding embodiments, wherein the package is configured to be resealed after it is opened.

[00202] Embodiment 47. The article of any one of the preceding embodiments, wherein the package is in a form of a bucket, a bag, a box, or a pouch.

[00203] Embodiment 48. The article of embodiment 47, wherein the package is in the form of a bucket.

[00204] **Examples**

[00205] Example 1

[00206] Wheels having the dimension of 125x1.6x22.3 mm were formed with or without a barrier layer. For wheels with barrier layers, the barrier layer included from outmost surface to innermost surface PET/tie layer/foil /linear low density polyethylene sealant, with the sealant layer immediately adjacent the bonded abrasive body and the PET film defining an exterior surface of the bonded body. The barrier layers were molded on both major surfaces of the green bodies during formation of the green bodies. All the green bodies with or without barrier layers were formed by pressing the mixture at room temperature and at a pressure from 90 to 120 bar (corresponding to 9 MPa to 12 MPa) using a cold pressing machine (e.g., 350 Ton Press manufactured by Poggi Pasqualino). All the green bodies were cured in an oven at approximately 200 °C to form the wheels. A set of Sample S1 were formed by packing 3 wheels with the barrier layers in a bag made of the same material as the barrier layer. A set of Sample CS2 were formed by packing 3 wheels without the barrier layer in the same type of bag. Samples CS3 were unpacked wheels with the barrier layers. All of the samples were exposed to 90% RH at 20 °C for up to 6 months.

The weight of each wheel was tested before packing and prior to the exposure, and tested again after exposure for 1 month, 3 months, or 6 months. The average water vapor uptake of wheels in the same package or 3 wheels of Sample CS3 is illustrated in FIG. 14. Water vapor uptake of each wheel was measured on certain days by determining the weight difference between a wheel prior to exposure and after and comparing the weight difference to the weight prior to exposure.

[00207] As illustrated in FIG. 14, Sample S1 demonstrated lower water vapor uptake for the tested periods of time comparing to CS2 and CS3. After 6-month of exposure to humidity, the water vapor uptake of Sample S1 remained significantly lower than Samples CS2 and CS3, and significantly lower than the water vapor uptake threshold of 0.3%. It is believed that after moisture in the product exceeds 0.3%, the grinding performance of the wheels, such as, grinding or cutting, can be degraded.

[00208] Embodiments disclosed herein represent a departure from the state of the art. Particularly, the combination of a barrier layer and package described in embodiments herein can allow improved and extended protection of abrasive tools from environmental humidity, such as by reducing water vapor uptake of the abrasive tools, which can be expected to improve performance of the abrasive tools over time and mitigate aging of the abrasive tools. In particular instances, a package can contain a plurality of abrasive tools, such as at least 10, at least 40, or even at least 100 abrasive articles. In those situations, storage of the remaining abrasive articles can be expected to be improved and extended after some of the abrasive articles have been taken out of the package for use.

[00209] Note that not all of the activities described above in the general description or the examples are required, that a portion of a specific activity may not be required, and that one or more further activities may be performed in addition to those described. Still further, the order in which activities are listed is not necessarily the order in which they are performed.

[00210] Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims. Reference herein to a material including one or more components may be interpreted to include at least one embodiment wherein the material consists essentially of the one or more components identified. The term "consisting essentially" will be interpreted to include a composition including those materials identified and excluding all other materials except in minority contents (e.g., impurity contents), which do not significantly alter the properties of the material. Additionally, or in the alternative, in certain non-limiting embodiments, any of the compositions identified herein may be essentially free of materials that are not expressly disclosed. The embodiments herein include range of contents for certain components within a

material, and it will be appreciated that the contents of the components within a given material total 100%.

[00211]The specification and illustrations of the embodiments described herein are intended to provide a general understanding of the structure of the various.embodiments. The specification and illustrations are not intended to serve as an exhaustive and comprehensive description of all of the elements and features of apparatus and systems that use the structures or methods described herein. Separate embodiments may also be provided in combination in a single embodiment, and conversely, various features that are, for brevity, described in the context of a single embodiment, may also be provided separately or in any subcombination. Further, reference to values stated in ranges includes each and every value within that range. Many other embodiments may be apparent to skilled artisans only after reading this specification. Other embodiments may be used and derived from the disclosure, such that a structural substitution, logical substitution, or another change may be made without departing from the scope of the disclosure. Accordingly, the disclosure is to be regarded as illustrative rather than restrictive.

WHAT IS CLAIMED IS:

1. An article comprising:

a bonded abrasive including a body and a barrier layer coupled to the body, wherein the body comprises abrasive particles contained within a bond material; and

a package having an interior volume and the bonded abrasive contained in the interior volume, wherein the bonded abrasive article has a water vapor uptake of at most 0.3% when exposed to 90% relative humidity at 20°C for more than 3 months.

2. An article comprising:

a bonded abrasive including a body and a barrier layer coupled to the body, wherein the body comprises abrasive particles contained within a bond material; and

a package having an interior volume and the bonded abrasive contained in the interior volume, wherein the package has a water vapor transmission rate of at most 2 g/m^2-day.

3. An article comprising:

a plurality of bonded abrasives, each including a body and a barrier layer coupled to the body, wherein the body comprises abrasive particles contained within a bond material; and

a package having an interior volume and the plurality of bonded abrasives contained in the interior volume, wherein the package has a water vapor transmission rate of at most 2 g/m^2-day.

4. The article of any one of the preceding claims, wherein the barrier layer comprises a water vapor transmission rate of at least 0.00001 g/ m^2-day, at least 0.00005 g/m^2-day, at least 0.0001 g/m^2-day, at least 0.0005 g/m^2-day, at least 0.001 g/m^2-day, or at least 0.005 g/m^2-day, at least 0.01 g/m^2-day, at least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.04 g/m^2-day, at least 0.05 g/m^2-day, or at least 0.06 g/m^2-day, at least 0.07 g/m^2-day, at least 0.08 g/m^2-day, at least 0.09 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-dayat least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-day.

5. The article of any one of the preceding claims, wherein the barrier layer comprises a water vapor transmission rate of at most 2.0 g/m^2-day, at most 1.8 g/m^2-day, at most 1.6 g/m^2-day, at most 1.4 g/m^2-day, at most 1.2 g/m^2-day, at most 1.0 g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day, at most 0.5 g/m^2-day, or at most 0.4 g/m^2-day, at most 0.3 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/ g/m^2-day, at most 0.18 g/ g/m^2-day, at most 0.16 g/ g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, or at most 0.05 g/m^2-day.

