An abrasive article and methods of making and using the same are disclosed. The abrasive article includes a particle impermeable back-up pad attached to an abrasive disc. The abrasive disc includes a plurality of perforations therethrough. When the abrasive article is moved and contacted against a workpiece, debris from the workpiece is captured between the back-up pad and workpiece.
NON-LOADING ABRASIVE ARTICLE

FIELD

[0001] The present disclosure relates generally to abrasive articles, and more particularly to back-up pad/abrasive disc combinations.

BACKGROUND

[0002] Back-up pads are used in the abrasives field to support an abrasive article, such as a disc or sheet during abrading. These abrasive articles can be in various forms, such as a disc, a sheet, or a polygon and, may optionally, contain holes or slits to aid in dust extraction. The back-up pad includes a generally planar major surface, to which the abrasive article, such as a disc or sheet, may be attached. Although back-up pads may be hand held, back-up pads are more commonly used in conjunction with a powered abrading apparatus such as electric or pneumatic sanders.

[0003] Abrasive discs and sheets (hereinafter collectively “discs”) may be attached to a back-up pad in various ways. One attachment method includes an abrasive disc having pressure sensitive adhesive (PSA) on one surface thereof, such that the abrasive disc may be adhered to the major surface of the back-up pad. The major surface of the back-up pad may have, for example, a smooth foam, vinyl, or cloth surface to facilitate attachment of the abrasive disc. An example of such a back-up pad is available from 3M Company of St. Paul, Minn., under the designation “STIKIT” brand back-up pad. An example of an abrasive disc for attachment to that back-up pad is available from the same company under the designation “STIKIT” brand abrasive disc.

[0004] A second type of back-up pad includes a major surface having a plurality of hooks projecting therefrom. The hooks are adapted to engage certain structures provided on the back face of an abrasive disc to releasably attach the disc to the back-up pad. An example of such a back-up pad is available from the 3M Company of St. Paul, Minn., under the designation “HOOKIT” brand back-up pad, and an example of an abrasive disc for attachment to that back-up pad is available from the same company under the designation “HOOKIT” brand abrasive disc. Alternatively, the back-up pad major surface can include engaging structures to cooperate with hooks on an abrasive disc. An example of such an assembly is available from 3M Company under the designation “HOOKIT II” brand back-up pad and abrasive disc.

SUMMARY

BRIEF DESCRIPTION OF THE DRAWING

[0005] The present disclosure will be further explained with reference to the appended Figures, wherein like structures are referred to by like numerals throughout the several views, and wherein:

[0006] FIG. 1 is a section view of an example embodiment of a back-up pad and abrasive disc combination according to the present disclosure;

[0007] FIG. 2 is an example embodiment of a disc according to the present disclosure;

[0008] FIG. 3 is example embodiment of a disc according to the present disclosure;

[0009] FIG. 4 an example embodiment of a disc according to the present disclosure;

[0010] FIG. 5 an example embodiment of a disc according to the present disclosure;

[0011] FIG. 6 an example embodiment of a disc according to the present disclosure;

[0012] FIG. 7 an example embodiment of a disc according to the present disclosure; and

[0013] FIG. 8 an example embodiment of a disc according to the present disclosure.

DETAILED DESCRIPTION

[0014] Generally, the invention of the present disclosure is directed to an abrasive article including a back-up pad removably attached to an abrasive disc. With the context of this disclosure, removably attached means that the disc is secured to the back-up such that it will not detach during an abrading operation, but can be removed from the back-up pad via manual means, e.g., taken off by hand. The abrasive disc includes a plurality of perforations or holes there-through for allowing passage of debris (swarf, dust, particles, metal, etc.) from a workpiece into the area or volume between the back-up pad and the abrasive disc.

[0015] FIG. 1 illustrates an exemplary article 105 including back-up pad 110 with an abrasive article 130 attached thereto. Abrasive layer 111 of article 130 comprises a plurality of abrasive particles 120 attached to a flexible backing 112 by adhesive coating 121. The backing 112 has a front side 113 and a backside 114. Attachment layer 115 is provided as a pressure sensitive adhesive layer (PSA) to releasably attach the abrasive article 130 (layers 111 and 112) to the facing layer 116 provided on the front surface 117 of molded foam layer 118. Foam layer 118, on its rear surface 119, is attached to a rigid metal backing plate 122. A threaded stud 123 is fixed in a known manner to the back side of the rigid backing plate 122 to allow attachment of the back-up pad 110 to a suitable tool or drive means (not shown) capable of, for example, rotatably driving the pad 110 and the article 130 around the longitudinal axis of threaded stud 123. The back-up pad 110 is substantially impermeable to matter that is removed during the abrading process.

