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(71) **Demandeur/Applicant:**
3M INNOVATIVE PROPERTIES COMPANY, US
(72) **Inventeurs/Inventors:**
DAVELOOSE, PAUL N., US;
COLE, MATTHEW S., US;
GUNES, IBRAHIM S., US;
YE, SHENG, US;
CORN, STEWART H., US;
VASHISTHA, DEVAL Y., US;
SHINDE, SHRIDHAR B., US
(74) **Agent:** SMART & BIGGAR

(54) **Titre :** ARTICLES DE BROSSAGE TRAITES AUX UV ET METHODES DE FABRICATION DESDITS ARTICLES
(54) **Title:** UV TREATED SCRUBBING ARTICLES AND METHODS OF MAKING SAME

(57) **Abrégé/Abstract:**

A scrubbing article including a substrate and a UV treated texture layer on a surface of the substrate. The substrate is formed from a single layer of foam or sponge material having a thickness that is conducive to handling or holding. The UV treated texture layer is a resin-based material forming a textured abrasive layer on the surface of the substrate.



UV TREATED SCRUBBING ARTICLES AND METHODS OF MAKING SAME
ABSTRACT

5 A scrubbing article including a substrate and a UV treated texture layer on a surface of the substrate. The substrate is formed from a single layer of foam or sponge material having a thickness that is conducive to handling or holding. The UV treated texture layer is a resin-based material forming a textured abrasive layer on the surface of the substrate.

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UV TREATED SCRUBBING ARTICLES AND METHODS OF MAKING SAME

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Background

The present disclosure relates to scrubbing articles having a UV cured textured surface. More particularly, the present disclosure relates to scrubbing articles formed by a thick, single layer substrate and a UV treated texture layer formed on at least one surface of the substrate to provide the scrubbing article with enhanced surface treating capabilities.

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A variety of cleaning articles in the form of pads and wipes have been developed and made commercially available for household and industrial use. Consumers oftentimes desire to use the articles for cleaning or surface treating tasks requiring scrubbing which in turn may include various degrees of abrading and/or scouring. For example, it can be difficult, if not impossible, to remove dried food from a countertop using an inherently soft article. Furthermore, overly flexible or drapable articles may prove unwieldy when used to scour a surface as there is no substantive handle for comfortable holding of the article when scrubbing or scouring a surface. Further still, while a scouring or abrading action is often desired, consumers likewise desire a scrubbing pad or wipe that is not overly abrasive on relatively soft or easily scratched surfaces. Finally, consumers often find cleaning articles that are pre-loaded with a cleaning/disinfecting/sanitizing chemical or chemicals to be useful and convenient.

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In addition, manufacture of cleaning articles oftentimes involves forming a texture or abrasive layer on a surface of one substrate and subsequently bonding or laminating the textured substrate to a secondary substrate or material, for example to provide the desired handle thickness described above. Requiring additional substrates involves added time and cost in the manufacturing process. It is therefore desirable to provide a single substrate material that has the desired handling properties noted above such that an abrasive surface may be formed directly onto the thick substrate.

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Scrubbing articles have been developed to address some of the above-identified desires and concerns. For example, U.S. Patent No 7,829,478 to Johnson et al., describes a scrubbing wipe article including a nonwoven substrate and a texture layer. The texture layer is a non-crosslinked, abrasive resin-based material that is printed onto at least one surface of the nonwoven substrate. Johnson et al. teach that the texture layer composition

is printed onto the substrate and then caused to coalesce to bond the composition to the substrate. Johnson et al. further describe that the resin constituent does not crosslink as part of the coalescing step and that coalescing represents a distinct advantage over other scrubbing wipe article forming techniques in which a lengthy curing period is required to achieve a sufficient hardness value. The nonwoven scrubbing wipe article of Johnson et al. can be used “dry” or can be loaded with a chemical solution.

U.S. Patent App. Pub. No 2006/0286884 to Thioliere et al. describes a wiping article comprising a liquid-absorbent web material and abrasive areas comprising cured binder material disposed on a surface of the web. The web material may include woven, knitted and non-woven materials. Non-woven materials may include dry-laid, wet-laid and spun-bonded materials. Suitable binder materials are disclosed that can be cured by heating, cooling or ultraviolet light.

U.S. Patent App. Pub. No. 2007/0212965 to Smith et al. describes a flexible scrubbing material that combines at least two discrete components, one being a continuous flexible substrate and one a discontinuous abrasive layer affixed to the flexible substrate. The abrasive layer is a set of plates formed from a material different than the continuous flexible substrate. The plate material is a printable material that subsequently solidifies, such as epoxy. Smith et al. teach that the abrasive plates can be formed from a solidified material such as ultraviolet or thermally curable polymeric materials with or without abrasive particles embedded inside. Smith et al. further describe a technique for printing the plates onto the substrates such as conventional screen-printing, UV etching and roller-printing. An adhesive is sprayed on the fabric prior to application of the plates.

Other cleaning wipe constructions include or incorporate mildly abrasive particles within or at a surface of the base substrate. For example, U.S. patent No. 5,213,588 to Wong et al. describes an abrasive wipe consisting of a paper towel-like base substrate having printed thereon a mixture containing irregularly-shaped polymeric particles.

Various materials and material compositions may be used to form a textured surface layer of a scrubbing material. Further, texture layers may be deposited or formed on a substrate using a variety of methods. Some methods include printing, coating (e.g., roll, spray etc.), embossing, micro-replicating, or etching (e.g., laser, mechanical, etc.) a material or materials onto a substrate to form a textured surface (also referred to herein as an “abrasive surface”) having various degrees of abrasion. Crosslinking of the materials

(i.e., abrasives) formed on the substrate can significantly improve a variety of properties of the deposited or formed abrasives, including the durability, hardness, tensile and impact strength, high-heat properties, solvent and chemical resistance, abrasion resistance, and environmental stress crack resistance.

5 Ultraviolet light curing is a known photochemical process in which high-intensity ultraviolet light is used to cure various materials including coatings and adhesives. UV treatment can be used to effect sterilization, polymerization and crosslinking of materials. UV treatment is a rapid, clean and relatively cost-effective method for crosslinking and/or polymerizing materials and offers many advantages over traditional drying methods such
10 as increased production speed, reduced reject rates and improved properties of the treated materials.

As described above, a scrubbing article having a thickness that allows for comfortable handling by a user is desired. Likewise, improvements in the properties of the scrubbing surface (e.g., texture layer) of a scrubbing article may be beneficial and
15 therefore desirable. Finally, improvements to the manufacturing processes of scrubbing articles can be advantageous. A need therefore exists for a scrubbing article that includes the benefits and advantages of a thick, single layer substrate having a UV treated textured surface for scrubbing.

Summary

20 A scrubbing article including a substrate made of a single-layer foam or sponge material and a UV crosslinked texture layer formed on a surface of the substrate. Substrates of the present disclosure may be formed to have a thickness that allows for ease of handling during a scrubbing or cleaning function. The substrate can have a thickness of between 1 and 5 cm and may particularly have a thickness of 3 cm. A second texture layer
25 can be formed on any other surface of the substrate. In some embodiments the texture layer defines a pattern. In embodiments, the texture layer includes a plurality of randomly distributed texturings. The texture layer has a hardness at least equal to and in embodiments, greater than the hardness of the substrate. In embodiments, the texture composition includes a resin and at least one photoinitiator and can include additional
30 minerals, fillers, colorants, thickeners, defoaming agents, surfactants or other constituents. In embodiments, a chemical can be absorbed into the substrate, formed on the substrate surface, and/or provided as part of the texture layer composition.

Methods of manufacturing a scrubbing article according to the disclosure include forming a UV treatable composition onto a surface of a substrate to form a UV crosslinkable texture layer and UV crosslinking the UV crosslinkable texture layer by exposing the layer to UV radiation to form a UV crosslinked texture layer. In methods
 5 according to the disclosure, the UV treatable composition is a UV crosslinkable composition. In some embodiments, the UV treatable composition is a UV polymerizable composition.

Brief Description of the Drawings

FIG. 1 is a perspective view of an exemplary scrubbing article in accordance with
 10 the present disclosure;

FIG. 1A is an enlarged plan view of a portion of the surface of the scrubbing article of FIG. 1;

FIG. 2 is an enlarged, cross-sectional view of a portion of the article of FIG. 1 along the lines 2-2 shown in FIG. 1;

15 FIG. 3 is an enlarged, cross-sectional view of the article portion of FIG. 2 being applied to a surface;

FIG. 4 is a simplified, schematic diagram of a method of manufacture in accordance with an embodiment of the present disclosure; and

20 FIGS. 5A-5B are top views of alternative embodiments of a scrubbing article in accordance with the present disclosure.

Detailed Description

FIG. 1 illustrates an embodiment of a scrubbing article 10 in accordance with the present disclosure. Scrubbing article 10 may be described as a consumer cleaning or
 25 scrubbing article 10. As used throughout this Specification, the term “consumer” is in reference to any household, cosmetic, industrial, hospital or food industry applications and the like of the article 10. Further as used throughout this Specification, the term “scrubbing” is used to describe surface treating and may include cleaning, abrading and/or scouring, including various levels or degrees of abrading and/or scouring action (e.g.,
 30 heavy duty, non-scratch, etc.). The article 10 comprises a substrate 12 and a texture layer 14 (referenced generally in FIG. 1). The substrate 12 and the texture layer 14 can comprise a variety of different materials as described further below. Regardless, the

texture layer 14 is characterized as including an abrasive composition that is formed on the substrate 12 and is exposed to UV light (UV treated) to form a UV treated (UV crosslinked and/or UV polymerized) texture layer 14, as will be described more fully below. It is to be understood that where an “UV crosslinkable or UV crosslinked”
5 material or composition is disclosed throughout this Specification, likewise an “UV polymerizable or UV polymerized” material or composition may be included (added) or substituted. In other words, the present disclosure encompasses texture layer 14 compositions that may include UV polymerized/polymerizable materials (e.g., monomers) or UV crosslinked/crosslinkable materials (e.g., multifunctional monomers, polymers), or
10 may include both, whether or not indication is specifically made to these alternative texture layer composition possibilities.

With additional reference to FIG. 2, the substrate 12 defines first and second opposing surfaces 16, 18. The thickness of the substrate 12 (denoted by reference “t”) and of the texture layer 14 may be exaggerated or understated in FIGS. 2 and 4. The texture layer 14
15 is formed on one or more surfaces of the substrate (e.g., surface 16). The texture layer 14 can also penetrate the surfaces 16, 18 to some degree. In some embodiments, the scrubbing article 10 further includes a chemical solution (not shown) loaded into, or absorbed by, the substrate 12 and/or provided as part of the texture layer composition. Applicable chemical solutions are likewise described in greater detail below. The texture
20 layer 14 may be configured to accommodate a wide variety of chemical solutions including those that are neutral, cationic, or anionic. Further, the scrubbing article 10 is equally useful without a chemical solution.

Compositions of the substrate 12 and the texture layer 14, as well as processing thereof, are provided below. The scrubbing article 10 may be described as providing a
25 “scrubbiness” attribute. The term “scrubbiness” is in reference to an ability to abrade or remove a relatively small, undesirable item otherwise affixed to a surface as the article is moved back and forth over the item. A substrate can be given a scrubbiness characteristic not only by forming a hardened scrubbing material on the substrate’s surface (i.e., harder than the substrate itself), but also and perhaps more prominently via the extent to which
30 the so-formed material extends from or beyond the substrate surface in conjunction with side-to-side spacing between individual sections of the scrubbing material. The texture

layer of the present disclosure provides and uniquely satisfies both of these scrubbing requirements.