6. The article of any one of the preceding claims, wherein the body comprises a first major surface, a second major surface opposite the first major surface, and a peripheral surface extending between the first and second major surfaces, wherein the barrier layer is adhered to at least one of the first and second major surfaces.

7. The article of any one of the preceding claims, wherein the barrier layer comprises a wax, oil, a polymer, a metal, or any combination thereof.

8. The article of any one of the preceding claims, wherein the barrier layer is directly bonded to at least one of the first and second major surfaces.

9. The article of any one of claims 1 to 7, wherein the barrier layer is in a peelable configuration having a peel strength of not greater than 3000 g/in.

10. The article of any one of the preceding claims, wherein the barrier layer comprises a metal-containing film, a polymer-containing film, a metal foil, or any combination thereof.

11. The article of any one of the preceding claims, wherein the barrier layer comprises a polymer selected from the group consisting of a thermoplastic and a thermoset.

12. The article of any one of the preceding claims, wherein the barrier layer comprises a polymer selected from the group consisting of polyamides, polyesters, polyethlyenes, polypropylene, polyvinyls, epoxies, resins, polyurethanes, rubbers, polyimides, phenolics, polybenzimidazole, aromatic polyamide, and a combination thereof.

13. The article of any one of the preceding claims, wherein the polymer-containing film comprises a polymer including a biaxially-oriented material.

14. The article of claim 13, wherein the polymer comprises polyethylene terephthalate, nylon, or a combination thereof.

15. The article of any one of the preceding claims, wherein the barrier layer comprises aluminum, iron, tin, copper, scandium, titanium, vanadium, chromium, manganese, nickel, zinc, yttrium, zirconium, niobium, molybdenum, silver, palladium cadmium, tantalum, tungsten, platinum, gold, or any combination thereof.

16. The article of any one of the preceding claims, wherein the barrier layer comprises a metal-containing film including aluminum, a metal foil including aluminum, or a combination thereof.

17. The article of any one of the preceding claims, wherein the barrier layer comprises a polymer-containing film overlying the metal-containing film.

18. The article of any one of the preceding claims, wherein the barrier layer comprises a polymer-containing film bonded directly to the metal-containing film.

19. The article of any one of the preceding claims, wherein the barrier layer comprises a polymer-containing film and wherein the polymer-containing film is bonded directly to at least one of the first and second major surface of the body.

20. The article of any one of the preceding claims, wherein the barrier layer comprises a first polymer-containing biaxially-oriented nylon, a second polymer-containing film including polyethylene, a third polymer-containing film including polyethylene, and a fourth polymer-containing film including co-extruded polyethylene, and a foil.

21. The article of any one of the preceding claims, wherein the barrier layer comprises a wax-containing film as an outermost film of the barrier layer.

22. The article of any one of the preceding claims, wherein the barrier layer comprises a coating including a polymer, oil, wax, or any combination thereof.

23. The article of claim 22, wherein the coating is in direct contact with the body.

24. The article of any one of claims 1 to 6, wherein the barrier layer comprises a coating including wax, wherein the coating is in direct contact with the body.

25. The article of any one of claims 1 to 6, wherein the barrier layer comprises a coating including a polymer including polyurethane, polyvinylidene chloride (PVDC), latex, or any combination thereof, , wherein the coating is in direct contact with the body.

26. The article of any one of the preceding claims, wherein the package has a water vapor transmission rate of at most 1.9 g/m^2-day, at most 1.8 g/m^2-day, at most 1.7 g/m^2-day, or at most 1.6 g/m^2-day, at most 1.5 g/m^2-day, or at most 1.4 g/m^2-day, at most 1.3 g/m^2-day, at most 1.2 g/m^2-day, at most 1.1 g/m^2-day, at most 1.0 g/ g/m^2-day, at most 0.9 g/m^2-day, at most 0.8 g/m^2-day, at most 0.7 g/m^2-day, or at most 0.6 g/m^2-day, at most 0.5 g/m^2-day, or at most 0.4 g/m^2-day, at most 0.3 g/m^2-day, at most 0.25 g/m^2-day, at most 0.22 g/m^2-day, at most 0.20 g/ g/m^2-day, at most 0.18 g/ g/m^2-day, at most 0.16 g/ g/m^2-day, at most 0.15 g/m^2-day, at most 0.13 g/m^2-day, at most 0.11 g/m^2-day, at most 0.09 g/m^2-day, at most 0.07 g/m^2-day, or at most 0.05 g/m^2-day.

27. The article of any of the preceding claims, wherein the package comprises a water vapor transmission rate of greater than 0 g/m^2-day, at least 0.0001 g/m^2-day, at least 0.001 g/m^2-day, at least 0.01 g/m^2-day, at least at least 0.02 g/m^2-day, at least 0.03 g/m^2-day, at least 0.04 g/m^2-day, at least 0.05 g/m^2-day, or at least 0.06 g/m^2-day, at least 0.07 g/m^2-day, at least 0.08 g/m^2-day, at least 0.09 g/m^2-day, at least 0.1 g/m^2-day, at least 0.2 g/m^2-day, at least 0.3 g/m^2-day, at least 0.4 g/m^2-day, at least 0.5 g/m^2-day, or at least 0.6 g/m^2-day.

28. The article of any one of the preceding claims, wherein the package comprises a packaging material forming a side wall surrounding the interior volume.

29. The article of claim 28, wherein the packaging material comprises a self-supporting material.

30. The article of any one of the preceding claims, wherein the package comprises a packaging material including an elemental metal, an alloy, a polymer, or any combination thereof.

31. The article of any one of the preceding claims, wherein the package comprises a packaging material including a metal coated in a polymer film.

32. The article of any one of the preceding claims, wherein the package comprises a packaging material including iron, nickel, chromium, aluminum, tin, or a combination thereof.

33. The article of claim 32, wherein the packaging material comprises steel.

34. The article of claim 32 or 33, wherein the packaging material comprises tin-coated steel.

35. The article of any one of claims 32 to 33, wherein the packaging material comprises plastic-coated steel.

36. The article of any one of the preceding claims, wherein the package comprises a packaging material including a high density polyethylene, low density polyethylene, polypropylene, or any combination thereof.

37. The article of any one of the preceding claims, wherein the package comprises a packaging material including a metalized film.

38. The article of any one of the preceding claims, wherein the package comprises a packaging material including a metal foil.

39. The article of any one of the preceding claims, wherein the package comprises a packaging material including a plastic.

40. The article of any one of claims 1 to 29, wherein the package comprises a packaging material consisting essentially of an organic material.