[0016] Various perforation (interchangeably, also holes) configurations in the abrasive disc can be used with the particle impermeable back up pad. FIG. 2 illustrates a 5-hole disc 230, which is typically 3-8 inches (76.2-203.2 mm) in diameter. The holes 250 are spaced-regularly around the disc 230, at about 72 degree intervals. Such discs are available under the trade designation “DUST-FREE SANDING DISCS—5 HOLE,” from 3M Company, St. Paul, Minn.

[0017] While the above-described discs include circular holes (or perforations), other shapes can be used, either
singly or in combination. Referring to FIG. 4, an exemplary disc 420 includes alternating rectangular shaped perforations 452 arranged regularly around the disc 420. Triangular perforations 452 are placed between the rectangular perforations near the periphery of the disc 420.

[0018] FIG. 5 illustrates an 8-perforation disc 520, which is typically 3.8 inches (76.2-203.2 mm) in diameter. The perforations 550 are spaced-regularly around the disc 520, at about 45-degree intervals. The perforations 550 have an end 551 near the periphery of the disc 520 and extend inwardly along a diameter of the disc 520 to a second end 553 near the center of the disc 520.

[0019] FIG. 6 illustrates an 8-perforation disc 630, which is typically 3.8 inches (76.2-203.2 mm) in diameter. The perforations 650, 652 are spaced-regularly around the disc 630. The perforations 650, 652 are arcuate and have a circularly-shaped end 651, 653 near the periphery of the disc 630 and extend inwardly to a second cusp-shaped end 655, 657 near the center of the disc 630.

[0020] FIG. 8 illustrates a 13-perforation disc 820, which is typically 3.8 inches (76.2-203.2 mm) in diameter. Eight perforations 850 are spaced-regularly around the disc 820 near the disc 820 periphery, at about 45-degree intervals. The remaining five perforations 850 include a center hole and an X-shaped layout of the remaining four perforations surrounding the center hole.

[0021] Other possible arrangements include the holes or perforations distributed over the entire disc, both uniformly and non-uniformly. The holes or perforations can also be distributed over annular sections of the disc. The perforations on a given disc can be of uniform size, or can be of various shapes and sizes.

[0022] To increases the amount of debris that can be accommodated between the disc and the back-up pad, means for accumulating the debris can be optionally included. For example, the back-up pad can have an undulating surface, wherein the low points in the surface will allow more debris to be trapped. The back-up pad can also include cavities, which allows debris to be trapped. An interface pad can also be included between the back-up pad and the disc, adding further debris holding capacity. An exemplary interface pad is available under the trade designation “SOFT INTERFACE PAD,” available from 3M Company, St. Paul, Minn.

[0023] The back-up pad of the invention can be used in any of a variety of desired abrading applications so long as it is properly designed to meet the requirements of the given abrading application. The foam material and mixing proportions of the components of the foam should be formulated to meet the needs of the desired abrading application.

[0024] It is within the capability of one of ordinary skill in the art to select the back-up pad to meet the requirements of the abrading for which the pad is used. It is to be understood that the term abrading, and its variants, as used herein are meant to include operations used to reduce or refine a workpiece surface through frictional contact between the workpiece surface and an abrasive article, such as grinding, sanding, finishing, cleaning or polishing operations. These abrading applications can vary widely from final polishing of ophthalmic lenses to heavy stock removal of metal parts. These abrading applications can also involve either abrading by hand or abrading with a machine as the mode of driving the abrasive article in motion. The abrading motions may include a linear motion, random motion, rotary motion, oscillation, random orbital motion, combinations thereof or the like.

[0025] The shape of the foam back-up pad may be a square, triangle, rectangle, oval, circle, pentagon, hexagon, octagon, polygon, or any other suitable shape. The diameter for a circular back-up pad ranges from about 0.5 to 50 inches (1.25 cm to 127.0 cm), typically 1 to 30 inches (2.5 cm to 76.2 cm). The length and/or width of the back-up pad can range from about 0.05 to 50 inches (0.13 cm to 127.0 cm), typically 1 to 30 inches (2.5 cm to 76.2 cm). In some instances, a coated abrasive article will overhang the back-up pad by a very slight amount, i.e., typically less than 0.1 inches (0.25 cm), preferably less than 0.05 inches (0.13 cm). The thickness of the foam body member generally will range from between about 0.2 cm to 7.0 cm typically 0.5 cm to 5.0 cm, and preferably between 1.0 cm to 3.0 cm.