By way of further explanation, the texture layer 14 defines a plurality of discrete portions (e.g., the various dot-like portions shown in FIG. 1 and referenced generally at 5 20a, 20b). Discrete portions 20a, 20b may form a randomly textured surface or may form a pattern on the substrate surface 16. Further, discrete portions (e.g., 20a, 20b) may comprise varying relative sizes or may be substantially uniform in size. For instance, and as illustrated in FIG. 1A, dots 20a are relatively larger than dots 20b. Further, discrete portions (e.g., 20a, 20b) may extend or project outwardly from the surface 16 at 10 substantially uniform distances or, alternatively, may extend or project outwardly from the surface 16 at varying distances (i.e. the discrete portions 20a, 20b can have similar or varying heights with respect to the surface 16). In some embodiments, discrete portions (e.g., 20a, 20b) may extend to any distance in a range of about 10 to about 200 microns outwardly from the surface 16. In other embodiments, discrete portions (e.g., 20a, 20b) 15 may extend to any distance in a range of about 10 to about 20 microns outwardly from the surface 16. In still further embodiments, discrete portions (e.g., 20a, 20b) may extend to a distance of about 10 to about 15 microns outwardly from the surface 16. Regardless, a variety of texturings and/or patterns can be provided on the substrate 12. Alternative exemplary embodiments of patterns useful with the present disclosure are shown in FIGS. 20 5A-5B.

Regardless of the pattern design and/or extension distance of portions (e.g., 20a, 20b) from the surface 16, during a scrubbing application, a user (not shown) will normally hold the article 10 by grasping the article for example along a side or edge 15. The thickness "t" of article 10 allows for easy grasping or holding of the article 10 as described 25 more fully below. The user will then position the scrubbing article 10 such that the texture layer 14 is facing the surface to be scrubbed. An example of this orientation is provided in FIG. 3 whereby the scrubbing article 10 is positioned to clean or otherwise treat a surface 30. As should be understood, the surface 30 to be cleaned is application specific, and can be relatively hard (e.g., a table top or cooking pan) or relatively soft (e.g., human skin, 30 polymeric baking vessels, etc.). Regardless, in the exemplary embodiment of FIG. 3, the surface 30 to be scrubbed may have a mass 32 that is undesirably affixed thereto. Again, the mass 32 will be unique to the particular scrubbing application, but includes matters

such as dirt, dried food, dried blood, etc. The scrubbing article 10 of the present disclosure facilitates scrubbing removal of the mass 32 as a user repeatedly forces the texture layer 14 (or a portion or section thereof) back and forth across the mass 32. Each section (for example, the portions 20a, 20b) of the texture layer 14 must be sufficiently
5 hard to either abrade or entirely remove the mass 32 during the scrubbing motion. In addition, the texture layer 14 must extend an appreciable distance from the substrate surface 16 to ensure intimate surface interaction with the mass 32 along not only an outer most surface 40, but along sides 42 as well. Portions 20a, 20b, while depicted as having uniform, sharp corners or edges (at the intersection of surface 40 and sides 42), may
10 likewise or instead have rounded edges or corners or may be non-uniform in cross-section. What is important is that the extension of the texture layer is such that the desired scrubbiness is achieved. Notably, many cleaning wipes incorporating a blown fiber “scrubbing” or texture layer provide only a minimal thickness or extension relative to the substrate surface, likely giving rise to a less than desirable scrubbiness characteristic.
15 Further, it is preferred that the discrete portions (for example, the portions 20a, 20b) provided by the texture layer 14 of the present disclosure be sufficiently spaced from one another to ensure intimate contact between the mass 32 and the sidewall 42 of the particular texture layer portion 20a, 20b during a cleaning operation. Further still, it is desirable that the texture layer 14 has abrasion resistance such that the composition
20 forming the texture layer 14 remains substantially intact on the substrate 12 during and after the article 10 is used to scrub a surface 30. If both surfaces 16, 18 have a texture layer 14, then each side can be used in the manner described above. However, if one side is not textured, the non-textured side may be used for milder scrubbing or wiping functions. In this manner, the scrubbing article can be used as a multifunctional or
25 multipurpose cleaning article.

Importantly, the UV treated texture layer 14 of the present disclosure may be configured to have a relative hardness at least equal to or greater than the hardness of the substrate 12 to which the layer is imparted, as briefly referred to above. Stated otherwise, the local hardness of the texture layer portions (e.g., 20a, 20b) or overall texture layer 14 is
30 equal to or greater than the hardness of the entire article 10, or the “global hardness”. Article 10 may thus be defined as having global flexibility, since the substrate 12 is softer or more flexible in relation to the harder, less flexible abrasive/texture layer 14. Hardness

of a texture composition 14 after having been formed on a substrate as well as hardness of a substrate (for comparison) can be achieved in a number of ways. For example, hardness of a material can be established by determining the Rockwell indentation hardness, such as described in ASTM E18 – 14a: Standard Test Methods for Rockwell Hardness of Metallic
 5 Materials; by determining Knoop and Vickers hardness, such as described in ASTM E384 – 10: Standard Test Method for Knoop and Vickers Hardness of Materials; by determining the durometer hardness, such as described in ASTM D2240 – 05: Standard Test Method for Rubber Property—Durometer Hardness, or by determining the Brinell hardness, such as described in ASTM E10 – 14: Standard Test Method for Brinell Hardness of Metallic
 10 Materials. An article having these characteristics is uniquely useful as a scrubbing article in that the article 10 is sufficiently flexible to allow a user to make contact in, on and about a variety of objects to be scrubbed, while the hardness of the abrasive layer 14 provides the desired scrubbing performance. The above features are readily achieved via the textured layer and UV treatments of the present disclosure as described below.

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Substrates

The substrate 12 can be formed from a variety of cloth, foam and sponge materials and may take a variety of forms. Any cloth, foam or sponge material or combination of materials suitable for use as a consumer scrubbing article can be used including, without
 20 limitation, polyurethane foams such as the polyurethane foam commercially available under the trade designation, TEXTURED SURFACE FOAM, POLYETHER, M-100SF from AERO TECHNOLOGIES LLC, Newark, DE, USA, cellulose sponges such as the sponge commercially available under the trade designation of SCOTCH-BRITE STAY CLEAN NON-SCRATCH, cat. No. 20202-12 from 3M COMPANY, St. Paul, MN, USA,
 25 and biodegradable L200, N250, S100 sponge cloths from Kalle GmbH, Wiesbaden, Germany.

As used herein, the term “foam” refers to a colloidal dispersion made of two distinct phases formed by two dissimilar materials. Thus, a foam may also be referred to as a solidified colloidal dispersion. For polyurethane (PU) foams, for example, a gas
 30 (most commonly carbon dioxide gas formed during foaming reactions) is dispersed within the PU liquid to form a distinct dispersed phase. This dispersion is subsequently solidified to obtain solid PU foam. The term “sponge” as used herein is likewise used to describe a

solidified colloidal dispersion. For example, in forming a cellulose sponge, a salt is dispersed in the cellulose mixture (viscose) to form a distinct dispersed phase. The dispersion is subsequently solidified and the salt is eliminated to obtain solid cellulose sponge. Definitions of sponge and foam materials as used herein may be consistent with
5 those defined in, "Foundations of Colloid Science", Vol. 1, Robert J. Hunter, Oxford University Press, New York, 1987, incorporated by reference here in its entirety.

The materials and forms of the substrate 12 can be selected to provide varying ranges of desired properties, such as extensibility, elasticity, durability, flexibility etc., that are particularly suited to a given scrubbing task and/or are particularly suited to forming a
10 texture composition thereon. As indicated, materials useful for substrate 12 may be selected to have durability properties in a wide range. For example, the durability of materials suitable for use in scrubbing articles is often categorized as "disposable" (meaning that an article formed from the material is intended to be discarded immediately after use), "semi-disposable" (meaning that an article formed from the material can be
15 washed and re-used a limited number of times), or "reusable" (meaning that an article formed from the material is intended to be washed and re-used). Scrubbing articles 10 of the present disclosure can be selected or formed to have any of these durability properties. Also as indicated above, materials may be selected based upon their flexibility.

According the present disclosure, consumers may prefer a relatively more rigid
20 article that still maintains some degree of flexibility. A rigid article may be one that is formed of a composition and into a form that substantially holds its shape both when held by a user or when placed on an irregular surface. Notably, a more rigid cleaning article may still have some degree of flexibility so as to conform to contours of a surface to be scrubbed. However, the articles contemplated by the present disclosure may be of the type
25 that return to an original form after having been bent, compressed or otherwise manipulated during a cleaning action.

The substrate 12 may be selected or formed to have a surface (e.g., 16) that readily accepts the formation of a texture layer 14 thereon. In particular, the surface of the substrate may be formed to have a skinned layer to obtain a "smoother", more uniform,
30 less porous or finer-pore surface. By smoother or more uniform is meant that the surface (or surfaces) of the substrate has characteristics that differ from the body 13 (FIG. 2) of the substrate 12 or from a majority of the substrate material not comprising the surface. Even

where the surface or surfaces (16, 18) may be formed as described above to have smoother surface characteristics, the entire substrate remains of the same chemical composition.

The substrate 12 has a thickness “t” (FIG. 2) that advantageously allows a user to hold the article 10 by grasping the article along a side or edge 15. A user may, however, grasp the article at surfaces 16, 18 as well. What is important is that the thickness “t” of article 10 allows for easy grasping or holding of the article 10 generally since a “handle” is created by the thick nature of the substrate 12. The thickness “t” of the substrate 12 may be for example in a range of 2-5 cm. The thickness “t” can be about 2 cm, about 3 cm, or about 4 cm. As a point of reference, the term “thick” as used herein may be in relation to household cleaning cloths or wipes or commonly available dish cloths that are drapable or have thicknesses on the order of 0.5cm or less. These types of relatively thinner articles/substrates have ergonomic disadvantages in handling and may become unwieldy to use to scour a surface. Conversely, thicker substrates 12 as described herein, provide a handle by virtue of their thickness. The handle allows for more comfortable holding and ease of use during a scouring or abrading function.

The substrate 12 as depicted in the cross-sectional view of FIG. 2 is a single layer structure. The article 10 is configured such that the texture layer 14 can be formed directly onto a surface (e.g., surface formed by and indicated at side 15, surfaces 16, 18, etc.) of the single layer substrate 12 and form a useful scrubbing article, without the need for lamination, bonding, or otherwise joining etc. of the article 10 to another substrate layer. In other words, the substrate 12 as well as the article 10 are non-laminate structures. The substrate 12 can, however, include additional layers such as an adhesion promoter layer or tie layer, for example.

Other sponges and foams are likewise contemplated and these examples are not meant to be limiting. Regardless of the exact construction, however, the substrate 12 is highly conducive to handling by a user otherwise using the article 10 for scrubbing purposes and is selected having regard to the intended use of the scrubbing article 10.