41. The article of any one of the preceding claims, wherein the bonded abrasive article has a water vapor uptake of at most 0.3% or at most 0.2% or at most 0.1% when exposed to 90% relative humidity at 20°C for 4 months.

42. The article of any one of the preceding claims, wherein the bonded abrasive article has a water vapor uptake of at most 0.3% when exposed to 90% relative humidity at 20°C for at least 3 moths, at least 4 moths, at least 5 months, or at least 6 months.

43. The article of any one of the preceding claims, wherein at least 3, at least 5, at least 8, at least 10, at least 15, at least 20, at least 30, at least 50 , or at least 100 bonded abrasives are contained in the interior volume.

44. The article of any one of the preceding claims, wherein the bond material comprises an organic bond material.

45. The article of any one of the preceding claims, wherein the bonded abrasive article comprises an ultra thin wheel, a grinding wheel, combination wheel, or a cutoff wheel.

46. The article of any one of the preceding claims, wherein the package is configured to be resealed after it is opened.

47. The article of any one of the preceding claims, wherein the package is in a form of a bucket, a bag, a box, or a pouch.

48. The article of claim 47, wherein the package is in the form of a bucket.

ABSTRACT

An article can include a package and an abrasive tool that includes a barrier layer. The abrasive tool can include a bonded abrasive. The package can have an interior volume and the abrasive tool can be contained in the interior volume. In an embodiment, the abrasive article can have a water vapor uptake of at most 0.3% when exposed to 90% relative humidity at 20°C for more than 3 months. In another embodiment, the package can have a water vapor transmission rate of at most 2 g/m^2-day.