[0026] The foam back-up layer, as used in most abrading applications, will be molded to present a pair of substantially parallel spaced major surfaces or faces. Referring to FIG. 1, the front face 117 of the foam back-up pad 110 provides a surface upon which a pad-facing layer 116 can be provided. Examples of materials useful for forming the front facing layer include cloth, nonwoven substrates, treated cloth, treated nonwoven substrates, polymeric films and the like. Examples of preferred front facing materials include loop fabric, cloth sheeting, vinyl sheeting, hooks, nylon coated cloths, vinyl coated nonwovens, vinyl coated cloth, hook faced materials, and the like. The loop fabric can be a knitted loop, brushed loop, a chenille stitched loop, and the like. The polyurethane material of the foam layer 118 is bonded to the pad-facing layer 116 and can be hardened in situ on the pad facing. For instance, a polyurethane material can be foamed directly to the back side of a pad facing such as loop fabric, thereby adhering to the pad facing. Alternatively, the front facing material can be adhesively bonded to the polyurethane foam. If the polyurethane is foamed onto the front facing material, the front facing material preferably is first sealed to prevent undesired excessive penetration of the foam therethrough.

[0027] If the foam back-up pad is intended to be used in machine driven applications, it will typically have some type of mechanical attachment system opposite the side of the loop fabric to secure the back-up pad to the machine. One such system comprises rigid backing plate 122 fixed to the rear surface 119 of the foam back-up pad 110 with threaded stud 123 fixed to the plate 122 (e.g., by welding) for attachment of the foam pad 110 to a drive motor, such as described in U.S. Pat. No. 4,844,967 (Goralski), incorporated herein by reference. Backing plate 122 is affixed (e.g., by rivets) to a larger diameter fiberglass plate (not shown) or an equivalent member, and the foam surface 119 is bonded directly to the fiberglass to thereby affix the mounting system to the back-up pad 110. Any of a variety of systems or means can be provided for detachable coupling of the foam pad 110 to different types of drive motor assemblies. Such means are known in the art and may include, for example, central concentric openings extending through the foam and the backing plate and accommodating the threaded end of a headed bolt, with the bolt head abutting the surface of the backing plate affixed to the foam with the head of the bolt positioned in the central opening of the foam and the
threaded end of the bolt engaging the drive member of a drive motor assembly. For random orbital applications, the support member may contain a threaded stud or other attachment system for mounting onto the machine. Other means that can be provided to adapt the back-up pad for operation with drive mechanisms include those disclosed in U.S. Pat. No. 4,631,220 (Clifton), incorporated herein by reference. It will be understood that the invention is not limited by the specific mounting system employed, and those skilled in the art will appreciate that the specific mounting system employed for use with a specific back-up pad will depend on the type of tool to be used with the pad.

[0028] For manual abrasive operations held in the hand, various shapes or configurations of foam back-up pads may be utilized. Two such types include hand pads and foamed back-up pads used on long planing boards. The strength and other physical properties required for these manual abrasive operations is less than those for random orbital applications where the strength and physical property requirements of the foam become much more significant. The physical properties of the foam depend on the end use application. As the back-up pad is used in abrading applications, there can be a manual grip handle associated with it.

[0029] In some instances, it is preferred to incorporate a pressure sensitive adhesive onto the backside of the abrasive article so that the backing of the abrasive article can be secured to the facing layer of the foam back-up pad. Representative examples of pressure sensitive adhesives suitable for this invention include latex crepe, rosin, acrylic polymers and copolymers e.g., polybutylacrylate, polyacrylate ester, polyvinyl ethers, e.g., polyvinyl n-butyl ether, alkyl adhesives, rubber adhesives, e.g., natural rubber, synthetic rubber, chlorinated rubber, and mixtures thereof. The preferred pressure sensitive adhesive is an isocyanate: acrylic acid copolymer.

[0030] Alternatively, a hook and loop type attachment system may be employed to secure the abrasive article to the facing of the foam back-up pad. The hook fabric may be on the backside of the abrasive article with hooks on the front side of the back-up pad. Otherwise, the hooks may be on the backside of the abrasive article with loops on the front side of the back-up pad. This hook and loop type attachment system is further described in U.S. Pat. No. 4,609,581 (Ott); U.S. Pat. No. 5,254,194 (Ott et al.); U.S. Pat. No. 6,759,162 (Chesley et al.); U.S. Pat. No. 5,605,747 (Chesley et al.); U.S. Pat. No. 5,607,345 (Barry et al.); and U.S. patent publication No. 03-0159363-A1 (Chesley et al.), each of which is incorporated herein by reference. The opposite exposed front side of the abrasive article has an abrasive coating that is responsible for the abrading action.