Texture Layer Compositions

As discussed above, the texture layer 14 is an abrasive composition that is formed on substrate 12 and subsequently UV crosslinked or UV polymerized or both as will be described below. The exact composition of the texture layer 14 can vary depending upon

desired end performance characteristics. To this end, a texture layer composition is initially formulated and then formed on the substrate 12. This composition will include a selected resin and may include additional constituents such as mineral(s), filler(s), colorant(s), thickener(s), defoaming agent(s), surfactant(s) etc. Regardless of the exact
5 composition, however, the selected composition is UV treatable (i.e., polymerizable, crosslinkable) and imparts the desired features (e.g., manufacturability, scrubbiness, durability, hardness and abrasion resistance) to the scrubbing article 10. As a point of reference, the texture layer composition 14 may be described as "UV crosslinkable" or "UV polymerizable", or both, *prior to* UV treatment (e.g., crosslinking, polymerization) of
10 the texture layer 14 and as "UV crosslinked" or "UV polymerized", or both, *after* the texture layer 14 has undergone UV treatment. The processes of printing and UV treating the texture layer compositions of the present disclosure are further discussed below. In addition, as defined herein, an interim scrubbing article 17 is formed after the texture layer composition 14 is formed on substrate 12 but prior to UV treatment of the composition 14
15 and will likewise be discussed in further detail below.

Various materials are suitable for forming the texture layer 14. As described above, texture layer 14 comprises a resin composition and may comprise various polymers and/or monomers. Some acceptable resins include those resins selected from the group consisting of styrene-butadiene resin, acrylic resin, phenolic resin, nitrile resin, ethylene
20 vinyl acetate resin, polyurethane resin, styrene-acrylic resin, vinyl acrylic resin and combinations thereof. Other non-limiting examples of binder resins useful with the present disclosure include amino resins, alkylated urea-formaldehyde resins, melamine-formaldehyde resins, acrylic resins (including acrylates and methacrylates) such as vinyl acrylates, acrylated epoxies, acrylated urethanes, acrylated polyesters, acrylated acrylics,
25 acrylated polyethers, vinyl ethers, acrylated oils, and acrylated silicones, alkyd resins such as urethane alkyd resins, polyester resins, reactive urethane resins, phenolic resins such as resole and nonvolac resins, phenolic/latex resins, epoxy resins, and the like. The resins may be provided as monomers, oligomers, polymers, or combination thereof. Monomers may include multifunctional monomers capable of forming a crosslinked structure, such as
30 epoxy monomers, olefins, styrene, butadiene, acrylic monomers, phenolic monomers, substituted phenolic monomers, nitrile monomers, ethylene vinyl acetate monomer, isocyanates, acrylic monomers, vinyl acrylic monomer and combinations thereof. Other

non-limiting examples of binder resins useful with the present disclosure include amino acids, alkylated urea monomers, melamines, acrylic monomers (including acrylates and methacrylates) such as vinyl acrylates, acrylated epoxies, acrylated urethanes, acrylated polyesters, acrylated acrylics, acrylated ethers, vinyl ethers, acrylated oils, and acrylated
5 silicones, alkyd monomers such as urethane alkyd monomers, and esters.

Other desirable features of texture layer 14 compositions include compositions having a molecular weight that allows for the formed UV treatable texture layer 14 to have sufficient (e.g., minimum level of) adhesion to the substrate 12 to which it is applied such that it does not readily wipe off of or shift along the substrate surface 16 (i.e., such that the
10 texture layer 14 formed on the substrate stays on the substrate surface 16 after transfer of the texture layer 14 to the substrate 16 and prior and/or subsequent to UV treatment). Specifically, materials may be selected to have molecular weights or viscosities allowing the texture layer 14 composition to be flowable in a manner that will fill the holes or voids of a stencil pattern during transfer to or forming of the composition on a substrate 12,
15 sufficiently to adhere to the substrate 12 and to hold the desired pattern shape upon removal of the stencil from the substrate.

The composition of the texture layer includes a photoinitiator and can optionally include a promoter or a retardant as part of the formulation or composition of texture layer 14, according to some embodiments of the present disclosure, as described in detail in
20 textbooks such as *Ullmann's Encyclopedia of Industrial Chemistry* (section "Radiation Chemistry"). Exemplary photoinitiators are those provided in TABLE 1A, herein below. Some initiators and promoters that can assist UV crosslinking or UV polymerization, or both, include include alpha-hydroxy and alpha-aminoacetophenones or phosphine oxides, commercially available under the trade designations of Darocur 1173, Irgacure 651,
25 Irgacure 369, Irgacure 819, Lucirin TPO, all commercially available from BASF CORP., Florham Park, NJ, USA; those based on aromatic ketones, such as benzophenones, thioxanthenes, methylphenylglyoxylate, and camphorquinone; co-initiators, such as N-phenylglycine, ethyl p-dimethylaminobenzoate, and 2-mercaptobenzoxazole; onium salts, such as iodonium or sulfonium salts, commercially available under the trade designations,
30 such as Irgacure 250 (from BASF CORP., Florham Park, NJ, USA), Cyracure UVI 6976 (from DOW CHEMICAL COMPANY, Midland, MI, USA), and Esacure 1187 (from LEHMANN & VOSS & CO., Hamburg, Germany).

In some embodiments, the texture layer 14 optionally further includes a particulate additive for enhanced hardness. To this end, and as described in greater detail below, the scrubbing article 10 of the present disclosure is useful in a wide variety of potential applications having different scrubbing requirements. For some applications, it is desirable that the scrubbing article 10, and in particular the texture layer 14, be more or less abrasive than others. While the above-described resin component of the texture layer 14 independently imparts a scrubbiness feature to the article 10 greater than other available scrubbing articles, this scrubbiness characteristic can be further enhanced via the addition of a particulate component. With this in mind, a wide variety of minerals or fillers as known in the art can be employed. Useful minerals include Al_2O_3 , "Minex" (available from The Cary Co. of Addison, Illinois), SiO_2 , TiO_2 , etc. Exemplary fillers include CaCO_3 , talc, etc. Where employed, the particulate component additive comprises less than 70% by weight of the texture layer 14, more preferably less than 50% by weight, most preferably less than 30% by weight. Further, the particulate component may consist of inorganic, hard, and small particles. For example, the "Minex" mineral particulate component has a median particle size of 2 microns and a Knoop hardness of about 560. Of course, other particle size and hardness values may also be useful. The inorganic nature of the particulate component, in conjunction with the non-ionic resin component, renders the resulting texture layer 14 amenable for use with any type of chemical solution.

The texture layer 14 can further include a colorant or pigment additive to provide a desired aesthetic appeal to the wiping article 10. Appropriate pigments are well known in the art, and include, for example, products sold under the trade name SUNSPERSE, available from Sun Chemical Corp. of Amelia, Ohio. Other coloring agents as known in the art are equally acceptable and in some embodiments comprise less than 10% of the texture layer composition by weight.

Additionally, the texture layer composition can include a thickening agent or agents to achieve a viscosity most desirable for the particular printing technique employed and speed of the manufacturing line. In this regard, appropriate thickening agents are known in the art and include, for example, methylcellulose and a material available under the trade name "RHEOLATE 255" from Rheox, Inc. of Hightstown, New Jersey. Another acceptable thickening agent is available from Huntsman International LLC, High Point, NC, USA under the trade designation of LYOPRINT PT-XN. A thickening agent may be

unnecessary depending upon the selected resin and processing technique; however, where employed, the thickening agent preferably comprises less than approximately 40% by weight of the texture layer composition. In other embodiments, a salt component may be provided in the composition to aid in causing an ionic reaction between components of an emulsion and thereby likewise generate an increase in the viscosity of the composition, as is known in the art. Notwithstanding the above, the composition of texture layer 14 may be non-ionic, according to some embodiments.

As indicated above, anti-foaming agents may be included in the composition to provide defoaming or emulsification of the composition. As described in *Ullmann's Encyclopedia of Industrial Chemistry* (section "Foams and Foam Control"), some anti-foaming materials are carrier oils; such as water-insoluble paraffinic and naphthenic mineral oils, vegetable oils, tall oil, castor oil, soybean oil, peanut oil; silicone oils, such as dimethylpolysiloxanes; hydrophobic silica; Hydrophobic fat derivatives and waxes, such as fatty acid esters of monofunctional and polyfunctional alcohols, fatty acid amides and sulfonamides, paraffinic hydrocarbon waxes, ozokerite, and montan wax, phosphoric acid mono-, di-, and triesters of short- and long-chain fatty alcohols, short- and long-chain natural or synthetic fatty alcohols, water-insoluble soaps of long-chain fatty acids, including aluminum stearate, calcium stearate, and calcium behenate, perfluorinated fatty alcohols; water-insoluble polymers, such as low molecular mass, fatty acid modified alkyd resins, low molecular mass novolaks, copolymers of vinyl acetate and long-chain maleic and fumaric acid diesters, and methyl methacrylate–vinylpyrrolidone copolymers, poly(propyleneglycols) and high molecular mass propylene oxide adducts to glycerol, trimethylol, propane (1,1,1-tris(hydroxymethyl)propane), pentaerythritol, triethanolamine, dipentaerythritol, polyglycerol, addition products of butylene oxide or long-chain a-epoxides with polyvalent alcohols. An example anti-foaming agent is a silicone emulsion commercially available under the trade designation of XIAMETER AFE-1520, manufactured by Dow Corning Corporation of Midland, MI, USA.

In some embodiments, the composition of the texture layer 14 may include binder resins, ceramic microparticles or processing agents as described in U.S. Provisional Patent Application Serial No. 62/121,644, entitled, "Consumer Scrubbing Article with Ceramic Microparticles and Method of Making Same" filed on February 27, 2015 and incorporated by referenced herein in its entirety.

Finally, and as previously described, the scrubbing article 10 of the present disclosure can be used “dry” or can be loaded with a chemical (solution or solid) for disinfecting, sanitizing or cleaning (e.g., a soap). The term “loaded” is in reference to a chemical solution being absorbed by the substrate 12 prior to being delivered to a user. In addition or alternatively, the chemical may be sprayed onto a surface of the cloth. In still further embodiments, a chemical may be provided in or as part of the texture layer composition 14. Thus, deposited (e.g., printed) texture layer 14 may comprise printed soap scrubbing dots (e.g., 20a, 20b, FIG. 1). With these various constructions, during use, the chemical solution is released from the substrate 12 as the user wipes the scrubbing article 10 across a surface. Thus, in embodiments where the chemical is provided as part of the texture layer 14, the texture layer (i.e., scrubbing portions 20a, 20b) may gradually decrease in size as the chemical is consumed during a scrubbing application. Due to the preferred non-ionic nature of the texture layer 14, virtually any desired chemical (solution or solid) can be used including water, soap, quaternary ammonium salt solutions, LauricidinTM-based anti-microbials, alcohol-based anti-microbials, citrus-based cleaners, solvent-based cleaners, cream polishes, anionic cleaners, amine oxides, etc. That is to say, where employed, the chemical solution can be anionic, cationic, or neutral.

Formation of the Scrubbing Article

Manufacture or formation of the scrubbing article 10 of the present disclosure is depicted in the simplified block form of FIG. 4 and generally includes formulating the appropriate texture layer composition, imparting the composition to the substrate 12 (e.g., via printing, coating, etching, embossing, molding, micro-replication, etc.), and then UV treating the deposited or formed composition, thereby resulting in a UV crosslinked or UV polymerized (or both) texture layer 14. Various techniques for actual depositing or imparting of the composition 14 to the substrate 12 are described below. Importantly, however, and as noted above, the texture layer composition is formulated such that constituents may be UV crosslinked and/or UV polymerized as part of the UV treating step. This, along with the disclosed substrate constructions, represents distinct advantages over other techniques used to form a scrubbing article having a textured surface.