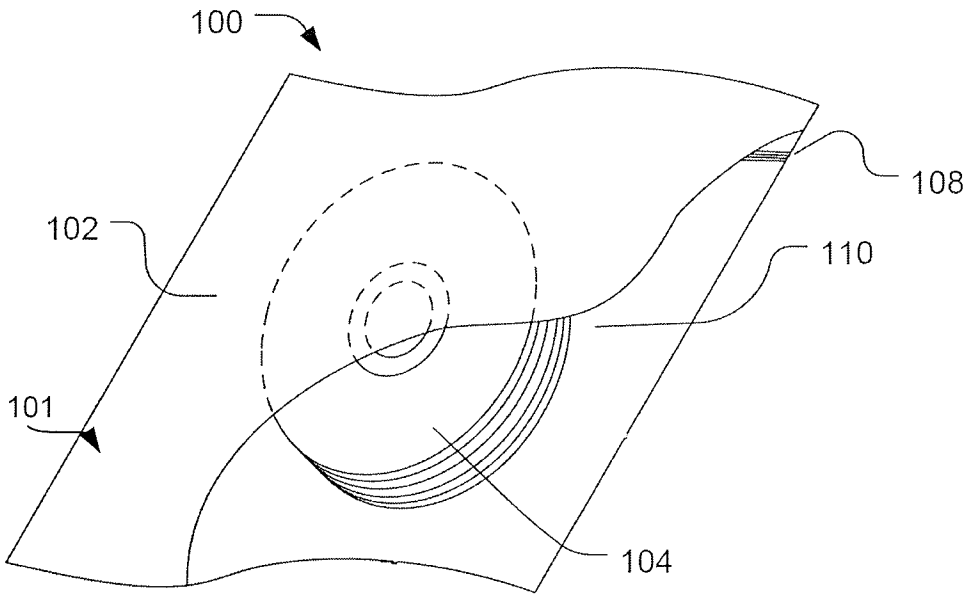

FIG. 1

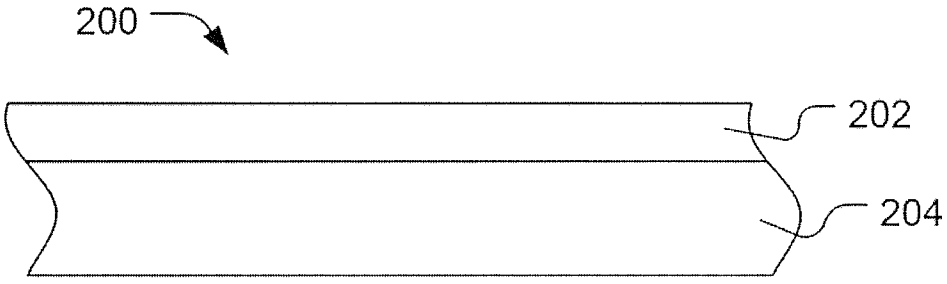

FIG. 2

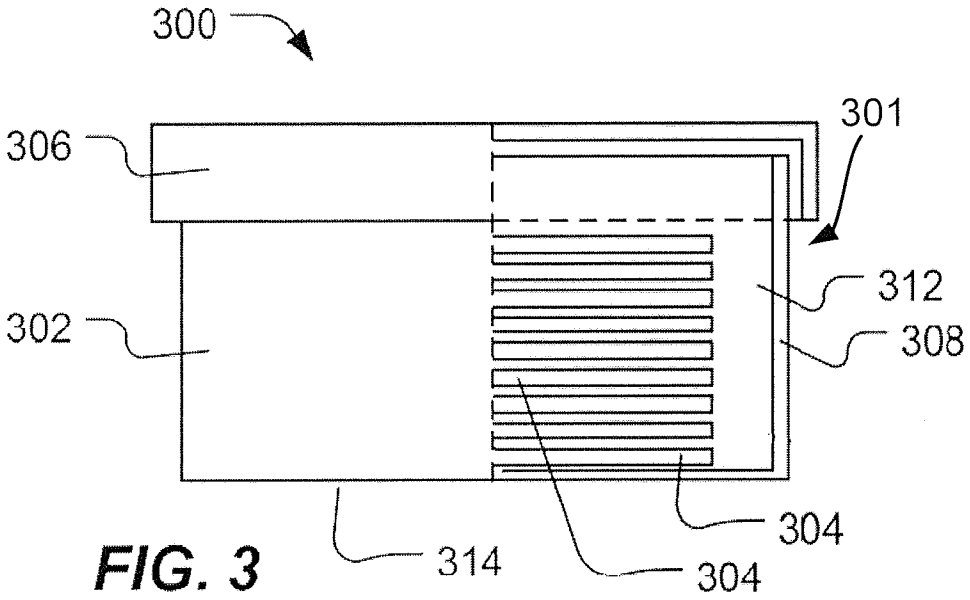

FIG. 3

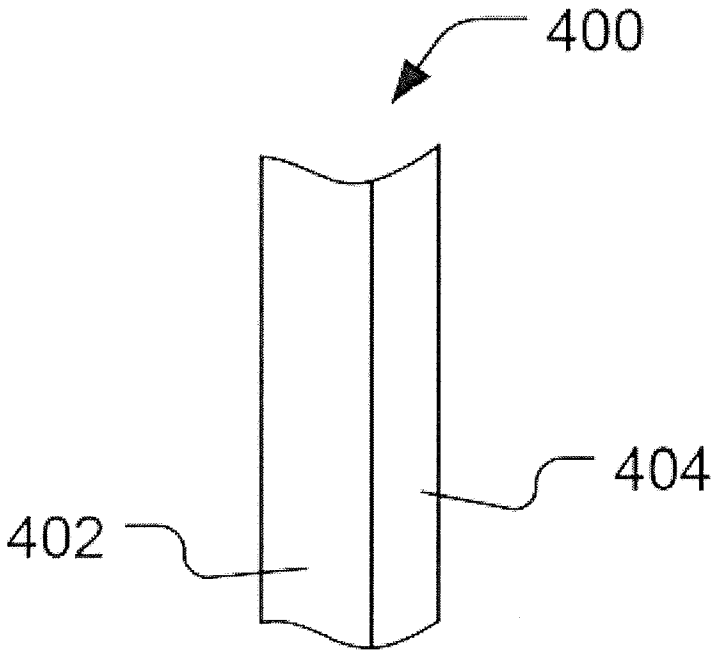

FIG. 4

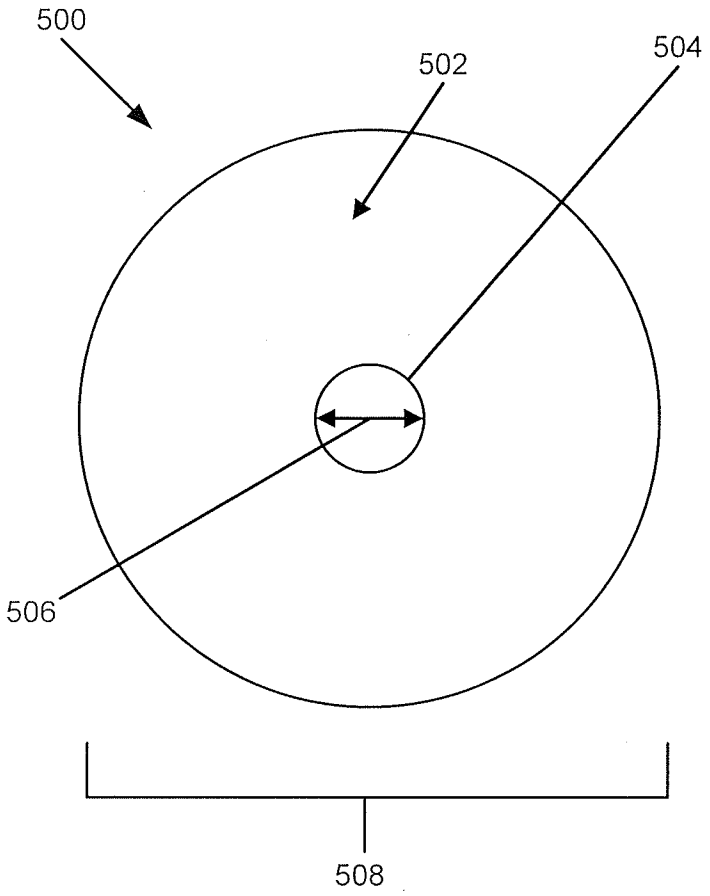

FIG. 5A

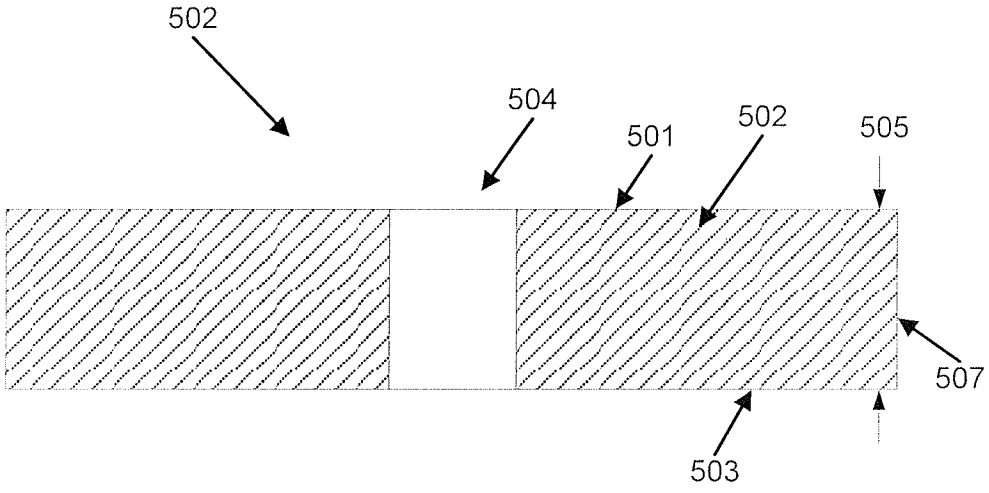

FIG. 5B

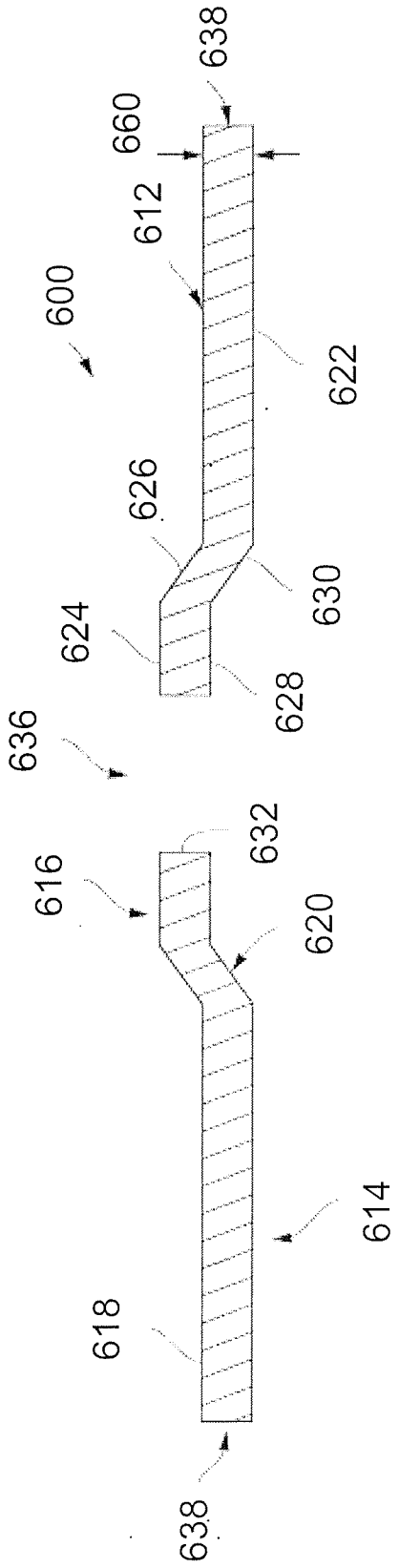