EXAMPLES

[0031] The following materials were obtained from 3M Company, Saint Paul, Minn. As noted, some materials were subsequently modified for evaluation purposes.

[0032] “AD1”: A P320 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive disc, commercially available under the trade designation “210U P320 STIKIT DISC”;

[0033] “AD2”: A 5-hole P320 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive paper disc, commercially available under the trade designation “21OU C320 STIKIT DUST-FREE DISC”, wherein a single center-hole, 1/8 inch (3.5 cm) diameter, was die punched out of the abrasive film disc;

[0034] “AD3”: A P400 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive disc, commercially available under the trade designation “210U P400 STIKIT DISC”;

[0035] “AD4”: A 5-hole P400 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive paper disc, commercially available under the trade designation “210U P400 STIKIT DUST-FREE DISC”, wherein a single center-hole, 1/8 inch (3.5 cm) diameter, was die punched out of the abrasive film disc;

[0036] “AD5”: A P400 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive paper disc, commercially available under the trade designation “21OU P400 HOOKIT II DISC”;

[0037] “AD6”: A 5-hole P400 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive paper disc, commercially available under the trade designation “210U P400 HOOKIT II DUST-FREE DISC”, wherein a single center-hole, 1/8 inch (3.5 cm) diameter, was die punched out of the abrasive film disc;

[0038] “AD7”: A P400 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive paper disc, having a stearate anti-loading supersize, commercially available under the trade designation “216U P400 FRE-CUT HOOKIT II DISC”;

[0039] “AD8”: A 6-hole P400 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive paper disc, having a stearate anti-loading supersize, commercially available under the trade designation “216U P400 FRE-CUT HOOKIT II DUST-FREE DISC”;

[0040] “AD9”: A 9-hole P400 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive paper disc, having a stearate anti-loading supersize, commercially available under the trade designation “216U P400 FRE-CUT DUST-FREE HOOKIT II DISC”;

[0041] “AD10”: A P500 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive film disc, commercially available under the trade designation “360L P500 HOOKIT II”;

[0042] “AD11”: As per “AD10”, wherein a single center-hole, 1/8 inch (3.5 cm) diameter, was die punched out of the abrasive film disc;

[0043] “AD12”: A 5-hole P500 grade alumina, resin bonded, 5-inch (12.7 cm) diameter abrasive film disc, commercially available under the trade designation “360L P500 HOOKIT II DUST-FREE DISC”, wherein a single center-hole, 1/8 inch (3.5 cm) diameter, was die punched out of the abrasive film disc;

[0044] “AD13”: A P1000 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive film disc, commercially available under the trade designation “260L P1000 HOOKIT II DISC”;

[0045] “AD14”: A 6-hole P1000 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive film disc,
commercially available under the trade designation “260L P1000 HOOKIT II DUST-FREE DISC”;

0046) “AD15”: A P1000 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive film disc, commercially available under the trade designation “260L P1000 STIKIT DISC”;

0047) “AD16”: A 6-hole P1000 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive film disc, commercially available under the trade designation “260L P1000 STIKIT DUST-FREE DISC”;

0048) “AD17”: A P1000 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive film disc, commercially available under the trade designation “260L P1000 HOOKIT DISC”;

0049) “AD18”: A 6-hole P1000 grade alumina, resin bonded, 6-inch (15.2 cm) diameter abrasive film disc, commercially available under the trade designation “260L P1000 HOOKIT DUST-FREE DISC”;

0050) “AD19”: A P320 grade alumina, resin bonded, 5-inch (12.7 cm) x 3-inch (7.6 cm) rectangular abrasive paper sheet, commercially available under the trade designation “334U P320 HOOKIT II”;

0051) “AD20”: As per “AD19”, wherein 13 holes of ⅜-inch (0.32 cm) diameter, in an evenly distributed 3x3/2x2 array, were die punched out of the abrasive sheet, having the hole pattern as illustrated in FIG. 8;

0052) “BP1”: Back-up pad having pressure sensitive adhesive as a means for attaching abrasive discs, available under the trade designation “STIKIT LOW PROFILE DISC PAD”;

0053) “BP2”: Back-up pad having hooks as a means for attaching abrasive discs in a hook and loop mechanical fastener system, available under the trade designation “HOOKIT LOW PROFILE DISC PAD”;