Prior to forming a texture layer 14 on a substrate 12, depending upon the type of substrate, the surface 16 of the substrate 12 may be primed or treated. Priming may involve mechanical, chemical, physical and material application methods. For example, some surface priming methods that may be especially useful with the present disclosure include heating, applying pressure, consolidating, flame treating, melting, cutting or removing substrate material. Alternatively, priming may include application of a chemical primer such as an adhesive. Notably, however, in some embodiments, no primer is necessary prior to transfer of the texture layer 14 composition onto the substrate 12 and achieve adequate adhesion.

The texture layer 14 composition can be formed on one or more surfaces of the substrate 12 using a variety of known techniques such as printing, (e.g., screen printing, gravure printing, flexographic printing, etc.), coating (e.g., roll, spray, electrostatic), etching, laser etching, injection molding, micro-replicating, and embossing. In general terms, and with reference to FIG. 4, texture former(of various types) 58 deposits or imparts a UV treatable (i.e., crosslinkable and/or UV polymerizable) texture layer 14 onto substrate 12 in any desired pattern, such as any of the various patterns described above. The texture former 58 can include, for example, a printer, roll coater, spray coater, etching device, laser, embossing equipment, microreplication machine, etc. As one specific, non-limiting example, use of a printing method for imparting the texture layer 14 to the substrate 12 may be advantageous in that printing techniques can provide a relatively high-definition (e.g., sharp) printed composition 14. Some printing techniques may also afford relative ease of manufacture and lower cost as compared to other texture forming techniques described above. Regardless of the texture forming technique, as previously described, the texture layer 14 covers less than an entirety of the substrate surface to which it is transferred (i.e., the surface 16 of FIG. 2), and is preferably formed in a pattern including two or more discrete sections. In this regard, a wide variety of patterns can be provided. For example, the pattern can consist of a plurality of dots as shown in FIG. 1. Alternatively, the lines can be connected to one another. In yet alternative embodiments, and with additional reference to FIGS. 5A-5B, the texture layer consists of a plurality of discrete lines, dots, and/or images. Further, other desirable pattern components, such as a company logo, can be formed. Alternatively, a more random distribution of texture layer

sections can be imparted to the substrate 12. The present disclosure contemplates that virtually any pattern can be obtained.

Once the texture layer 14 is formed on the substrate 12, but prior to exposure to UV radiation (as discussed below), an interim scrubbing article 17 is formed. The interim scrubbing article 17 is characterized as having a UV treatable texture layer 14 that has not yet undergone UV treatment (i.e., the UV light exposure step has not yet been performed). The interim scrubbing article 17 may thus also be referred to as an interim textured scrubbing article 17. Regardless, the interim scrubbing article 17 may next be allowed to remain undisturbed (allowed to wait) for a period of time or may directly or immediately proceed to an optional curing step. The interim scrubbing article 17 may undergo an optional curing step whereby the article 17 is exposed to heat, such as given by an oven (60, FIG. 4) or infrared light (not shown), for a short period of time. Oven and/or infrared light exposure times may vary and may for example be in a range of less than 5 minutes, 3 minutes or less, or 2 minutes or less. With regard to infrared exposure, often infrared light exposure is more cost effective than heating via an oven. However, unless the composition of material undergoing infrared light exposure is naturally highly absorbing of infrared light, an additive may be required to allow absorption of the infrared light by the composition. An example of an additive useful for aiding in infrared absorption is carbon black. Regardless, the optional step can facilitate a stronger or more desirable adherence of the texture layer 14 to the substrate surface 16 and can provide a more stable, less tacky texture layer 14. It is to be understood that subjecting the texture layer 14 to the UV light itself can likewise be enough to complete polymerization or crosslinking such that the heat or infrared treatment) is unnecessary. Likewise, it is to be understood that for some compositions of texture layer 14, no water or solvent is present in the texture layer 14 prior to UV treatment, thus no evaporation step may be desired or necessary. For example, in embodiments of the present disclosure, the texture layer composition 14 comprises a material that does not require a water based or solvent based resin or compound to achieve material flow sufficient to transfer to a substrate (e.g., 12) in a desired pattern.

Next, after the texture layer 14 has been formed on the substrate 12, and after any optional steps described above, the interim textured scrubbing article 17 is subjected to UV radiation to crosslink or polymerize, or both, the texture layer 14 composition

provided thereon. As illustrated in FIG. 4, a UV light 62 irradiates UV treatable texture layer 14 of interim scrubbing article 17 to thereby form a UV treated (i.e., UV crosslinked and/or UV polymerized) texture layer 14 on substrate 12 thus forming the resultant scrubbing article 10. Due to the stable nature or chosen viscosity of the texture layer 14 composition, the UV treatable texture layer 14 and the UV treated texture layer 14 will have a substantially similar or a same texture pattern i.e., the pattern created by the initial deposition or formation of texture layer 14 will not substantially change, if at all, prior to or after UV treatment of the texture layer 14.

Regardless of the exact composition and dimensions of substrate 12 and the composition, dimensions or pattern of the texture layer 14, the scrubbing article 10 of the present disclosure provides a marked improvement over previous consumer scrubbing articles in terms of cost as well as ease and flexibility of the manufacturing processes that may be used in forming scrubbing articles. In addition, scrubbing articles of the present disclosure exhibit suitable abrasion resistance performance and may beneficially include a single layer substrate or non-laminated article that provides superior handling. Likewise, UV crosslinked texture layers 14 of the present disclosure may have increased durability, hardness, tensile and impact strength, high-heat properties, solvent and chemical resistance, and environmental stress crack resistance. Exemplary scrubbing articles 10 are provided below. The components and/or weight percent amounts provided by the compositions can readily be varied, yet fall within the scope of the present disclosure.

EXAMPLE A:

TABLE 1A: Texture Layer (Printing Abrasive) Materials

Item	Description
Acrylate	Trimethylolpropane Triacrylate with a viscosity of 106 cps at 25C and the glass transition temperature of 62°C, commercially available under the trade designation SR351 from SARTOMER USA LLC, Exton, PA, USA.
Epoxy-1	An undiluted, clear, difunctional bisphenol A/epichlorohydrin derived liquid epoxy resin, commercially available under the trade designation of EPON Resin 828 from HEXION SPECIALTY CHEMICALS, INC, Houston, TX, USA.

Epoxy-2	3,4-Epoxy cyclohexylmethyl-3,4-epoxycyclohexane carboxylate resin with an epoxide equivalent weight of 131-143 and with a viscosity of 350-450 cp (at 25°C), commercially available under the trade designation of CYRACURE UVR 6110 from DOW CHEMICAL COMPANY, Midland, MI, USA.
Photoinitiator-1	2-Benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butanone-1, commercially available under the trade designation IRGACURE 369 from BASF CORP., Florham Park, NJ, USA.
Photoinitiator-2	50 wt. % Triarylsulfonium hexafluoroantimonate salt in propylene carbonate commercially available under the trade designation CPI6976 from ACETO Corp., Port Washington, NY, USA.
Silica	Untreated, amorphous, synthetic, colloidal fumed silica with a specific surface area of 200 m ² /g, commercially available under the trade designation of CABOSIL M5 from CABOT CORPORATION, Billerica, MA, USA.
Filler-1	240 grit aluminum oxide ceramic powder with a specific gravity of 3.965 at 25°C
Filler-2	Natural Wollastonite mineral powder with a specific gravity of 2.9 at 25°C, commercially available under the trade designation of NYCO from MINERA ROCA RODANDO S. de R.L. de C.V., Hermosillo, Sonora, MEXICO.
Filler-3	Ground calcium carbonate powder with a specific gravity of 2.7 at 25°C, commercially available under the trade designation of #10 WHITE from IMERYS PIGMENTS, Roswell, GA, USA
Pigment	Liquid purple pigment, commercially available under the trade designation of REACTINT VIOLET X80LT from MILLIKEN & COMPANY, Spartanburg, SC, USA.
Thickener	Fully neutralized, anionic acrylic polymer dispersion with a specific gravity of 1.1, commercially available under the trade designation of LYOPRINT PT-XN from HUNTSMAN INTERNATIONAL LLC, High Point, North Carolina, USA

Preparation of Texture Layer Compositions

All ingredients of TABLE 1A were weighted out to the nearest 0.1 grams in separate rigid plastic containers in desired quantities. A mixture was prepared by placing all ingredients in a rigid plastic container. The photoinitiator was placed last and care was exercised not to expose the photoinitiator to excessive ambient light. The mixture was first mixed by hand for 30 seconds and a lid was secured on the container before starting the mixing. The mixture was then mixed for 30 seconds in a laboratory centrifugal mixer commercially available from FLACKTEK INC., Landrum, SC, USA under the trade designation of SPEEDMIXER DAC 400.1 VAC-P. The rotation speed of the mixer was set to 2500 rpm. After 30 seconds, the mixer was stopped, and the plastic container which had the mixture in it was removed from the mixer and wrapped with aluminum foil. The

container was left undisturbed on a laboratory bench for 24 hours. The list of prepared acrylate and epoxy mixtures is presented in TABLES 2A and 3A.

TABLE 2A: Composition of the Prepared Acrylate Mixture

Component	Weight (g)
Acrylate	134.1
Filler-3	142.4
Filler-1	69.7
Photoinitiator-1	3.0
Pigment	0.7
Silica	7.1
Thickener	2.0
TOTAL	359.1

TABLE 3A: Composition of the Prepared Epoxy Mixture

Component	Weight (g)
Epoxy-1	75.0
Epoxy-2	75.0
Silica	20.4
Photoinitiator-2	7.5
Filler-2	90.0
Filler-1	45.5
TOTAL	313.4

5

TABLE 4A: Substrate Materials

Foam	Polyurethane foam sheet with a density of 27 kg/m ³ , with dimensions of 20 cm x 10 cm x 2.54 cm, and with a relatively less porous top and bottom surfaces, commercially available under the trade designation of TEXTURED SURFACE FOAM, POLYETHER, M-100SF from AEARO TECHNOLOGIES LLC, Newark, DE, USA .
Cellulose sponge	Cellulose sponge sheet commercially available under the trade designation of SCOTCH-BRITE STAY CLEAN NON-SCRATCH SCRUB SPONGE, with a thickness of 1.7 cm and with a catalog number of 20202-12 from 3M COMPANY, ST. PAUL, MN, USA

The foam and cellulose sponge specimens were used as-received. It is evident that any other thick non-woven substrate would be similarly useful. An example of a commercially available thick non-woven substrate was the non-woven bath sponge with a

10

thickness of 3 cm, commercially available under the trade designation of ACTIBEL TONIFICANTE from 3M ESPANA, S.A., Madrid, SPAIN.

Printing the Prepared Compositions onto the Prepared Substrates

5 For each of the prepared substrates of TABLE 4A, a metal stencil with the texture pattern shown in FIG. 1 was placed on top of the substrate specimen. The substrate was secured on a flat laboratory bench by applying adhesive tape on its edges. Then, a metal stencil with the desired printing pattern was placed on top of the substrate specimen. Approximately 50 grams of the prepared printing mixture was placed on the stencil with
10 the help of a wooden applicator. The printing mixture was then applied on the printing pattern of the stencil with a shearing motion while applying hand pressure downwards, with the help of a hand-held squeegee. It was observed that the printing mixture filled the holes of the printing pattern and was transferred onto the substrate specimen. Then, the stencil was removed and the printed substrate specimen was left undisturbed on a
15 laboratory bench for one minute.