FIG. 6A

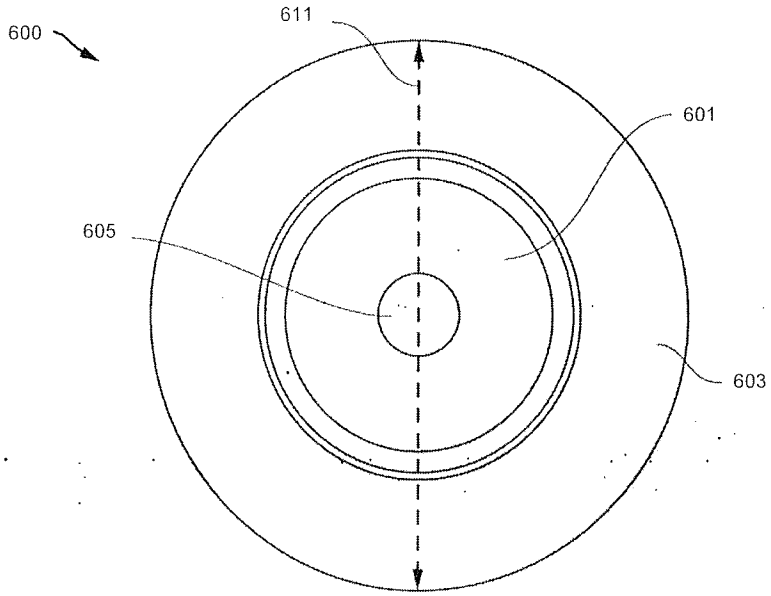

FIG. 6B

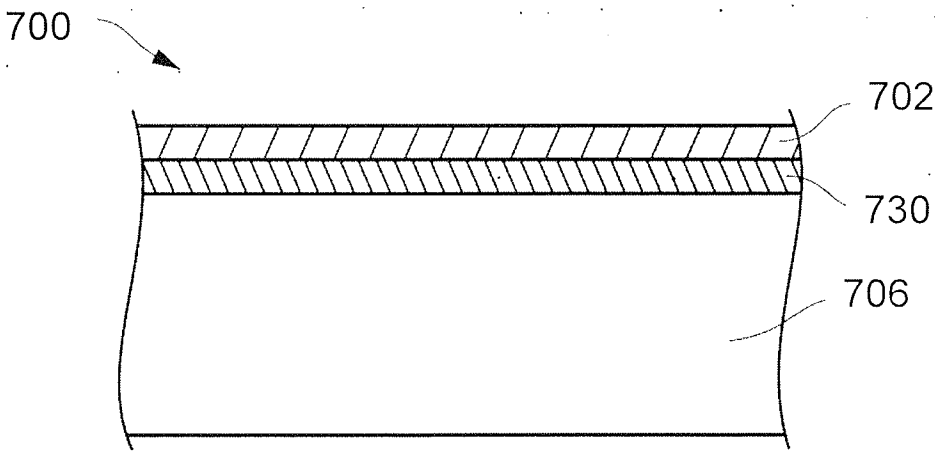

FIG. 7

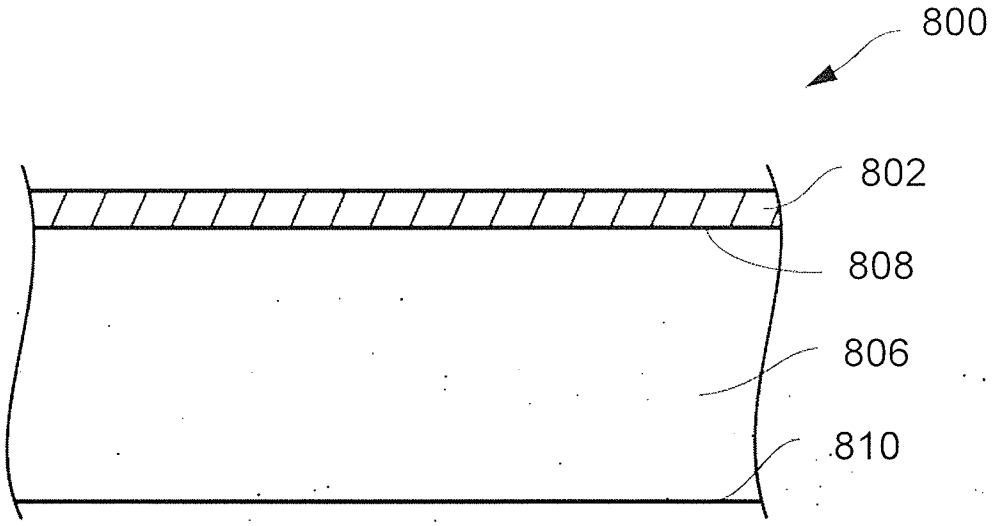

FIG. 8

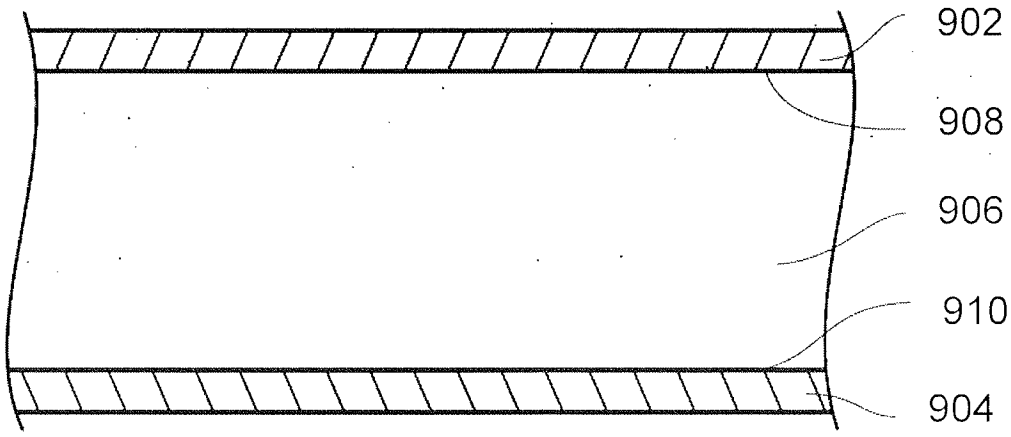

FIG. 9

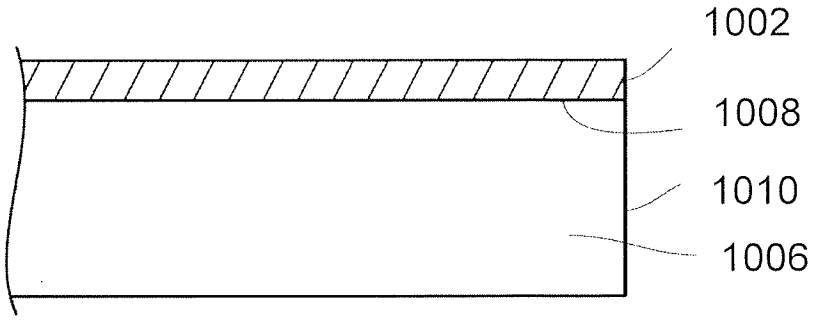

FIG. 10A

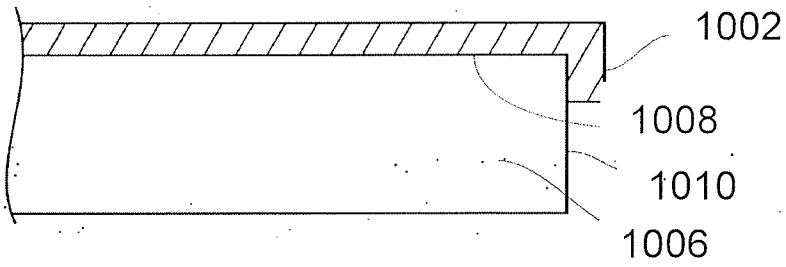

FIG. 10B