0054) “BP3”: Back-up pad having loops as a means for attaching abrasive discs in a hook and loop mechanical fastener system, available under the trade designation “HOOKIT II DISC PAD”;

0055) “BP4”: As per backup pad BP1, wherein a polypropylene mask having a pressure sensitive adhesive coated macro structure, 0.317 mm x 0.317 mm x 0.35 mm height, and 0.156 mm channels between macro structures, was laminated to the face of the back up pad;

0056) “BP5”: Hand-held back-up pad having pressure sensitive adhesive as a means for attaching abrasive discs, available under the trade designation “HOOKIT II CENTER WATER FEED FOAM DISC PAD”;

0057) “BP6”: A hard hand sanding block, 2¼-inch (7.0 cm) x 5-inch (12.7 cm), commercially available under the trade designation “HOOKIT II HAND BLOCK”;

0058) “TP1”: A mild steel test panel coated with a grey primer, commercially available under the trade designation “URO 1140S” from E. I. DuPont de Nemours Company, Wilmington, Del.;

0059) “TP2”: A mild steel test panel coated with a powder primer, commercially available under the trade designation “PCV 7011S” from PPG Industries, Pittsburgh, Pa.;

0060) “TP3”: A mild steel test panel coated with a urethane clearcoat, commercially available under the trade designation “DCU 2021” from PPG Industries;

0061) “TP4”: A mild steel test panel coated with a primer, commercially available under the trade designation “TAUPE U28RW03SK” from BASF Automotive Refinish Technologies, Inc., Southfield, Mich.;

0062) “TP5”: A mild steel test panel coated with black primer, commercially available under the trade designation “SIKKENS COLORBUILD BLACK” from Akzo Nobel Coatings Inc., Norcross, Ga.

Test Methods

0063) The following test methods were used.

Off-Hand Abrasion Test.

0064) An abrasive disc was secured to the appropriate size backup pad according to the respective attachment system. The disc pad was then attached to a dual action sander, commercially available as model number “57015”, from the Dynabrade Company, Clarence, N.Y. Abrasion tests were run for up to 138 seconds, in various intervals, over three adjacent sections of the test panel, at an air pressure of up to 620.5 kPa (90 Psi) and a disc-to-panel angle of 0-2.5 degrees.

Surface Finish

0065) Surface finish (Rz) is the average individual roughness depths of a measuring length, where an individual roughness depth is the vertical distance between the highest point and the lowest point. The surface finish of abraded test panels were measured using a profilometer under the trade designation “PERTHOMETER MODEL M4P-127527” from Mahr Corporation, Cincinnati, Ohio. Surface finish values were measured at five points within each of the three abraded sections of the test panel at the end of the third sanding interval.

Cut Rate

0066) Cut-rate refers to the ability of the abrasive article to remove stock material or surface particles from the workpiece. The cut rate is the amount of weight loss of the test panel during the sanding operation. The test panel was weighed with an accurate electronic balance before the sanding test began. Using the sample test fixture the painted panel was sanded as described above. After each sanding cycle the test panel was cleaned of accumulated swarf by blowing with compressed air. The test panel was re-weighed to establish the weight loss (cut) during each sanding interval. The cumulative weight loss for each sanding interval was then recorded. The tests were run in triplicate.

Stiction

0067) Sanding a smooth abrasive coating may create what is known in the industry as “stiction”, whereby the abrasive coating may stick to the workpiece surface, with unwanted results. It is preferred to minimize stiction in fine finishing applications.
Examples 1-5 & Comparatives A-D

Samples of test panel TP1 were sanded according to the method described above at a pressure of 620.5 kPa (90 Psi). Results are listed in Table 1.

<table>
<thead>
<tr>
<th>Example</th>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Total Cut (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>AD2</td>
<td>BP1</td>
<td>30, 60, 90</td>
<td>Not Measured</td>
<td>6.0</td>
</tr>
<tr>
<td>Comparative A</td>
<td>AD1</td>
<td>BP1</td>
<td>30, 60, 90</td>
<td>Not Measured</td>
<td>6.6</td>
</tr>
<tr>
<td>Example 2</td>
<td>AD2</td>
<td>BP4</td>
<td>30, 60, 90</td>
<td>Not Measured</td>
<td>7.2</td>
</tr>
<tr>
<td>Comparative B</td>
<td>AD1</td>
<td>BP4</td>
<td>30, 60, 90</td>
<td>Not Measured</td>
<td>6.1</td>
</tr>
<tr>
<td>Example 3</td>
<td>AD4</td>
<td>BP1</td>
<td>30, 60, 90</td>
<td>1.79, 1.68, 1.51</td>
<td>5.0</td>
</tr>
<tr>
<td>Example 4</td>
<td>AD4</td>
<td>BP4</td>
<td>30, 60, 90</td>
<td>2.68, 1.92, 1.66</td>
<td>5.7</td>
</tr>
<tr>
<td>Comparative C</td>
<td>AD3</td>
<td>BP1</td>
<td>30, 60, 90</td>
<td>1.84, 1.53, 1.46</td>
<td>4.8</td>
</tr>
<tr>
<td>Example 5</td>
<td>AD6</td>
<td>BP3</td>
<td>30, 60, 90</td>
<td>Not Measured</td>
<td>5.2</td>
</tr>
<tr>
<td>Comparative D</td>
<td>AD5</td>
<td>BP3</td>
<td>30, 60, 90</td>
<td>Not Measured</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Examples 6-8 & Comparatives E-G