It was observed that the relatively smooth surfaces of the foam and cellulose sponge substrates substrate enabled more uniformly printed (sharp) patterns.

UV Treatment of the Printed Samples

20 After one minute, the printed specimens were subjected to UV radiation under a standard D-bulb (EPIQ 6000, commercially available from Heraeus Noblelight America LLC, Gaithersburg, MD, USA), in a continuous line with a line speed of 9.33 m/min. The D-bulb had a power of 600 W.

Testing Abrasive Properties of the Printed Samples

The abrasive properties of the printed specimens were tested with a Frazier Schiefer Uniform Abrasion Tester, commercially available from Frazier Precision Instrument Company, Inc. Hagerstown, MD, USA. In the test, the printed specimens were first saturated with deionized water and then used as the abradant. An optically
30 transparent, rigid plastic disk was used as the substrate to be abraded. The disk was laser cut with a diameter of 10.2 cm and with a thickness of 0.3 cm from a rigid plastic sheet

commercially available from Evonik Industries AG, Essen, Germany, under the trade designation of ACRYLATE GP. During the test, the abradant abraded the disk with a rotation speed of 250 rpm and the test was terminated when total revolutions reached 1000. The weight of the disk was measured before and after the test to the nearest 0.001 grams. The difference between the weight values was recorded and reported as the percentage of the initial weight in TABLE 5A (under the column of 'abraded weight from the disk after 1000 revolutions').

TABLE 5A: Evaluation of Abrasive Properties of the Printed Samples

Specimen	Abraded weight from disk after 1000 revolutions (wt%)
Acrylate printed on non-woven	0.47
Acrylate printed on foam	0.31
Acrylate printed on cellulose sponge	0.61
Epoxy printed on non-woven	0.23
Epoxy printed on foam	0.14
Epoxy printed on cellulose sponge	0.19

RESULTS

The data presented TABLE 5A indicate that the acrylate formulation printed on different substrates was more abrasive than the epoxy formulation.

EXAMPLE B:

TABLE 1B: Printed Article Composition

Item	Description
Acrylate	Trimethylolpropane triacrylate, commercially available as SR351 from Sartomer USA, Exton PA, USA.
Filler 1	CaSiO ₃ , commercially available as Wollastocoat M400 from NYCO Minerals, Inc., Willsboro, NY, USA.
Filler 2	Untreated, amorphous, synthetic, colloidal fumed silica commercially available as CABOSIL M5 from CABOT CORPORATION, Billerica, MA, USA.
Pigment	Liquid purple pigment, commercially available as REACTINT VIOLET X80LT from MILLIKEN & COMPANY, Spartanburg, SC, USA.
Flow agent 1	Cross-linkable silicone acrylate, commercially available as Tegorad 2100 from Evonik Industries AG, Essen, Germany
Flow agent 2	Polydimethylsilane with a viscosity of 1000 cPs, commercially available as Element14* PDMS 1000 from Momentive Performance Materials, Inc., Waterford, NY, USA.
Photoinitiator-1	Phenylbis(2,4,6-trimethylbenzoyl)phosphine oxide, commercially available as IRGACURE 819 from BASF CORP., Florham Park, NJ, USA.
Photoinitiator-2	Diphenyl(2,4,6-trimethylbenzoyl)-phosphinic acid ethyl ester, commercially available as LUCERIN TPO-L from BASF Corp, Florham Park, NJ, USA.
Foam 1	Cellulose sponge cloth with a unit weight of 100 g/ m ² , approximately 1 mm thick, commercially available from Kalle GmbH, Wiesbaden, Germany
Foam 2	Open cell, polyurethane foam with an approximate density of 26 kg/m ³ , approximately 18 mm thick, commercially available

	from NCFI Polyurethanes, Inc., Mount Airy, NC, USA
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Preparation of Texture Layer Compositions

All texture layer compositions were mixed with a DAC-400 SpeedMixer™ asymmetric centrifugal mixer (Flacktek Inc., Landrum, SC USA) using Flacktek plastic mixing containers. For ink composition 1, 1.5 g of photoinitiator 1 was added to a mixing container with 162.5 g of the acrylate and mixed for several minutes until the photoinitiator was dissolved, then 135.0 g of filler 1, 5.7 g of filler 2, 0.2 g of pigment, 4.7 g of flow agent 1, and 4.7 g of flow agent 2 were added to the container and mixed for 3 minutes at 2500 rpm. For ink composition 3, 3.0 g of photoinitiator 2 was added to a mixing container with 161.7 g of the acrylate and mixed for several minutes until the photoinitiator was well mixed in the acrylate, then 141.1 g of filler 1, 7.9 g of filler 2, 0.2 g of pigment, 4.7 g of flow agent 1, and 4.7 g of flow agent 2 were added to the container and mixed for 3 minutes at 2500 rpm. The compositions of the two inks are listed below:

TABLE 2B: The Texture Layer (Printing Abrasive) Compositions

MATERIAL	MATERIAL 1 (g)	MATERIAL 1 (%)	MATERIAL 3 (g)	MATERIAL 3 (%)
Acrylate	162.5	51.73	161.7	50.05
Photoinitiator-1	1.5	0.478		
Photoinitiator-2			3.0	0.929
Filler 1	135.0	42.99	141.1	43.66
Filler 2	5.7	1.799	7.9	2.43
Pigment	0.2	0.048	0.2	0.046
Flow agent 1	4.7	1.481	4.7	1.439
Flow agent 2	4.7	1.481	4.7	1.439
Totals	314.1	100	323.1	100

TABLE 3B: Substrate Materials

Foam 1	Cellulose sponge cloth with a unit weight of 100 g/ m ² , approximately 1 mm thick, commercially available from Kalle GmbH, Wiesbaden, Germany
Foam 2	Open cell, polyurethane foam with an approximate density of 26 kg/m ³ , approximately 18 mm thick, commercially available from

	NCFI Polyurethanes, Inc., Mount Airy, NC, USA
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Substrate Preparation

The substrates were used as-received with the exception of cutting. Foam 1 (cellulose sponge cloth) was prepared by cutting into squares approximately 22 cm by 22 cm. Foam 2 was prepared by cutting into squares approximately 17 cm by 17 cm.

5 Printing the Prepared Compositions onto the Prepared Substrates and Dot Height

The printing composition was screen printed onto substrates Foam 1 and Foam 2 using a metal screen with circular openings approximately 1.8 mm in diameter; each opening was separated from other openings by a distance of approximately 2 mm. The ink was forced through the holes in the screen using a squeegee. The resulting printed articles therefore
10 had a pattern of printing composition dots. The printing composition dots were either raised or at the sponge surface, depending on the substrate and amount of printing composition applied. On the cellulose sponge cloth substrate of Foam 1, the printing composition dots were raised with a cured printing composition dot height of approximately 0.5-1.6 mm. On the more porous polyurethane sponge of Foam 2, the
15 printing composition dots were at the surface of the sponge (but exposed when the sponge was compressed). Printing composition viscosity will have an effect on printing composition dot height. A more viscous printing composition would result in a higher printing composition dot height, and a less viscous printing composition would result in a lower printing composition dot height. The printing composition viscosity was not varied,
20 however: both printing compositions were on the order of 10,000 cPs (as measured with a Brookfield Model RVTD viscometer).

Curing Conditions

Printing compositions were cured under either 395 nm LED ultraviolet lamps
25 (Phoseon) or a D-bulb lamp (Heraeus-Fusion), without nitrogen purge. Curing was done at line speeds up to 60 m/min (200 ft/min). At this speed using the D-bulb, printing compositions were cured with a measured energy as low as 223 mJ/cm², 83 mJ/cm², 9 mJ/cm² and 267 mJ/cm² for UVA, UVB, UVC, and UVV, respectively. At this speed, for the 395 nm LED bulb, printing compositions were cured with a measured energy as low as
30 42 mJ/cm².

RESULTS

Durability of the finished article (i.e., adhesion of the printing composition dots) was tested using a straight line washability tester (Gardner Laboratory, Silver Spring, MD) similar to that described in ASTM D-3450, with the following differences:

- a. The finished articles were placed in the sponge holder and backed with additional polyurethane (for the printed polyurethane sponge) or cellulose sponge (for the cellulose sponge cloth) so that the printed surfaces of the finished article were exposed to the scrub solution.
- b. The scrub solution was a 0.15% by volume solution of Dawn® dishwashing liquid (Dawn® is a registered trademark of Proctor and Gamble), in deionized water. Enough scrubbing solution was added to keep the finished articles wet, without excess water splashing out. The scrub solution was completely replaced for each test.
- c. The weighted sponge holder was approximately 344 g (with dry cellulose sponge backing and dry printed sponge cloth) and 340 g (with dry polyurethane sponge backing and printed polyurethane sponge).
- d. The surface being scrubbed was a clean piece of glass, free of scratches.

Both of the finished article with Foam 1 and the finished article with Foam 2 exceeded 5000 cycles (over 2 hours continuous scrubbing) without loss of printed composition dots. The finished articles were determined to be non-scratching, as the glass substrate remained free of scratches after the tests.

25 EXAMPLE C:

TABLE 1C: Printed Article Composition

Item	Description
Acrylate	55 wt% of a mixture comprising: • 70 wt% UVR 6110 UV curable epoxy acrylate available from The Dow Corning Corporation of Midland, MI, USA. • 30 wt% Trimethylolpropane triacrylate, commercially available as SR351 from Sartomer USA, Exton PA, USA

Filler	40 wt% of a mixture comprising: • 20 wt% Super Gloss 90 calcinated clay available from 20 Microns Limited, 134/135 Hindustan Kohonoor Industrial Complex, LBS Marg, Vikhroli (W), Mumbai-83, INDIA. • 80 wt% UV Curable epoxy binder OPV9051 available from UV Resin Private Limited, 339, Shivaji Nagar, Indore – 3, Madhya Pradesh, INDIA.
Pigment	3-4 wt% PVC based printing ink - Red (SG 510) available from Seiko Advance (India) Pvt Ltd. Plot No. 442, Pace City – II, Sector 37, Guragaon, Haryana, 122001, INDIA.
Photoinitiator-1	3 wt% CPI 6976 available from Aceto Corporation, New York, NY, USA
Photoinitiator-2	1 wt% Irgacure 819 available from BASF CORP., Florham Park, NJ, USA
Substrate	Scotch Brite® Sponge Wipe (having a moist dimension of 15 cm L x 18 cm W x 4.975 mm D available from 3M India Ltd., 48-51, Electronic City, Hosur Road, Bangalore 560100, INDIA.

Substrate Preparation

The substrates were used as-is except in the case where the moisture content was high to a degree based on hand-feel. If upon touching, the user's hand did not feel moist, it was not considered "wet." If upon touching, a user's hand felt wet, the substrate was placed in a HAO-L oven set at 105 degrees C for 15 minutes (oven available from Thermocon Instruments (P) Limited, 872, HAL, 3rd Stage, (opp BEML gate), Bangalore – 75, INDIA).