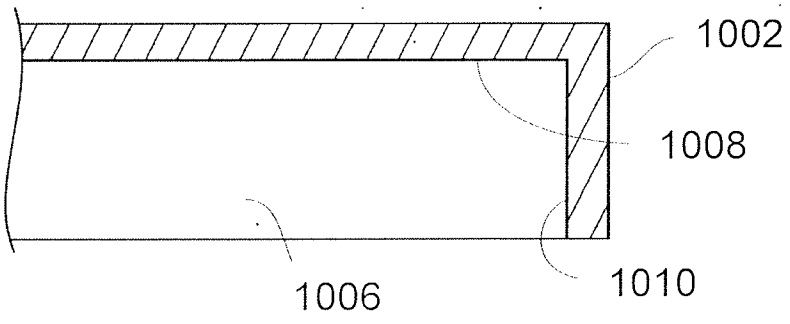

FIG. 10C

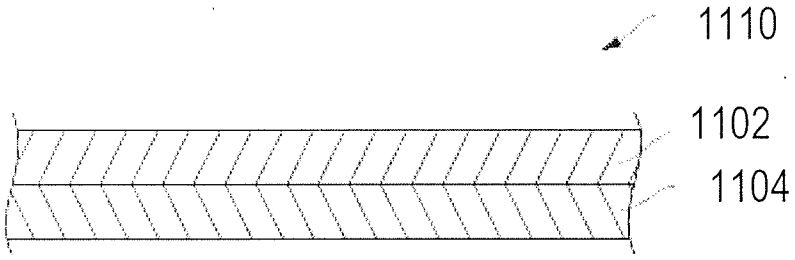

FIG. 11A

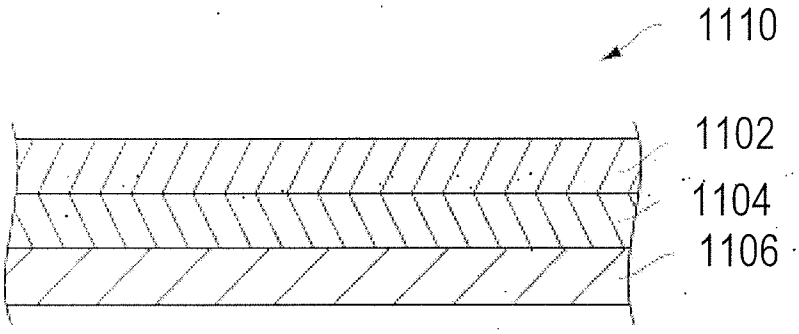

FIG. 11B

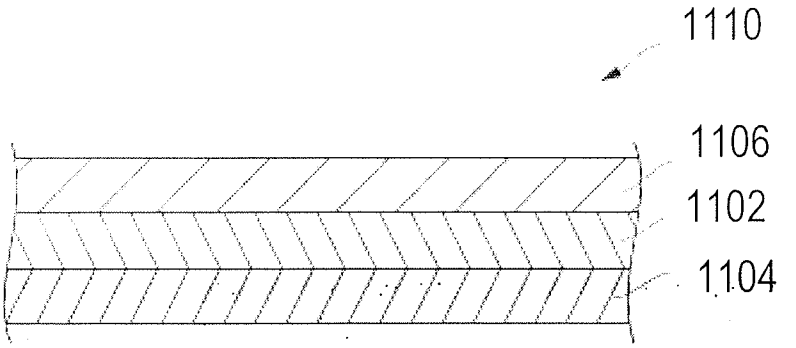

FIG. 11C

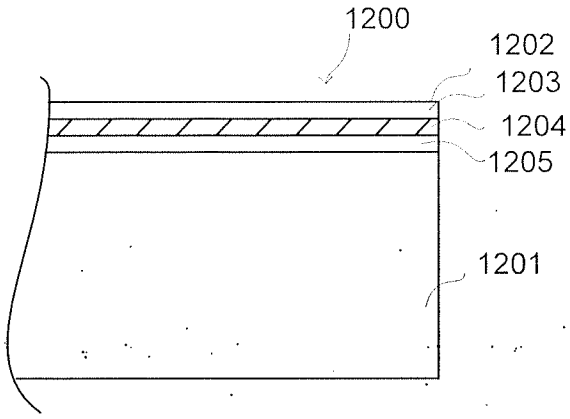

FIG. 12A

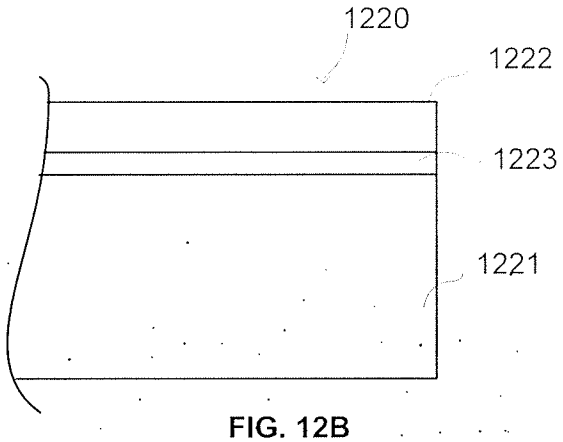

FIG. 12B