Samples of test panel TP2 were sanded according to the method described above at a pressure of 620.5 kPa (90 Psi). Results are listed in Table 2.

<table>
<thead>
<tr>
<th>Example</th>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Total Cut (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 6</td>
<td>AD6</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>1.86, 1.42, 1.34, 1.24</td>
<td>5.86</td>
</tr>
</tbody>
</table>

Comparative E | AD5 | BP3 | 30, 60, 90, 120 | 1.36, 0.95, 1.01, 0.95 | 4.26 |

Comparative F | AD5 | BP3 | 30, 60, 90, 120 | 1.36, 0.95, 1.01, 0.95 | 4.26 |

Example 9 & Comparative H

Samples of test panel TP1 were sanded according to the method described above at a pressure of 620.5 kPa (90 Psi). Results are listed in Table 3.

<table>
<thead>
<tr>
<th>Example</th>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Total Cut (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 9</td>
<td>AD9</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>1.86, 1.42, 1.34, 1.24</td>
<td>5.86</td>
</tr>
<tr>
<td>Comparative H</td>
<td>AD7</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>1.36, 0.95, 1.01, 0.95</td>
<td>4.26</td>
</tr>
</tbody>
</table>

Examples 10-11 & Comparative I

Samples of test panel TP1 were sanded according to the method described above at a pressure of 620.5 kPa (90 Psi). Results are listed in Table 4.

<table>
<thead>
<tr>
<th>Example</th>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Total Cut (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 10</td>
<td>AD11</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>1.82, 1.31, 1.16, 1.13</td>
<td>5.42</td>
</tr>
<tr>
<td>Example 11</td>
<td>AD12</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>1.88, 1.40, 1.25, 1.23</td>
<td>5.76</td>
</tr>
<tr>
<td>Comparative I</td>
<td>AD10</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>1.50, 1.10, 1.11, 1.02</td>
<td>4.72</td>
</tr>
</tbody>
</table>
Examples 12-14 & Comparatives J-L

[0072] Samples of test panel TP3 were sanding according to the method described above at a pressure of 248.2 kPa (36 Psi). An interface pad, commercially available under the trade designation “HOOKIT II SOFT INTERFACE PAD” from 3M Company, was applied between the abrasive disc and the back-up pad. Results are listed in Table 5. Three different lots of “260L P1000 HOOKIT II DISC” and “260L P1000 HOOKIT II DUST-FREE DISC” were evaluated.

### Table 5

<table>
<thead>
<tr>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Total Cut (grams)</th>
<th>Finish (microinches)/ (micrometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 12</td>
<td>AD14, Lot 1</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.30</td>
<td>76.8 (1.95)</td>
</tr>
<tr>
<td>Comparative J</td>
<td>AD13, Lot 1</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.35</td>
<td>81.0 (2.06)</td>
</tr>
<tr>
<td>Example 13</td>
<td>AD14, Lot 2</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.35</td>
<td>89.1 (2.26)</td>
</tr>
<tr>
<td>Comparative K</td>
<td>AD13, Lot 2</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.33</td>
<td>87.3 (2.22)</td>
</tr>
<tr>
<td>Example 14</td>
<td>AD14, Lot 3</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.21</td>
<td>53.3 (1.35)</td>
</tr>
<tr>
<td>Comparative L</td>
<td>AD13, Lot 3</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.25</td>
<td>56.4 (1.43)</td>
</tr>
</tbody>
</table>

Examples 15-16 & Comparatives M-N

[0073] Samples of test panel TP2 were sanded according to the method described above at a pressure of 275.8 kPa (40 Psi) using a STIKIT disc pad. Results are listed in Table 6.