Printing the Prepared Compositions onto the Prepared Substrates and Dot Height

To prepare the printed compositions, take a 250ml beaker and transfer 150 grams of filled UV curable resin composition (OPV9051 grade) and add 6 grams of SG 510 Red Ink to the beaker (i.e. 4%) under constant stirring. Then using stirrer model IKA Eurostar-ST PCV at 150 rpm for 15 minutes at room temperature. Then, allow the mixture to settle at room temperature.

Mount a polyester mesh screen frame with the desired print design to an ATMA printing machine Model No. AT-80 P available from ATMA CHAMP ENT. CORP., No. 65, Wuquan 7th Road, WUGU Dist., New Taipei City 248, TAIWAN. The prepared composition, as prepared above, was poured at the middle of the screen. The printing bar
 5 was run left and right one time to spread the ink over the mesh screen frame. The printing speed was set at 8m/min. Then the substrate was placed under the screen and printed with single/and double pass. The printed substrate was then dried with a Fusion UV dryer model no. P600 M available from Heraus Nobelight Fusion UV Inc., 910 Clopper Road, Gaithersburg, Maryland 20878, USA for curing and setting of the coated composition on
 10 the substrate.

The Effect of Substrate Dimension and Feel after UV Curing

To determine the effect of UV curing on product dimension, three wipes were prepared as generally discussed above. Each wipe passed through the UV curing chamber a different number of times. A “single pass” wipe was passed through the UV curing
 15 chamber one time. A “two pass” wipe was passed through the UV curing chamber twice and a “three pass” wipe was passed through the UV curing chamber three times. At a UV curing chamber feed rate of 17 units, the wipe was exposed to about 2,500 mJ/cm² for each pass. It was observed that the “three pass” wipes did show some dimensional change and that the wipe felt harsh and stiff to the touch. After leaving the wipe overnight
 20 in the oven (without heat), the wipe regained the original dimensions and feel, thus indicating that UV curing and drying was not irreversibly altering the dimension and feel of the wipe.

Impact of Drying & Moistening Test

The three wipes were further tested to evaluate the impact of drying and
 25 moistening the wipe on stability of the printed texture layer. It was observed that after wetting the wipe and then drying at 105 degrees C for two hours in a TEMPO dryer model no. TI 126D (available from TEMPO Instruments & Equipments (1) PVT. LTD., To Syringe Comp, W.E. Highway, B/H, Samrat Hotel, Pandurang Wadi, PO: Mira, Dist.. : Thane – 401 104, INDIA), no cracks were found in the texture layer on any of the three
 30 wipes. The wipes were then re-wetted and, again, no cracks formed in any of the printed texture layer. The three wipes were also washed for two hours in a Samsung WA80K8SEG/XTL washing machine (available from Samsung India, Mumbai,

Maharashtra, INDIA) at 60 degrees C. In this experiment, a noticeable loss of the printed texture layer was observed in each of the wipes.

The one pass wipe suffered considerable printed textured layer loss. The two pass wipe had noticeable loss of the printed textured layer but the printed textured layer did not crack. The three pass wipe retained the most of the printed textured layer and the printed texture layer only slightly wore off. The performance of the two pass wipe and the three pass wipe were deemed satisfactory in this regard.

Crocking Performance (Surface Abrasion) Test

In a surface abrasion or crocking test, each of the three wipes were tested per AATCC 8 test method and the test was continued even after 10 turns to check the performance consistency of abrasive coating on a sponge wipe substrate. The equipment used for testing was a MECRUB XT MAG-C0221 crock meter available from MAG SOLVICS PRIVATE LTD, Coimatore-642109, INDIA. The wipes were tested until a severe loss of printed texture layer occurred. A severe loss of printed texture layer occurred in 10 cycles for the single pass wipe, 50 cycles for the two pass wipe and 10 cycles for the three pass wipe.

Scrubbing Performance Test

The one pass, two pass and three pass wipes were also tested on a crayon stain to determine how many scrubbing passes would be required to remove the stain. This test was conducted using a 57 mm long x 7.5 mm diameter wax crayon available from Camel Wax Crayons, Kokuyo Camlin Ltd, 48/2, Hilton House, Central Road, MIDC, Andheri(E), Mumbai-400093, INDIA. The Camlin Wax crayon was used to make a stain. A circle of 3 cm in diameter was made on a granite table top and was colored in by manually holding the crayon like a pencil. The granite table top was a regular, non-polished surface without any deep cracks, holes or uneven surface areas. All of the crayon stains were made at the same time. The test wipe made moist and pliable with water and the printed side was manually wiped over the crayon stain in the same way used by typical consumers of such wipes for in-home use. The test for each wipe was conducted by the same operator at the same time to adopt generally uniform speed and pressure throughout the test in attempts to avoid variations in the results. The number of strokes need to clean the crayon stain

completely from the granite test surfaces was recorded. Each pass of the wipe constituted one stroke. Post cleaning of the stain, the granite test surface was cross-checked to ensure the stain was completely cleaned from the test surface. As illustrated in TABLE 3C below, the one pass, two pass and three pass wipes all performed better than many of the
5 other scrubbing articles tested.

TABLE 2C: Scrubbing Performance of Textured Layer

	Type of Wipe			
	Scotch Brite® Sponge wipe (NOT printed)	"One Pass" Wipe	"Two Pass" Wipe	"Three Pass" Wipe
Number of strokes required to clean the Crayon stain	68	65	37	40

RESULTS

The above testing of the one, two and three pass wipes described in Example C
10 indicate that the printed surface of the single pass wipe produces a very light coating that is removed relatively easily in washing and rubbing tests. The double pass wipe performed satisfactory in all tests described in Example C. The three pass wipe was stiffer and, as a result, the printed surface wore out in the crocking and washing tests.

Although the present disclosure has been described with reference to preferred
15 embodiments, workers skilled in the art will recognize that changes can be made in form and detail without departing from the spirit and scope of the present disclosure.

What is claimed is:

1. A scrubbing article comprising:
a substrate comprising one of a foam and a sponge material;
an ultraviolet (UV) crosslinked texture layer formed on a surface of the substrate.
- 5 2. The scrubbing article of claim 1, wherein the substrate comprises a thickness of at least 2 cm.
3. The scrubbing article of claim 1, wherein the substrate comprises a thickness of at
10 least 3 cm.
4. The scrubbing article of claim 1, wherein the the UV crosslinked texture layer is formed on at least two surfaces of the substrate.
- 15 5. The scrubbing article of claim 1, wherein the texture layer defines a pattern.
6. The scrubbing article of claim 5, wherein the pattern includes a plurality of discrete segments.
- 20 7. The scrubbing article of claim 6, wherein the discrete segments include at least one of series of unconnected lines, dots or images.
8. The scrubbing article of claim 1, wherein the texture layer extends a maximum 200microns outwardly from the surface of the substrate.
- 25 9. The scrubbing article of claim 1, wherein the texture layer includes a plurality of randomly distributed texturings.
10. The scrubbing article of claim 1, further comprising:
30 a chemical solution absorbed into the substrate.

11. The scrubbing article of claim 1, wherein the texture layer comprises a hardness that is at least equal to a hardness of the substrate.

12. The scrubbing article of claim 1, wherein the texture layer hardness is greater than
5 the hardness of the substrate.

13. The scrubbing article of claim 1, wherein the substrate consists of a single layer of material.

10 14. A method of manufacturing a scrubbing article comprising:
transferring a resin composition onto a surface of a substrate to form a UV
treatable texture layer on the surface and thereby form an interim scrubbing article;
treating the interim scrubbing article with UV radiation to form a UV crosslinked
texture layer on the substrate surface;
15 wherein the substrate comprises one of a foam and a sponge material.

15. The method of claim 14, wherein the UV crosslinked texture layer has a relative hardness greater than a hardness of the substrate.

20 16. The method of claim 14, wherein the UV treatable texture layer and UV crosslinked texture layer each define a pattern.

17. The method of claim 14, further comprising:
prior to the treating step, exposing the interim scrubbing article to heat to evaporate
25 an amount of solvent from the UV treatable texture layer.

18. The method of claim 14, wherein the UV treated texture layer comprises a UV polymerized texture layer having a relative hardness equal to or greater than a hardness of the substrate.