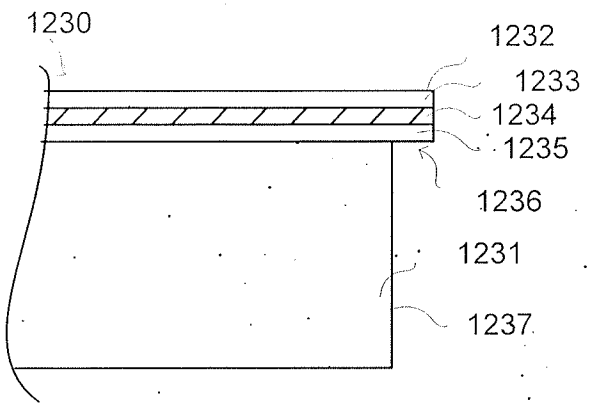

FIG. 12C

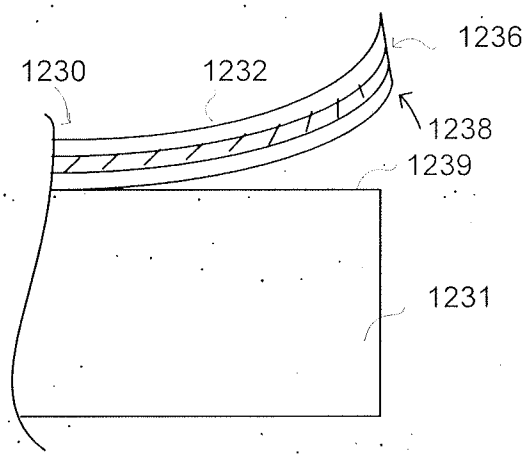

FIG. 12D

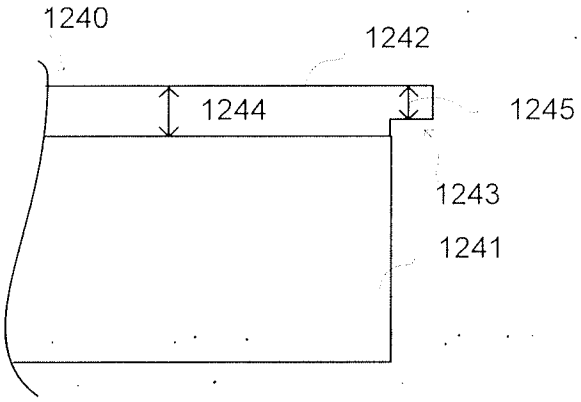

FIG. 12E

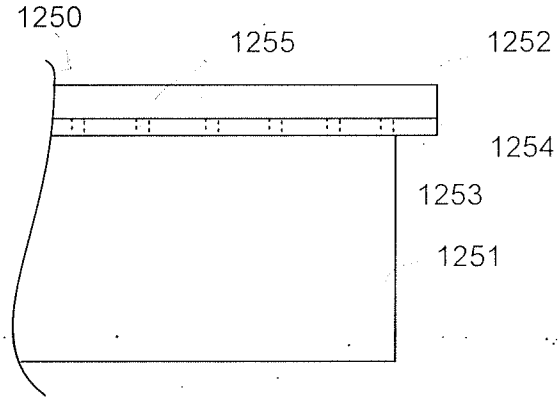

FIG. 12F

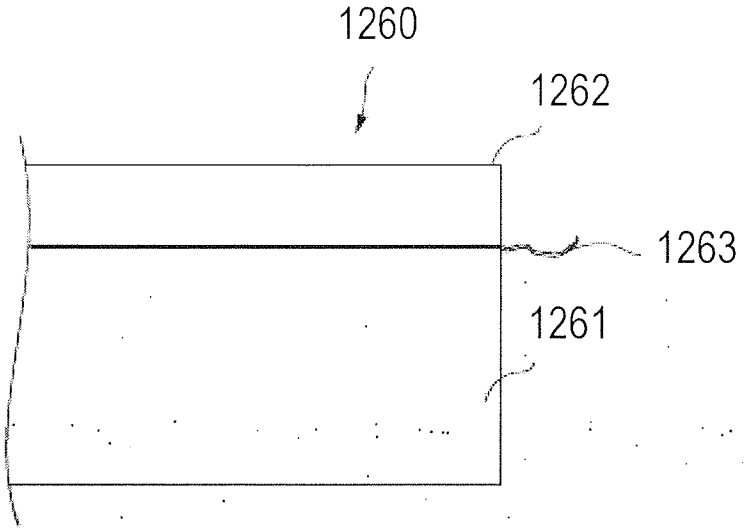

FIG. 12G

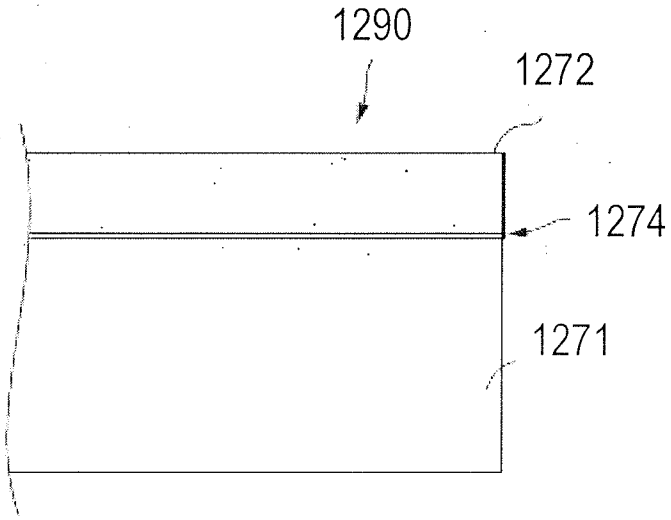

FIG. 12H

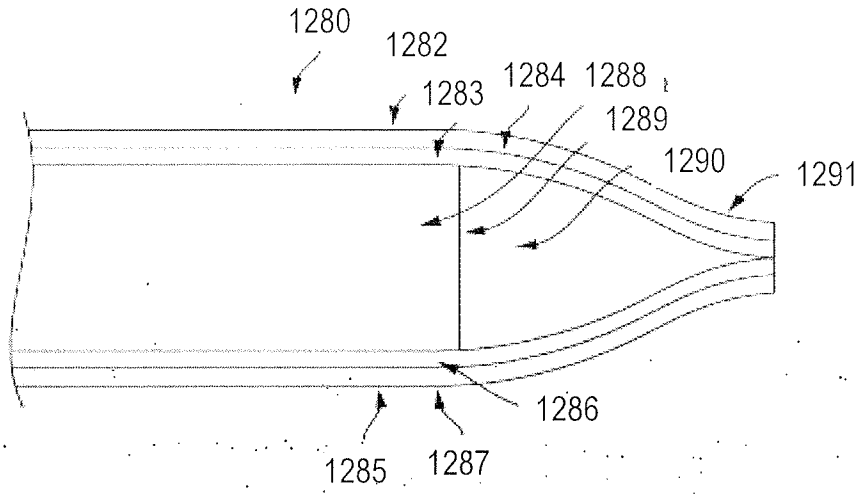