### Table 6

<table>
<thead>
<tr>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Finish (microinches)/ (micrometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 15</td>
<td>AD16</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.16, 0.27, 0.42, 0.54</td>
<td>36.0 (0.94)</td>
</tr>
<tr>
<td>Comparative M</td>
<td>AD15</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.19, 0.35, 0.51, 0.65</td>
<td>33.5 (0.85)</td>
</tr>
<tr>
<td>Example 16</td>
<td>AD16</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.22, 0.44, 0.64, 0.85</td>
<td>30.8 (0.78)</td>
</tr>
<tr>
<td>Comparative N</td>
<td>AD15</td>
<td>23, 46, 69, 92, 115, 138</td>
<td>0.21, 0.47, 0.69, 0.84</td>
<td>31.5 (0.80)</td>
</tr>
</tbody>
</table>
Example 17 & Comparative O

Samples of test panel TP4, moistened with a thin film of water, were hand sanded using HOOKIT II discs attached to hand sanding block BP5. Sanding interval and stiction results are listed in Table 7.

### Table 7

<table>
<thead>
<tr>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Total Cut (grams)</th>
<th>Stiction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 17 AD6</td>
<td>BP5</td>
<td>30</td>
<td>30.3</td>
<td>Low stiction</td>
</tr>
<tr>
<td>Comparative O AD5</td>
<td>BP5</td>
<td>30</td>
<td>33.3</td>
<td>High stiction</td>
</tr>
</tbody>
</table>

Example 18 & Comparative P

Samples of test panel TP5, were dry hand sanded using HOOKIT II sheets attached to hard hand sanding block BP6, in a series of 4 intervals of 5 strokes (backward-forward) each. Cut performance and stiction ratings, as an average of triplicate samples, are listed in Table 8.

### Table 8

<table>
<thead>
<tr>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Cut Rate (grams)</th>
<th>Stiction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 18 AD20</td>
<td>BP6</td>
<td>0.47, 1.05, 1.34</td>
<td>No stiction</td>
</tr>
<tr>
<td>Comparative P AD19</td>
<td>BP6</td>
<td>0.49, 1.02, 1.24</td>
<td>High stiction</td>
</tr>
</tbody>
</table>

Examples 19-21 & Comparatives Q-S

Samples of test panel TP3 were sanded according to the method described above at a pressure of 248.2 kPa (36 Psi). With respect to Example 20 and Comparative R, an interface pad, commercially available under the trade designation “HOOKIT SOFT INTERFACE PAD” from 3M Company, was applied between the abrasive disc and the back-up pad. With respect to Example 21 and Comparative S, an interface pad, commercially available under the trade designation “HOOKIT II SOFT INTERFACE PAD” from 3M Company, was applied between the abrasive disc and the back-up pad. Results are listed in Table 9.

### Table 9

<table>
<thead>
<tr>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Finish (microinches)/(micrometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 19 AD16</td>
<td>BP1</td>
<td>30, 60, 120</td>
<td>0.40, 0.69</td>
<td>84.8 (2.15)</td>
</tr>
<tr>
<td>Comparative Q AD15</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>0.33, 0.58, 0.97</td>
<td>78.9 (2.00)</td>
</tr>
<tr>
<td>Example 20 AD18</td>
<td>BP2</td>
<td>30, 60, 90, 120</td>
<td>0.32, 0.67, 1.25</td>
<td>74.2 (1.89)</td>
</tr>
<tr>
<td>Comparative R AD17</td>
<td>BP2</td>
<td>30, 60, 90, 120</td>
<td>0.34, 0.62, 1.25</td>
<td>73.4 (1.82)</td>
</tr>
<tr>
<td>Example 21 AD14</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>0.30, 0.62, 1.12</td>
<td>71.5 (1.82)</td>
</tr>
<tr>
<td>Comparative S AD13</td>
<td>BP3</td>
<td>30, 60, 90, 120</td>
<td>0.31, 0.62, 1.10</td>
<td>73.7 (1.47)</td>
</tr>
</tbody>
</table>

Examples 22-24 & Comparatives T-V

Samples of test panel TP2 were sanded according to the method described above at a pressure of 275.8 kPa (40 Psi). With respect to Examples 23-24 and Comparatives U-V, interface pads, as described previously, were applied between the abrasive disc and the back-up pad. Results are listed in Table 10.