30

19. A method of manufacturing a scrubbing article comprising:

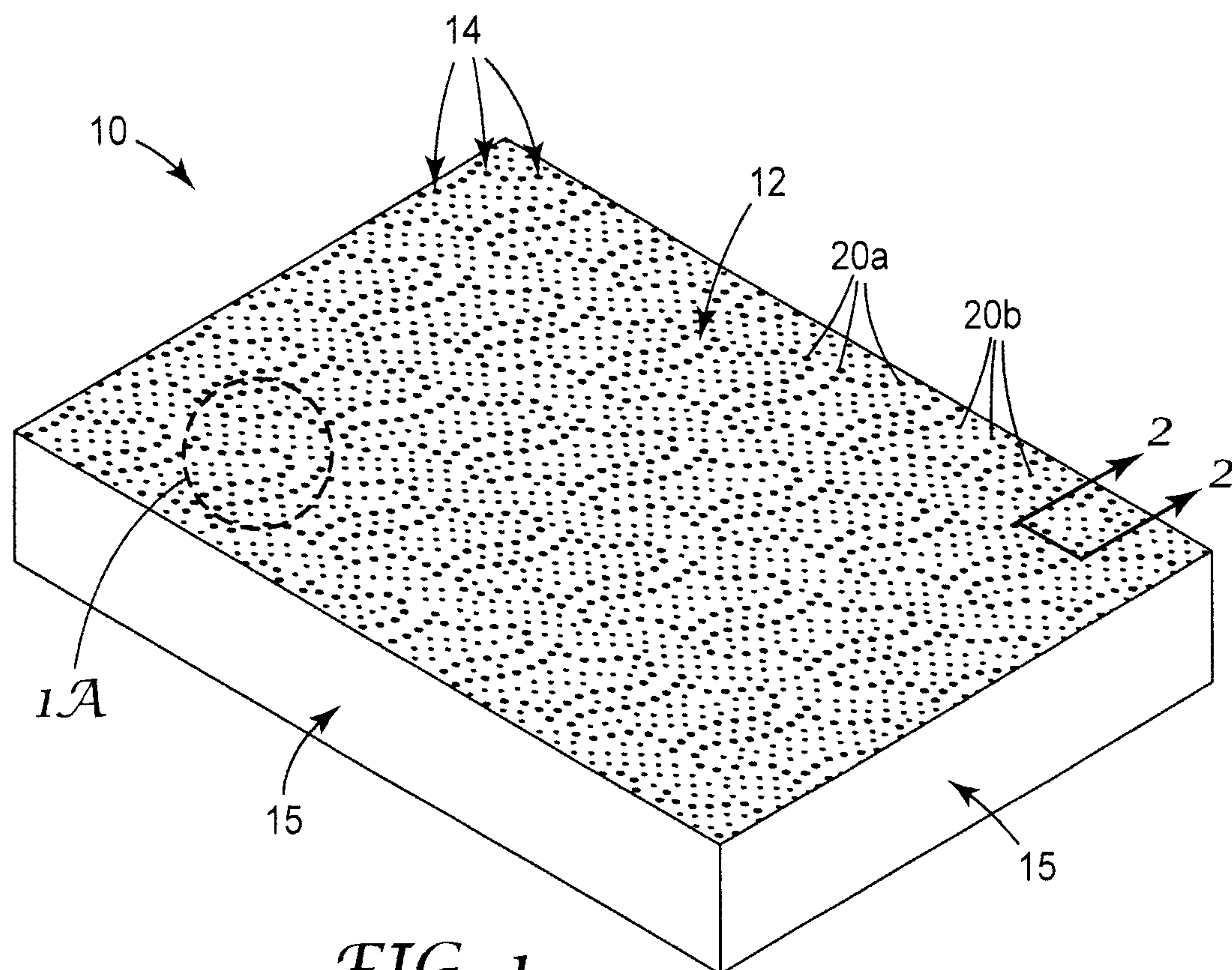
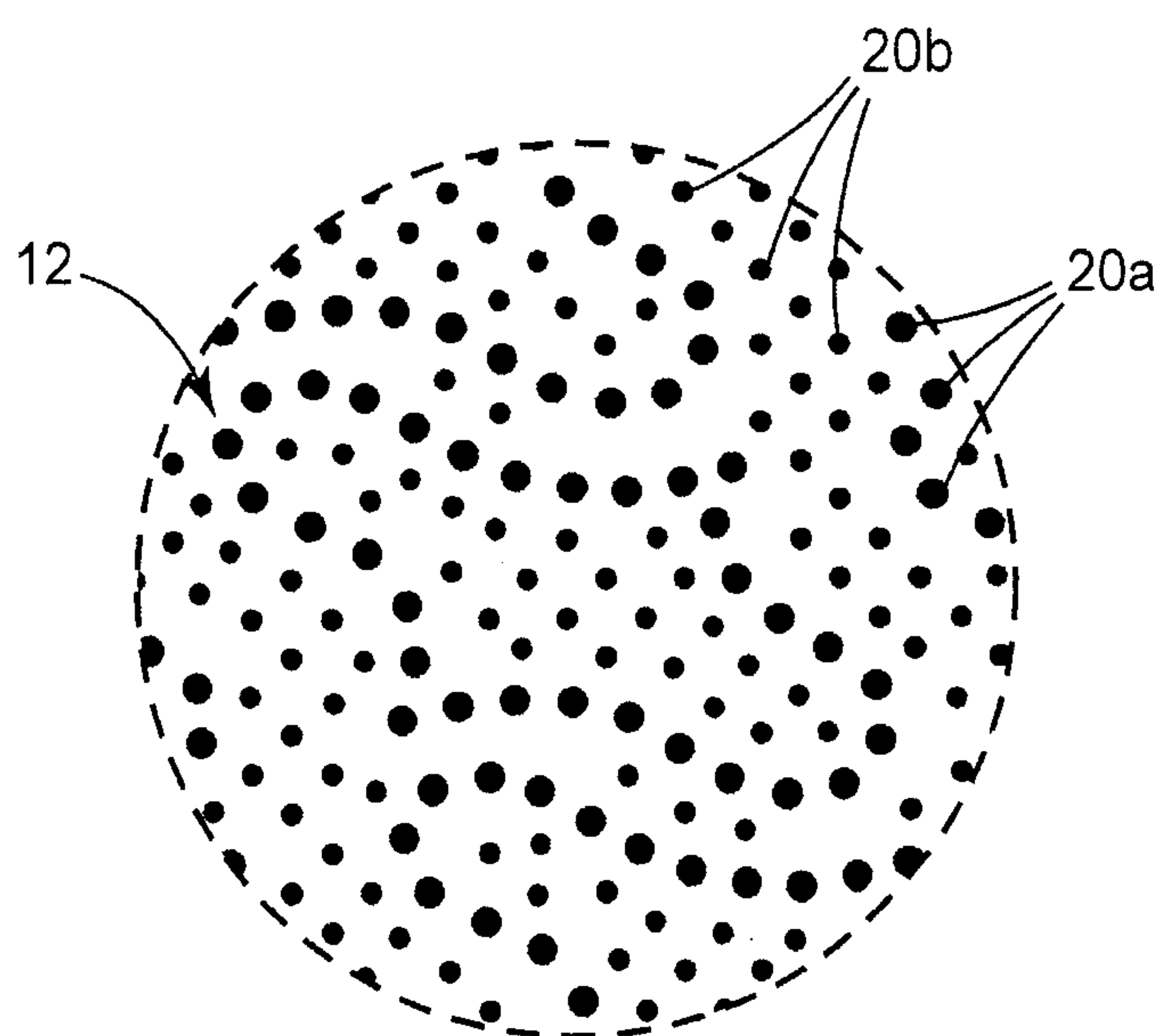
forming a UV treatable composition on a surface of a substrate to form a UV crosslinkable texture layer; and

UV treating the texture layer by exposing the texture layer to UV radiation to form a UV crosslinked texture layer;

5 wherein the substrate consists essentially of a sponge or a foam material.

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*FIG. 1**FIG. 1A*

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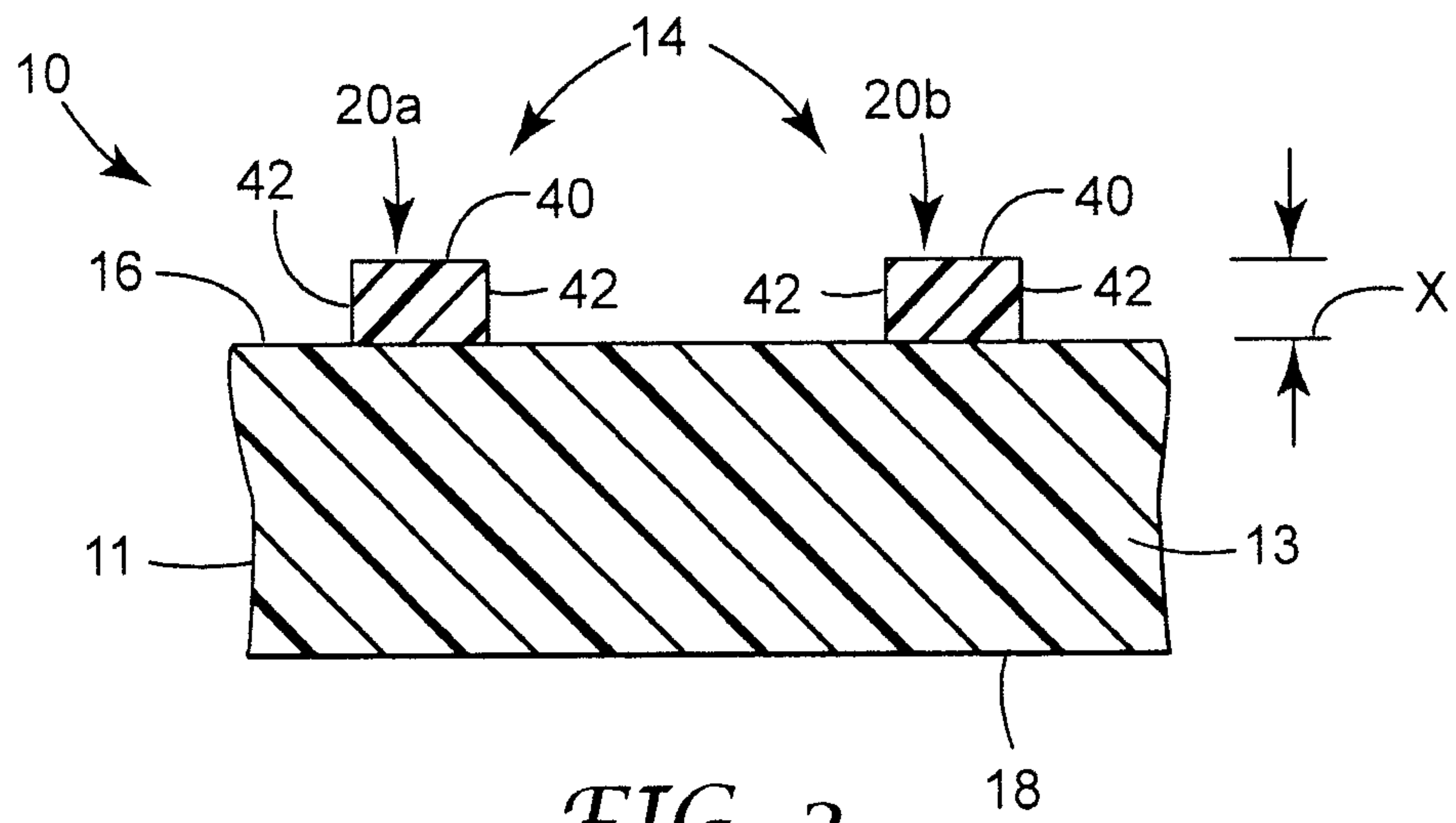