FIG. 12I

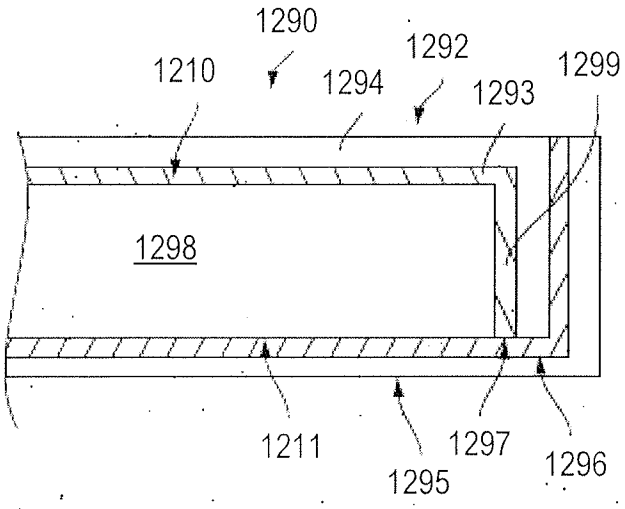

FIG. 12J

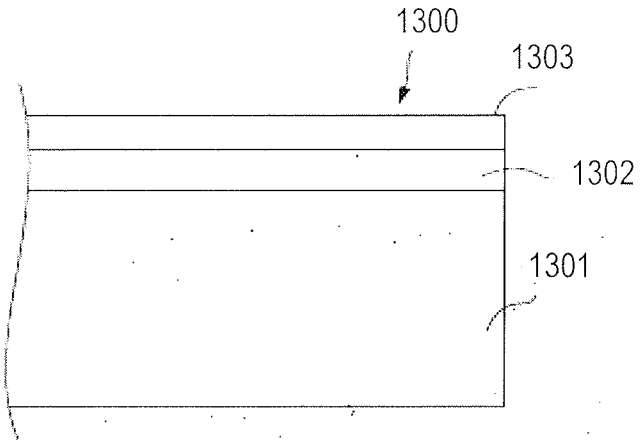

FIG. 13

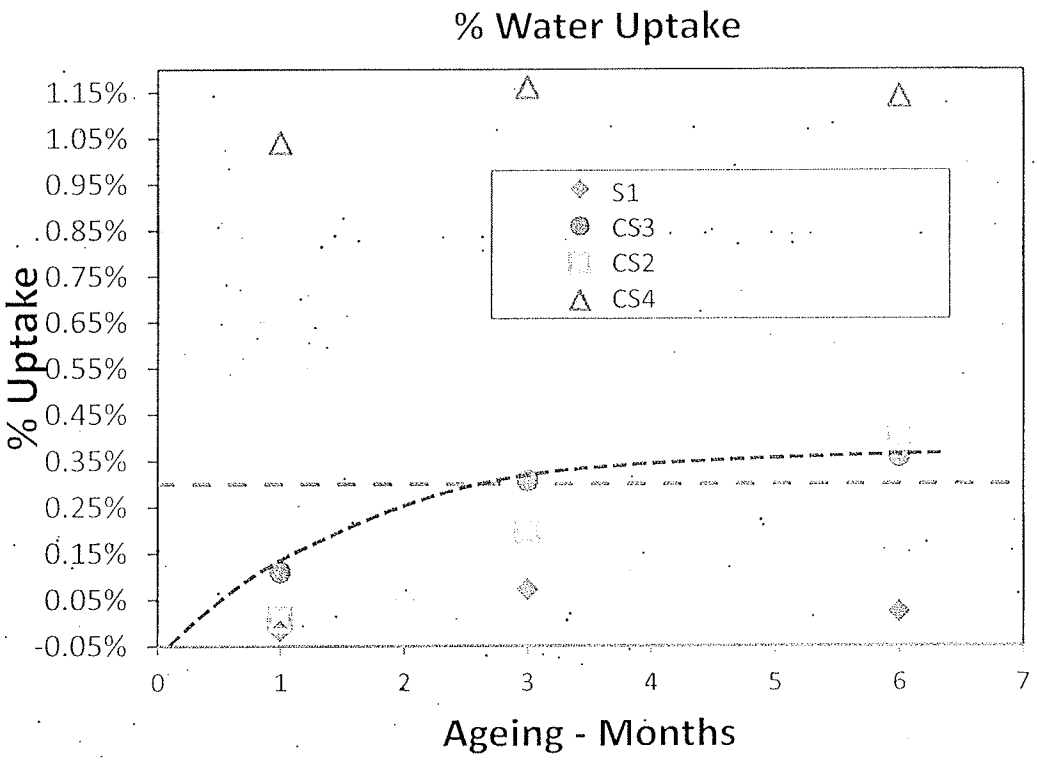
% Water Uptake
1.15%
1.05%
0.95%
0.85%
0.75%
0.65%
0.55%
0.45%
0.35%
0.25%
0.15%
0.05%
-0.05%
% Uptake
S1
CS3
CS2
CS4
0
1
2
3
4
5
6
7
Ageing - Months

FIG. 14