### Table 10

<table>
<thead>
<tr>
<th>Abrasive Disc</th>
<th>Back-up Pad</th>
<th>Sanding Interval (seconds)</th>
<th>Cut Rate (grams)</th>
<th>Finish (microinches)/(micrometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 22 AD16</td>
<td>BP1</td>
<td>15, 30, 45, 60</td>
<td>0.25, 0.38, 0.62</td>
<td>40.1 (1.02)</td>
</tr>
<tr>
<td>Comparative T AD15</td>
<td>BP1</td>
<td>15, 30, 45, 60</td>
<td>0.16, 0.36, 0.69</td>
<td>48.0 (1.22)</td>
</tr>
<tr>
<td>Example 23 AD18</td>
<td>BP2</td>
<td>15, 30, 45, 60</td>
<td>0.22, 0.46, 0.82</td>
<td>53.3 (0.85)</td>
</tr>
<tr>
<td>Comparative U AD17</td>
<td>BP2</td>
<td>15, 30, 45, 60</td>
<td>0.20, 0.36, 0.63</td>
<td>43.0 (1.09)</td>
</tr>
<tr>
<td>Example 24 AD14</td>
<td>BP3</td>
<td>30</td>
<td>0.17, 0.38, 0.77</td>
<td>58.1 (0.97)</td>
</tr>
<tr>
<td>Comparative V AD13</td>
<td>BP3</td>
<td>30</td>
<td>0.17, 0.40, 0.68</td>
<td>39.4 (1.00)</td>
</tr>
</tbody>
</table>
The abrasive disc, the means for the attachment of the article to the back-up pad, the foam facing layer, the rigid backing plate and threaded stud, as mentioned above in connection with the discussion above, while useful and necessary from a practical standpoint to the present invention, can be supplied by known means and constructions in the field and thus should require no further details than that provided herein to be understood by one of ordinary skill in the art.

1. An article comprising:
   a back-up pad having a particle impermeable major surface; and
   an abrasive disc removably attached to the impermeable major surface, the abrasive disc including a plurality of perforations therethrough.

2. The article of claim 1, wherein the perforations are distributed over the entire disc.

3. The article of claim 2, wherein the perforations are substantially uniformly distributed over the entire disc.

4. The article of claim 1, wherein the perforations are distributed over an annular section of the disc.

5. The article of claim 1, wherein the perforations are of substantially uniform size.

6. The article of claim 1, wherein the disc is attached to the back-up pad via a hook and loop arrangement.

7. The abrasive article of claim 6, wherein the hooking members are on the back-up pad and the loop members are on the disc.

8. The article of claim 1, further including an adhesive layer between the back-up pad and the disc.

9-10. (canceled)

11. The article of claim 1, wherein the plurality of perforations is less than 14.

12. A method of sanding comprising:
   providing an article comprising a back-up pad having a particle impermeable major surface; an abrasive disc removably attached to the impermeable major surface, the abrasive disc including a plurality of perforations therethrough;
   moving the abrasive article; and
   contacting a workpiece with the abrasive article.

13. The method of claim 12, wherein the perforations are distributed over the entire disc.

14. The method of claim 13, wherein the perforations are substantially uniformly distributed over the entire disc.

15. The method of claim 12, wherein the perforations are distributed over an annular section of the disc.

16. The method of claim 12, wherein the perforations are of substantially uniform size.

17. The method of claim 12, wherein the disc is attached to the back-up pad via a hook and loop arrangement.

18. The method of claim 17, wherein the hooking members are on the back-up pad and the loop members are on the disc.

19. The method of claim 12, further including an adhesive layer between the back-up pad and disc.

20-22. (canceled)

23. The method of 12, wherein the method of sanding includes wet sanding.

24. The method of claim 12, wherein the method of sanding includes dry sanding.

25. The method of claim 12, wherein moving the abrasive article includes manually moving the abrasive article.

26. The method of claim 12, wherein moving the abrasive article includes moving the abrasive article with a powered device.

27. A method of making an article comprising:
   removably attaching a particle impermeable back-up pad to a disc, wherein the disc includes a plurality of perforations therethrough.

28. The method of claim 27, wherein the perforations are distributed over the entire disc.

29. The method of claim 28, wherein the perforations are substantially uniformly distributed over the entire disc.

30. The method of claim 27, wherein the perforations are distributed over an annular section of the disc.

31. The method of claim 27, wherein the perforations are of substantially uniform size.

32. The method of claim 27, wherein the disc is attached to the back-up pad via a hook and loop arrangement.

33. The method of claim 32, wherein the hooking members are on the back-up pad and the loop members are on the disc.

34. The method of claim 27, further including an adhesive layer between the back-up pad and the disc.

35-36. (canceled)

37. The method of claim 26, wherein the powered device is an electric sander.