FIG. 2

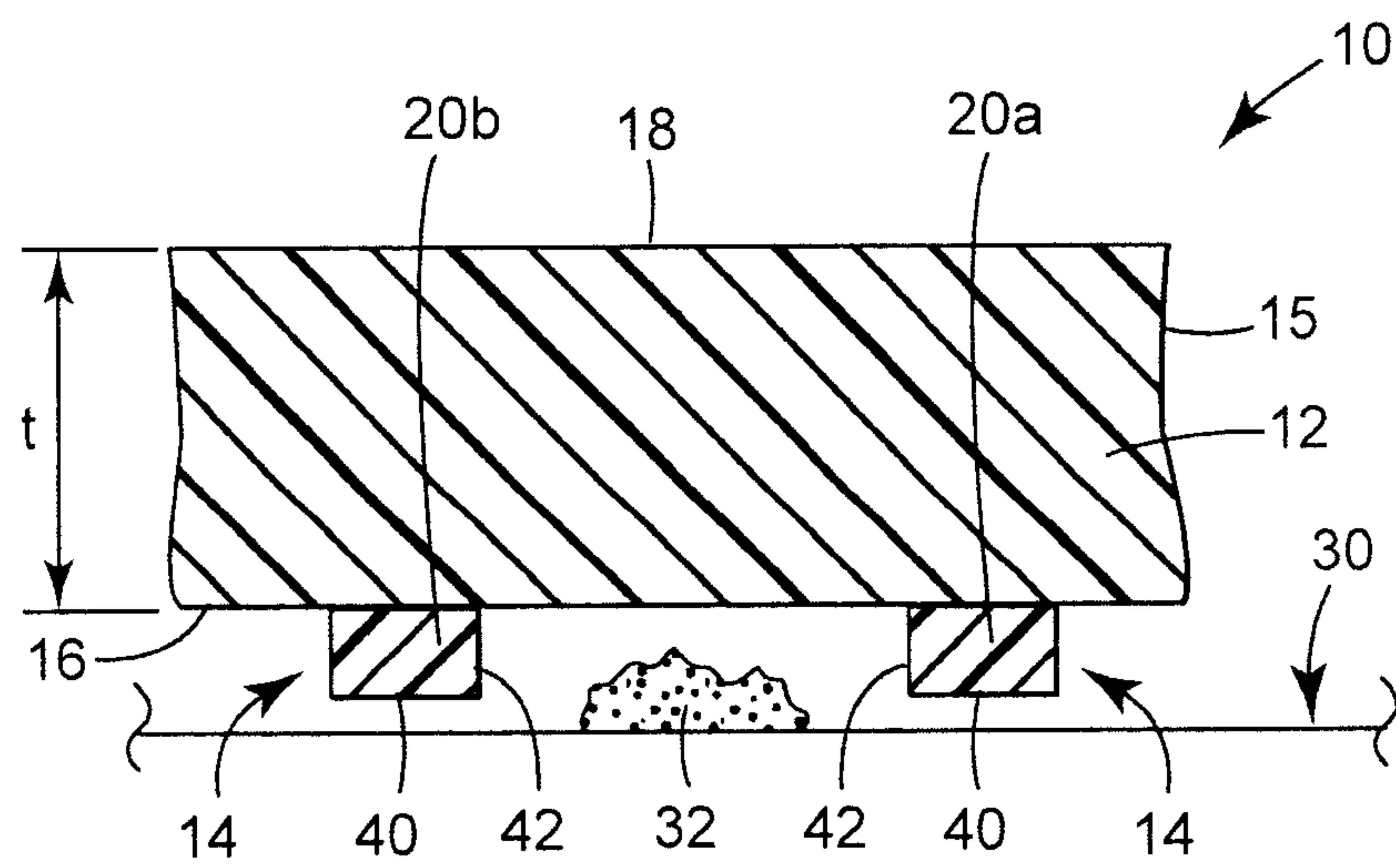


FIG. 3

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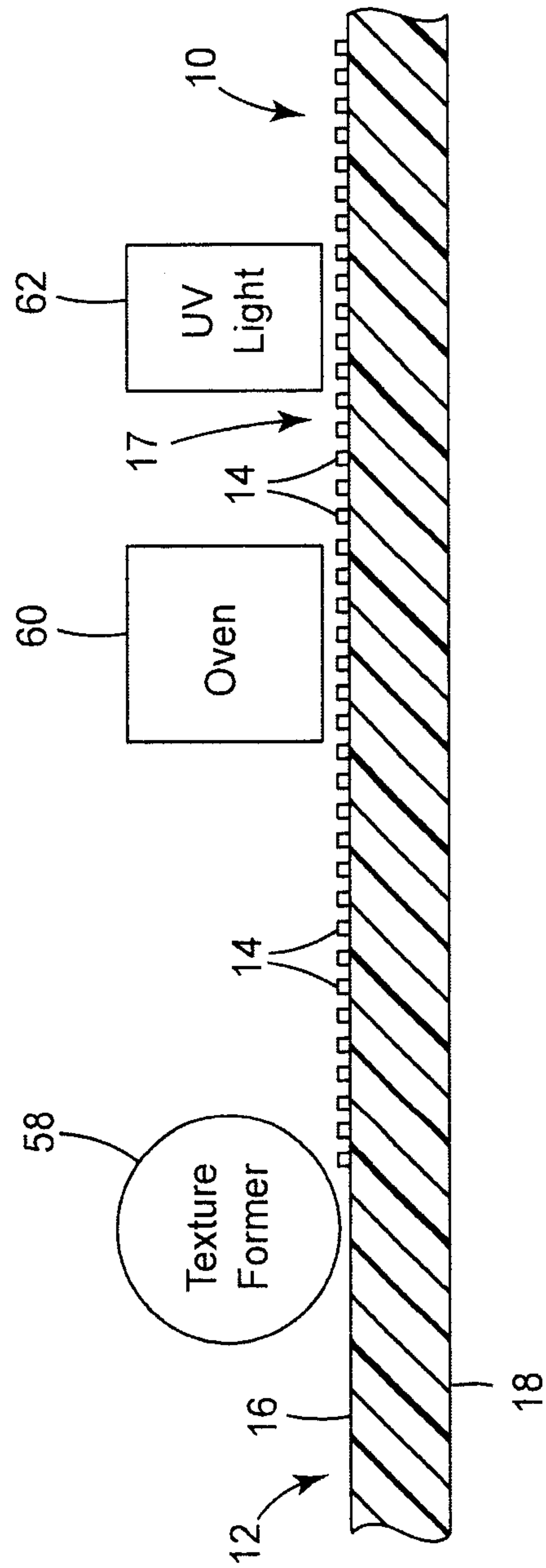


FIG. 4

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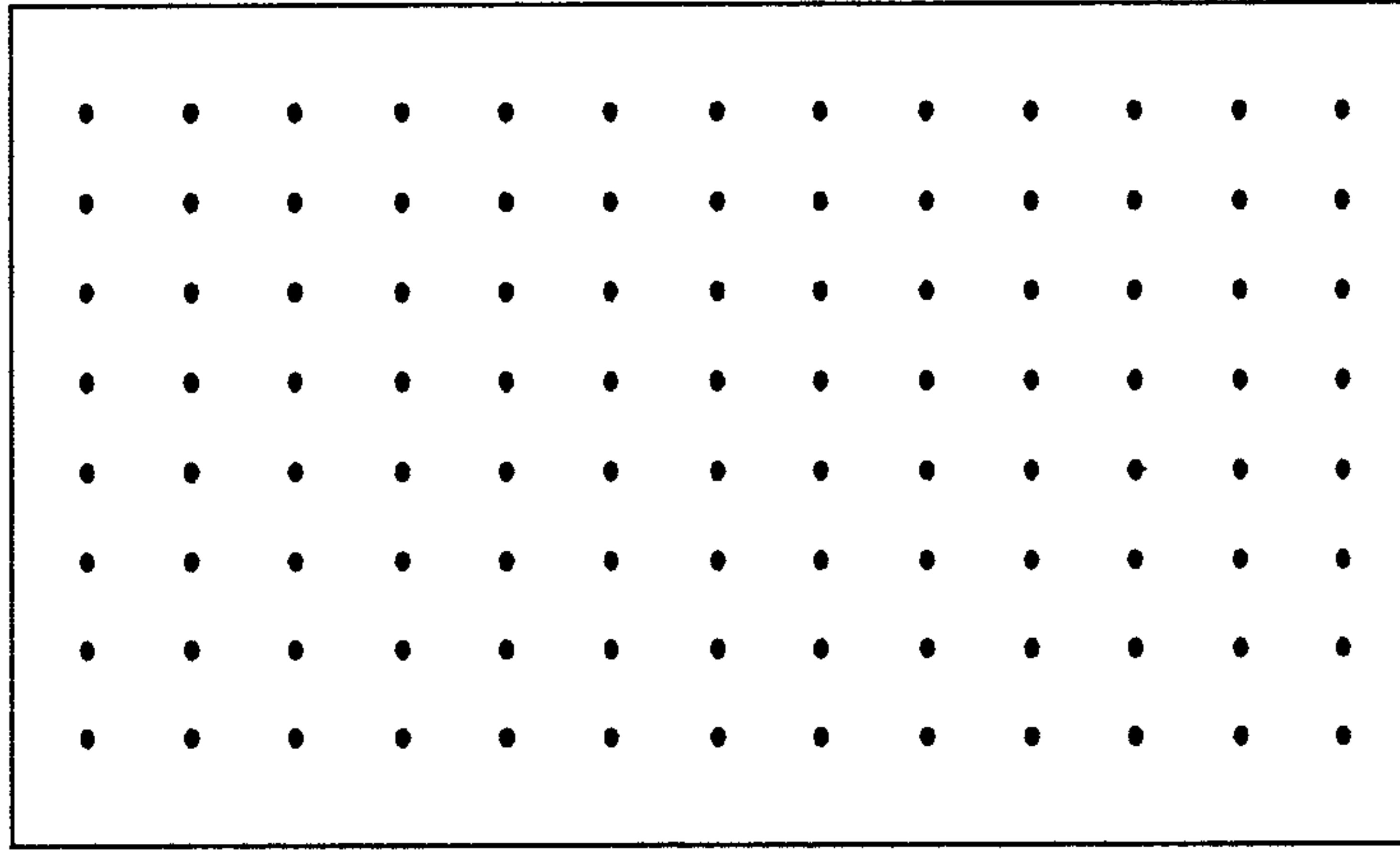


FIG. 5A

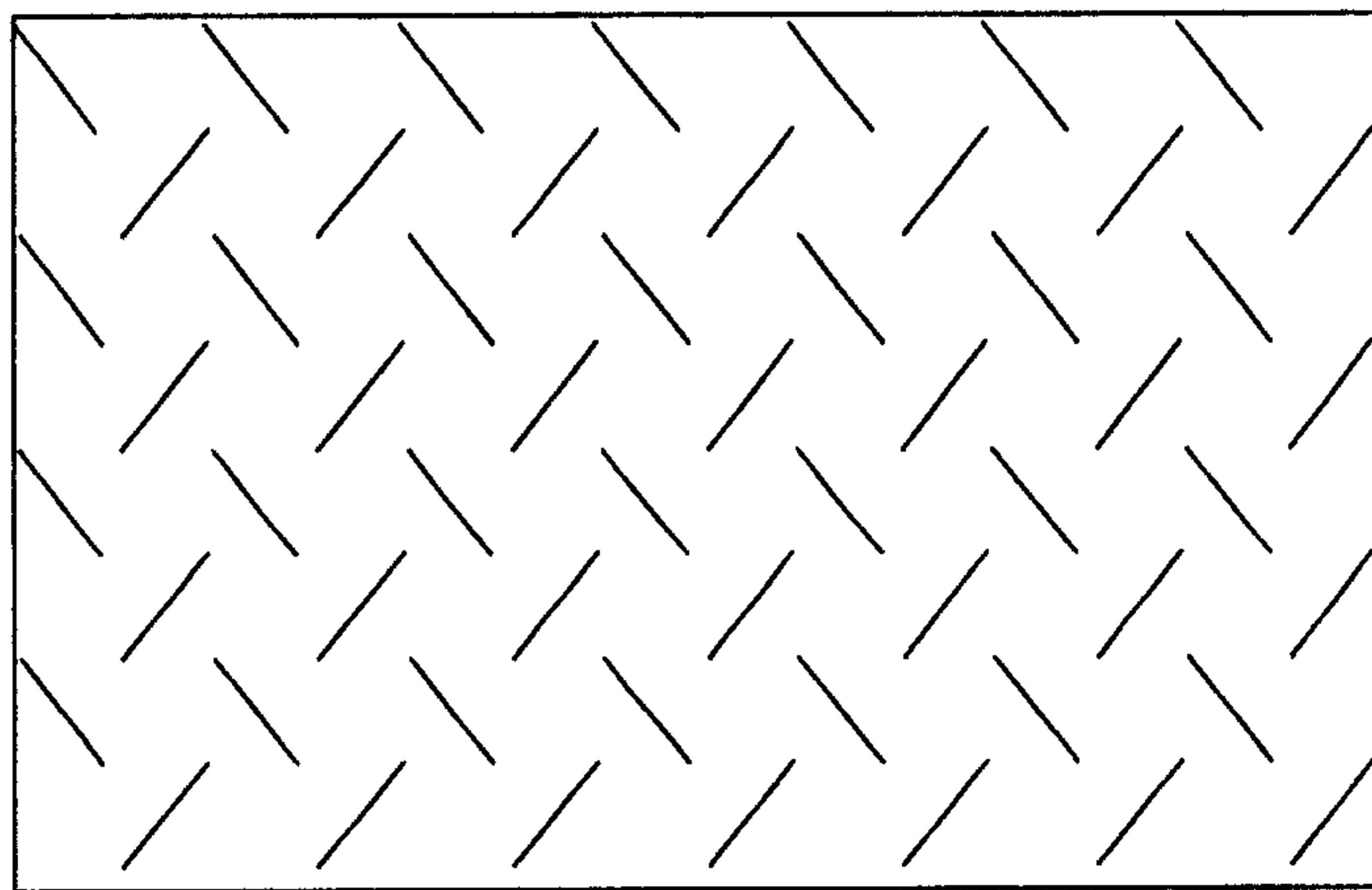


FIG. 5B